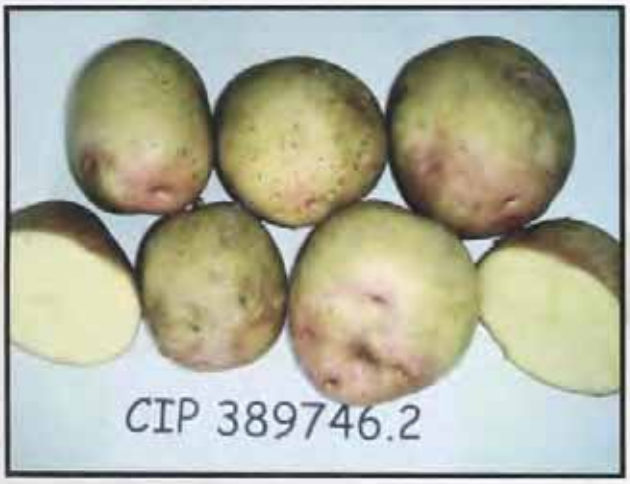
Annual Report

2010/11 (2067/68)



Nepal Agricultural Research Council

NATIONAL POTATO RESEARCH PROGRAMME

Khumaltar, Lalitpur, Nepal

2011

ANNUAL REPORT

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NEPAL AGRICULTURAL RESEARCH COUNCIL

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Cover page photographs:
Top left to right: Pipeline potato varieties CIP 389746.2 and L 235-4.
Bottom left to tight: Promising sweetpotatoes genotypes CIP 400039 and CIP 440021.

TABLE OF CONTENTS

ACKNOWLEDGMENT

The National Potato Research Programme (NPRP) gratefully acknowledges for contributions on potato research from NARC disciplinary Divisions, Regional Agriculture Research Stations, Agriculture Research Stations and National Potato Development Programme (NPDP), Khumaltar.

NPRP is thankful to the CIP, Lima, Peru and its Regional Office Delhi for providing potato clones as per demand and supporting TPS research and development in Nepal. Thanks are due to collaborative farmers who participated in the On-farm research, seed distribution and assisted in promoting new varieties and technologies.

Mr. B.M. Sakha, Senior Scientist, is highly acknowledged for his tedious effort for correction and compilation of this report. I would like to thank other Senior Scientists Mr. I.P. Gautam, Mr. J. Ghimire, Dr. S.P. Dhital and Dr. B.B. Khatri for bringing this Annual Report in this shape and all other technical and administrative staff of NPRP for their usual support and efficient works. The active involvement of Dr. Mark Sporleder, CIP Nepal in potato research team is also highly appreciable.

Mr. Buddhi Prakash Sharma
Coordinator
National Potato Research Programme
Khumaltar, Lalitpur

ACRONYMS

BS	Basic seed
CIP	International Potato Center
DAS-ELISA	Double Antibody Sandwitched - Enzyme Linked Immuno Sorbant Assay
F_1	First generation
F_1C_1	First clonal generation of TPS
FYM	Farm yard manure
GC	Ground coverage
HPS	Hybrid Potato Seed
HYV	High yielding variety
IDM	Integrated disease management
LSD	Least significant difference
NAST	Nepal Academy of Science and Technology
NPDP	National Potato Development Programme
NPRP	National Potato Research Programme
NS	Not-significant
OFSP	Orange fleshed sweet potato
PLRV	Potato Leaf Roll Virus
PTM	Potato tuber moth
PVA	Potato Virus A
PVM	Potato Virus M
PVS	Potato Virus S
PVX	Potato Virus X
PVY	Potato Virus Y
TPS	True Potato Seed
TV	Television
VDC	Village Development Committee

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important crops in Nepal. It is utilized as a major vegetable in *Terai* and mid hills and used as a vegetable and staple food in high hills. In the year of 2009/10, area under potato was reported 185,342 ha and total production 2,517,696 tons with an average productivity of 13.587 t/ha. It occupies the fifth position in area coverage, second in total production and first in productivity among the food crops grown in Nepal. It serves as a staple food in the high hills and plays a vital role in the food security in the country. Out of the total area under potato, around 17% is in the high hills and mountains, 43% in the mid-hills and 40% in *Terai* (ABPSD, 2010).

Area, production and productivity comparison of food crops in Nepal

Food crops	Area (ha)	Rank	Production (tons)	Rank	Productivity (t/ha)	Rank
Potato	185,342	V	2,517,396	II	13.437	I
Paddy	1,481,289	I	4,023,823	I	2.716	II
Maize	875,660	II	1,855,184	III	2.119	IV
Wheat	7,311,131	III	1,556,539	IV	2.129	III
Millet	268,473	IV	299,523	V	1.116	V

Source: Ministry of Agriculture and cooperatives, Agri-business Promotion and Statistics Division, (2010)

The first official attempt to improve potato production was initiated in 1962 under a joint programme between Nepal and India. During its earlier phase (1960-75), several potato farms and other infrastructures were developed in Nepal. With the increased importance of potato crop in national food production, National Potato Development Programme (NPDP) was incepted in 1972 at Kirtipur with a nationwide mandate to conduct potato research and development activities. Two potato farms, one at Jaubari, Ilam and another at Nigale, Sindhupalchowk, were established during 1980s. In 1974, NPDP was relocated to Khumaltar and linkages were established with International Potato Center (CIP) Lima, Peru, which is still effective.

During the early phase of the programme, major focus was on seed potato production through contract system. Later in 1989, a tissue culture laboratory was established with the financial and technical support of Swiss government and the contract growers were encouraged to form a cohesive group for informal production of high quality seed. Source seed as pre-basic seed is to date being supplied by the tissue culture laboratory.

In 1991, with the establishment of Nepal Agricultural Research council (NARC), NPDP was separated into two programs, National Potato Research Programme (NPRP) and Potato Development Section (PDS) with specific mandates on research and development respectively. As a national commodity research programme, NPRP is responsible since then for launching appropriate research projects on potato crop throughout the country to improve the livelihoods of Nepalese farmers.

Scenario of area and productivity of potato

Potato is grown in quite diversified climatic conditions under rain fed, partially irrigated and full irrigated conditions. With the support of irrigation projects and accessibility of inputs during the last decades (1994/95-2009/10) area of potato cultivation has been increased by 87.44%. With the little improvement on the management of disease and insect pest and

supply of quality potato seed at the farmer's field level, productivity of potato is increased by 56.3% in the fiscal year 2009/10 as compared to 1994/95 (Fig. 1).

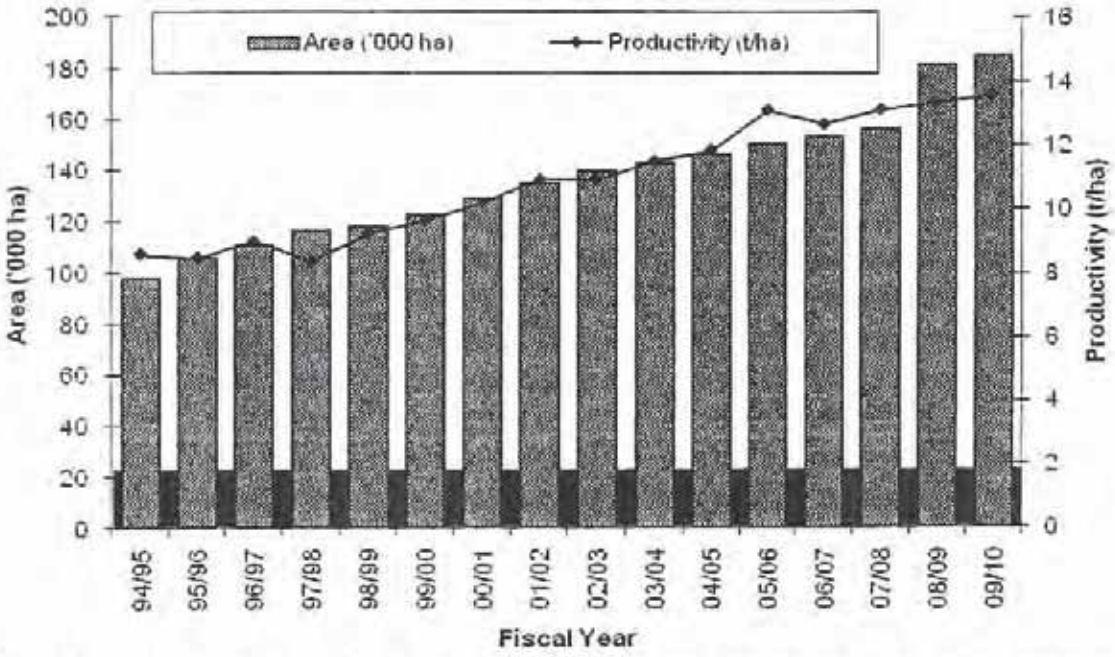

Fig.1. Area and Productivity of potato crop during the last sixteen years (1994/95 to 2009/10)

The goal, purpose, expected outputs and activities to be carried out to achieve the National goal of farmer's livelihoods improvement through this National Potato Research Programme is summarized in the Log frame (Appendix VI).

Goal: To improve the livelihoods of Nepalese farmers through root and tuber crops.

Objectives:

1. Develop appropriate technologies to increase the production and productivity of root and tuber crops for different agro-ecological zones of the country.
2. Identify and solve production constraints of seed and ware potatoes through on station and farmer's participatory multi location on-farm research.
3. Produce high quality healthy source seed of released/recommended potato varieties.
4. Establish coordination with potato stake holders in the country.
5. Develop and strengthen linkages between National and International potato R & D related organizations.
6. Identify and develop appropriate varieties for processing and storage under ordinary conditions.

To achieve above mentioned objectives following projects were conducted during the year 2010/11.

1. Genetic diversity of *Phytophthora infestans*, Metalaxyl sensitivity and cost effective management of late blight and wart diseases in Nepal
2. Coping with climate change effects on potato through variety selection and crop management
3. Sweet potato variety development for food and nutrition security

4. Weed management study in potato
5. Evaluation of organic potato production practices in the hills of Nepal
6. Variety improvement of potato for processing
7. Potato variety development and improvement for different agro-ecologies of Nepal.
8. Sustainability studies for pre-basic seed potato production
9. Pre basic and source seed production on potato
10. Evaluation of TPS families in the nursery beds and field conditions
11. Farm management project

NPRP also manages a full-fledged tissue culture laboratory for the pre-basic seed (PBS) potato production. About 100,000 to 200,000 tuberlets of different varieties are produced each year under quarantine glasshouse conditions at Khumaltar and sold to seed growers through National Potato Development Programme/DOA. PBS is also further multiplied in Horticulture Farms under NARC, and DoA for basic seed-1 production to meet the farmer's demand of their respective command areas.

CIP Peru and its Regional office Delhi are supporting for potato research in Nepal in the field of technology generation and supply of potato germplasms. Farmer's participatory researches on adaptation of TPS families have also been implemented in collaboration with CIP Regional office Delhi.

EXECUTIVE SUMMARY

1.0 Variety improvement

- Based on phenotype and yield characteristics of tested clones observed in IET Khumaltar, clones CIP 392228.66, CIP 394034.65 and CIP 397073.15 are promoted to CVT for the hills. At ARS (Hort.) Pokhara clones CIP 388676.1, CIP 225861.2 and CIP 380606.6 performed better and are promoted to CVT in terai. Since the results were not conclusive this year from ARS (Hort.) Jumla, clones CIP 392222.25, CIP 394034.65, PRP 35861.18, CIP 395192.1, CIP 397077.16, Desiree x LBr 40.7 will be retested one year more in same conditions.
- In CVT RARS, Nepalgunj, clones CIP 394003.161, CIP 393077.159 and CIP 392244.3 were found superior to other tested clones and check varieties in their phenotypic and yield performance, hence, these clones are promoted to CFFT for next year. Likewise from Tarahara, CIP 393085.5 has been promoted to CFFT. Clones CIP 394050.110 and PRP 25861.1 are promoted to CFFT from the central hills. From ARS Pakhribas, clones CIP 394050.110 and PRP 25861.1 are promoted to CFFT. Similarly, clones CIP 388764.26LB, CIP 387115.8LB, CIP 393637.10 and CIP 393233.64 are promoted to CFFT in Lumle command area.
- Clones CIP 393619.8 and CIP 392271.58 are promoted to FAT From RARS Nepalgunj, and remaining clones namely PRP 85861.11, PRP 85861.8 and CIP 392271.58 are to be repeated one year more in the CFFT. Likewise in RARS Tarahara, clone CIP 389746.2 is recommended to test for one year more in FAT, however, for the hill FATs, clones PRP 25861.11, L 235-4 and CIP 393385.39 are to be assessed one year more in different sites.
- Based on several years' on-station and on-farm performance and farmers' preferences the clones CIP 389746.2 and L 235-4 will be proposed to release as the commercial verities soon for Terai and hills, respectively.

2.0 Coping with climate change effects on potato through variety selection and crop management in Nepal

- Activities were undertaken at Hattiban Research Farm Khumaltar and RARS Parwanipur Bara. Clones CIP 391598.75, NPI 106, CIP 391011.47, CIP 392242.25, CIP 391058.35, CIP 394003.161, CIP 392243.17, PRIMICIA, CIP 378711.7, LBr 40, L235-4, CA x 27/40.7, K. SETO-1 and CIP 394007.55 were found better in rainfed conditions in Khumaltar conditions and these clones will be further assessed next year in more locations in the hills. Clones CIP 391598.75, NPI 106, CIP 391011.47, CIP 392242.25, CIP 391058.35, CIP 394003.161, CIP 392243.17, Primicia, CIP 378711.7, LBr 40, L 235-4, Cax 27/40.7, Khumal Seto-1, CIP 394007.55, K. Chipsona-2 and Ca x LBr-40.6 did well in all of the three moisture conditions.

- At RARS Parwanipur, same trial will be planted for one year more with best selected clones in 3 different moisture conditions.

3.0 Weed management study on potato

- Among the treatments tested for weed control in potato at ARS (Hort.) Malepatan Pokhara, the highest tuber yield (34.7 t/ha) was recorded in black polythene sheet mulching followed by Pendimethalin 1.0 kg a.i./ha (32.4 t/ha). Weed control efficiency was found maximum (99.5%) in Metribuzin.

- In NPRP Khumaltar at Hattiban research farm, the highest tuber yield (37.6 t/ha) was recorded in black plastic mulching followed by Metribuzin 0.75 kg a.i./ha (28.3 t/ha). Maximum weed control efficiency was (93.7%) in black plastic mulching. It is noticed from the findings that all the weed control treatments produced better yield in comparison to weedy check, both in Malepatan, Pokhara and Tikathali, Lalitpur.

- In farmer's field, both plastic mulching and Paraquat spray showed similar response to potato yield. But for weed control, Metribuzin was the best in both places.

4.0 True potato seed (TPS) research

- Evaluation TPS families for seedling tuber production in the nursery bed during 2067/67 revealed that the TPS families C96H-02.4 x C98HT-64.8 and C96H-02.4 x C99HT-2-58.1 produced the highest tuber yield (4.2 kg/plot of 7.2 m^2) in NPRP, Khumaltar. In case of RARS, Nepalgunj, the highest tuber yield (2.35 kg/plot) was recorded in the family LT 8 x TPS 13. In Jumla, the genotype 903027 produced the highest tuber yield (3.78 kg/plot).

- Evaluation of F_1C_1 tuberlets of TPS for potato production during 2067/68 revealed that both check varieties Janak Dev and Kufri Jyoti out yielded (17.8 and 15.5 kg/plot of 7.2 m^2, respectively) all tested F_1C_1 generations in NPRP, Khumaltar. However, C96H-02.4x C99HT-2-58.1 produced the highest yield (14.7 kg/plot) among the tested F_1C_1 generations. In case of RARS, Nepalgunj, the F_1C_1 generation MF II x TPS 67 and the check variety Janak Dev produced the highest yield (22.317 kg /plot). In a similar study in Tikathali, Lalitpur, Kufri Jyoti produced the highest yield (19.0 kg/plot) followed by C96-02.4 x C98HT-64.8 (yield 12.3 kg/plot). The tuber yield was maximum (7.3 kg/plot) in 903113 in the study conducted in Jumla.

5.0 Potato pathology

- Potato clones LBr-40, PRP 266264.01, PRP 276264.01, CIP-384321.15, CIP-392657.8, and PRP- 25861.1 were found resistant to late blight disease in all three agro climatic conditions inner Terai (Chitwan), Khumaltar (Mid hills) and Nigale (High hills).

- Dimethomorph (Acrobat) was found most effective against *Phytophthora infestans* under field at 0.1% spray solution and laboratory conditions at 50 ppm concentrations.

- Alternate sprays of Sectin (fenamidon 10% + mancozeb 50%) or Acrobat (dimethomorph 50%) with Uthane M-45 (mancozeb 75%) for 4 sprays at an interval of 9 days was found cost effective in managing late blight under Khumaltar field conditions.

- Krinoxyl Gold (metalaxyl 8%+ mancozeb 64%) manufactured at Nepal Krishi Rasayan, Bara, Nepal was found very less effective against late blight.

- Seed tuber treatment by dipping at 0.4% solution (4 g/l water) of Antracol (propineb 70%) for thirty min prior to planting was found effective in controlling powdery scab disease of potato at Sharadanagar, Chitwan.

- Potato clones BSUPO3, CIP-389746.2, PRP-225861.2, L235.4, CIP-384321.15, CIP-394050.110, PRP-25861.11 and CIP-393385.39 showed moderate level of resistance to wart incidence ranging 2.43 to 29 percent as compared to susceptible varieties 70-100 percent.

6.0 Organic potato production

- The combination of 'Janakdev' of potato variety and 'Kwian Thong' non chemical fertilizer increased the yield up to 90.5% more than the farmers' practices (farmers' variety and farmers fertilizes practices. i.e., application of 10 tones FYM/ha) at Lakuri Bhanjanyang, Lalitpur and Muralikhola, Kavre conditions during the spring-summer season planting. In economic term, the combination of Janakdev potato variety with 15 kg Kwian Thong/ropani gives extra income of NRs. 7,155/ropani.

- The mulching trial in Dailekh and Muralikhola, Lalitpur showed that black plastic mulch was effective for enhancing productivity in both locations. It increased 59.49% yield in Saltanda, Dailekh for winter season planting and 62.0% at Muralikhola, Kavre condition for spring-summer season planting.

- The intercropping of potato with radish followed by turnip was found profitable in Dailekh condition with 1: 1.389 cost benefit ratio in radish and 1: 1.3.61 in turnip.

- The intercropping of tomato with potato was not recommended due to low cost benefit ratio.

- Up-scaling and dissemination of these technologies is recommended for organic potato production in pocket areas.

7.0 Seed potato research

- For the efficient and rapid multiplication of plantlets under *in vitro* conditions, 2-3 single nodal explants per test tube and 10 single nodal explants per Jar were found the best plant density under *in vitro* conditions.

- In the use of natural light for incubation of *in vitro* plantlets, two weeks incubation under standard growth room (SGR) and then transferred in natural light for two weeks was found equally good with the plantlets incubated under SGR condition.

- For microtuber production, among the evaluated five conditions, transferred to darkness after 60, 70 days in light produced the highest number and fresh weight of microtuber in early and medium potato varieties, respectively.

- In the used of *in vitro* plantlets and undersized minitubers for PBS production under control condition (screen house), *in vitro* plantlets produced higher in main stem and tuber per plant, but minitubers produced the higher yield per plant with higher percentage of bigger sized minitubers.

- In the planting space of plantlets for PBS production under screen house condition, the wider the plant spacing higher the plant height, number of main stem, number of tuber and tuber yield, and vice versa. Similarly, in the case of size distribution of PBS, it was

found that wider the plant spacing higher the percentage of bigger size and lesser the smaller size of PBS.

- In the used of different size of PBS for basic seed production under farmers' field, it showed that bigger the size of PBS higher the plant height, main stem, higher the tuber and tuber yield per plant and vice versa. Similarly, in the case of size distribution of minitubers, it was found that wider the plant spacing higher the percentage of bigger size tubers and lesser the smaller size of tubers.

- In the demonstrate performance of basic seed-2 and farmer's seed for potato production in farmers' field, it was showed that there were not significant different between basic seed-1 from Khumal tar and farmer's seed in plant height, number of main stem and tuber per plant, however, tuber yield was observed higher in basic seed-1 than the farmer's seed in both of the evaluated potato cultivars Kufri Jyoti and Janak Dev. Similarly, basic seed-1 produced bigger size tuber than the farmer's seed. Similar trends were observed in both of the evaluated potato cultivars Kufri Jyoti and Janak Dev. This result indicated that basic seed-1 is better in quality than the farmer's for higher yield.

8.0 Post harvest research

- The effect of nitrogen and potassium have found positive role for production of processing grade tuber and total yield of potato. The application of 150 kg nitrogen and 60 kg potassium along with 100 kg phosphorus and 20 t FYM /ha is recommended for production of processing grade tubers and higher yield of potato in Khumaltar and similar soil and environment condition.

- Potato can be safely stored in ambient room temperature (28±0.6°C temperature and 88-89% RH) under dark with minimum storage losses (15%) up to 90 days. These potatoes were found suitable for processing due to increase in dry matter, specific gravity and decrease the amount of reducing sugars. The weight loss percentage ranges from 10.73 to15.73% at 90 days stored at ambient room temperature. The dry matter content increased from 16.785 to 18.15%, reducing sugars decreased from 167.06 to 145.2 mg/ 100 fresh weight and specific gravity increased from 1.0637 to 1.0717 after 90 days storage.

- There was 7% weight loss of cold stored potato for 120 days and it was increased up to 9.63% after 15 days reconditioning in ordinary condition. There was only mean increase of 15.76% reducing sugars after cold storage. It could be due to high reducing sugars before storage of immature tubers due to continuing raining and stagnation of water in potato field for 3-4 days.

9.0 Seed potato production

- Total of 22,920 *in vitro* plantlets of eleven cultivars in autumn season, total 13,330 *in vitro* plantlets of ten cultivars in spring season to the glasshouse/screenhouse and total 4,450 *in vitro* plantlets of seven cultivars were supplied to Nala, Kavre farmers' group for autumn and spring season planting.

- During autumn 2010, total 33,308 PBS of eleven cultivars (Cardinal, Desiree, Janak Dev, Khumal Seto-1, Kufri Jyoti, Kufri Sinduri, Khumal Rato-2, IPY-8, Khumal Laxmi, TPS 67 and MF-II) were produced.

- During spring 2011, total 58,358 of ten cultivars (Cardinal, Desiree, Janak Dev, Khumal Seto-1, Kufri Jyoti, IPY-8, Khumal Laxmi, TPS 7, TPS 67 and MF-II) were produced and total 91,666 PBS were produced during the F.Y. 2010/11.

- Under basic seed production program, total 3,045 kg seeds of Cardinal, Desiree, Janak Dev, Khumal Rato-2, Khumal Seto-1, Kufri Jyoti, NPI-106, IPY-8 and Khumal Laxmi have been produced at Hattiban Farm for further seed multiplication.

- For the fiscal year 2010/11, the following rate was fixed for per unit of PBS : Rs. 6.00 for larger than 5 g sized minituber, Rs. 5.50 for 1-5 g sized, Rs. 3.00 for 0.5-1 g sized, Rs. 0.75 for 0.25-0.50 g and Rs. 0.25 for smaller than 0.25 g sized.

- Total of 98 potato germplasms have been maintained under *in vitro* condition at NPRP laboratory.

10.0 Sweet potato variety improvement

- Under germplasm collection, maintenance and evaluation activity, total 21 sweet potato clones from CIP and four local germplasm from different parts of Nepal were collected and maintained under *in vitro* and *in vivo* conditions at Khumaltar.

- In the initial evaluation trial (IET), at RARS, Tarahara, CIP clone of sweet potato 440039 produced the highest yield (826 g/plant) followed by 440328 (527 g/plot) and at ARS (Hort.) Pokhara, the highest yield was produced by the clone 400039 (636 g/plant) followed by 440015 and 440021. Skin and flesh color of the tubers of all CIP clones were found to be light orange to dark orange.

आ.व. २०६७/६८ को उपलब्धि सारांशमा

१.० आलुको जातिय उत्थान अध्ययन परिक्षण

- आ.व. २०६७/६८ मा खुमलटारमा लगाइएको प्रारम्भिक जातिय परिक्षण (IET) मा CIP 392228.66, CIP 394034.62 र CIP 397073.15 नामक आलुका जातहरु उत्कृष्ट देखिए । त्यसैगरी कृषि अनुसन्धान केन्द्र, (वागवानी) जुम्लामा CIP 39222.25, CIP 394034.65, PRP 35861.18, CIP 395192.1 आदि जातहरु फेरी एकवर्ष दोहोऱ्याएर परिक्षण गर्नुपर्ने देखिन्छ । कृषि अनुसन्धान केन्द्र (वागवानी) पोखरामा लगाइएको प्रारम्भिक परिक्षणमा CIP 388676.1, CIP 225861 र CIP 380606.6 जातहरुले राम्रो नतिजा दिए । उत्कृष्ट देखिएका खुमलटारका र पोखराका यिनी जातहरुलाई समन्वयात्मक जातिय परिक्षण (Coordinated Varietal Trial) मा आगामी वर्ष लगिनेछ ।

- समन्वयात्मक जातिय परिक्षण अर्थात CVT अन्तरगत नेपालगञ्जमा उत्कृष्ट देखिएका CIP 394003.161, CIP 393077.159 र CIP 392244.3 नामका आलुका जातहरुलाई आगामी वर्ष कृषककको खेतवारीमा परिक्षण गरिने छ । त्यस्तै क्षेत्रिय कृषि अनुसन्धान केन्द्र, तरहराबाट CIP 393085.5 नामको जातलाई पनि कृषकको खेतवारीमा परिक्षण गरिनेछ । CIP 394050.110 र PRP 28661.1 जातहरु पहाडमा राम्रा देखिएका छन् । राष्ट्रिय आलुवाली अनुसन्धान कार्यक्रम, खुमलटारले विकास गरेको आलुको जातिय उत्थान अवधारणा अनुसार IET मा उत्कृष्ठ जातहरुलाई CVT मा र CVT मा उत्कृष्ठ पाइएका जातहरुलाई CFFT अर्थात कृषकको खेतवारीमा परिक्षणमा पुऱ्याइने परियोजनामा सहभागी कृषकहरु र प्राविधिक वैज्ञानिकहरुको मुल्याङ्कनका आधारमा सर्वोत्कृष्ठ मानिएका जातहरु (CIP 389746.2 र L235-4) लाई व्यावसायिक खेतीका लागि आ. व. २०६८ ६९ मा उन्मोचन प्रकृयामा समावेश गरिनेछ भने जातीय अनुसन्धान कार्यलाई निरन्तरता दिइने छ ।

२.० बदलिँदो हावापानी र वातावरणको असर सहन सक्ने आलुका जातहरुको पहिचान र बाली उत्पादन प्रविधि विकास सम्बन्धि अध्ययन परिक्षण

- आ. व. २०६७/६८ मा यस परियोजना अन्तर्गतका दुईवटा कृयाकलाप मध्ये एक राष्ट्रिय आलुवाली अनुसन्धान कार्यक्रम खुमलटारमा र अर्को क्षेत्रीय कृषि अनुसन्धान केन्द्र, परवानीपुर, वारामा संचालित गरिएका थिए । खुमलटारमा संचालित कृयाकलापमा गत दुई वर्षको आंकडाका आधारमा आलुका जातहरु CIP 391598.75, NPI 106, CIP 391011.47, CIP 392242.25, CIP 391058.35, CIP 394006.161, CIP 392243.17, Primicia, CIP 37871.7, LBr 40, L235-4, Ca x 27/40, खुमल सेतो-१ र CIP 394007.55 आकाशे पानी मात्रको अवस्था अर्थात Rainfed conditions मा पनि राम्रो उत्पादन दिन सक्ने देखिए । CIP 391598.75, NPI-106, CIP 39101.47, CIP 392242.25, CIP 391058.35, CIP 394003.161, CIP 392243.17, Primica, CIP 37871.7, LBr 40, L235-4, Ca x 27/40, Khumal Seto-1, CIP 394007.55, K. Chipsona र Ca x LBR 40.6 जातहरु असिंचित, सिंचित र छापो हालेको लगायत तिनवटै अवस्थमा सन्तोषजजक पाईए ।

- यस परियोजनाबाट निष्कर्षमा पुग्न क्षेत्रिय कृषि अनुसन्धान केन्द्र, परवानीपुरमा यहि सेट अर्को वर्ष पनि लगायर हेर्नुपर्ने देखिन्छ ।

३.० आलुवालीमा झार नियन्त्रण सम्बन्धि अध्ययन परिक्षण

- कृषि अनुसन्धान केन्द्र (वागवानी), मालेपाटन, पोखरामा गरिएको परिक्षणको नतिजा अनुसार आलुको सवभन्दा बढी उत्पादन (३४.७ टन/हेक्टर) कालो प्लाष्टिकको छापो हालेको प्लटमा पाइयो भने

झारनाषक विषादी पेन्डिमिथालिन १ के.जी. हेक्टर प्रयोग गरेको प्लटबाट दोश्रो बढी उत्पादन (३२.४ ट/हे.) भएको पाइयो। सबैभन्दा बढी (९९.५%) झार नियन्त्रण क्षमता मेट्रिब्यूजिनमा पाइएको छ।

- राष्ट्रिय आलुबाली अनुसन्धान कार्यक्रम, खुमलटार, ललितपुरमा गरिएको अर्को परिक्षणमा आलुको सबभन्दा बढी उत्पादन (३७.६ ट/हे। कालो प्लाष्टिकले छापो हालेकै प्लटमा पाइयो। मेट्रिब्यूजिन ०.७५ के.जी हे. छरेको प्लटबाट दोश्रो बढी उत्पादन (२८.३ टन हे.) भएको पाइयो। सबैभन्दा बढी (९३.७%) झार नियन्त्रण क्षमता भने कालो प्लाष्टिकको छापो प्रयोगमा देखियो। पोखरा तथा ललितपुर दुवै क्षेत्रमा गरिएको परिक्षणहरुमा सबै झार नियन्त्रण विधिहरुले झार नियन्त्रण नै नगरिएको प्लटहरु भन्दा राम्रो उत्पादन दिएको भेट्टिएको छ।

- कृषकहरुको खेतमा गरिएको अर्को परिक्षणमा कालो प्लाष्टिकको छापो तथा पाराक्वेट प्रयोगले लगभग समान स्तरमा आलुको उत्पादन बढाएको देखिएको छ। झार नियन्त्रण क्षमताको दृष्टिले मेट्रिब्यूजिन उत्कृष्ट ठहरिएको छ।

४.० टि.पि.एस. जातीय अध्ययन परिक्षण

- आ.व. २०६७ ६८ मा नर्सरी ब्याडमा सिडलिङ्ग ट्यूबर उत्पादनको लागि गरिएको टि.पि.एस. परिवारहरुको परिक्षणको नतिजा अनुसार खुमलटारमा टि.पि.एस परिवारहरु C96H-02.4 x C98HT-64.8 र C96H-02.4x C99HT-2-58.1 ले सबभन्दा बढी आलु उत्पादन (४.२ के.जी ७.२ व.मी.) दिएको पाइयो। त्यस्तै नेपालगञ्ज र जुम्लामा गरिएको परिक्षणहरुमा LT 8 x TPS 13 र ९०३०२७ ले सबभन्दा बढी आलु (क्रमशः २.३५ के.जी. र ३.७८ के.जी ७.२ व.मी.) उत्पादन गरेको पाइएको छ।

- आलु उत्पादनको लागि आ.व. २०६७ ६८ मा नै गरिएको टि.पि.एस. परिवारको पहिलो पुस्ताहरुको अर्को परिक्षणमा C96H-02.4 x C99HT-2-58.1) ले जनकदेव र कुफ्रि ज्योति (क्रमशः १७.८ र १५.५ के.जी प्लट) बाहेक सबभन्दा बढी उत्पादन (१४.७ के.जी प्लट) दिएको पाइयो। नेपालगञ्जमा गरिएको सोही परिक्षणमा MF II x TPS 67 र जनकदेवले सबभन्दा बढी (२२.३ के.जी प्लट) उत्पादन दियो। टिकाथली, ललितपुरमा गरिएको परिक्षणमा C96-02.4 x C98HT-64.8 ले कुफ्रि ज्योति (१९.० के.जी प्लट) पछि सबभन्दा बढी (१२.३ के.जी प्लट) आलु उत्पादन गरेको देखियो। जुम्लामा ९०३११३ जातले सबभन्दा बढी आलु उत्पादन (७.३ के.जी प्लट) दिएको पाइयो।

५.० आलुबालीमा लाग्ने डढुवारोग सम्बन्धि अध्ययन परिक्षण

- तराइ-भित्रि मधेस, मध्यपहाड तथा उच्चपहाडको हावापानीमा गरिएको परिक्षणमा आलुका यी जातहरु LB-40, PRP-266264.01, PRP-276264.01, CIP-384321.15, CIP-392657.8 र PRP-25861.1 डढुवारोग अवरोधी पाइयो।
- आलुको डढुवारोग रोकथामका लागि एक्रोब्याट (डाइमेथोमर्फ ५०%), ०.१% का दरले ९ दिनको अन्तरमा चार पटक छर्दा प्रभावकारी पाईयो भने प्रयोगशालामा गरिएको परिक्षणमा न्यूनतम मात्रा (५० पि.पि.एम.) मा पनि डढुवारोगको कारक ढुसीको वृद्धि पूर्ण रुपले रोकिएको पाईयो।
- खुमलटारको हावापानीमा एक्रोब्याट (डाइमेथोमर्फ ५०%) वा सेक्टीन फेनामिडन १०% + म्यान्कोजेब ५०%) दुईपटक र यूथेन एम-४५ (म्यान्कोजेब ७५%) दुईपटक एक पछि अर्को गरि ९ दिनको अन्तरमा चार पटक छर्दा कम लागतमा आलुको डढुवा रोग व्यवस्थापन गर्न सकिने देखियो।

- नेपाल कृषि रसायन, वाराको उत्पादन क्रिनोक्सील गोल्ड (मेटालाक्सील ८% + म्यान्कोजेब ६४%) आलुको डढुवा रोग व्यवस्थापनका लागि ज्यादै कम प्रभावकारी पाइयो ।
- शारदानगर-५, चितवनमा गरिएको प्रारम्भिक परिक्षणमा, एन्ट्राकोल (प्रोपिनेब ७०%) को ०.४% को घोल (४ ग्रा/लि. पानी) मा ३० मिनट डुबाई उपचार गरेको बीउ रोप्दा आलुको धुले दाद (Powdery scab) रोगको रोकथाम हुनसक्ने देखियो ।
- निगाले (२४६० मि.) मा ऐंजेरु रोग (wart) संक्रमित माटोमा रोपिएका आलुका विभिन्न जातहरु मध्ये $BSUPO_3$, CIP-389746.2, PRP-225861.2, L-235.4, CIP-384321.15, CIP-394050.110, PRP-25861.11 र CIP-393385.39 जातहरु, रोगग्राह्य जातहरु (७०-१००% संक्रमण) को तुलनामा मध्यम ऐंजेरु अवरोधी (२.४३-२९% संक्रमण) पाइए ।

६.० प्रांगारिक आलु उत्पादन अध्ययन परिक्षण

- ललितपुर जिल्लाको लाकुरी भञ्ज्याङ्गमा गत: तिनवर्षसम्म विभिन्न आलुका जातसँग उच्च उत्पादन दिनसक्ने उपयुक्त प्रांगारिक मल र जातको छनौट गर्दा जनकदेव आलुमा क्विनथोङ्ग मल प्रयोग गर्दा उत्पादनमा ९०.५ प्रतिशतसम्म र खुद आम्दानीमा रु. ७,१५५।- प्रति रोपनी कृषकको जात र मलखादको मात्रा भन्दा बढी पाईयो ।
- दैलेख जिल्लाको साल्टडा (वँसीक्षेत्र) र काभ्रेको मुरलीखोला (मध्यपहाड) मा विगत ३ वर्ष गरिएको छापो परिक्षणको नतिजा अनुसार कालो प्लाष्टिको छापो दिँदा छापो नदिएको आलु भन्दा दैलेखमा ५९.६ र काभ्रेमा ६२.० प्रतिशत उत्पादन वृद्धि भएको पाईयो ।
- दैलेखमा गरिएको आलुवालीमा आधारित वाली प्रणालीको नतिजा अनुसार आलुसँग मूला तथा सगलम लगाउँदा बढी फाईदा देखियो । खुद आम्दानी आलुसँग गोलभेंडा लगाउँदा पाइएता पनि गोलभेंडा खेती गर्दा बढी लागत लाग्ने हुँदा फाईदा देखिएन । आलुसँग मूला तथा सलगम लगाउँदा खर्च र आम्दानीको अनुपात १:३.८९ र १:३.६१ पाईयो भने आलुसँग गोलभेंडा लगाउँदा १:१.९२ मात्र पाईयो ।
- अर्गानिक आलु उत्पादन प्रविधिको व्यापक विस्तारको लागि तिन वर्षको परिक्षणको नतिजा बुकलेटमा प्रकाशित गरी १,००० प्रति विभिन्न जिल्ला तथा अनुसन्धान केन्द्रमा वितरण गरियो। यसको अलावा निजिस्तरबाट पनि राष्ट्रिय आलुवाली अनुसन्धान कार्यक्रमको स्विकृतिमा १००० प्रति बुकलेट प्रकाशन गरि वितरण गरियो ।

७.० बीउ आलु अध्ययन परिक्षण

- प्रयोगशालाभित्र द्रुत प्रशारणको लागि प्रति टेष्टटयूव २-३ र प्रतिबोतल १० एकल आख्ले टुक्रा राखि प्रशारण गर्नु राम्रो मानिन्छ ।
- प्राकृतिक प्रकाशको प्रयोग सम्बन्धमा प्रथम दुई हप्ता Stantard growth room र बाँकी दुई हप्ता प्रयोगशाला भित्रै तर सूर्यको राम्रो प्रकाश पुग्ने ठाउँमा राख्नाले विरुवाको बृद्धि र विकास राम्रो भएको पाइयो ।
- प्रयोगशालाभित्र शुक्ष्म बीउ आलु उत्पादनका लागि प्रथमत: ६०-७० दिन स्टान्डर्ड प्रकाश भएको कोठामा र त्यसपछि बाँकी दुई महिना अँध्यारो कोठामा स्थानान्तर गर्नाले धेरै संख्या र ठूलो दाना उत्पादन हुने पाइयो ।
- पुन: प्रयोग गरेको minituber ले भन्दा in vitro विरुवाले प्रति बोट डाँठ संख्या र आलु दाना बढि दिने र minituber ले ठूलो दाना र कुल उत्पादन बढि दिने अनुसन्धानबाट पत्ता लागेको छ ।
- पूर्व-मूल बीउ आलु (PBS) उत्पादनमा रोप्ने दुरी सम्बन्धमा दुरी बढि भएका विरुवा अग्लो हुने, प्रति बोटमा मूल डाँठको सख्या बढि हुने र उत्पादन पनि बढि हुने देखियो भने कम दुरीमा रोप्नाले यी सबै कुरामा कम देखियो ।

- मूल बीउ उत्पादनमा PBS को साइजको असर सम्बन्धमा अध्ययन गर्दा PBS बीउ ठूलो रोपेमा बिरुवाको वृद्धि बढि, मूल डाँठको संख्या बढि, प्रति बोट आलुदाना बढि र प्रति बोट उत्पादन पनि बढि हुने देखियो भने सानो बीउ रोप्नाले त्यसको बिपरित परिणाम देखापर्‍यो ।
- कृषकको खेतमा बेसिक बीउ आलु र कृषकको आफ्नै बीउ आलु रोपी उत्पादनमा तुलना गर्दा बोटको वृद्धि आदि कुरामा खासै फरक नदेखिएतापनि उत्पादनमा भने कृषकको बीउले भन्दा बेसिक बीउ आलुले नै उत्पादन बढि दिएको पाइयो ।

८.० उत्पादनपरोन्त प्रविधि अध्ययन परिक्षण

- विगत वर्षमा परिक्षण गरिएका २२ विभिन्न आलुका जातहरु मध्ये नौवटा जातको पुन: परिक्षण गर्दा कुफ्री ज्योति र पि.आर.पी. २५८६१.१ भन्ने जात बढी उत्पादन दिने देखिए । तर प्रशोधनको लागि कुफ्री ज्योति जात उपयुक्त देखिएन भने पि.आर.पी. २५८६१.१ भन्ने जात कुफ्री चिप्सोना-२ भन्दा पनि राम्रो देखियो । यस जातमा अन्य जात भन्दा सुख्खा पदार्थ बढी हुने, यसबाट बनाईएको चिप्स धेरै राम्रो हुने प्रारम्भिक अनुसन्धानबाट थाहा भएको छ ।
- भण्डारण परिक्षणको नतिजा अनुसार कुफ्री ज्योति आलुलाई खुमलटार जस्तो हावापानीमा ९० दिनसम्म अँध्यारो कोठामा भण्डारण गर्दा जम्मा १५ प्रतिशतसम्म नोक्सान हुने देखियो । यसरी भण्डारण गरिएका आलु शितभण्डारमा भण्डारण गरिएका आलुभन्दा चिप्स प्रशोधनका लागि बढी उपयुक्त देखियो ।
- आलुको बढी उत्पादन र गुणस्तरीय चिप्स प्रशोधनको लागि खुमलटारमा गरिएको परिक्षण अनुसार प्रतिहेक्टर १५०:१००:३० के.जी. नाइट्रोजन, फस्फोरस र पोटास मलको साथै २० टन हे. कम्पोष्ट मल राख्दा बढी फाईदाजनक देखियो ।

९.० बीउ आलु उत्पादन

- शरद सिजनमा २२,९२० र हिउँदे सिजनमा १३,३३० गरि जम्मा ३६,२५० बिरुवाहरु तथा नाला कृषक समूहलाई ४,४५० बिरुवाहरु प्रयोगशालामा उत्पादन भयो ।
- पूर्व-मूल बीउ आलु (PBS) उत्पादन सम्बन्धमा शरद सिजनमा ३३,३०८ दाना र हिउँदे सिजनमा ५८,३५८ दाना गरि जम्मा ९१,६६६दाना PBS उत्पादन भयो ।
- PBS को मूल्य निर्धारण सम्बन्धमा: सबैभन्दा ठूलाको (५ ग्राम) रु. ६।००, १-५ ग्राम साइजको रु. ५।५०, ०.५-१ ग्राम साइजको रु. ३.००, ०.२५-०.५ ग्राम साइजको रु. ०।७५ र सबैभन्दा सानो ०.२५ ग्रामको रु. ०।२५ प्रति दाना मूल्य कायम भयो ।
- आ.व. २०६७६८ मा जम्मा ३,०४५ केजी मूल बीउ हात्तिवन फार्ममा उत्पादन भयो ।

१०.० सखरखण्डको जातिय विकास अध्ययन परिक्षण

- यस कार्यक्रम अन्तर्गत सि.आइ.पि. पेरुवाट २१ जात र स्थानिय चार जात गरि जम्मा २५ जातहरुको सखरखण्ड संकलन गरि अध्ययन, संरक्षण र वृद्धि गर्ने कार्य खुमलटारमा भइरहेको छ ।
- सखरखण्डको जातिय विकास कार्यक्रम अन्तर्गत क्षेत्रिय कृषि अनुसन्धान केन्द्र तरहरा, खुमलटार र कृ.अ.के., पोखरामा माथि उल्लेखित २४ वटा जातहरु समावेश गरि IET अन्तर्गत दोश्रो वर्षमा अध्ययन अनुसन्धान भइरहेको छ ।

1.0 VARIETAL IMPROVEMENT/DEVELOPMENT

National Potato Research Programme (NPRP) is mandated to conduct various research activities on potato crop throughout the country and varietal research is one of them. After several years of on-station and on-farm studies suitable varieties are selected and recommended for commercial cultivation for different agro-ecological zones. For this purpose, variety improvement through a conventional breeding method at Hattiban Research Farm and varietal evaluation trials throughout the country were continued in the research stations and in farmers' fields during the year 2010/011 also. The material and methods applied and results obtained from different activities of this project are as following:

1.1 BREEDING WORKS

Some late blight disease resistant potato clones received from International Potato Center (CIP), Lima Peru and clones available with NPRP were used as the progenitors for this purpose. Crossing work was undertaken in the summer season, using clones LBr 40, LBr 20, MS 42-3 and Janak Dev as female and Kufri Jyoti, Desiree and Khumal Rato-2 as male progenitors. True seeds produced in the previous years from crossing were grown in wooden trays and seedlings emerged were transplanted directly in the fields during rainy season to screen them against late blight disease and for their other vegetative and yield characters. True seeds obtained this year are kept in desiccator for future use. In the fields, vigorous, tuber bearing and late blight resistant genotypes were selected from segregating population and then grown in 1st field nursery. Selected plants will be again grown in 2nd field nursery for observation and tuber production. This is an on-going procedure and genotypes selected from 2nd field nursery will be introduced in varietal evaluation scheme of the programme.

1.2 GERMPLASM EVALUATION

It has been one of the major research activities of NPRP since the establishment of NARC. Germplasms are sourced mainly from International Potato Center (CIP), Lima, Peru and NPRP's own source. Newly introduced germplasm are evaluated in Potato Research Farm at Hattiban, Khumaltar and at different Agriculture Research Stations throughout the country with the objective of identifying suitable varieties for the diverse agro-ecological zones with due consideration of both farmers and consumers preference on plant appearance, disease resistance and tuber yield, and their marketability. Eight different potato varieties are released so far for commercial cultivation, clones L-235-4 and CIP 389746.2 are in pipeline and several others are in evaluation scheme.

NPRP follows a varietal evaluation scheme and under this scheme newly received germplasm are first multiplied in in-vitro and then under screen-house conditions, followed by preliminary evaluation in observation nurseries (PON) under field conditions at Khumaltar and ARS (Hort.) Pokhara. The best-performing materials are bulked at both locations and the lines promoted from this stage are further tested as Initial Evaluation Trials (IETs) and later as coordinated varietal trials (CVTs) in different collaborative farms and stations throughout the country. Most promising lines from CVT are further promoted to coordinated farmers' field trials (CFFTs) carried out at out-reach research sites of different farms and research stations. In all the on-station trials, performance of the tested clones is recorded and in on-farm trials farmer's preferences are additionally recorded. After additional two or more than two years' of farmers' acceptance test (FATs) the most preferred clones are recommended for commercial cultivation in respective ecological domain and then a proposal is submitted to

variety releasing committee for releasing the clone as a variety. In the mean time, the best performing clones are kept in the process of cleaning in the laboratory and seed multiplication scheme of NPRP.

1.2.1 INITIAL EVALUATION TRIALS (IETs)

Introduction

IET is the first step of variety screening for yield potentiality and adaptability in different agro-ecological zones and resistant to the major diseases (mainly late blight) and pest response. During the year 2067/68 (2010/11), IETs were planted at Hattiban Research Farm, Khumaltar, ARS (Hort.) Rajikot, Jumla and another set at ARS (Hort.) Pokhara, as the representative sites from summer main season and winter main season, respectively.

Materials and Methods

At NPRP Khumaltar, 22 different clones were assessed for their vegetative and yield characteristics. Similarly, 18 clones were tested at ARS (Hort.) Pokhara and 19 clones at ARS (Hort.) Jumla against check varieties Desiree and Kufri Jyoti at Khumaltar, Desiree and Kufri Sindhuri at ARS (Hort.) Pokhara and varieties Desiree, Kufri Jyoti and Jumli Local at Jumla. In all of the locations, trials were laid out in randomized complete block design (RCBD) with three replications.

The plots were fertilized @100:100:60 kg NPK together with 20 tons of compost per hectare as basal dose. Well-sprouted tubers ranging from 20 to 50 gm sizes were planted in a rod-row design with 60 x 25 cm row to row and plant to plant spacing.

Following data were gathered from all of the 3 sets of trials:

a. Growth parameters

1. Emergence (%) at 15 and 30 days after planting in winter season trial and 30 and 45 days in summer season trials
2. Plant height (average of 5 plants/clone)
3. Plant uniformity (after 6 weeks of planting at 1-5 scale)
4. Plant vigor (after 6 weeks of planting at 1-5 scale)
5. Number of main stems per plant (average of 5 plants), and
6. Late blight rating (using 1-9 scale)

b. Yield and Yield parameters

1. Number of plants harvested
2. Number and weight fraction of the tubers in three grades (small, medium and large)
3. Total number and weight of tubers/plot
4. Yield tons per hectare
5. Color, shapes and eye depth of the tubers

Some of the clones included in the trials were from last year's entries and remaining was new introduction.

Table 1.1. The list of clones included in IETs 2010/11

SN	NPR,P Khumaltar	ARS (Hort.), Pokhara	ARS (Hort.), Jumla
1	CIP383085.5	388676.1	MS 35.9
2	CIP392271.58	225861.2	Caxlbr40-11
3	PRP55861.8	15860.8	392228.66
4	CIP394007.55	393077.16	302271.58
5	CIP391004.18	377957.5	Cax27/40.5
6	CIP392228.66	Ms 42.3	Prp 55861.7
7	PRP85861.6	380606.6	393574.61
8	CIP393574.72b	396286.6	391061.73
9	PRP225861.2	399101.1	55861.6
10	CIP394034.65	397012.22	55861.8
11	CIP388676.1	396311.1	Gogu valley
12	CIP377957.5	397073.15	392222.25
13	CIP396311.1	394038.105	394034.65
14	CIP397073.15	35861.13	35861.18
15	CIP395195.7	394611.112	395192.1
16	CIP397077.16	395195.7	397077.16
17	CIP395192.1	ms52.2105	Des x LBr40.7
18	CIP394611.112	L 235-4	392244.3
19	CIP3960663.8	Desiree (ch)	W. valley
20	CIP393248.55	K. Sindhuri (ch)	Jumli local (ch)
21	CIP384866.5		Desiree (ch)
22	PRP15860.8		K Jyoti (ch)
23	Desiree (ch)		
24	K. Jyoti (ch)		

Results and Discussion

At *NPRP Khumaltar*, IET results revealed that plant emergence at 30 DAP was the highest (96%) in clone CIP 388676.1 and lowest (4%) in CIP 393574.72B (Table 1.2). At 45 DAP the emergence rate increased considerably ranging to 79 to 100 per cent. Percentage ground cover at first observation was the highest (60) on clones PRP 85861.6, CIP 3960663.8 and variety Kufri Jyoti and lowest (23) in CIP 397073.15, whereas in second observation, clone CIP 3960663.8 was highest (68%) followed by PRP 85861.6 and PRP 55861.8 (67%). Plant vigor ranged from 2 to 5 in 1 to 5 scales, measuring highest (5.0) in the clones CIP 384866.5, CIP 3960663.8 and Kufri Jyoti, respectively.

Plant uniformity as measured in 1 to 5 scales differed considerably between tested clones; however, plants of clone CIP 396063.8 and Kufri Jyoti were observed highly uniform (5.0) and the rest of the clones were in between. Average numbers of main stems per plant was counted the highest (4.9) in clones CIP 388676.1followed by CIP 396311.1 (4.2) and CIP 396063.8 (4.1), respectively. Plants of clone CIP 384866.5 were measured tallest (51.4 cm) in plant height followed by clone PRP 55861.8 (51.3), whereas in other clones it remained between of 21.6 to 46.3 cm.

Table 1.2. Phenotypic and yield performance of tested clones in IET at Khumaltar, 2067/68

Clones	Emergence (%)		Grnd cover (%)	Uniformity	Stem/plnt (#)	Plant height (cm)	Tuber size distributions (# & % wt)						Total/plot		Yield (t/ha)
							US		SS		OS				
	I	II					#	wt	#	Wt	#	Wt	#	Wt kg	
CIP383085.5	48	90	52	3	3.3	26.4	53	15	67	62	9	22	129	3.9	15.3
CIP392271.58	37	98	42	3	2.9	30.1	27	11	51	67	7	23	85	3.3	11.0
PRP55861.8	67	100	67	4	3.0	51.3	56	10	87	68	13	23	156	5.5	10.0
CIP394007.55	21	94	53	3	2.7	36.7	45	10	56	69	5	21	106	3.1	10.0
CIP391004.18	59	98	52	3	3.4	30.6	77	10	74	84	3	7	122	3.4	9.7
CIP392228.66	84	100	42	3	3.9	21.6	116	24	78	73	1	3	195	2.9	24.3
PRP85861.6	77	100	67	4	3.1	34	66	9	117	71	13	20	196	6.1	9.0
CIP393574.72b	4	88	48	3	2.5	42.5	30	9	47	72	6	20	83	2.8	8.7
PRP225861.2	67	90	48	4	3.3	40.5	74	10	81	61	14	29	169	5.2	10.3
CIP394034.65	86	90	47	3	2.9	28.1	135	24	88	72	2	4	225	3.7	24.3
CIP388676.1	96	100	58	4	4.9	26.7	98	14	116	77	6	10	220	5.8	13.7
CIP377957.5	88	100	45	3	3.5	26.0	107	21	96	76	1	3	204	3.7	20.7
CIP396311.1	61	96	63	4	4.2	34.2	84	10	101	65	15	26	200	5.6	9.7
CIP397073.15	48	96	27	3	3.0	29.2	75	30	38	64	2	6	115	2.2	29.7
CIP395195.7	29	79	38	3	2.4	38.6	38	8	69	72	7	19	114	3.8	8.3
CIP397077.16	15	100	52	4	2.3	35.3	44	12	39	48	12	40	95	3.2	12.0
CIP395192.1	17	92	72	4	3.2	46.3	35	4	84	55	24	41	143	6.7	4.3
CIP394611.112	86	88	63	4	2.7	45.1	128	16	132	77	5	7	265	5.6	16.0
CIP3960663.8	71	96	68	5	4.1	40.5	46	6	98	67	17	27	161	6.2	5.7
CIP393248.55	29	96	45	3	2.6	30.1	75	18	78	78	1	4	154	3.2	18.0
CIP384866.5	84	98	75	4	2.8	51.4	86	10	118	67	16	23	220	6.8	9.7
PRP15860.8	73	98	38	3	2.6	25.1	68	15	63	80	1	5	132	2.6	15.3
Desiree (ch)	58	100	35	4	3.9	22.7	46	14	60	77	3	11	109	2.5	13.7
K. Jyoti (ch)	42	100	63	5	3.9	38.1	50	7	82	57	19	36	151	5.9	7.0
CV (%)															17.2
LSD (0.05)															5.08
F-value															<.001

In the yield and its parameters, clone CIP 394611.112 produced highest (128) and clone CIP 392271.58 the lowest (27) number of under size tubers (Table 1.2). Weight of under size tubers was weighted highest (30%) from the clone CIP 397073.15 followed by clones CIP 392228.66 and CIP 394034.65, respectively (Table 1.2). The highest number of seed size tubers was obtained from clone CIP 394611.112 (132), whereas the highest percent weight was obtained from the clone CIP 391004.18 (84) followed by clone PRP 15860.8 (80). Among the tested clones in the trials, CIP 395192.1 was the highest over size tuber producer clone in number and weight category (41%), both.

Total number of tubers per plot was obtained the highest (265) from clone CIP 394611.112 followed by clone CIP 394034.65 (225). Per plot tuber yield was obtained highest from the clone CIP 384866.5 (6.8 kg) followed by CIP 395192.1 (6.7 kg), PRP 85861.6 (6.1 kg), CIP 395192.1 and CIP 3960663.8 (6.2 kg), respectively.

Highest yield tons per hectare was calculated from clone CIP 397073.15 (29.7 t/ha) followed by CIP 392228.66 (24.3 t/ha), CIP 394034.65 (24.3 t/ha) and CIP 377957.5 (20.7 t/ha). All other clones were either inferior or at par to the check variety Kufri Jyoti., however, Desiree, another check variety produced very low yield this year in this site. Overall yield difference in tons per hectare was highly significant (Table 1.2).

Based on the results, clones CIP 392228.66, CIP 394034.65 and CIP 397073.15 are promoted to CVT, clones CIP 393574.72B, CIP 388676.1, CIP 377957.5, CIP 396311.1, CIP 397073.15, CIP 397077.16, CIP 395192.1, CIP 394611.112, CIP 3960663.8, CIP 384866.5 and PRP 15860.8 are repeated for one year more and the rest of the clones are discarded from the evaluation scheme due to their inferiority and yields.

At *ARS (Hort.), Pokhara*, total of 18 clones were evaluated and compared with Desiree and Kufri Sindhuri as the check (Table 1.3). Among the tested clones, clone CIP 380606.6 had the highest percentage of plant emergence (100%). In majority of the clones emergence remained more than 90%, but in the case of clone CIP 394038.105 lowest emergence percentage (50%) was recorded. Percent ground cover of the plants was measured highest (87%) in clone CIP 396311.1 followed by PRP 35861.3 (80%) and lowest in the clone CIP 396286.6 (27%). Among the tested clones CIP 394038.105 was observed poorer in ground cover. Plants were measured tallest (63.0 cm) in the clone PRP 35861.13 and shortest (28 cm) in CIP 396286.6. Clone CIP 396286.6 was observed highly resistant and clones MS 52.2105, CIP 394611.112, CIP 397012.22 and CIP 388676.1 highly susceptible to late blight disease.

Average number of main stems per plant was counted highest (5) in clones PRP 225861.2 and CIP 394611.112 followed by CIP 388676.1 (4), PRP 15860.8, CIP 380606.6, CIP 396311.1 and PRP 35861.13. Plant uniformity as rated in 1 to 5 scales, was observed highest (5) in the clones PRP 225861.2, CIP 396311.1 and CIP 397073.15 whereas lowest (2) in the clones CIP 396286.6 and CIP 394038.105. Plant vigour was observed almost same in as plant uniformity.

Average number of under size tubers was counted highest (77) in clone L 235-4 and lowest (8) in MS 52.2105 and CIP 393077.16 (Table 1.3). Clone MS 42.3 gave highest percent weight (16) of under size tubers. Along with the check variety Kufri Sindhuri, clones L 235-4, CIP 395195.7, CIP 380606.6 and CIP 397012.22 were the highest seed size tuber producer clones in the trial. Clone L 235-4 produced highest (60) percent seed size tubers followed by variety Kufri Sindhuri (59). Highest number of oversize tubers were obtained from the clones CIP 395195.7 (25) followed by CIP 396311.1 (24), MS 52.2105 (24) and CIP 394038.105 (22). None of the tubers were of over size in the clone L 235-4 and variety Kufri Sindhuri. Clone MS 52.2105 had the highest percent weight of oversize tubers (45) followed by CIP 394038.105 (40). Total number of tubers was counted highest (202) in the clone L 235-4 and lowest (59) in MS 52.2105. Tubers were counted very high in variety Kufri Sindhuri (194) compared to another check variety Desiree (85). Total weight of the tubers per plot was harvested highest (6.9 kg) from the clone CIP 380606.6 followed by CIP 395195.7 (6.3 kg) and CIP 399101.1 (5.8 kg) and CIP 388676.1 (5.7 kg) respectively. A highly significant difference in the tuber yield was observed between the tested clones. Clone CIP 380606.6 was the highest yielder (32.7 t/ha) followed by CIP 394038.105 (32.1 t/ha) and CIP 395195.7 (30.0 t/ha), respectively (Table 1.3).

Based on the results obtained, clones CIP 388676.1, CIP 225861.2 and CIP 380606.6 are promoted to CVT. Clones CIP 377957.5, CIP 396286.6, CIP 399101.1, CIP 397012.22, CIP 396311.1, CIP 397073.15, CIP 394038.105, PRP 35861.13, CIP 394611.112, CIP 395195.7 and L 235-4 are to be retested one year more in Pokhara conditions and rest of the clones are rejected from the evaluation.

At *ARS (Hort.), Jumla*, 19 different clones were assessed and compared with Kufri Jyoti and Desiree varieties as an improved check and Jumli Local as local check (Table 1.4). Except

the clone CIP 392228.66 (56%) all other clones had very high number of plant emergence. All the 3 check varieties had one hundred percent emergence. Highest percent ground cover of the foliage was observed in clone CIP 394034.65 (90%) and lowest (32%) in CIP 392228.66. Plants of clone PRP 55861.7 were measured tallest (49.7 cm) and shortest (14.3 cm) in clone Gogu Valley. Average number of main stems per plant was counted highest (5) in clone Ca x 27/40.5 followed by MS 35.9 (4.0). Plants of majority of the clones tested were having highly uniform plants except the clones CIP 392228.66 (2) and CIP 392244.3 (2).

Clone CIP 392222.25 among all the tested clones produced the highest number (74) of under size tubers followed by check variety Jumli Local (66). Average number of seed size tubers was obtained highest (48) from variety Kufri Jyoti followed by clones CIP 394034.65 and CIP 395192.1 (39) and lowest (7) from CIP 392228.66, whereas maximum percentage of seed size tubers were harvested from the clone CIP 392244.3 (65%) and CIP 394034.65 (63%). Clone CIP 395192.1 produced highest number (22) of oversize tubers followed by variety Kufri Jyoti (21). In the clone CIP 394034.65 and variety Jumli Local none of the tubers were from oversize category. Clones PRP 55861.8 produced highest percentage of oversize tubers (62) followed by PRP 35861.18 and CIP 397077.16 (53), respectively. Total number of tubers were harvested highest from variety Kufri Jyoti (125) followed by clone CIP 394034.65 (113) and CIP 395192.1 (98). Total weight of the tubers per plot was obtained highest (4.4 kg) from clone CIP 395192.1 followed by variety Kufri Jyoti (4.1 kg). A highly significant difference was observed in yield tons per hectare between the clones tested in the trial. The clone CIP 395192.1 was found the highest yielder (18.2 t/ha) followed by Kufri Jyoti (17.0 t/ha). All other clones were low yielder (Table 1.4). Based on the results obtained this year, none of the clones are promoted to CVT, however, CIP 392222.25, CIP 394034.65, PRP 35861.18, CIP 395192.1, CIP 397077.16, Desiree x LBr 40.7 are recommended to retest one year more in same conditions and all others clones are to be rejected.

Table 1.3. Phenotypic and tuber characteristics of tested clones in IET at ARS (Hort.) Pokhara, 2067/68

Clones	Emer-gence (%)	Ground cover (%)	Plant height (cm)	LB (%)	Stem /plant (#)	Unifor-mity	Plant vigor	Tuber size distributions (# & % wt)						Total tuber//plot		Adj. yield (t/ha)
								US		SS		OS				
								#	wt	#	wt	#	wt	#	wt	
CIP388676.1	98	68	39	72	4	4	4	22	2	95	47	18	20	135	5.7	27.9
PRP225861.2	98	73	47	23	5	5	5	33	2	85	47	16	20	135	5.1	24.3
PRP15860.8	92	63	42	63	4	3	3	40	5	75	42	18	21	133	4.4	22.7
CIP393077.16	84	63	48	47	3	4	3	9	2	61	42	14	24	84	4.2	22.3
CIP377957.5	96	62	40	62	2	3	3	18	3	65	41	18	25	101	4.9	24.4
MS 42.3	90	50	36	65	3	4	3	47	16	56	52	7	1	110	2.9	13.8
CIP380606.6	100	70	43	57	4	4	4	41	2	130	45	19	22	191	6.9	32.7
CIP396286.6	81	27	28	10	3	2	2	35	9	59	52	3	7	97	2.5	13.4
CIP399101.1	90	62	44	65	2	3	4	44	5	106	42	19	21	169	5.8	29.9
CIP397012.22	92	58	45	77	2	3	4	23	4	65	40	15	25	102	4.5	23.1
CIP396311.1	92	87	49	75	4	5	5	16	2	54	34	24	33	94	5.3	26.7
CIP397073.15	92	75	48	78	3	5	5	12	2	43	31	19	35	74	3.9	19.8
CIP394038.105	50	37	42	30	3	2	2	11	1	44	27	22	40	77	4.8	32.1
PRP35861.13	92	80	63	53	4	4	5	19	3	94	46	15	21	129	5.4	28.7
CIP394611.112	98	67	44	80	5	4	4	56	9	126	50	7	9	189	5.2	25.3
CIP395195.7	96	65	47	52	2	4	4	23	4	67	31	25	35	115	6.3	30.0
MS52.2105	87	53	49	85	3	3	3	8	3	28	19	24	45	59	4.3	22.0
L 235-4	92	60	36	43	3	4	4	77	8	124	60	0	0	202	4.7	23.1
Desiree (ch)	94	50	39	67	2	3	3	17	5	55	41	13	23	85	3.5	17.5
K. Sindhuri (ch)	92	60	44	60	2	3	3	79	9	115	59	0	0	194	4.2	20.5
LSD (0.05)																7.338
CV (%)																18.5
F - value																<.001

Table 1.4. Phenotypic and yield performance of potato clones in IET at ARS (Hort.) Jumla, 2067/68

Clones	Emergence (%)	Ground cover (%)	Plant height (cm)	Stem /plant (#)	Uniformity	Tuber size distributions (size & % wt)						Total tuber/plot		Yield (t/ha)
						US		SS		OS				
						#	Wt.	#	Wt.	#	Wt.	#	Wt. kg	
MS 35.9	83	57	41.7	4.0	3	37	29	29	60	3.7	11	70	1.8	7.5
CaxIbr40-11	94	72	18.3	3.0	4	27	16	23	50	8.0	34	58	1.7	7.2
CIP392228.66	56	32	17.0	2.3	2	26	44	7	48	1.0	8	34	0.5	2.0
CIP302271.58	81	53	29.0	4.3	4	22	16	20	41	8.3	43	50	1.9	8.1
Ca x27/40.5	96	78	38.0	5.0	4	26	12	28	39	15.3	50	69	3.4	14.0
PRP55861.7	100	85	49.7	3.7	4	19	11	33	46	16.7	43	69	2.8	11.5
CIP393574.61	85	48	27.0	2.7	4	30	16	17	25	19.0	59	66	2.9	12.0
CIP391061.73	98	82	39.3	2.3	5	29	13	31	50	11.7	37	72	2.4	9.8
PRP55861.6	98	82	42.0	3.0	5	28	10	35	39	20.3	51	83	3.5	14.6
PRP55861.8	100	85	43.0	3.3	5	17	9	18	29	19.0	62	54	3.1	12.7
Gogu Valley	79	52	14.3	2.3	3	20	19	17	45	7.7	36	45	1.2	4.9
CIP392222.25	96	82	33.3	3.7	4	42	14	34	41	17.7	45	94	3.6	14.9
CIP394034.65	100	90	25.7	2.7	5	74	37	39	63	0.0	0	113	2.2	9.2
PRP35861.18	94	75	30.3	3.0	5	14	6	28	35	24	59	65	3.5	14.4
CIP395192.1	100	85	23.3	3.0	5	38	13	39	41	22.0	46	98	4.4	18.2
CIP397077.16	100	88	19.0	3.3	5	24	10	28	36	18.7	53	71	3.0	12.6
D x LBr40.7	96	85	21.7	2.7	5	20	9	29	44	14.0	47	63	2.4	10.1
CIP392244.3	67	37	12.0	2.3	2	24	26	19	65	1.7	9	45	1.0	4.1
W. Valley	98	82	16.0	2.7	5	49	19	29	55	6.7	27	85	2.1	8.5
J. Local (ch)	100	85	22.0	3.3	5	66	53	23	47	0.0	0	89	1.3	5.3
Desiree (ch)	100	85	21.7	3.7	5	29	13	32	38	18.0	49	78	3.4	13.9
K Jyoti (ch)	100	85	23.0	3.3	5	56	15	48	44	21.0	41	125	4.1	17.0
CV (%)														19.1
LSD (0.05)														3.328
F-value														<.001

1.2.2 COORDINATED VARIETAL TRIALS (CVTs)

Introduction

CVT is the second step of multi-location on-station testing of clonal evaluation. The clones promoted from IETs are included in this step for further evaluation in different locations of the country. Under this scheme, the candidate lines are generally assessed for two years and only the most promising lines are promoted to farmers' field trials (FFTs).

Materials and Methods

In Terai, this trial was conducted at RARS Nepalgunj and RARS Tarahara and in the hills at ARS Pakhribas and NPRP Khumaltar, Lalitpur during the year 2067/068. In all of the four locations, the trials were laid out in randomized complete block design (RCBD) with four replications. The plot size was maintained at 7.2 m^2 in all the locations, with the spacing of 60 x 25 cm between the rows and plants, respectively.

Clones assessed are given below in Table No. 1.5:

Table 1.5. Clones tested in CVT at different stations during 2067/68

SN	RARS Nepalgunj	RARS Tarahara	RARS Lumle	NPRP Khumal	ARS Pakhribas
1	CIP384321.15	CIP384321.15	CIP392657.8	PRP55861.6	D. Valley
2	MS 35.9	MS 35.9	CIP392244.3	MS 35.9	T. Valley
3	CIP392617.54	CIP392617.54	CEZ 69.1	CIP394050.110	Winter valley
4	CIP394003.161	CIP394003.161	CIP393574.61	PRP25861.1	PRP115963.5
5	CIP393085.5	CIP393085.5	LBr 44	CIP394005.115	CIP394050.110
6	PRP35861.18	PRP225861.5	CIP392250.56	CIP393574.61	PRP25861.1
7	CIP396010.42	PRP85861.12	CIP393339.242	PRP35861.18	CIP394005.115
8	CIP393077.159	CIP392244.3	CIP393619.8	Desiree (ch)	CIP393574.61
9	CIP392244.3	CIP385556.4	Desiree (ch)	K Jyoti (ch)	PRP25861.8
10	CIP394051.4	Desiree (ch)	K.Sindhuri (ch)		Desiree (ch)
11	Desiree (ch)	K Sindhuri (ch)			Kufri Jyoti (ch)
12	K Sindhuri (ch)				

Experimental plots in all the locations were fertilized at the rate of 100:100:60 kg NPK along with 20 mt compost per hectare as basal dose. Seed of 25 -50 g sizes were used in the trials and all other cultural practices were followed as per PRP recommendations. Analysis of variance (ANOVA) was performed using statistical analysis programme MSTAT–C.

Results and Discussion

Terai

At *RARS Nepalgunj*, 10 different clones were assessed against Desiree and Kufri Sindhuri (Table 1.6). Plant emergence at first observation observed highest (74%) in the clone MS 35.9 and lowest (28%) in variety Kufri Sindhuri, whereas in second observation, all the clones assessed had more than 79% emergence. Percent ground cover at observed date remained below 50%. Average number of main stems were counted highest (5) in clone CIP 396010.42 followed by MS 35.9 (4.4). Clone MS 35.9 had the tallest plants (75.8 cm) followed by CIP 392617.54 (73.3 cm), whereas clone CIP 396010.42 and variety Desiree had the shortest plants measuring 50.8 cm. Plant uniformity remained 2 in clones CIP 392617.54, PRP 35861.18 and Desiree, 3 in CIP 396010.42 and 4 in clones. Early blight infection was rated highest in clone CIP 396010.42. Clones CIP 384321.15, MS 35.9, CIP 393085.5 along with Kufri Sindhuri were found less infected. Late blight severity was less this year, however, clones PRP 35861.18 and CIP 396010.42 were comparatively more susceptible and clones CIP 384321.15, CIP 393085.5 and variety Kufri Sindhuri were found minimum affected in this site.

Variation in tuber size distribution among the tested clones was found very high. Variety Kufri Sindhuri gave the maximum (359) number and weight (16%) of undersize tubers followed by clone MS 35.9 (176) in number and CIP 396010.42 in percent undersize tuber. The highest number of seed size tubers (367) was produced from clone MS 35.9. Not much differences was observed in percent seed size tuber production among the tested clones, however, highest number of oversize tubers were produced by clone CIP 394003.161 and CIP 394051.4 (21) followed by PRP 35861.18 (20), whereas the highest weight percentage of oversize tubers (24%) were from CIP 394051.4. Variety Kufri Sindhuri produced highest number of total tubers per plot (678) and lowest (293) in CIP 392617.54 (Table 1.6). Clone MS 35.9 produced highest weight (20 kg/plot) followed by CIP 394003.161 (19.8 kg/plot)

and CIP 393077.159 (19.3 kg/plot) respectively. It influenced yield tons per hectare and as a results, clone MS 35.9 became the highest yielder producing 27.4 t/ha. Clone CIP 394003.161 was found second highest yielder (25.2 t/ha). The differences between the tested clones were found statistically highly significant. Clone CIP 392617.54 was found lowest yielder (15.2 t/ha) among the tested clones this year in Nepalgunj.

Table 1.6. Plant and yield characteristics of clones in CVT at RARS Nepalgunj, 2067/68

Clones	Emergence (%)		Ground cover (%)	Stems /plant (#)	Plant ht. (cm)	Uniformity	EB	LB	Tuber size distributions (% wt & size)						Total/plot		Adj. yield (t/ha)
									US		SS		OS				
	Ist	IInd							#	wt	#	wt	#	wt	#	Wt kg	
CIP384321.15	42	90	46	2.9	54.3	4	1	1	149	8	285	86	5	5	439	17.0	23.1
MS 35.9	74	97	49	4.4	75.8	4	1	2	176	9	367	83	14	9	556	20.0	27.4
CIP392617.54	59	96	33	3.2	73.3	2	3	2	68	9	212	77	13	15	293	11.1	15.2
CIP394003.161	63	95	50	3.5	55.5	4	2	3	155	6	351	76	21	18	526	19.8	25.2
CIP393085.5	34	79	46	2.9	65.0	4	1	1	171	8	350	86	5	7	527	14.3	18.9
PRP35861.18	55	95	39	3.5	66.5	2	3	4	25	3	254	78	20	19	298	18.2	24.8
CIP396010.42	42	95	40	5.0	50.8	3	4	4	143	11	271	83	5	7	418	13.5	17.0
CIP393077.159	50	88	50	3.5	57.8	4	2	2	64	4	314	83	12	14	390	19.3	24.9
CIP392244.3	51	95	49	2.7	53.8	4	2	3	68	5	262	88	7	7	337	16.6	22.8
CIP394051.4	56	84	49	3.8	59.8	4	2	2	74	5	245	72	21	24	340	16.8	22.2
Desiree (ch)	45	97	33	3.5	50.8	2	3	4	44	4	266	86	9	10	319	14.9	20.5
K Sindhuri (ch)	28	88	45	3.8	65.0	4	1	1	359	16	304	73	15	11	678	16.7	22.6
F-value																	<.001
LSD (0.05)																	4.085
CV (%)																	12.9

Based on the results obtained from CVT RARS Nepalgunj, clones CIP 394003.161, CIP 393077.159 and CIP 392244.3 are promoted to CFFT next year, clones CIP 384321.15, MS 35.9, CIP 393085.5 and CIP 35861.18 are recommended to repeat one year more as CVT in this place and remaining clones like CIP 392617.54, CIP 396010.42 and CIP 394051.4 are to be rejected from the evaluation scheme.

At *RARS. Tarahara.* nine different clones were assessed for their performance against Desiree and Kufri Sindhuri (Table 1.7). In the first observation, clone CIP 392617.54 had the highest plant emergence (93%) among the tested clones in the trial, whereas in second observation, more than 80% tubers were found emerged. All the tubers planted were emerged in clones PRP 225861.5 and variety Kufri Sindhuri in second observation. Early blight disease was scored at highest (8 in 1 to 9 scale) in Desiree followed by PRP 85861.12 (7). The late blight disease was not that severe this year, However, clones CIP 384321.15, MS 35.9, CIP 3940003.161 and PRP 85861.12 were less infected compared to the clones CIP 392617.54, PRP 85861.12, PRP 225861.5, CIP 392244.3 and CIP 385556.4.

Undersize tubers were counted highest from clone CIP 393085.5 (169) followed by variety Kufri Sindhuri (164) whereas the highest percentage of tuber weight from this size category (21) was in clone CIP 392617.54. Clone MS 35.9 produced the highest number of seed size tubers (126) and lowest (57) by CIP 385556.4. Highest weight percentage of seed size tubers were obtained from the clone CIP 392244.3 (54%). All other clones had less weight percentage of seed size tubers compared to variety Desiree (50). Oversize tubers were harvested highest (59) in clones CIP 384321.15 and CIP 393085.5 (Table 6). Highest percentage of oversize tubers (50%) were harvested from the clone CIP 394003.161 whereas the lowest (25%) in CIP 392244.3. Total number of tubers per plot were counted highest (343) in clone CIP 393085.5 followed by MS 35.9 (318) and Kufri Sindhuri (287),

respectively. All other clones assessed had low yield per plot compared to check variety Kufri Sindhuri. The number of tubers per plot was directly correlated with the weight total, as highest weight was harvested from the clones CIP 393085.5 (13.7 kg/plot) followed by MS 35.9 (12.4 kg/plot) and CIP 393085.5 (11.9 t/ha).

Table 1.7. Plant characteristics of potato clones in CVT at RARS Tarahara, 20067/68

Clones	Emergence (%)		Ground cover (%)	Plant height (cm)	Uniformity	Stem /plnt (#)	LB	Tuber distributions (wt % & size)						Total/plot		Yield (t/ha)
								US		SS		OS		#	kg	
	I	II						#	Wt	#	Wt	#	Wt			
CIP384321.15	84	90	55	25.0	3	2	3	116	17	89	37	59	46	264	11.3	18.0
MS 35.9	73	90	80	57.2	5	2	3	149	18	126	43	44	39	318	12.4	19.5
CIP392617.54	93	96	60	48.9	3	3	4	92	22	75	48	23	32	189	8.3	12.5
CIP394003.161	83	95	65	29.4	3	2	3	86	14	68	36	49	50	203	8.1	12.5
CIP393085.5	68	83	70	47.2	3	5	4	169	16	114	38	59	46	343	13.7	23.2
PRP225861.5	83	100	40	27.8	4	4	4	66	8	119	49	58	44	243	11.9	16.5
PRP85861.12	84	95	80	34.1	4	4	3	55	14	60	41	35	46	150	7.4	11.1
CIP392244.3	80	93	65	29.1	3	6	4	87	21	99	54	23	25	210	8.3	12.7
CIP385556.4	83	889	80	28.5	3	3	4	67	19	57	46	23	35	147	6.6	10.5
Desiree (ch)	84	95	60	19.7	3	5	3	74	19	89	50	28	34	190	6.9	10.4
K Sindhuri (ch)	78	100	80	36.3	3	5	4	164	16	83	39	40	38	287	6.9	10.5
CV (%)																13.8
F-value																<.001
LSD (0.05)																2.845

A highly significant difference was observed in the yields tons per hectare. Almost all of the clones assessed were high yielder compared to both of the check varieties. Clone CIP 393085.5 was found highest yielder producing 23.2 t/ha. On the basis of plant and yield characteristics, clone CIP 393085.5 has been promoted to CFFT, clones CIP 384321.15, MS 35.9 and PRP 225861.5 are to be retested and all other remaining clones will be discarded from the variety evaluation scheme.

Hills

One set of CVT with seven different new cones was planted this year at Hattiban Research Farm of NPRP Khumaltar. Varieties Desiree and Kufri Jyoti were considered as the check varieties (Table 1.8). Plant emergence was highly satisfactory this year showing 97 to 100% emergence. Percent ground cover at first observation was recorded highest (58%) in CIP 394005.115 and lowest (43%) in CIP 393574.61, whereas in second observation, it ranged from 40% (Desiree) to 80% (CIP 394005.115).

Tallest plants were measured in clone PRP 35861.18 (65.5 cm) and shortest (28.5 cm) in Desiree. Plants of all the tested clones were highly uniform this year in the trial scaling 4 to 5 in scale, however, plants of clone PRP 25861.1, CIP 394005.115 and variety Desiree were more uniform than others. Plant vigor had also the same trend in the trial as was in plant uniformity. Average number of main stems per plant were counted highest (4.5) in 1 to 5 scale in clone CIP 394050.110 followed by PRP 25861.1 (4.2). Other clones had less number of main stems per plant compared to the variety Kufri Jyoti (3.6).

Table 1.8. Performance evaluation in clones in CVT at NPRP Khumaltar, 2067/68

Clones	Emergence (%)	Ground cover (%)		Plant ht. (cm)	Uniformity	Vigor	Stem/plant (#)	Tuber size distribution (# & wt)						Total/plot		Adj. yield (t/ha)
								US		SS		OS				
		I	II					#	wt	#	wt	#	wt	#	Wt kg	
PRP55861.6	100	51	75	61.2	4	4	3.0	190	64	193	32	11	5	394	8.4	11.7
MS 35.9	98	50	70	51.7	4	4	3.5	343	65	349	33	9	3	700	14.1	19.2
CIP394050.110	97	48	73	54.0	4	4	4.5	346	54	403	45	6	2	755	15.6	21.7
PRP25861.1	100	56	71	60.7	5	5	4.2	121	37	251	45	39	18	411	15.3	21.2
CIP394005.115	100	58	80	44.7	5	5	3.2	159	49	303	46	13	6	475	13.2	18.3
CIP393574.61	90	43	63	49.0	4	3	3.0	116	40	184	40	36	20	336	12.7	15.5
CIP35861.18	99	49	59	65.5	4	4	3.0	71	24	164	42	51	34	286	14.5	20.1
Desiree (ch)	100	46	40	28.5	4	4	3.5	150	64	149	30	10	6	309	7.1	9.9
K Jyoti (ch)	100	56	71	41.1	5	5	3.6	94	30	213	45	46	25	353	15.1	21.0
CV (%)																13.8
LSD 0.05																3.527
F-value																<.001

In the yield and its parameters, the highest number of undersize tubers was obtained from the clone CIP 394050.110 (346), followed by clone MS 35.9 (343). Clone PRP 35861.18 had the lowest number (71) of undersize tuber, whereas clone MS 35.9 had the highest percent weight (65) of under size tubers followed by PRP 55861.6 and variety Desiree (64). Seed size tubers were produced the highest by number in clone CIP 394050.110 (403). Except the clones CIP 394005.115 (46) all other clones were either at par or inferior to variety Kufri Jyoti in the percentage seed size tuber weight. PRP 35861.18, one of the NPRP bred clones had the highest number of oversize tubers and percent oversize tuber weight as well (34).

Check variety Kufri Jyoti had the second highest (25) percent oversize tubers compared to all other assessed clones in the trial. Total number of tubers per plot was counted highest (755) in the clone CIP 394050.110 which influenced the total weight per plot and average yield tons per hectare also. All the tested clones were superior to variety Desiree in total number of tubers, total weight kg and yield tons per hectare, however Kufri Jyoti another check variety ranked third in yield tons per hectare. A highly significant difference was observed in yield tons per hectare between the tested clones (Table 1.8).

Based on the performance, clones CIP 394050.110 and PRP 25861.1 are promoted to CFFT, clones PRP 55861.6, MS 35.9, PRP 35861.18 and CIP 393574.61 are to be repeated one year more in CVT at Khumaltar and remaining clone will be rejected from the testing.

At *RARS, Lumle* eight different genotypes were tested against varieties Kufri Jyoti, Kufri Sindhuri and Desiree (Table 1.9).

In the trial average number of tubers per plant were counted highest (11) in clone CIP 392250.56 followed by LBr 44 (9.5) and CIP 393339.242 (9.0), respectively whereas lowest (3.2) in CIP 392657.8 and Desiree (3.5).

Clone CEZ 69.1 produced highest number (123) and highest weight (36%) of under size tubers among the tested clones. Whereas seed size tubers were obtained highest (46) from variety Kufri Jyoti followed by Desiree (45) another check variety (Table 8). Clone CIP 393339.242 produced highest percentage weight of seed size tubers (36%) and lowest (25%) in clone CIP 393619.8. Highest number of oversize tubers was harvested in variety Kufri Jyoti (46) and second in Deiree (45).

Table 1.9. Performance of potato clones in CVT at RARS Lumle, 2067/68

Clones	Plt hvtd. (#)	Plant height (cm)	Tubers /plant (#)	Tuber # & wt (%) distribution						Total tubers/plot		Yield (t/ha)
				US		SS		OS				
				#	Wt	#	wt	#	wt	#	kg	
CIP392657.8	21		3.2	42	20	20	29	19	51	80	2.5	7.0
CIP 392244.3	23		6.7	84	24	30	27	19	48	144	4.2	11.8
CEZ 69.1	23		8.7	123	36	27	28	30	36	169	3.6	10.0
CIP 393574.61	23		4.7	69	22	32	33	24	45	125	3.7	10.4
LBr 44	23		9.5	101	28	39	30	28	42	168	4.7	13.1
CIP 392250.56	21		11.0	71	29	25	28	21	43	116	3.3	9.4
CIP 393339.242	23		9.0	106	27	42	36	23	37	171	4.3	12.2
CIP 393619.8	23		4.5	42	13	29	25	38	62	109	4.3	11.9
Kufri Jyoti (ch)	24		7.7	66	12	46	28	51	59	163	6.1	17.1
Desiree (ch)	24		6.7	103	24	45	34	29	42	177	4.9	13.7
K. Sindhuri (ch)	21		3.5	40	18	20	33	16	48	76	2.2	6.3
F-value												**
CV (%)												18.0
LSD (0.05)												2.9

Sixty-two percent of the tubers obtained were over size in clone CIP 393619.8. Per plot tuber production was highest (6.1 kg) in Kufri Jyoti followed by Desiree (4.9 kg), whereas variety Kufri Sindhuri was the lowest (2.2 kg). In the yield tons per hectare, a highly significant differences between the tested clones was observed. Variety Kufri Jyoti gave highest tuber yield (17.1 t/ha) followed by another check variety Desiree (13.1 t/ha) and LBr 44 (13.1 t/ha, respectively. Variety Kufri Sindhuri was lowest yielder (7 t/ha) among the tested clones and Kufri Sindhuri among the tested variety (6.3 t/ha) probably due to the severity of late blight disease.

Based on the results obtained, clones CIP 388764.26LB, CIP 387115.8LB, CIP 393280.64, CIP 393637.10 and CIP 393233.64 are promoted to CFFT for next year.

At *ARS, Pakhribas*, nine clones were assessed and compared with varieties Desiree and Kufri Jyoti (Table 1.10). Plant emergence was counted 66 to 94% in the clones evaluated.

Table 1.10. Phenotypic and yield performance of tested clones in CVT at ARS Pakhribas, 2067/68

Clones	Emergence (%)	Ground cover (%)	Uniformity	Plant ht. (cm)	Stems /plant (#)	LB	Tuber size distributions (# & % wt)						Total/plot		Yield (t/ha)
							US		SS		OS				
							#	wt	#	wt	#	wt	#	Kg	
D.Valley	83	54	3	18.2	3	8	71	26	53	45	15	30	139	4.4	6.1
T. Valley	66	54	3	13.9	3	7	75	64	14	36	0	0	89	1.1	1.6
Wintr alley	94	49	3	21.4	2	8	124	49	47	32	14	20	184	4.1	5.7
PRP115963.5	77	58	4	30.4	4	5	74	25	55	49	15	26	144	4.5	6.3
CIP394050.110	86	86	5	40.7	3	3	291	40	151	42	34	18	476	13.7	19.1
PRP25861.1	87	87	4	50.3	4	3	217	21	143	29	94	50	455	20.3	28.2
CIP394005.115	88	79	4	41.3	4	4	146	32	107	45	29	23	281	8.7	12.1
CIP393574.61	90	53	4	23.0	3	5	81	24	80	52	17	24	179	5.5	7.7
PRP25861.8	87	82	4	33.2	3	5	86	17	72	44	28	38	186	7.1	9.8
Desiree (ch)	93	60	4	32.2	3	5	120	26	89	46	28	29	237	7.4	10.2
K. Jyoti (ch)	92	66	5	34.0	3	4	105	17	154	53	38	30	297	10.6	14.7
CV (%)															11.2
LSD (0.05)															1.777
F-value															<.001

Clone Winter Valley had the highest percent emergence (94) followed by Desiree (93) and Kufri Jyoti (92%). Percent ground cover was measured highest (87%) in PRP 25861.1 and lowest (49%) in the clone Winter Valley. Plant uniformity was measured highest in 1 to 5 scales, in clone CIP 394050.110 (5) and Kufri Jyoti variety (5). Plants of clone PRP 25861.1 were tallest (50.3 cm) and shortest (13.9 cm) in T. valley. Average number of main stems were counted highest (4) in the clones PRP 115963.5, PRP 25861.1 and CIP 394005.115 whereas lowest (2) in Winter Valley. Clones D. Valley, Winter Valley and T. Valley were highly susceptible to the late blight disease whereas clones CIP 394050.110 and PRP 25861.1 were less susceptible scoring 3 in 1 to 9 scales (Table 1.10).

Number of undersize tubers was counted highest in the clone CIP 394050.110 (291) followed by PRP 25861.1 (217), whereas percent weight was highest in the clone T. Valley (64%). Seed size tuber number was also counted highest (151) in the clone CIP 394050.110 followed by the variety Kufri Jyoti (154) and the clone PRP 25861.1 (143). Percent seed size weight was obtained highest (53) from variety Kufri Jyoti and the clone CIP 393574.61 (52). None of the tubers obtained were from oversize category in the trial. Out of 455 tubers in the plot highest number of oversize tubers (94) were counted in the clone PRP 25861.1, it influenced its weight percentage also. As a result highest weight percentage was obtained in the clone PRP 25861.1 (50%) followed by PRP 25861.8 (38%). Total number of tubers was counted highest (476) in the clone CIP 394050.110 and lowest (89) in T. valley (Table 1.10). Total harvest of the tubers per plot was highest (20.3 kg) in the clone PRP 25861.1 followed by CIP 394050.110 (13.7 kg/plot), whereas all other tested clones produced less than variety Kufri Jyoti (10.6 kg). A highly significant difference in the yield tons per hectare was observed. Among the tested clones, PRP 25861.1 was found the highest yielder (28.2 t/ha) followed by CIP 394050.110 (19.1 t/ha). The average yields in all other clones remained inferior to one of the check varieties Kufri Jyoti (14.7 t/ha).

Based on overall performance, clones CIP 394050.110 and PRP 25861.1 are promoted to CFFT, clones D. Valley, T. Valley, Winter Valley, PRP 115963.5 are to be retested one year more and clones PRP 25861.8, CIP 393574.61 and CIP 394005.115 are to be discarded from the trials.

1.2.3 COORDINATED FARMERS FIELD TRIALS (CFFTS)

Introduction

Clones promoted from on-station trials are tested as CFFTs in different outreach research sites of NARC by research partners throughout the country (Table 10). NPRP also conducts some on-farm trials in its own initiation. Most important plant and yield parameters, farmers' feedback on the plant and tuber appearance, foliage characteristics and taste of assessed clones in comparison to the existing popular varieties from respective locations are obtained in the CFFTs. Highly preferred clones selected from CFFT are further verified under farmers' field conditions as farmer's acceptance tests (FATs) prior to release as the commercial varieties.

Materials and Methods

In all the locations, plots consisted four rows, each planted with 12 tubers. Row to row and plant to plant spacing was maintained at 60 x 25 cm. The trials were designed as RCBD with four replications. Plots were fertilized at the rate of 100:100:60 kg NPK and 20 tons compost

per hector as basal dose in furrow. Seed size used was 25 to 50 g. All other cultural practices were followed as per the NPRP recommendations. Potato clones used in Terai and hill CFFTs are as following:

Table 1.11. Potato clones used in CFFT at different locations

Terai (winter season)		Hills (summer season)		
RARS, Nepalgunj	RARS Tarahara	RARS Lumle	ARS Pakhribas	NPRP Khumal
PRP85861.11	CIP389746.2	CIP387115.8LB	CIP385499.11	CIP385499.11
PRP85861.8	PRP85861.11	CIP388764.26LB	CIP393385.39	CIP393385.39
CIP393619.8	PRP85861.8	CIP392271.58	L235.4	L 235-4
CIP392706.35	CIP39338539	CIP393280.64	CIP388580.6	PRP25861.11
CIP392271.58	CIP396233.64	CIP393637.10	CIP392661.18	CIP392661.18
Desiree (ch)	Desiree (ch)	PRP85861.11	Desiree (ch)	Desiree (ch)
K. Sindhuri (ch)	K. Sindhuri	K. Jyoti (ch)	PRP25861.11	Kufri Jyoti(ch)
			K. Jyoti (ch)	Rosita (ch)
			Local (ch)	

Observations taken:

- Plant emergence (counting at 15 and 30 DAP in the plains and 30 and 45 DAP in the hills)
- Plant uniformity (after 5 -6 weeks using 1 - 5 scale)
- Percentage ground cover (average of 5 plants)
- Number of main stems per plant (average of 5 plants)
- Maturity categories (early, medium and late)
- Late blight rating (1-9) scale
- Insect damage on foliage
- Number of tubers/plot
- Tuber yield (kg/plot) with tuber number and weight by size class (small, medium and large)
- Farmer's rating on plant, tuber and taste at harvest

Terai

At *RARS, Nepalgunj,* one set of CFFT with five clones was planted in its outreach research site this year. As in previous years, varieties Desiree and Kufri Sindhuri were used as the check varieties (Table 1.12). In the first observation, plant emergence was below 37%, whereas in second observation, it was almost doubled ranging from 63% (clone CIP 392206.35) to 77% (in variety Desiree). Percent ground cover remained below 48% this year. Plants of variety Kufri Sindhuri were taller than all of the tested clones.

Average number of main stems per plant were counted highest (4.7) in the clone PRP 85861.8 followed by clone PRP 85861.11. Number of main stems per plant was higher in Desiree (3.5) than Kufri Sindhuri (2.9). Plant uniformity ranged from 2 (clone CIP 393619.8) to 4 (clone PRP 85861.11). Not much difference in early blight disease infection was observed between the tested clones. But in the case of late blight disease, variety Kufri Sindhuri was found less infected than all other clones, however, disease severity did not cross the scale of 4 in 1 to 9 scales.

Clone PRP 85861.8 gave the highest number (253) and weight (13) of undersize tubers. The number of seed size tubers were harvested highest (402) from clone PRP 85861.11 followed by PRP 85861.8 (399). But the differences in percent weight of seed size tubers between the tested clones and check varieties remained lower. Number of oversize tubers remained lower

this year in all of the clones, counting highest five tubers in clone CIP 393619.8 and lowest one in Kufri Sindhuri. Percent weight of oversize tubers was found highest (5) in clone CIP 393619.8 followed by CIP 392271.58. Number of tubers per plot were counted highest (654) in the clone PRP 85861.8 and lowest (294) from CIP 393619.8, however, total weight of the tubers per plot were obtained highest (22 kg) from the clone PRP 85861.11 (Table 1.12).

Table 1.12. Phenotypic an yield characteristics of advanced potato clones in CFFT Nepalgunj, 2067/68

Clones	Emergence		Ground cover (%)	Plant height (cm)	Stem /plant (#)	Uniformity	Lb	Tuber size & wt. distribution						Total/plot		Adj. yield (t/ha)
								US		SS		OS				
	I	II						#	wt	#	wt	#	wt	#	wt	
PRP85861.11	34	70	48	36.7	4.2	4	3	104	9	402	89	2	2	551	22	30.1
PRP85861.8	37	74	35	45.9	4.7	3	4	253	13	399	86	2	2	654	18	24.3
CIP393619.8	27	69	35	44.8	2.8	2	4	48	4	241	92	5	5	294	18	25.1
CIP392706.35	26	63	40	42.8	3.6	3	4	176	9	296	88	3	3	475	18	24.5
CIP392271.58	26	71	39	41.6	2.8	3	3	51	3	281	92	4	5	336	17	23.8
Desiree (ch)	35	77	35	40.0	3.5	3	4	60	6	251	92	3	3	314	16	22.9
KSindhuri (ch)	30	74	35	51.5	2.9	3	2	117	11	342	88	1	1	560	18	24.1
CV (%)																16.1
LSD 0.05																5.954
F-value																0.282

Yield differences between tested clones was not statistically significant this year, however, clone PRP 85861.11 produced highest yield (30.1 t/ha) and lowest by variety Desiree (22.9 t/ha). Based on the results, clones CIP 393619.8 and CIP 392271.58 are promoted to FAT and remaining clones namely PRP 85861.11, PRP 85861.8 and CIP 392271.58 are to be repeated one year more in the CFFT (Table 1.12).

At *RARS, Tarahara OR sites,* five advanced potato clones were tested and compared with standard commercial varieties Desiree and Kufri Sindhuri (Table 1.13). More than 68% plant emergence was observed in the trial. The highest emerging clone was PRP 85861.11 (95%) and lowest emerging clone CIP 396233.64 (68%).

Table 1.13. Clonal performance of potato clones in CFFT Tarahara, 2067/68

Clones	Emergence (%)	Ground cover (%)	LB	Plant ht. (cm)	Plant uniformity	Stem /plant (#)	Tuber distributions (# & %wt)						Total/plot		Adj. Yield (tha)
							US		SS		OS				
							#	wt	#	wt	#	wt	#	wt	
CIP 389746.2	78	785	1	41.7	4	2.7	83	12	68	28	73	60	14.1	223	18.4
PRP 85861.11	95	81	1	36.2	5	4.1	189	16	154	43	72	42	15.7	415	21.7
PRP 85861.8	75	85	1	44.8	4	4.2	252	25	106	32	68	43	16.1	425	21.4
CIP 39338539	73	735	2	45.8	4	3.3	240	24	166	45	59	32	12.0	464	15.1
CIP 396233.64	68	70	2	46.1	4	2.4	164	24	96	41	40	35	10.1	300	12.9
Desiree (ch)	86	74	3	44.1	3	4.1	122	18	122	50	39	32	9.5	283	12.3
K. Sindhuri (ch)	81	64	4	40.4	3	5.0	229	25	163	51	28	25	7.9	419	9.3
LSD (0.05)															6.957
F- value															0.011
CV (%)															29.4

Percent ground cover ranged 64 (Kufri Sindhuri) to 85 (PRP 85861.8). Both of the check varieties were more affected by late blight disease than tested clones this year. Clones CIP 389746.2, PRP 85861.11 and PRP 85861.8 were observed almost resistant this year in this location. Plants of all tested clones were almost same in the height showing very low variability. Plants of tested clones were highly uniform compared to both of the check

varieties. Average number of main stems per plant was counted highest (5) in Kufri Sindhuri and lowest (2.4) in clone CIP 396233.64.

Number of undersize (<25 gm) tubers were counted highest (252) in PRP 85861.9 followed by CIP 393385.39 (240) and variety Kufri Sindhuri (229), respectively (Table 1.13). Percentage weight of undersize tuber category was highest (25%) in the clone PRP 85861.8 and variety Kufri Sindhuri. Clone CIP 393385.39 produced highest number of seed size tubers (166) followed by Kufri Sindhuri (163). Both of the check varieties produced highest seed size tuber weight percentage compared to the tested clones in the trial. Highest number and weight percentage of oversize tubers were produced by the clone CIP 389746.2 and lowest by Kufri Sindhuri. Per plot harvest of tuber was highest (464) in clone CIP 393385.39 and lowest in CIP 389746.2 (224). Highest weight of the tubers per plot was obtained from clone PRP 85861.8 (16.1 kg). All of the tested clones were superior in the tuber weight compared to both of the check varieties in the trial. A highly significant difference was observed in yield tons per hectare between the tested clones. Clones PRP 85861.11 was found highest yielder (21.4 t/ha) followed by PRP 85861.8 (21.4 t/ha). Based on the results, clones CIP 389746.2 and CIP 389746.2 are recommended to test for one year in FAT, clones PRP 85861.11 and PRP 85861.8 for retesting and remaining clone CIP 396233.64 to be discarded from the trial.

At *Kundule, Baglung*, a RARS Lumle outreach research site, a total of six clones were tested against variety Kufri Jyoti (Table 1.14). In the height, plants of clone CIP 393637.10 were tallest (24.6 cm) followed by CIP 393280.64 (23.3 cm). Average number of main stems was counted highest in variety Kufri Jyoti (6.4) and lowest (3.8) in CIP 393637.10.

Table 1.14. Performance of potato clones under CFFT at Kundule, Baglung, 2067/68

Clones	Plants hvtd. (#)	Plant height (cm)	Stem /plant (#)	Tuber size distributions (# & %wt)						Total tuber/plot (#)	Total weight (kg)	Yield (t/ha)
				US		SS		OS				
				#	wt	#	wt	#	Wt			
CIP387115.8LB	24	20.1	4.0	75	15	48	28	42	56	165	6.8	18.7
CIP388764.26LB	24	19.6	6.3	243	38	65	34	28	29	335	7.0	19.6
CIP392271.58	24	21.4	5.0	13	19	61	32	50	49	244	7.8	21.5
CIP393280.64	24	23.3	5.1	128	32	53	30	35	38	216	6.9	19.1
CIP393637.10	23	24.6	3.8	118	28	36	30	24	42	178	4.2	11.7
PRP85861.1	23	9.5	4.8	265	42	50	26	31	32	346	6.4	17.8
Kufri Jyoti (ch)	24	19.2	6.4	143	26	64	32	40	42	246	7.6	21.1
F-value												*
CV (%)												8.9
LSD (0.05)												4.0

Average number and percent weight of undersize tubers were produced highest by clone PRP 85861.1 (265 and 42%) indicating this clone slight late in maturity, whereas clone CIP 388764.26LB produced highest number of seed size tubers (65) followed by Kufri Jyoti (64) and CIP 392271.58 (61) respectively. Percent weight of seed size tubers was obtained highest from clone CIP 388764.26LB (34%). Number and percent weight of oversize tubers were obtained from clone CIP 392271.58 (50), whereas clone CIP 387115.8LB produced highest (56) percent weight of oversize tubers. Total number of tubers per plot was harvested highest (346) from clone PRP 85861.1 whereas highest tuber weight per plot from clone CIP 392271.58 (7.8 kg) followed by variety Kufri Jyoti (7.6 kg). The differences in tuber yield tons per hectare between the tested clones was significantly different. CIP 392271.58 was highest yielding clone among all the tested clones in the trial. All other clones were inferior to check variety Kufri Jyoti (Table 1.14).

Hills

At *ARS, Pakhribas,* five different potato clones were assessed against varieties Desiree and Kufri Jyoti this year under farmers' field conditions (Table 1.15). More than 81% tubers were emerged this year in the trial. Percent ground cover was highest (81%) in the clone CIP 38580.6. Farmer's local had the lowest ground cover (46%).

Plants of clone CIP 393385.39 and PRP 25861.11 along with CIP 385499.11 were less affected by hailstone, whereas local cultivar was severely damaged. Tallest plants were measured from CIP 388580.6 (52.1 cm) followed by PRP 25861.11 (47.6 cm). Plants of Desiree variety were shortest in the height (29.0 cm). Clone CIP 385499.11 was highly susceptible to late blight disease scoring 9 in 1 to 9 scales. Least affected clone was CIP 393385.39 (2). Plant uniformity was rated highest (5) in clone L 235-4. Plant vigor was higher in clones L 235-4, CIP 388580.6 and PRP 25861.11 (5) and lowest (2) in the Local check.

Table 1.15. Phenotypic and yield characteristics of potato clones in CFFT at Pakhribas, 2067/68

Clones	Grnd cover (%)	Plt ht. (cm)	Unifor Mity	Plant vigor	LB	Hail stone	Tuber size distribution (size & %wt)						Total/plot		Yield (t/ha)
							US		SS		OS				
							#	wt	#	wt	#	wt	#	Wtkg	
PRP385499.11	70	34.8	4	4	9	3	135	21	147	48	46	32	328	12	16.0
CIP393385.39	74	45.9	4	4	2	2	175	23	138	43	54	34	367	14	20.2
L235.4	68	46.7	5	5	6	5	285	45	102	42	13	13	340	9	12.0
CIP388580.6	81	52.1	4	5	6	5	121	22	95	41	46	38	262	10	13.3
CIP392661.18	65	36.4	3	3	5	7	132	31	73	37	27	32	231	8	10.5
PRP25861.11	76	47.6	4	5	4	2	152	19	120	33	73	49	345	15	21.5
Desiree (ch)	54	29.0	3	4	7	6	130	23	103	50	28	27	261	9	11.8
K. Jyoti (ch)	63	29.4	4	4	6	4	149	24	113	40	58	37	318	11	15.8
Local (ch)	46	40.9	3	2	6	8	121	28	53	39	17	34	191	6	8.5
LSD(0.05)															2.169
CV (%)															10.3
F-value															<.001

Number and percent weight of small sized tubers were harvested highest from clone L 235-4 (285 and 5). Tuber numbers of seed size category was produced highest (147) from CIP 385499.11. Variety Desiree had the highest weight percentage of seed size tuber. Clone PRP 25861.11 produced the highest number of oversize tubers (73) and weight percentage as well (49%). Total number and weight of the tubers per plot were harvested highest from the clone CIP 393385.39 (367) and PRP 25861.11 (15 kg/plot) respectively. Tubers yield tons per hectare between the tested clones significantly. Clone PRP 25861.11 produced highest yield (21.5 t/ha) followed by CIP 393385.39 (20.2 t/ha), respectively. All three check varieties were inferior to tested clones in the yields. Among the check varieties, local check was very inferior. Based on the results obtained, clones PRP 25861.11 and CIP 393385.39 are to be promoted to FAT, clones CIP 385499.11, L 235-4 and CIP 388580.6 are to be repeated one year more CFFT and clone CIP 392661.18 has to be discarded from variety evaluation scheme (Table 1.15).

One set of CFFT with five different clones was planted in the farmers' fields from Dolakha/Sindhupalchowk districts (Table 1.16). Varieties Desiree, Kufri Jyoti and Rosita were considered as the check in the trial. Tubers of variety Desiree had one hundred percent emergence and remaining clones ranged from 81 to 90%. Percent ground cover was highest (90%) in clone Rosita whereas lowest (10%) in Desiree. Plants of variety Kufri Jyoti were

also poorer compared to other improved clones assessed in the trial. Along with Rosita, clones L 235-4, PRP 25861.11 and CIP 392661.18 were found highly resistant to late blight, whereas variety Kufri Jyoti was also highly susceptible compared to all of the improved clones assessed.

Plants of clone CIP 393385.39 were measured tallest (68.3 cm) followed by L 235-4 (66.7 cm) and CIP 392661.18 (65.5 cm) and Desiree, shortest (20.9 cm). Plants of clone L 235-4 were highly uniform rating 5 in 1 to 5 scales. In other clones, it rated 3 to 4. Plants of Rosita had highest (4.9) and Desiree had lowest number (1.9) of main stems/plant.

In yield data (Table 1.16), clone CIP 393385.39 produced highest number of undersize tubers (118) followed by Rosita (109), whereas the variety Desiree had the highest percent weight of undersize tubers (15%). Rosita, a highly adopted old improved variety had the highest number of seed size tubers followed by the clone L 2354 (229). Variety Desiree had highest percent weight of seed size tubers (77%). Oversize tuber numbers and percent weight were obtained highest from PRP 25861.11. Variety Rosita had a highest total number of tubs per plot (371) followed by L 35-4 (346) whereas the total weight per plot was obtained highest from clone PRP 25861.11 (16.4 kg) followed by Rosita (12.9 kg).

Table 1.16. Phenotypic and yield characteristics of potato clones in CFFT at Dolakha, 2067/68

Clones	Emergence (%)	Grond cover (%)	LB	Plant ht. (cm)	Plant uniformity	Stem plant (#)	Tuber size distributions (# & %wt)						Total plot		Adj. Yield (t/ha)
							US		SS		OS				
							#	wt	#	wt	#	wt	#	Wt	
CIP385499.11	81	55	2	40.1	4	3	52	7	149	73	18	21	219	8.2	13.7
CIP393385.39	85	82	3	68.3	4	4.2	118	10	189	71	19	19	327	11.0	17.8
L 235-4	88	82	1	66.7	5	4.2	98	9	229	71	21	19	346	11.6	18.5
PRP25861.11	85	78	1	58.2	4	3.7	47	3	193	55	48	41	288	16.4	**26.9**
CIP392661.18	88	87	1	65.5	3	3.1	34	4	129	65	21	31	185	9.4	15.0
Desiree (ch)	100	10	7	20.9	3	1.9	57	15	78	77	5	10	139	3.2	4.4
K. Jyoti (ch)	90	28	6	28.8	4	2.7	59	6	167	73	17	21	243	8.6	13.7
Rosita (ch)	83	90	1	59.9	4	4.9	109	9	237	71	24	20	371	12.9	21.2
F value															0.004
CV (%)															26.4
LSD (0.05)															

A highly significant difference was observed in yield tons per hectare. Among the tested clones, PRP 25861.11 gave the highest yield tons per hectare (26.9) followed by Rosita (21.2 t/ha). Both of the improved check varieties were highly inferior to the local check (Rosita) and all of the assessed clones in the trial at this location. Results clearly demonstrated that Desiree and Kufri Jyoti varieties are not appropriate to use as the check in this location.

Based on the results obtained, clone L 235-4 and PRP 25861.11 are promoted to FAT, clones CIP 385499.11 and CIP 393385.39 to be retested one year more in CFFT and clone CIP 392661.18 has been rejected from the screening list.

2.0 COPING WITH CLIMATE CHANGE EFFECTS ON POTATO THROUGH VARIETY SELECTION AND CROP MANAGEMENT IN NEPAL

2.1 PRELIMINARY SCREENING OF MOISTURE STRESS RESISTANT CLONES AT KHUMALTAR

Total of 33 clones were assessed at Hattiban Research Farm Khumaltar in the year of 2067/068 (Table 2.1) under rain-fed, irrigated and rice-straw mulching conditions. All of other cultural practices were followed as per NPRP recommendations. One irrigation given at immediately after the planting in all treatments helped plant emergence in all the treatments. Later on, except on irrigated treatment, rain-fed and mulching plots were stopped irrigation.

Among the tested clones, percent emergence was counted highest (96%) in clones CIP 391058.35, BR 63/65, BSU PO3 and LBr 40 in rain-fed treatment at 45 DAP, whereas in the treatment of frequent irrigation, majority of the clones had more than 90% emergence. Percent emergence in mulching treatment was better than rainfed conditions and lower than irrigated conditions. The clones CIP 394007.55, CIP 394051.4, LBr 40 and NPI 106 had one hundred percent emergence at 45 DAP. Percent ground cover was observed at 75% in the clone CIP 393574.72B followed by CIP 393385.39, whereas in irrigation treatment, ground cover was rated up to 88% in CIP 393385.39 followed by CIP 392242.25 (85%). In mulching treatment, clone CIP 393574.72B had highest (83%) ground coverage and lowest (38%) in clone Ca x LBr40.6.

Plants were measured tallest (31.2 cm) in clone BSU PO3 in treatment 1 (rainfed). Clone CIP 378711.7 had tallest plants in irrigated conditions, whereas in mulching, plants of Khumal Seto-1 were taller (31.6 cm) than all other assessed clones in the trial. Average of plant vigor between rainfed and irrigated treatment did not differ; however, mulching treatment was inferior to both of the other treatments. Average number of main stems were counted highest (4.7) in clone CIP 393385.39 followed by CIP 389660.9 (4.5) in treatment #1. In treatment #2 also the main stem numbers did not differ considerable. But in treatment #3, the average number of main stems per plant was counted lower. Plant uniformity among the tested clones in treatment #1 was highest (5) in clones CIP 392244.3, CIP 393385.39 and CIP 393574.72B, whereas in treatment #2 plants of majority of the clones were more uniform. In treatment #3, none of the clones reached to 5 in 1 to 5 scales. Results showed that the treatment had the direct effect on plant uniformity.

In yield and its attributes, the treatment effect can be easily seen. Total number of tubers was counted highest (157) in clone CIP 391598.8 in rainfed treatment condition followed by NPI 106 (146). In irrigated and mulched treatments, clone L 235.4 (194 and 161, respectively) produced highest number of tubers per plot. In rainfed conditions, clone CIP 391598.8 produced the highest weight (3.9 kg/plot) followed by NPI 106 (3.1 kg/plot). CIP 391011.5 was the highest yield producer clone (4.7 kg/plot) in irrigated and mulched conditions, both. Clone CIP 391598.8 produced highest yield tons per hectare (25.7 t/ha) followed by NPI 106 (22.6 t/ha), whereas in irrigated conditions, CIP 391011.5 produced the highest tuber yield (31.2 t/ha). In mulched treatment clone CIP 391011.5 produced highest yield tons per hectare (26.9 t/ha), followed by LBr 40 (26.0 t/ha).

Based on overall performance of two consecutive years, clones CIP 391598.75, NPI 106, CIP 391011.47, CIP 392242.25, CIP 391058.35, CIP 394003.161, CIP 392243.17, PRIMICIA, CIP 378711.7, LBr40, L235-4, CA X 27/40.7, K. SETO-1 and CIP 394007.55 were found better in rainfed conditions in Khumaltar conditions and these clones will be further assessed next year in more locations in the hills.

In among the three treatments, percent emergence, percent ground cover, average number of main stems per plant, total tuber number per plot, total weight per plot and average tuber yield per plot were superior in irrigation treatment. No difference was observed in plant vigor between rainfed and irrigated treatments (Table 2.1). Clones CIP 391598.75, NPI 106, CIP 391011.47, CIP 392242.25, CIP 391058.35, CIP 394003.161, CIP 392243.17, Primicia, CIP 378711.7, LBr 40, L 235-4, Ca x 27/40.7, Khumal Seto-1, CIP 394007.55, K. Chipsona-2 and Ca x LBr-40.6 did well in all of the three moisture conditions.

2.2 PRELIMINARY SCREENING OF MOISTURE STRESS RESISTANT CLONES AT RARS PARWANIPUR, BARA

At RARS Parwanipur, Bara 68 different clones were assessed for their suitability in 3 different moisture conditions as in Khumltar, Laliptur (rainfed, irrigated and mulched conditions). Percent emergence in irrigated and mulched conditions was slightly better compared to rainfed treatment (Table 2.2.1). Plant emergence in all of the three treatments did not differ between the tested clones, however average emergence in rainfed treatment remained slightly lower (90%) than other two treatments (95%).

Plant vigor in majority of the clones was higher in moisture conditions followed by irrigated conditions, but plants were measured taller in rainfed conditions compared to irrigated treatment but shorter than in moisture conditions. The effect of moisture treatments on plant height varied with clones. Average number of main stems per plant counted slightly higher in mulched treatment followed by irrigation. Late blight disease was severe in mulched plants compared to both of other treatments. The severity in rainfed conditions was slightly observed higher than irrigation.

Total number of tubers per plot was counted comparatively higher in irrigated plot, but not much difference observed between rainfed and mulching treatments. The effect of treatments on tuber number differed with clones. Average weight of the tubers per plot was obtained highest from mulched treatment followed by irrigated and rainfed treatments. The weight of the tubers was also affected considerably by the treatments. Clones from mulched plots produced slightly higher tuber yield than irrigated and rainfed plots. Since this is one year result, further verification is recommended with the best performing clones for one year more (Table 2.2.2).

Table 2.1. Treatment effects on vegetative characteristics of different clones, 2067/68, NPRP Khumaltar

Clones	Emergence (%)			Ground cover (%)			Plant height (cm)			Plant vigor (1-5 scale)			Stem/plant (#)			Total tuber/plot Number			Total tuber/plot Wt kg			Adj. yield (t/ha)		
	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
CIP 378711.7	71	100	84	43	58	53	8.4	36.6	28.5	3	4	3	2.2	2.0	2.3	64	109	98	2.1	4.4	2.1	17.3	26.4	12.9
CIP 389660.9	88	100	75	60	65	55	21.4	24.6	23.0	3	5	2	4.5	4.5	3.7	85	98	41	1.9	3.1	1.9	13.7	19.3	12.6
CIP 391011.47	84	100	96	38	45	48	11.9	16.9	16.2	3	4	3	2.8	3.8	2.9	99	149	104	3.0	4.7	3.9	20.7	31.2	26.9
CIP 391058.35	63	75	96	30	55	53	22.7	26.0	27.3	3	3	3	3.2	3.2	2.6	94	103	147	1.9	1.9	3.2	19.8	13.7	20.4
CIP 391061.73	96	100	96	45	53	48	19.5	24.0	21.8	3	4	4	3.0	2.8	2.4	38	60	91	1.2	1.9	2.3	8.6	13.2	16.9
CIP 391598.75	75	100	92	63	73	53	22.9	24.9	23.8	4	4	3	3.7	3.1	2.6	157	98	122	3.9	3.8	3.4	25.7	23.5	24.2
CIP 392242.25	88	91	91	63	85	60	27.0	30.2	23.6	4	5	3	3.2	3.4	3.1	110	136	101	2.9	2.6	3.1	20.5	16.2	20.7
CIP 392243.17	84	100	96	60	63	43	18.3	23.5	20.1	4	4	3	2.6	2.8	2.5	73	110	83	2.0	2.6	2.5	17.4	15.9	15.8
CIP 392244.3	88	92	88	68	78	53	27.4	31.6	28.8	5	4	4	4.0	4.2	3.6	41	79	96	1.0	2.5	1.9	7.4	15.9	15.4
CIP 393385.39	88	100	92	73	88	73	23.8	27.8	23.2	5	5	4	4.7	4.3	3.6	84	139	135	1.8	2.9	3.1	13.8	17.5	20.7
CIP 394003.161	84	96	100	58	65	63	29.6	27.8	29.3	5	5	4	3.0	3.2	2.6	105	111	83	2.9	3.0	2.8	19.0	18.1	18.9
CIP 394007.55	75	100	96	45	68	60	22.4	31.5	28.6	4	5	4	2.9	3.5	2.5	54	77	103	1.6	2.2	1.8	15.5	13.1	13.1
CIP 394051.4	88	100	100	38	53	53	17.7	24.4	22.9	3	4	4	3.8	4.2	3.5	32	89	44	1.2	2.9	1.8	10.4	18.8	12.1
CIP 393574.72B	92	96	92	75	78	83	20.4	21.9	24.4	5	5	4	3.9	4.4	2.7	34	63	33	1.4	1.6	1.1	9.4	10.8	8.7
BR 63-65	96	100	92	63	68	55	20.7	24.6	22.3	5	5	4	3.1	3.1	3.4	62	118	85	1.0	2.2	2.2	7.1	13.6	15.9
BSU PO3	96	100	88	58	70	58	31.2	30.1	29.8	5	4	3	3.7	3.9	2.6	56	93	108	1.4	2.3	3.2	10.0	14.3	21.2
BW3	88	88	79	58	38	40	21.2	19.8	16.5	2	4	2	3.2	2.5	2.5	58	41	63	1.1	1.7	1.9	7.9	10.7	12.3
Cax 27/40.7	63	88	71	25	65	45	21.2	26.6	22.3	2	4	2	1.0	2.2	2.2	57	64	63	1.9	1.9	1.8	16.3	14.3	13.2
CaxLBr40.6	50	100	92	20	48	38	20.3	24.5	29.8	5	3	2	2.2	2.8	2.9	74	127	44	2.2	4.6	3.6	15.4	28.7	23.7
Desiree	75	75	84	45	48	50	25.0	26.9	16.5	3	3	3	3.2	3.6	2.8	65	61	3	1.5	1.9	2.9	12.7	15.2	20
Des x LBr40.10	59	100	84	28	70	58	20.5	24.3	22.3	2	4	4	2.4	1.9	2.8	77	82	85	1.9	3.0	1.6	13.4	20.2	10.1
Des x LBr 44.8	67	96	75	26	58	65	16.8	19.4	22.3	3	4	3	2.5	2.5	3.1	73	76	108	1.7	2.5	2.0	10.9	14.9	12.9
K. Ashoka	59	84	84	28	50	48	16.8	30.3	28.1	2	2	3	2.0	2.4	2.6	69	93	63	1.5	2.6	2.0	10.4	16.1	12.4
K. Kanchan	79	96	92	50	75	73	23.3	22.1	24.5	4	5	6	3.0	2.5	2.9	38	67	63	0.5	1.5	100	3.4	9.7	6.7
K. Sutlez	75	100	83	21	68	43	29.3	29.3	23.6	2	2	2	2.5	3.4	2.6	63	59	41	1.6	1.6	1.1	10.9	10.2	7.8
K. Chipsona-2	59	96	83	30	65	43	17.5	26.9	29.4	2	4	3	2.6	2.5	3.1	116	63	102	1.9	1.6	2.5	15.5	12.9	16.2
K. Jyoti	67	96	84	25	68	60	18.4	27.1	23.1	3	4	3	2.3	2.4	2.2	74	114	108	2.2	3.9	3.7	14.3	24.7	22.9
K. Seto 1	63	100	92	39	75	45	20.7	32.1	31.6	2	3	3	3.7	4.7	2.8	79	96	122	1.7	2.8	3.4	16.0	20.0	21.3
L 235-4	75	96	96	35	78	63	18.1	27.2	21.1	4	5	3	2.1	2.5	2.1	139	194	161	2.4	3.5	2.2	17.1	22.3	14.4
LBr 40	96	96	100	60	78	78	18.2	25.9	25.3	3	5	4	3.2	3.8	3.2	72	87	144	2.6	4.1	3.9	17.2	25.1	26
MS 35.9	58	75	92	38	48	63	18.6	22.9	23.8	32	3	3	2.6	2.8	2.3	134	119	91	1.9	2.5	1.4	13.2	15.3	9.9
NPI 106	75	88	100	30	58	55	19.4	23.6	21.8	3	4	3	3.7	4.3	3.0	146	136	115	3.1	3.6	3.1	22.6	22.9	19.8
Primicia	71	71	96	28	33	65	21.4	25.1	24.8	2	2	3	3.2	2.8	2.3	91	89	95	2.7	2.9	3.1	17.4	18.1	20.5
Mean	77	94	90	44	63	56	21.0	26.1	24.3	4	4	3	3.0	3.2	2.8	79.2	97.0	89.2	1.9	2.8	2.5	14.3	17.7	16.6

Treatments (T): T1: Rainfed, T2: Irrigated, T3: Mulched

Table 2.2.1 Clonal performance in different moisture conditions at RARS Parwanipur, 2067/68

Clones	Emergence (%)			Plant vigor (1-5 scale)			Plant height (cm)			Stem/plant (#)			Late blight (1 – 9 scale)			Total tuber/plot #			Total tuber/plot Wt kg			Yield (t/ha)		
	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
CIP 394004.161	100	100	100	5	9	9	34	29	35	1.6	1.8	1.8	3	5	9	111	84	52	3.2	0.9	1.4	21.3	6.0	9.0
CIP 392243.17	100	100	100	5	8	10	41	31	35	2.4	2	2.2	2	5	2	97	78	60	2.6	1.9	2.4	17.3	13.0	16.0
CIP 391058.35	100	100	100	4	8	9	48	32	43	1.8	1.8	2.4	1	2	3	65	101	83	1.9	1.7	2.2	12.7	11.0	14.9
CIP 392242.25	80	100	90	5	8	10	53	39	44	2.0	2.4	1.4	3	7	3	72	72	60	3.1	2.6	2.8	20.7	17.0	18.3
CIP 378711.7	100	100	90	5	10	9	41	41	44	2.4	1.4	1.6	3	7	8	72	69	77	2.4	2.9	3.2	16.0	19.3	21.0
Primica	100	100	60	4	8	9	30	29	38	1.2	1.8	1.6	5	2	1	64	72	42	1.4	2.3	2.0	9.3	15.1	13.3
CIP 396011.47	90	70	90	4	9	10	35	46	49	1.8	2.2	1.8	2	2	2	63	91	86	2.1	3.1	3.3	14.0	21.0	22.0
Ca x27/40.7	100	100	100	5	8	9	52	34	36	1.2	1.8	1.8	3	3	4	38	50	39	2.3	2.8	2.0	15.3	18.7	13.5
NPI -106	100	100	100	4	8	10	36	25	42	1.6	2.6	2.4	3	7	4	75	113	88	2.6	3.1	2.0	17.3	20.3	13.3
CIP 394007.55	90	100	90	4	8	10	23	39	50	1.2	1.8	1.8	4	3	3	41	57	41	1.7	2.0	1.8	11.3	13.3	11.7
LBr 40	100	100	100	5	9	9	43	54	54	2.2	2	1.4	4	8	2	49	42	43	2.1	2.6	1.5	14.3	17.0	10.2
CIP 389660.9	100	80	100	4	8	8	39	41	45	2.0	2.2	1.8	4	6	8	39	48	50	1.9	2.2	2.8	12.7	14.3	18.9
BR 63.65	100	100	100	4	8	9	35	41	45	3.4	2.6	2.2	0	8	4	94	80	44	2.4	2.5	1.9	16.0	16.7	12.4
Ca x 27/40.5	100	90	100	4	7	8	39	39	34	1.4	1.4	2	2	8	5	33	40	39	1.7	1.5	2.3	11.3	9.7	15.0
CIP 393619.8	70	100	100	3	8	8	28	24	53	1.2	1.4	1.8	2	5	5	45	48	42	1.6	2.2	2.5	10.3	14.3	16.3
CIP 39623.64	100	90	100	3	7	9	29	41	45	1.2	1.6	5	4	8	8	35	28	40	1.7	1.3	1.5	11.3	8.7	10.3
CIP 391061.73	100	100	80	4	8	8	34	38	31	1.8	1.8	1.8	15	8	7	26	51	36	1.0	1.2	1.5	5.1	7.7	10.0
K. Giriraj	80	900	100	4	7	9	33	23	30	1.6	2.4	2.2	5	6	7	47	51	31	1.9	1.9	1.2	12.7	12.5	7.7
L235.4	100	100	100	5	9	9	28	26	33	1.4	1.6	1.6	1	1	1	60	54	83	2.1	2.2	2.2	14.0	14.7	14.7
K. Sutlez	90	90	100	4	7	8	28	32	31	1.2	2.6	2.4	8	9	9	33	46	34	1.5	1.7	1.3	9.7	11.1	8.9
LBr 20	60	100	100	4	8	8	23	21	55	1.8	1.2	5	2	7	5	36	17	25	1.3	1.4	1.4	8.7	9.0	9.4
MS35.9	70	90	100	5	8	9	58	56	41	2.8	2.6	2	3	4	5	61	63	69	2.3	2.4	2.6	15.3	15.7	17.2
CIP 393077.159	80	100	100	5	10	8	31	40	33	1.6	1.6	1.2	3	1	4	42	43	36	2.2	3.4	2.4	14.7	22.7	16.2
CIP 392244.3	90	100	100	5	9	9	27	24	53	1.6	1.4	1.6	3	1	4	38	57	38	2.0	2.0	2.2	13.3	13.3	14.0
CIP 391598.75	100	100	100	4	9	8	42	39	42	2.6	1.8	2.2	5	6	6	76	63	73	2.3	2.7	3.2	15.3	18.0	21.0
CIP 389746.2	90	100	100	5	9	10	44	25	33	1.8	2.8	1.4	3	1	3	32	59	33	2.8	2.7	2.4	18.3	18.0	16.1
Ca x LBr40	70	100	100	5	9	9	31	27	47	2.0	1.6	2	2	1	5	48	51	47	2.8	3.9	2.1	18.7	26.3	14.1
Andinita	60	100	80	5	8	9	43	31	34	2.0	2.6	1.8	4	6	5	52	73	38	1.9	1.6	1.9	13.0	10.7	12.9
Des x LBr 40	70	90	100	4	7	10	29	29	49	1.2	1.8	1.4	4	8	8	38	49	54	2.1	2.6	2.8	14.0	17.3	18.3
CIP 392661.18	50	70	100	3	8	9	51	34	43	1.5	1	1.5	1	1	3	33	44	35	1.2	2.1	1.7	8.0	14.0	11.1
CIP389660.9	80	80	100	5	9	10	39	46	22	1.4	2.4	1.6	1	1	1	43	57	52	2.6	3.6	3.1	17.0	23.7	20.3
CIP 388574.72B	60	90	90	3	7	8	16	21	31	1.8	1.6	1.4	2	2	3	47	37	26	1.0	1.3	1.0	6.0	8.7	5.7
CIP 394051.4	70	100	90	4	7	8	38	19	31	2.8	1.4	1.8	2	7	8	21	24	28	1.7	1.2	1.8	11.0	7.7	12.1
Des x LBr 40.7	80	90	100	4	7	7	30	14	42	1.4	1.8	2.2	5	8	9	35	38	40	1.0	1.0	2.2	5.0	6.0	14.7
BSUP03	90	100	100	9	8	10	34	26	34	2.2	2	1.8	1	1	2	59	66	59	1.9	1.3	2.4	12.7	8.7	16.0
K. Chispona-2	70	100	100	7	8	10	45	21	45	2.4	1.6	2.1	4	1	3	77	62	65	1.8	1.0	2.9	12.0	2.7	19.3
Desiree x 27/40.8	90	100	100	9	8	7	37	34	37	1.8	1.4	5	7	2	3	64	80	59	2.0	1.4	2.5	13.3	9.3	16.7
Desiree x LBr44.8	100	100	100	9	9	8	43	29	43	3.0	2.4	1.4	9	1	5	69	75	44	1.8	2.0	2.2	12.0	13.3	14.7
Desiree x 27/40.6	90	100	90	10	10	8	37	33	43	1.4	1.4	1.4	4	1	2	43	102	46	2.6	2.5	3.0	17.3	16.7	20.2

Treatments (T): T1: Rainfed, T2: Irrigated, T3: Mulched

Table 2.2.2. Clonal performance in different moisture conditions at RARS Parwanipur, 2067/68

Clones	Emergence (%)			Plant vigor (1-5 scale)			Plant height (cm)			Stem/plant (#)			Late blight (1 – 9 scale)			Total tuber/plot #			Total tuber/plot Wt kg			Yield (t/ha)		
	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
K. Kanchan	100	100	100	9	9	9	39	26	37	1.2	1.4	1.6	1	1	2	38	54	36	1.0	1.3	1.3	4.7	8..7	8.3
K.Ashoka	90	100	80	9	10	8	25	38	39	2.4	2	2.2	5	1	7	57	97	81	2.2	2.7	4.0	14.7	18.0	26.7
CIP 391004.18	100	100	100	10	10	10	35	31	25	2	5.2	3	2	1	3	87	110	60	2.7	3.6	2.7	18.0	24.0	18.0
CIP 390663.8	90	90	90	9	10	10	33	30	35	4.2	3	3.4	4	1	4	90	55	65	3.1	2.5	4.0	20.7	16.7	26.7
CIP 39404.65	90	90	90	9	10	9	36	25	33	1.8	3.2	2.4	2	1	7	56	105	76	2.7	2.7	3.3	18.0	18.0	21.7
CIP 386611.22	90	100	90	8	7	8	32	31	36	1.6	1	1.4	9	2	9	35	32	25	1.9	1.0	1.6	12.3	5.0	10.3
Baronesa	80	100	90	9	10	9	62	28	32	2	2.2	2.2	9	5	9	59	67	56	2.7	2.5	2.7	18.0	16.7	18.0
CIP 395192.1	90	100	80	10	9	10	38	57	62	3.2	3	2.2	1	1	5	64	64	50	3.8	3.2	4.0	25.0	21.3	26.7
CIP 392270.32	100	100	90	9	9	10	45	25	38	3.2	4.2	3.2	3	2	5	89	98	92	1.9	2.4	2.6	12.7	16.0	17.3
K.Badsah	100	80	100	9	9	9	67	31	45	2.2	3	1.6	4	2	5	43	86	41	2.3	2.6	2.8	15.3	17.3	18.3
CIP 392280.64	100	90	100	10	9	9	47	65	67	3	1.8	3.6	4	1	5	83	85	72	2.8	2.8	2.9	18.7	18.7	19.3
CIP 387115.8LB	90	80	100	9	10	9	34	43	47	2.4	4.8	3.6	6	3	5	69	87	76	2.7	3.5	3.5	18.0	23.3	23.3
CIP 393574.61	100	80	90	8	9	8	29	27	34	2.6	1.8	1.8	7	1	4	71	66	59	1.0	2.3	2.6	4.4	15.3	17.3
CIP 397077.16	100	100	90	9	10	9	36	23	29	1.2	1.8	1.8	1	2	3	40	49	28	2.5	2.7	2.2	16.7	18.0	14.7
CIP 386612.5	100	100	100	8	9	9	34	24	36	2.6	2.6	2.8	3	1	3	61	72	71	2.7	2.9	3.2	18.0	19.0	21.3
CIP 392256.48	90	90	80	9	9	9	46	23	34	2.2	1.8	1.6	3	2	7	55	46	38	2.3	2.3	1.8	15.3	10.7	11.9
CIP 39256.48	90	100	90	8	9	8	32	25	46	1.6	1	2.2	9	3	9	46	46	39	1.5	1.5	1.1	10.0	7.0	7.1
CIP 388576.1D	100	90	90	7	9	8	23	28	32	2.8	4.4	4.4	8	1	9	65	78	67	2.5	2.5	2.9	16.7	19.3	19.3
CIP 39339.242	100	90	100	7	8	8	46	49	23	2.6	2.8	2.8	9	2	9	72	76	58	1.7	1.6	1.5	10.7	11.0	10.0
LBR44	90	90	100	7	10	9	49	36	46	2.4	3.4	2.4	8	1	9	60	59	54	1.4	2.7	1.9	18.0	9.3	12.7
CIP 388764.26LB	90	100	90	8	10	8	43	39	49	4.8	2.2	2.8	7	2	1	96	93	77	3.4	3.1	3.6	20.7	22.7	24.0
CEZ 69.1	80	100	100	6	8	9	32	26	43	2	2.2	3.2	5	2	1	78	61	98	2.1	1.9	2.2	14.0	12.3	14.3
CIP 388676.1	90	100	100	8	8	8	43	21	32	1.8	2.2	2.6	4	2	4	41	73	54	2.4	2.1	3.6	15.7	13.7	23.7
NPRP285861.2	90	80	100	9	8	9	71	24	43	3.4	3	2.2	5	2	2	61	91	55	1.9	1.2	2.2	12.3	8.0	14.7
CIP 358861.13	100	100	100	10	10	10	40	57	71	2.2	1.6	3.6	6	3	2	73	55	89	2.8	1.9	2.7	18.7	12.7	17.7
C 140	100	100	100	9	10	9	32	32	40	2.2	1.4	2.4	2	2	4	110	158	140	2.1	2.6	2.7	14.0	17.3	18.0
K. Sindhuri (ch)	100	100	90	8	9	8	41	38	32	2.2	2.2	1.8	2	1	2	111	131	83	2.4	2.9	2.3	16.0	19.3	15.3
CIP 388572.1K	100	100	100	9	9	9	31	41	41	2.8	2.2	2.6	6	4	3	69	61	70	2.3	2.2	2.6	15.3	14.3	17.3
Desiree	100	100	100	8	9	7	28	23	31	2	2.2	2.8	8	3	3	52	56	40	2.3	2.3	2.4	15.0	15.5	16.0
Mean	90	95	95	6.4	8.6	8.8	37.9	32.9	40.2	2.1	2.2	2.3	4.1	3.3	4.7	58.9	66.9	55.7	2.1	2.2	2.4	14.2	14.7	15.8

Treatments (T): T1: Rainfed, T2: Irrigated, T3: Mulched

3.0 WEED MANAGEMENT STUDY ON POTATO

Introduction

Potato is the most important vegetable crop as well as staple food crop of Nepal. The average on-station yield is recorded about 25 t/ha whereas the national productivity is quite low (13.58 t/ha). One of the causes of low productivity of potato is due to weed problem in the potato field especially during tuber bulking period (after 50 DAP) in all potato growing regions. So attention has to be paid to this aspect also. The yield losses in potato crop due to weeds range from 10-80 per cent. The result of three year's trial showed that the yield loss of potato due to weed infestation was from 26.7 to 89.8 percent in Khumaltar condition where as it was 23.4 to 75.1 % at Malepatan, Pokhara. Weeds are the major problems in potato production, which can reduce yields through direct competition for light, moisture and nutrients as well as by harboring insects and diseases that attack potatoes. From the research findings, it is noticed that if weeds are not controlled in potato field, they draw 47.5 kg N, 11.9 kg P and 51.9 kg K from the soil. This nutrient loss results in inadequate for proper potato growth, due to which yield will loss remarkably.

The cost of production goes even higher as weed control practices through human labor is costlier. These days, there is a labor scarcity at the time of crop period, especially for large scale production, and labor wages is also increasing over times. So farmers are facing problems to control weeds. Some farmers are even unaware of the yield loss due to weed competition in potato crop. So far, no research work has been done on weed management practices in potato crop in Nepal. So there was an urgent need to find out the low cost management options to minimize the losses caused by weed infestation. Keeping these points in view, weed management research was conducted at Agriculture Research Station (Hort.) Malepatan, Pokhara during winter season and at Hattiban Farm NPDP, Khumaltar during spring season of 2066/2067.

Materials and Methods

The experiment was laid out in RCBD with three replications of eleven treatments; weedy check, weed free check (Hand weeding at 15 days intervals), one hand weeding + earthing up, mulching with straw, mulching with black polythene sheet, Metribuzin 0.75 kg a.i./ha at 3-4 days after planting, Metribuzin 0.75 kg a.i/ha at 3-4 days after planting + one hand weeding at 45 days after planting, Pendimethalin 1.0 kg a.i./ha at 3-4 days after planting, Pendimethalin 1.0 kg a.i./ha at 3-4 days after planting + one hand weeding at 45 days after planting, Paraquat @ 0.5 kg /ha at 15 days after planting and Paraquat @ 0.5 kg /ha at 15 days after planting + one hand weeding at 45 days after planting.

The plot size was maintained 7.2 m^2 for each treatment with 60cm x 25cm row to row and plant to plant spacing. Fertilizers and manures were applied @ 100:100:60 kg NPK and 20 tons of compost per hectare. All chemical fertilizers and compost were applied as basal dose. Potato tubers were planted on 4th Munsir and harvested on 5th Chaita 2067 at Malepatan Pokhara where as at Hattiban Khumaltar, planting was done on 12th Magh and harvested on 02nd Jestha, 2068. One day after planting, irrigation was applied in both location and next day of irrigation, Metribuzin and Pendimethalin were sprayed as pre-emergence herbicides in the soil. Paraquat was sprayed after (5-10% germination) 18 days of planting as post emergence herbicide. Other cultural practices were applied as per the recommendation made by NPRP. Data were recorded on emergence percentage in 30 days at Malepatan Pokhara and in 45 days at Hattiban Khumaltar after planting, uniformity, ground coverage, plant height, number

of stems/plant, tuber size and tuber yield/plot. Statistical analysis was carried out applying M-stat C statistical package. Weed count was done at 45 days and before harvest using 0.5 m^2 area at two spots within a plot and they were categorized into broad leaf and narrow leaf grasses and sedges. Number, Fresh weight and dry weight (g/m^2) of weed was taken per individual treatment.

Weed control efficiency was calculated using the formula:

$$\text{Weed control efficiency} = \frac{\text{Weed DM matter yield in control} - \text{weed DM yield in treatment}}{\text{Weed dry matter yield in control}} \times 100$$

Results and Discussion

3.1 INTEGRATED WEED MANAGEMENT STUDY ON POTATO AT MALEPATAN, POKHARA

Emergence percentage

The highest emergence percentage (99.3) was found in black plastic mulching followed by hand weeding plus earthing-up and Paraquat @ 0.5 kg /ha (98.6) respectively and the lowest (94.4) was in the treatment straw mulching which was statistically non-significant. Proper germination might be due to the proper moisture in the soil with regular irrigation and well sprouted seed tubers used.

Ground coverage and uniformity

The highest ground coverage (98.3%) was recorded in black plastic mulching. It might be due to suppressed of weed germination by black plastic mulching so that the crop utilized soil nutrients properly and growth was fast. The lowest ground coverage (83.3%) was weedy check treatment which might be due to crop suppressed by weeds.

Black plastic mulching recorded the highest uniformity (5). Nearly total tubers emerged at the same time due to regular irrigation, proper soil temperature, well sprouted healthy tubers and uniform soil fertility in the field. The lowest uniformity (3.0) was recorded in control treatment.

Stems per plant and plant height (cm)

The highest number of stems (6.3) was recorded in plastic mulching followed by straw mulching (5.8) and the lowest (4.3) was in weedy check treatment (control) which might be due to the weed suppression.

The maximum plant height (67.4cm) was recorded in crop mulched with black polythene sheet followed by straw mulching (67.2 cm). The minimum plant height (51.7 cm) was obtained in the treatment Metribuzin 0.75 kg a.i./ha.

Late blight

Late blight symptoms were seen even in Janakdev in few weed control treatments.

Number of tubers and tuber yield (t/ha)

The significantly highest number of tubers (700.7) per plot was found in the treatment one hand weeding plus earthing up followed by straw mulching (426). The lowest number of tubers (253.7) was recorded in Paraquat plus one hand weeding. Similarly, significantly highest tuber yield (34.7 t/ha) was recorded in mulching with black polythene sheet followed by Pendimethalin 1.0 kg a.i./ha (32.4 t/ha). The lowest tuber yield (16.4 t/ha) was found in weedy check treatment. It showed that all the weed control treatments produced more yield as compare to control treatment.

Weed control efficiency

The highest weed control efficiency (99.5%) was observed in Metribuzin 0.75.kg a.i./ha followed Pendimethalin 1.0 kg a.i./ha (97.9%). The lowest weed control efficiency (36.6%) was in one hand weeding plus earthing up.

Table 3.1. Effect of weed control methods in tuber nuber and yield of potato at Malepatan, 2067/68

Treatments	Emerg %	Groun cover %	Unifor mity	Stems /plt (#)	Plant ht (cm)	Late light	Tubers /plot	Tuber yield t/ha	WC E (%)
Weedy control	95.1	83.3	3	4.3	55.9	2	318.3	22.8	0.0
Weed free check	97.2	85.0	4	4.6	57.9	2	299.0	26.2	80.0
One hand weeding + earthing up	98.6	83.3	4	4.4	53.7	0	700.7	24.3	36.6
Mulching with straw	94.4	93.3	4	5.8	67.2	0	426.0	30.6	81.3
Black plastic mulching	99.3	98.3	5	6.3	67.4	1.3	368.0	34.7	93.6
Metribuzin 0.75 kg a.i./ha	96.5	83.3	3	4.5	51.7	1.7	353.0	25.5	99.5
Metribuzin + one hand weeding	93.8	90.0	4	5.0	55.6	0	322.0	26.0	95.1
Pendimethalin 1.0 kg a.i./ha	95.1	88.3	4	4.9	52.9	2	328.7	32.4	97.9
Pendimethalin + one hand weeding	96.5	90.0	4	5.0	54.7	0	337.3	27.7	97.2
Paraquat @ 0.5 kg /ha	98.6	88.3	4	5.5	56.4	0	332.7	28.5	74.6
Paraquat + one hand weeding	95.8	86.7	4	4.5	55.6	1	253.7	28.2	72.7
F-test	NS	**		NS	**		NS	*	
LSD(0.05)	4.98	7.19		1.88	7.0		350.1	6.61	
CV %	3.0	4.8		22.2	7.2		56.0	13.9	

3.2 INTEGRATED WEED MANAGEMENT STUDY ON POTATO AT HATTIBAN FARM, KHUMALTAR

Emergence percentage

The highest percent of emergence (100) was recorded in Paraquat plus one hand weeding followed by crop mulched with black polythene sheet and Pendimethalin plus one hand weeding at 45 days (98.6%) and the lowest (91.7) was recorded in Pendimethalin 1.0 kg a.i./ha.

Ground coverage and plant uniformity

The significantly highest percent of ground coverage (85) was in the crop mulched with black polythene sheet followed by straw mulching (68.3). The lowest ground coverage (43.3) was in weedy check treatment which might be due to crop suppressed by weeds. Plant uniformity was found significantly highest (5) on mulching with black polythene sheet followed by Paraquat plus one hand weeding (4.3). It might be due to nearly total tubers emerged at the same time due to enhanced soil moisture, proper soil temperature in black polythene mulching treatment. The lowest uniformity (3.0) was recorded in the control treatment.

Stems per plant and plant height (cm)

The highest number of stems per plant (3.7) was recorded in weed free check and Metribuzin plus one hand weeding followed by Pendimethalin plus one hand weeding and the lowest (2.4) was in Pendimethalin 1.0 kg a.i./ha. It was statistically non-significant. The maximum plant height (76.5 cm) was recorded in mulching with straw followed by Pendimethalin plus one hand weeding (72.8cm) whereas the minimum plant height (53.8 cm) was obtained in control treatment. The result was statistically significant.

Number of tubers and tuber yield (t/ha)

The highest number of tubers (562.7/plot) was found when the crop was mulched with black plastic followed by straw mulching (478.0). The lowest number of tubers (263.3) was recorded in control treatment. The tuber numbers showed a significant result. The highest tuber yield (37.6 t/ha) was recorded in black polythene sheet mulching followed Metribuzin 0.75 kg a.i./ha (28.3 t/ha). The lowest tuber yield (2.9 t/ha) was obtained in weedy check treatment. The tuber yield was highly significant.

Weed control efficiency percentage

The highest weed control efficiency (93.7%) was observed on black plastic mulching followed by Pendimethalin plus one hand weeding. The lowest weed control efficiency was (41.2%) in one hand weeding plus earthing up.

Table 3.2. Effect of weed control methods in yield and yield attributing parameters in potato at Hattiban (2067-68)

Treatments	Emerg %	G. C. %	Uniformity	Stems / plant	Plant ht (cm)	Tubers /plot	Tuber yld (kg/plot)	Tuber Yld (t/ha)	WCE (%)
Weedy control	96.5	43.3	3.0	2.9	53.8	263.3	7.733	12.9	0.0
Weed free check	96.5	65.0	3.7	3.7	65.7	350.0	14.6	24.3	80.1
One hand weeding + earthing up	95.8	55.0	3.7	3.0	69.1	315.3	14.6	24.3	41.2
Mulching with straw	93.1	68.3	4.0	2.5	76.5	478.0	14.5	24.3	88.6
Black plastic mulching	98.6	85.0	5.0	2.9	70.1	562.7	22.6	37.6	93.7
Metribuzin 0.75 kg a.i./ha	97.9	61.7	3.3	2.9	70.6	385.3	17.0	28.3	87.5
Metribuzin + one hand weeding	95.2	63.3	3.7	3.7	67.4	362.0	16.1	26.8	92.0
Pendimethalin 1.0 kg a.i./ha	91.7	61.7	3.7	2.4	68.1	306.7	15.4	25.7	84.6
Pendimethalin + one hand weeding	98.6	60.0	3.7	3.6	72.8	352.3	16.6	27.7	92.1
Paraquat @ 0.5 kg /ha	94.4	51.7	3.3	3.4	58.1	291.7	10.5	17.4	55.4
Paraquat + one hand weeding	100	66.7	4.3	3.1	69.7	377.0	16.2	26.9	71.2
F-Test	NS	*	*	NS	**	**	**	**	
LSD(0.05)	6.7	14.4	0.84	1.17	9.49	124.1	3.64	6.08	
CV (%)	4.1	13.6	13.2	22.2	8.3	19.8	14.3	14.3	

Note: G.C.%= Ground Coverage %, WC Effecy.%= Weed control Efficiency

3.3 VERIFICATIONS OF WEED CONTROL METHODS ON POTATO YIELD IN FARMER'S FIELD

From two years research finding of Malepatan Pokhara and Hattiban Khumaltar, five weed control methods were selected for verification in farmer's field. The sites for verification were selected at Hemja Kaski and Tikathal Lalitpur. Three farmers from each site were selected as replications. The five treatments were control (no weeding), farmer's practice, black plastic mulching, Metribuzin as pre-emergence weedicide and Paraquat as post-emergence weedicide. The potato variety used was Janakdev. Other cultural practices were applied as NPRP recommendation. Potato planting was done in 2067-04-05 and harvested in 2067-11-28 at Hemja Kaski, whereas in case of Tikathali, Lalitpur, planting and harvesting were done in 2067-10-18 and 2068-02-04, respectively. First irrigation was done two days after planting (for herbicide application).

In Hemja Kaski, the highest tuber yield (28.8 t/ha) was recorded in plastic mulching followed by Paraquat spray, whereas in Tikathali Lalitpur, the highest tuber yield (34.7 t/ha) was obtained in Paraquat spray followed by plastic mulching (34.0 t/ha).

Table 3.3. Effect of the weed control methods in tuber yield of potato at Hemja Kaski (2067/68)

Treatments	Rep I		Rep II		Rep III		Mean no. and yield (kg)/plot		Yield (t/ha)
	No.	Yield	No.	Yield	No.	Yield	No.	Yield	
T1= control (no weeding)	376.0	12.9	370.0	16.0	319.0	13.3	355.0	14.1	19.5
T2=Farmer's Practice	332.0	15.6	450.0	18.5	348.0	17.4	376.7	17.2	23.8
T3=Mulching	410.0	17.0	433.0	23.2	393.0	22.0	412.0	20.7	28.8
T4=Metribuzin	300.0	17.0	478.0	19.2	374.0	15.0	384.0	17.1	23.7
T5=Paraquat	406.0	15.9	548.0	20.8	354.0	17.3	436.0	18.0	25.0

Table 3.4. Effect of the weed control methods in tuber yield of potato at Tikathali Lalitpur (2067/68)

Treatments	Rep I		Rep II		Rep III		Mean no. and yield (kg)/plot		Yield (t/ha)
	No.	Yield	No.	Yield	No.	Yield	No.	Yield	
T1= Control (no weeding)	566	20.9	482	18.9	405	16.45	484.3	18.75	26.0
T2=Farmer's Practice	391	17.6	487	23.7	469	16.45	449.0	19.25	26.7
T3=Mulching	534	27.5	512	22.1	582	23.75	542.7	24.45	34.0
T4=Metribuzin	512	21.7	545	23.4	405	20	487.3	21.70	30.1
T5=Paraquat	505	23.3	638	27.15	517	24.4	553.3	24.95	34.7

Conclusion

Among the treatments tested for weed control in potato at ARS (Hort.) Malepatan Pokhara, the highest tuber yield (34.7 t/ha) was recorded in black polythene sheet mulching followed by Pendimethalin 1.0 kg a.i./ha (32.4 t/ha). Weed control efficiency was found maximum (99.5%) in Metribuzin.

In NPRP Khumaltar at Hattiban research farm, the highest tuber yield (37.6 t/ha) was recorded in black plastic mulching followed by Metribuzin 0.75 kg a.i./ha (28.3 t/ha). Maximum weed control efficiency was (93.7%) in black plastic mulching. It is noticed from the findings that all the weed control treatments produced better yield in comparison to weedy check, both in Malepatan, Pokhara and Tikathali, Lalitpur.

In farmer's field, both plastic mulching and Paraquat spray showed similar response to potato yield. But for weed control, Metribuzin was the best in both places.

4.0 TRUE POTATO SEED (TPS) RESEARCH

4.1. EVALUATION TPS FAMILIES FOR SEEDLING TUBER PRODUCTION IN THE NURSERY BED

Introduction

This experiment was conducted at NPRP, Khumaltar; RARS, Nepalganj, and ARS (Hort.) Rajikot, Jumla. The major objectives were to identify the suitable TPS F_1 progenies with good uniformity, color, shape and resistant to pest and diseases and high productivity; to evaluate the parental lines and recommend TPS families for mid hill and Terai.

Materials and Methods

Twelve hybrid TPS families namely C96H-02.7x TPS - 13, C96H-13.29x TPS - 13, C96H-02.4x C98HT-64.8, C96H-02.4x C99HT -2-32.17, C96H-02.4x C99HT-2-58.1, C98HT-200.14 x C99HT-2-58.1, LT 8x TPS-13, LT 8 xTPS-67, MF II x TPS - 67, TPS 7 x TPS -67, HPS II/67 and HPS 7/67 were sown in nursery bed at NPRP Khumaltar, RARS, Nepalganj, and ARS Rajikot, Jumla received from the International Potato Center (CIP) Peru and HPS II/67 and HPS 7/67 were used as the check families for seedling tuber production. Plot size was 1 m x 1 m. TPS families were sown in RCBD with three replications. Nursery bed was raised to 15 cm high with a mixture of soil and farmyard manure (1:1 ratio). At the time of seed sowing half centimeter layer of fine compost was broadcasted and seeds were sown in the holes prepared by marker board and covered with further half centimeter layer of fine compost. Since seeds were very delicate and sensitive, beds were mulched with paddy straw. Plots were watered daily until seeds germinated well. Fertilizer was used at the rate of 150:100:50 NPK kg/ha. One hundred seedlings were maintained in 1-m^2 beds with 25 cm x 4 cm spacing; the excess plants were thinned out after germination. Earthing-up was done twice, once at 45 days after sowing (DAS) and another at 60 DAS. Harvesting was done at full maturity stage of the crops.

Results and Discussion

Khumaltar

Seeding of TPS family was done in Magh 11, 2067 and harvesting in 2068-02-16. After proper germination, hundred plants were maintained per plot in each treatment. The maximum number of stems per plant (1.9) was recorded in the family C96H-02.4 x C98HT-64.8 and minimum (1.2) in the family LT 8 x TPS-13 (Table 4.1). The maximum plant height (53.9 cm) was observed in the family HPS II/67 where as the minimum (42.7 cm) in the family LT 8 x TPS-67.TPS family HPS II/67 produced the maximum numbers of smallest (>20 g) seedling tubers (461.7), whereas the highest tuber yield (<20 g) was (1.2 kg/plot) in the family LT 8 xTPS-67HPS 7/67. The minimum numbers (11.7) per plot and tuber yield (0.03 kg) was recorded in the family HPS 7/67. It was due to low germination. The family C96H-02.7x TPS-13 produced the maximum tuber numbers (202), whereas the highest tuber yield (2.9 kg/plot) was in the family C96H-02.4 x C99HT-2-58.1 and the lowest numbers per plot (8.7) and tuber yield (0.2 kg) was recorded in the family HPS 7/67 of 20-40g seedling tubers. The highest tuber yield (0.5 kg/plot) and tuber numbers (13) of tuber size <40 grams was recorded in the family C96H 02.4 x C99HT-2-32.17, whereas the minimum number (1.7) and yield (0.1 kg) in LT 8 x TPS-13. The maximum tuber numbers (595/plot) was recorded in

the family HPS II/67, but the highest tuber yield (4.2 kg/plot) was in the family C96H-02.4 x C98HT-64.8 and C96H-02.4 x C99HT-2-58.1. The lowest tuber numbers and tuber yield (20.4 and 0.23 kg) was in the family HPS 7/67; it might be due to poor germination of the seed. The tuber numbers and yields among the TPS genotypes were statistically significant.

Table 4.1. Yield and yield attributing parameters in TPS Family of potato at Hattiban (2067/68)

Treatments	Emergence %	Stems / plant	Plant height (cm)	Undersized (>20 g) tubers/plot		Seed sized (20-40 g) tubers/plot		Over sized (<40 g) tubers/plot		Total no. and yield (kg)/plot	
				No.	Yield	No.	Yield	No.	Yield	No.	Yield
C96H-02.7 x TPS - 13	100	1.6	52.7	195.7	0.7	202.0	2.8	8.7	0.4	406.4	3.9
C96H-13.29 x TPS - 13	100	1.3	50.1	253.7	1.0	131.3	2.2	4.7	0.3	389.7	3.4
C96H-02.4 x C98HT-64.8	100	1.9	51.7	366.3	1.0	178.0	2.7	9.0	0.4	553.3	4.2
C96H-02.4 x C99HT -2-32.17	100	1.6	47.7	193.3	0.8	135.0	2.1	13.0	0.5	341.3	3.4
C96H-02.4 x C99HT-2-58.1	100	1.3	49.9	286.3	1.0	177.0	2.9	5.0	0.3	468.3	4.2
C98HT-200.14 x C99HT-2-58.1	100	1.3	49.2	187.7	0.7	97.0	1.4	11.7	0.5	296.4	2.5
LT 8 x TPS-13	100	1.2	53.3	245.7	0.9	139.7	2.2	1.7	0.1	387.1	3.2
LT 8 x TPS-67	100	1.5	42.7	357.7	1.2	150.7	1.8	4.0	0.2	512.4	3.2
MF II x TPS - 67	100	1.3	52.9	345.7	1.0	135.3	1.6	5.0	0.3	486.0	2.9
TPS 7 x TPS -67	100	1.4	46.2	296.7	0.9	104.7	1.2	2.3	0.1	403.7	2.2
HPS II/67	100	1.3	53.9	461.7	1.0	129.3	1.3	4.0	0.2	595.0	2.5
HPS 7/67	5	0	0	11.7	0.03	8.7	0.2	0.0	0.0	20.4	0.23
F-test										**	**
LSD(0.05)										141.8	3.86
CV %										21.6	19.3

Nepalganj

Seeds of twelve hybrid TPS families namely C96H-02.7x TPS - 13, C96H-13.29x TPS - 13, C96H-02.4x C98HT-64.8, C96H-02.4x C99HT-2-32.17, C96H-02.4 x C99HT-2-58.1, C98HT-200.14 x C99HT-2-58.1, LT 8x TPS-13, LT 8 xTPS-67, MF II x TPS - 67, TPS 7 x TPS-67, HPS II/67 and HPS 7/67 were sown in nursery bed on 17 Kartik, 2067 and harvested on 10 Falgun, 2067. Other cultural practices were adopted as recommendation made by NPRP. The highest percent of germination (80.0) was recorded in the family MFII x TPS 67 and the lowest (14.7) was in HPS 7/67 (Table 4.2). Plants were not grown properly; it may be due to soil fertility, irrigation problem or other causes. The maximum percent of ground coverage (40) was in C96H-02.4 x C99HT 2-58.1 and C98HT 200.14 x C99HT 2-58.1 and the minimum (15) was in HPS 7/67. Uniformity was found different among the families. Plant height was maximum (23.1cm) in the family LT 8 x TPS 13 and the minimum (7.5 cm) was recorded in HPS 7/67. The Minimum late blight infestation (1.7) was recorded in HPS 7/67 and the maximum (3.7) in LT 8 x TPS 67.

Maximum tubers (438.7) were produced in C96H-02.7 x C99HT 2- 32.17, whereas the highest yield (2.35 kg/plot) was recorded in the family LT 8 x TPS 13, though not statistically significant. The minimum tubers (56.3/plot) and yield (0.238 kg/plot) was recorded in the family HPS 7/67.

Table 4.2. Yield and yield attributing parameters in TPS Family of potato at Nepalgunj 2010/11(2067/68)

Treatments	Potato Emerg. %	G.Coverage %	Uniformity	Stems /plant	Plant ht (cm)	Late blight	Per plot	
							No	Yield (kg)
C96H 02.7 x TPS 13	43.0	23.3	2.3	1.5	11.6	2.3	228.7	1.233
C96H 13.29 x TPS 13	48.0	25.0	2.0	1.7	21.9	2.3	223.3	0.977
C96H 02.4 x C98HT 64.8	74.3	31.7	2.0	1.7	19.8	2.7	417.3	2.068
C96H 02.7 x C99HT 2- 32.17	69.0	33.3	1.3	2.0	21.1	2.0	438.7	1.840
C96H 02.4 x C99HT 2-58.1	67.0	40.0	1.7	1.7	16.3	3.0	349.7	1.443
C98HT 200.14 x C99HT 2-58.1	41.0	40.0	2.0	2.3	21.9	2.3	232.0	1.153
LT 8 x TPS 13	76.3	38.3	1.3	2.3	23.1	2.0	405.0	2.350
LT 8 x TPS 67	60.3	38.3	1.7	1.7	20.3	3.7	332.0	1.520
MFII x TPS 67	80.0	36.7	1.7	2.1	17.4	2.0	429.7	1.679
TPS 7 x TPS 67	66.0	35.0	2.3	1.9	16.5	2.0	397.3	1.572
HPS II/67	44.0	28.3	2.3	1.7	13.1	3.0	278.0	1.065
HPS 7/67	14.7	15.0	1.7	1.0	7.5	1.7	56.3	0.238
F-test	**	**	NS	**	**	*	*	NS
LSD(0.05)	27.16	8.467	1.315	0.62	4.578	1.188	195.1	1.102
CV %	28.2	15.6	41.7	20.2	15.4	29.0	56.0	62.4

Jumla

Seed sowing was done in 8 Chaitra, 2068 and harvesting was done in 20 Bhadra, 2068. Layout, treatment allocation and other cultural practices were adopted as NPRP Khumaltar's recommendation. According to the data recorded in ARS Jumla, there was more than 50 percent in germination of TPS families and crop stand was good due to regular rain fall. Results of total tubers per plot showed that genotype number 903035 produced the highest numbers (233/m^2) followed by 903027 (209/m^2), but in tuber yield, genotype 903027 produced the highest tuber yield (3.78 kg/plot) followed by genotype 903051 (3.22 kg/plot) (Table 4.3). The lowest tuber numbers (68) was in 903135, but the lowest tuber yield (0.9 kg/plot) was in the family 988143. The family HPS 7/67 was not germinated.

Table 4.3. Evaluation of TPS families for seedling tuber production at ARS Jumla, 2010/11 (2067/68)

Entries	Emergence %	Uniformity	G C (%)	Plant ht (cm)	Main stems /plant	Plant type	Flowering catagory	Tuber shape	Tuber color	Total tubers /plot	Tuber wt /plot (kg)
902007	21	4	76	57	2	E	M	Round	W	102	2.46
902014	66	5	90	54	2	E	M	Round	W	130	2.07
903027	68	5	91	71	3	E	M	Round	W	209	3.78
903035	75	5	87	56	3	E	M	Round	W	233	2.84
903051	73	5	90	55	3	E	M	Round	W	200	3.22
903135	59	4	77	54	2	E	M	Round	W	68	1.15
994013	56	4	72	50	2	E	M	Round	W	110	1.66
994014	62	4	78	48	2	E	M	Round	W	113	1.23
988141	70	5	78	52	2	E	M	Round	W	172	1.65
988143	56	5	72	49	3	E	M	Round	W	85	0.9
HPS 2/67	61	4	73	39	2	E	M	Round	W	179	1.17
HPS 7/67	0	0	0	0	0	0	0	Round	0	0	0

4.2 EVALUATION OF F_1C_1 TUBERLETS OF TPS FOR POTATO PRODUCTION

Introduction

This experiment was conducted at NPRP, Khumaltar; RARS, Nepalganj, Tikathali, Lalitpur and ARS (Hort.) Rajikot, Jumla. The major objectives were to identify the suitable TPS progenies with good uniformity, color, shape and resistance to pest and diseases, and high productivity, to recommend TPS families for respective agro-ecological zones and to evaluate the parental lines and ware potato production.

Materials and Methods

This trial was conducted using tuberlets from previous year's nursery bed trial. Fourteen TPS families were planted, where Kufri Jyoti and Janak Dev were used as check varieties. Size of each plot was 3 m x 2.4 m (7.2 m^2). Seed tubers (20-40 g) were planted on ridges by maintaining ridge-to-ridge 60 cm and plant-to-plant 25 cm distance. Fertilizer was used at the rate 100:100:60 NPK kg/ha with 20 t FYM/ha. Each TPS F_1C_1 generation was replicated three times. No fungicide application was applied and other management practices were followed as per NPRP recommendation.

Results and Discussion

Khumaltar

Planting at Khumaltar was done in 13th Magh, 2067 and harvesting was done in 2nd Jestha, 2068. The percent emergence was highest (95.1) in C96H-02.4 x C99HT-2-58.1 followed by C96H-02.7 x TPS - 13 (93.8) (Table 4.4), whereas the lowest was in Janak Dev (76.7). Percent of ground coverage was the highest (80.0) on C96H-02.4 x C99HT-2-58.1, but the lowest (63.3) was recorded in the family C96H-02.4 x C98HT-64.8. The plant uniformity was highest (4.0) in the families C96H-02.7 x TPS - 13, C96H-02.4 x C99HT-2-58.1, Janak

Table 4.4. Yield and yield attributing parameters in TPS F_1C_1 generation of potato at Hattiban (2067/68)

Treatments	Emer-gence %	Ground coverage %	Unifor mity	Stems/ plant (No.)	Plant height (cm)	Tuber no./plot	Tuber yld (kg) /plot
1. C96H-02.7x TPS - 13	93.8	78.3	4.0	3.8	58.9	489.3	11.9
2. C96H-13.29x TPS - 13	85.4	70.0	3.0	2.9	68.9	290.3	9.4
3. C96H-02.4x C98HT-64.8	81.3	63.3	2.7	3.6	61.3	289.3	8.6
4. C96H-02.4x C99HT -2-32.17	89.6	68.3	3.0	4.1	63.7	359.7	11.2
5. C96H-02.4x C99HT-2-58.1	95.1	80.0	4.0	3.6	69.1	448.0	14.7
6. C98HT-200.14xC99HT-2-58.1	88.2	71.7	3.3	3.2	81.3	358.7	12.4
7. LT 8x TPS-13	88.2	70.0	3.0	2.9	83.6	331.3	10.9
8. LT 8 xTPS-67	88.2	75.0	3.7	3.2	68.3	283.7	8.5
9. MF II x TPS - 67	81.2	70.0	3.3	3.5	62.5	368.3	12.0
10.TPS 7 x TPS -67	88.9	73.3	4.0	3.4	70.7	330.7	9.4
11.HPS II/67	82.6	70.0	3.7	3.5	71.5	477.3	12.9
12. HPS 7/67	84.1	70.0	3.7	3.6	63.5	377.7	10.8
13. Janak Dev	30.6	76.7	4.0	4.1	58.1	522.3	15.9
14 Kufri Jyoti	85.4	75.0	3.3	4.5	69.8	539.0	17.8
F-test						**	**
LSD(0.05)						141.8	3.856
CV %						21.6	19.3

Dev and TPS-7 x TPS-67, whereas the lowest (2.7) was in C96H-02.4 x C98HT-64.8. Maximum stems per plant (4.5) were in Kufri Jyoti followed by C96H-02.4 x C99HT-2-32.17 and Janak Dev (4.1) and the lowest (2.9) in C96H-13.29 x TPS-13 and LT 8 x TPS-13. Maximum plant height (83.6 cm) was recorded in LT 8 x TPS-13 and the lowest (58.1 cm). Late blight disease was not observed till 90 days. Maximum tubers per plot (539.0) and yield (17.8 kg/plot) were in Kufri Jyoti followed by Janak Dev (522.3) and (15.9 kg/plot). respectively. However, C96H-02.4x C99HT-2-58.1 produced the highest yield (14.7 kg/plot) among the tested F_1C_1 generations. But, family LT 8 x TPS-67 produced the minimum tubers (283.7) and yields (8.5 kg/plot). Both tubers and yield per plot were statistically significant.

Nepalgunj

In Nepalgunj. Percent emergence was the highest (72.2) in C96H 02.4 x C99HT 1-58.1 followed by C96H02.4 x C99HT 64.8 (69.5). whereas the lowest was in C96H 02.4 x C99HT 2-32.17 (53.5) (Table 4.5). It was statistically not significant. Percent of ground coverage (51.7) was significantly highest on MFII x TPS 67, HPS 7/67 and Janakdev but the lowest (31.7) was recorded in the families C95HA01.2 x C99HT 2-32.43.

Table 4.5. Yield and yield attributing parameters in TPS F_1C_1 generation of potato at Nepalgunj (2067/68)

Treatments	Emergence %	Ground coverage %	Uniformity	Stems /plant	Plant height (cm)	Tubers. /plot	Tuber yld (kg) /plot
MF II x TPS 67	61.8	51.7	3.0	2.1	47.3	652.3	22.317
C95HA 01.2 x C99HT 2-32.17	64.6	43.3	2.3	2.1	56.3	383.3	17.517
HPS 7/67	66.0	51.7	2.3	2.1	58.3	574.0	21.017
C96H 02.4 x C99HT 2-32.43	58.4	48.3	2.7	2.6	63.0	454.3	21.583
C98HT 200.14 x C99HT 2-32.17	61.1	46.7	3.0	2.3	61.7	387.3	18.467
C96H 02.4 x C99HT 2-32.17	53.5	41.7	3.3	1.8	60.7	473.3	20.583
HPS II/67	68.1	43.3	4.0	2.0	57.0	435.7	19.567
C95HA 01.5 x C99HT 2-32.17	66.0	40.0	2.3	1.7	58.7	402.0	18.433
C96H02.4 x C99HT 64.8	69.5	38.3	2.0	1.5	57.7	458.7	19.200
C96H 02.4 x C99HT 1-58.1	72.2	35.0	2.3	1.9	52.7	443.7	16.600
C95HA01.2 x C99HT 2-32.43	56.9	31.7	2.3	1.9	50.7	371.0	12.933
C98HT200.14 x C99HT 2-58.1	59.0	33.3	1.7	1.7	58.0	348.0	10.550
Janak Dev	61.8	51.7	3.0	2.1	47.3	652.3	22.317
Kufri Jyoti	64.6	43.3	2.3	2.1	56.3	383.3	17.517
F-test	NS	**	**	**	*	*	NS
LSD(0.05)	13.32	7.33	0.78	0.46	9.70	169.0	12.36
CV %	9.1	10.3	17.5	13.9	10.1	22.3	37.7

Uniformity was highest (4.0) on HPS 7/67 and the lowest (1.7) on C98HT200.14 x C99HT 2-58.1. Maximum stems per plant (2.6) were in C96H 02.4 x C99HT 2-32.43 and minimum (1.5) on C96H02.4 x C99HT 64.8. Plant height differences among the TPS families were statistically significant (Table 4.4). Plants of C96H 02.4 x C99HT 2-32.43 were tallest (63.0 cm) followed by C98HT 200.14 x C99HT 2-32.17 (61.7 cm). The shortest (47.3 cm) was on MFII x TPS 67. Late blight disease was not observed till 90 days. Maximum tubers (652.3) and yield (22.317 kg /plot) was in MF II x TPS 67 and Janak Dev, but family C98HT200.14 x C99HT 2-58.1 produced minimum tubers (348) and yield (10.550 kg/plot). The tuber number and yield were not statistically significant.

Tikathali-8 Changathali, Lalitpur

At Tikathali Lalitpur, planting was done in 19 Magh, 2067 and harvesting was done in 12, Jestha, 2068. Before harvesting potato plots were filled with heavy rain water. Farmers harvested immediately with informing NPRP and had recorded only tuber yield. Mean data of three farmers indicated that the highest tuber number (493.7) and yield (19.0 kg/plot) was produced in Kufri Jyoti followed by C96-02.4 x C98HT-64.8 (392.3 tuber No. and yield 12.3 kg/plot). The lowest tuber yield (5.7 kg/plot) was recorded in C98HT-200.14 x C99HT-2-58.1 (Table 4.6).

Table 4.6. Effect of TPS F_1C_1 generation in tuber no. and yield of potato at Tikathali, Lalitpur (2067/68)

Treatments	Undersized (>20 g) tubers/plot		Seed sized (20-40 g) tubers/plot		Over sized (>40 g) tubers/plot		Total no. and yield (kg/plot)	
	No.	Yield	No.	Yield	No.	Yield	No.	Yield
C96-02.4 x C98HT-64.8	176.3	2.2	207.7	9.3	8.3	0.8	392.3	12.3
HPS II/67	156.3	1.5	164.7	5.9	10.0	0.7	331.0	8.2
C96H02.4 x C99HT-2-32.43	152.3	1.6	135.7	7.7	6.7	0.6	294.7	10.0
C98HT-200.14 x C99HT-2-58.1	122.7	1.3	102.3	3.8	10.0	0.6	235.0	5.7
HPS 7/67	164.3	1.6	205.7	7.5	0.0	0.0	370.0	9.1
C95HA-01.2 x C99HT-2-32.17	168.3	1.5	156.7	7.3	0.0	0.0	325.0	8.7
C95HA-01.5 x C99HT-2-32.17	154.3	1.2	142.3	6.5	0.0	0.0	296.6	7.8
C96H-02.4 x C99HT-2-32.17	96.0	1.1	162.0	6.9	0.0	0.0	258.0	8.0
C96H-02.4 x C99HT-1-58.1	96.0	1.2	152.7	6.3	0.0	0.0	248.7	7.5
C95HA-01.2 x C99HT-2-32.43	124.7	1.2	141.3	6.3	0.0	0.0	266.0	7.5
Janak Dev	82.7	1.2	189.3	9.7	0.0	0.0	272.0	10.9
Kufri Jyoti	136.7	1.5	340.3	16.0	16.7	1.5	493.7	19.0

ARS, Jumla

Percent of germination was highest (93.8) in HPS II/67followed by 903027 (87.5), whereas the lowest (46.9) was in 903117 (46.9) (Table 4.7). Percent of ground coverage (82) was in HPS II/67 and 903027 but the lowest (55) was recorded in the family 903117 and 903135. Uniformity was highest (5.0) in HPS II/67 and the lowest (3) was in 903051, 903043 and 903117 respectively. Maximum stems per plant (4) were in HPS II/7 and minimum (2) in

Table 4.7. Yield and yield attributing parameters in TPS F_1C_1 generation of potato at ARS, Jumla (2067/68)

Entries	Emergence %	Uniformity	G C (%)	Pt ht (cm)	Main stems /plant	Pt type	Flowering cata.	Tuber color	Total tubers /plot	Tuber wt /plot (kg)	Tuber yld (t/ha)
HPS 2/67	93.8	5	82	44	4	E	M	W	205	6.1	11.2
HPS 7/67	68.8	4	70	52	2	E	M	W	117	4.8	7.4
903112	71.9	4	65	52	3	E	N	W	92	2.9	7.1
903051	56.3	3	57	62	3	E	N	W	139	4.2	9.2
903027	87.5	5	82	62	3	E	M	W	197	6.2	11.9
903035	81.3	5	67	62	3	E	N	W	110	6.6	10.8
903043	81.3	3	65	65	3	E	M	W	108	3.7	9.0
903117	46.9	3	55	59	2	E	M	W	78	5.0	4.9
903113	84.4	4	65	58	2	E	M	W	122	7.3	11.1
903135	62.5	4	55	52	3	E	M	W	61	1.8	6.9

HPS 7/67, 903117 and 903113. Plant height was maximum (65 cm) in the family 903043 and the minimum (44 cm) in HPS II/67. Late blight disease was not observed till 90 days. Maximum tubers per plot (205) was recorded in the family HPS II/67 where as the lowest numbers was in 903135 (61). The tuber yield was maximum (7.3 kg/plot) in 903113 and minimum tuber yield (1.8 kg/plot) in the family 903135.

4.3 EVALUATION OF TPS FAMILIES FOR SEEDLING TUBER PRODUCTION IN THE FARMERS' FIELD

Tikatali, Lalitpur

Due to the lack of seeds of deferent genotypes; only seeds of HPS II/67 were distributed in farmer's field. Planting was done in different locations according to the season of potato planting. Seeding was done in 2067-10-18 in two farmer's field. Germination was good. After removal of plastic, frost damaged all the seedlings so that recording of data was not possible.

Dillichaur, Jumla

Only two tuber families namely HPS 7/67 and HPS II/67 were distributed in farmer's field of Dillichaur, Jumla. Each genotype was planted in four farmers' field with 1 m^2 plot size. The genotype HPS II/67 was germinated, but HPS 7/67 was not germinated. The highest tuber yield (1.98 kg/plot) was recorded in the farmer's field of Kali Buda in Upper Larpa, whereas the lowest yield (1.28 kg/plot) was recorded in the field of Fulmaya Buda in Lower Larpa, Dillichaur (Table 4.8).

Table 4.8. Tuber number and yield of HPS II/67

Farmer's Name	Address	<10 g		11-20 g		>20 g		Total	
		No	Wt (kg)	No	Wt (kg)	No	Wt (kg)	No	Wt (kg)
Mrs. Ful Maya Buda	Lower Lorpa, Dillichaur, Jumla	53	0.35	38	0.6	9	0.4	100	1.28
Mr. Kali Buda	Upper Lorpa, Dillichaur, Jumla	138	0.55	84	0.9	20	0.5	242	1.98
Mr. Dhaneshor Buda	Upper Lorpa, Dillichaur, Jumla	39	0.22	77	1.3	4	0.2	120	1.72
Mrs. Tara Buda	Upper Lorpa, Dillichaur, Jumla	86	0.3	116	1.2	7	0.2	209	1.70
	Mean	79	0.36	79	0.99	10	0.33	168	1.67

5.0 RESEARCH ON POTATO DISEASES

Potato (*Solanum tuberosum*) is one of the important food crops of Nepal, which stands fourth position after the rice, wheat and maize. Productivity of potato in Nepal is low (13.35 t/ha) as compared to neighboring countries and of global average. Disease is one of the major yield reducing factors. Many diseases have been reported infecting potatoes in the world. The major diseases frequently occurring in Nepal are late blight (*Phytophthora infestans*), bacterial wilt (*Ralstonia solanacearum*), black scurf (*Rhizoctonia solani*), wart (*Synchytrium endobioticum*), common scab (*Streptomyces scabiei*), powdery scab (*Spongospora subterranea*), black leg (*Erwinia carotovora*), early blight (*Alternaria solani*), cercospora leaf spot (*Cercospora concors*), phoma leaf spot (*Phoma andina*), sclerotinia stem rot (*Sclerotinia scleriotiorum*) and the virus diseases PVA, PVS, PVX, PVM, PVY and PLRV are of major concern. Out of these viruses PLRV, PVX and PVY have been found frequently infecting potato as single or in combination. In fiscal year 2067/68, research activities were mainly focused on late blight, wart, and powdery scab. To minimize the losses due to virus infection transmission, virus free quality pre basic seeds (PBS) production is continued in NPRP tissue culture lab and that have been described under the chapter 'pre basic seed production'.

5.1 LATE BLIGHT RESEARCH

5.1.1 EFFICACY OF FUNGICIDES AGAINST POTATO LATE BLIGHT UNDER FIELD CONDITIONS

Materials and methods

Field experiment was carried out during autumn season of 2010 at Hattiban, Lalitpur. Planting was done on 16th Sept 2010. Treatments were arranged in randomized complete block design (RCBD) with three replications. Plot size was 2.4 m x 3.0 m. Planting distance was 60 cm for row-to-row and 25 cm for plant to plant. Plant nutrients applied in the form of N, P_2O_5 and K_2O @ 100:100:60 kg respectively, through urea, di-ammonium phosphate and muriate of potash and were applied as basal on the line demarcated for potato planting. Farm yard manure @ 20 t/ha was also applied above the chemical fertilizer. Sprouted tubers, approximately of similar physiological age, were planted at 5-6 cm depth on ridges.

Efficacy of newly introduced fungicides i.e. Acrobat, Sectin and Agrifos-400 were compared with the conventional most common fungicide, Krinoxyl Gold (Metalaxyl 8%+ Mancozeb 64%) in three spray frequencies 2, 4 and 6 times at 18, 9 and 6 days intervals, respectively. Also, the test fungicides (Acrobat, Sectin and Agrifos-400) were alternately sprayed with Uthane M-45 for the total of four sprays at 9 days interval. Spray volume was 800 liter/ha for the first three sprays and 1000 lit/ha for next two sprays and 1200 lit/ha for last spray with the same amount of active ingredient of fungicide depending on the coverage of crop canopy. Potato variety 'Kufri Jyoti' was used in the experiment. Late blight severity was recorded on percent leaf area damage at weekly intervals starting from first initiation of disease symptoms. Tuber yield, biomass and late blight incidence on tuber was recorded at harvest.

As soon as late blight symptoms were detected at 26 DAP, two central rows having 18- 20 plants within each plot was visually estimated for percent foliage area covered by late blight lesions at 7 to 14 days interval. Observations continued until untreated plots of susceptible

cultivars reached 100% foliage area damaged. Observations were taken at 26, 40, 46, 52, 59, 68, 74 DAP. For each plot and assessment date, the area under the disease progress curve was estimated using the following formula (AUDPC; Campbell and Madden 1990).

$$AUDPC = (T_{i-1} - T_i) * \left[\frac{(D_{i-1} - D_i)}{2}\right]$$

Where, T is the time in days since planting and D was the estimated percentage of area with blighted foliage.

Relative AUDPC (RAUDPC) for the entire season was estimated using the following formula (Baker et al. 2000).

$$RAUDPC = \frac{\Sigma (T_{i-1} - T_i) * \left[\frac{D_{i-1} - D_i}{2}\right]}{T_{max} * 100}$$

Results and Discussion

Late blight severity at 30 DAP was not significantly different for all treatments. There after, disease severity increment was fast in successive observations at 10 days intervals in untreated control plots and reached up to 75 percent at 70 DAP. Disease severity was minimum (6.33%) at Acrobat six time-sprayed plots followed by Sectin six time-sprayed (12.67%) and Acrobat four time-sprayed plots (18.67%). Similar severity trend was observed at 80 DAP and with respect to overall AUDPC (Table 5.1). AUDPC was minimum in Acrobat six time-sprayed (AUDPC 185) followed by Sectin six time-sprayed plots (AUDPC 377) as compared to untreated control plots (AUDPC 2381). Data observed at 10 days intervals are presented in Table 5.1.

Table 5.1. Efficacy evaluation of fungicides under field conditions at Khumaltar, 2010

Treatments (Fungicides)	30 DAP	40 DAP	50 DAP	60 DAP	70 DAP	80 DAP	AUDPC*	
Acrobat two sprays	0.03	4.33	26.67	35.00	43.33	55	1369	*de*
Acrobat four sprays	0.07	1.67	8.23	12.67	18.67	22.67	534	*jk*
Acrobat six sprays	0.03	1.00	2.33	4.33	6.33	8.33	185	*l*
Agrifos-400 two sprays	0.10	6.00	30.00	39.00	48.33	59	1529	*de*
Agrifos-400 four sprays	0.07	4.00	20.00	29.33	35.67	42.67	1104	*fg*
Agrifos-400 six sprays	0.10	1.67	9.00	15.00	21.67	26.67	608	*ij*
Sectin two sprays	0.17	6.33	30.00	36.67	45.00	56.67	1468	*de*
Sectin four sprays	0.10	2.33	13.33	20.00	25.67	32.67	777	*hi*
Sectin six sprays	0.03	1.33	5.33	10.00	12.67	16.67	377	*k*
Krinoxyl Gold two sprays	0.07	11.67	40.00	53.33	66.67	80	2101	*b*
Krinoxyl Gold four sprays	0.40	11.00	38.33	50.00	61.67	71.67	1970	*b*
Krinoxyl Gold six sprays	0.20	7.67	35.00	46.67	55.00	65	1770	*c*
Acrobat 2 sp + Uthane M-45, 2 sp	0.03	3.67	15.00	23.33	27.67	35	872	*h*
Agrifos 2 sp + Uthane M-45, 2 sp	0.13	5.00	23.33	33.33	40.00	48.33	1259	*ef*
Sectin 2 sp + Uthane M-45, 2 sp	0.13	4.00	15.33	26.00	30.67	39.33	958	*gh*
Untreated Control (water spray)	0.10	18.33	43.33	53.33	75.00	96	2381	*a*
F value	NS	24.1	72.6	46.12	63.6	72.3	110.51	
LSD (0.05)	0.26	2.74	4.43	6.65	7.17	8.12	176.5	
CV %	41.9	29.2	12	13.2	11.2	10.3	8.8	

*Note: *Data followed by same letters are not significantly different*

Disease progress was slow during the first 10 days after symptoms appearance in untreated control plots and disease severity increased fast after 60 DAP (Figure 5.1). Alternate spray of Acrobat with Uthane M-45 and Sectin with Uthane M-45 gave good control of late blight

when compared with untreated control (Figure 5.2). Effects of fungicides on ground cover of foliage at 90 DAP also were found significant differences between the treatments ranging from 5 to 70 percent (Figure 5.3).

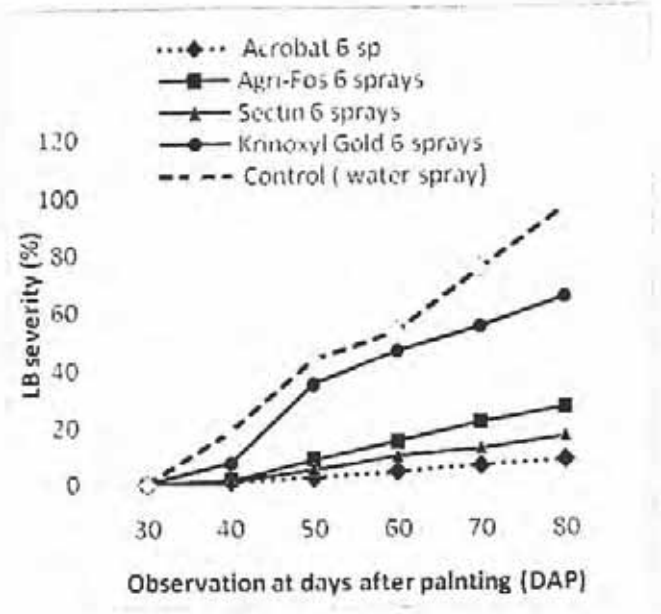

Figure 5.1. Effect of fungicide spray- frequencies on late blight severity at 30-80 DAP.

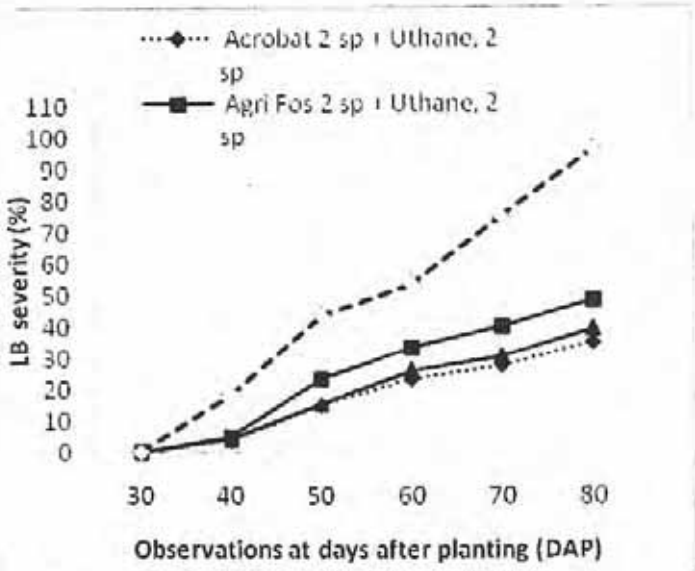

Figure 5.2. Effects of alternate sprays of three fungicides (Acrobat, Sectin and Agrifos-400) with Uthane M-45 (4 sprays) on late blight severity at 30-80 DAP.

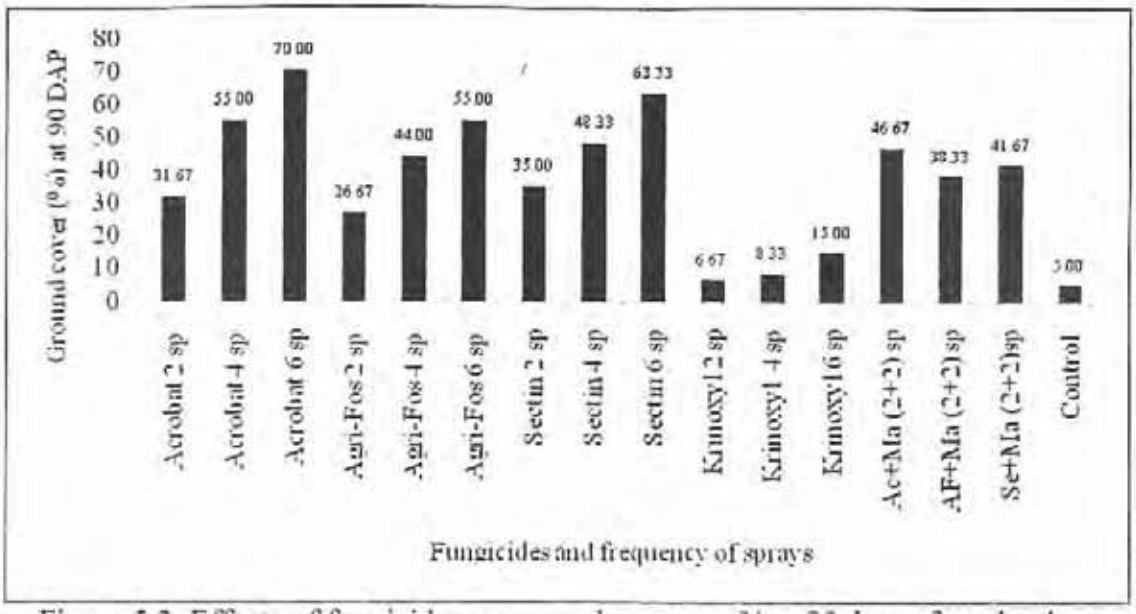

Figure 5.3. Effects of fungicides on ground coverage % at 90 days after planting.

All the treatments, except Krinoxyl Gold two-spray, had significant effect on vine mass production when compared with untreated control. Vine mass production was the highest in the plots sprayed six times with Acrobat, Sectin and Agrifos-400. Similarly, six time sprays of Sectin, and Acrobat gave significantly higher tuber yield than the rest of the treatments (Table 5.2).

Table 5.2. Effects of fungicides on vine mass, tuber blight and tuber yield under field conditions at Khumaltar, 2010

Treatment	Vine weight ($kg/3m^2$plot)		Tuber blight incidence (%)		Tuber yield $kg/3m^2$ plot		Tuber yield (t/ha)	
Acrobat two sprays	0.29	*hi*	1.12	*cde*	3.77	*cde*	12.58	*de*
Acrobat four sprays	0.56	*cd*	0.59	*de*	4.45	*bcd*	14.83	*bcd*
Acrobat six sp	0.90	*a*	0.14	*e*	5.59	*a*	18.65	*a*
Agrifos-400 two sprays	0.39	*fgh*	0.00	*e*	2.97	*efg*	9.90	*ef*
Agrifos-400 four sprays	0.61	*bc*	0.00	*e*	4.37	*bcd*	14.58	*bcd*
Agrifos-400 six sprays	0.70	*b*	0.00	*e*	5.43	*ab*	18.10	*ab*
Sectin two sprays	0.44	*efg*	0.71	*de*	3.53	*def*	11.74	*de*
Sectin four sprays	0.58	*cd*	0.74	*de*	4.82	*abc*	16.07	*abc*
Sectin six sprays	0.81	*a*	0.43	*de*	5.67	*a*	18.90	*a*
Krinoxyl Gold two sprays	0.26	*ij*	2.99	*b*	2.14	*gh*	7.12	*f*
Krinoxyl Gold four sprays	0.36	*ghi*	2.89	*b*	2.61	*fgh*	8.71	*ef*
Krinoxyl Gold six sprays	0.31	*hi*	2.15	*bc*	2.77	*efg*	9.22	*ef*
Acrobat, 2 sp + Uthane M-45, 2 sp	0.65	*bc*	1.12	*cde*	4.53	*bcd*	15.10	*cd*
Agrifos-400, 2 sp + Uthane M-45, 2 sp	0.49	*def*	0.95	*de*	3.45	*ef*	11.49	*de*
Sectin, 2 sp + Uthane M-45, 2 sp	0.54	*cde*	1.57	*de*	4.56	*bcd*	15.20	*cd*
Untreated control (water spray)	0.17	*j*	6.71	*a*	2.12	*h*	7.06	*f*
F value	34.07		22.26		12.47		12.47	
LSD (0.05)	0.10		1.05		0.9677		3.226	
CV %	12.1		45.4		14.8		14.8	

Note: Data indicating the same alphabets are not significantly different.

There was no tuber blight incidence at harvest on Agrifos-400 sprayed plots as compared to untreated control plots (6.71%). However, other fungicides also had significant effects on

minimizing tuber blight infection (Table 5.2). Tuber yield obtained from six time Sectin-sprayed (18.9 t/ha) and six time Acrobat-sprayed plots (18.65 t/ha) were significantly higher than rest of the treatments.

5.1.2 EFFICACY OF FUNGICIDES UNDER LABORATORY CONDITIONS

Isolation of pathogen

Leaf samples with *P. infestans*-infected single lesion were washed with distilled water, put into the moist Petri dishes and incubated for 24 h at 16±1°C, RH 85 ±5% with 12 h light cycle using seed germinator. Tubers of susceptible variety 'Kufri Jyoti' were washed and surface sterilized by dipping in 2% sodium hypo-chloride (NaOCl) solution for 5 min and washed again with distilled water for 3 times. Tubers were cut into slices of 5-10 mm thick and placed two slices per Petri dish. After sporulation of lesion on incubated leaf, small piece from the edge of a growing lesion (5 mm^2) was transferred onto the tuber slice. After 5 days of incubation at 16±1°C the mycelium has grown through the tuber slice. A little plug of mycelium without touching potato tissue was transferred onto Petri dishes containing rye agar-A medium. Petri dishes were incubated at 16±1°C for 8 days. Cultures were examined for confirming the desirable isolate. Cultures were again transferred to rye agar slants incubated for 16°C for 15 days and placed into refrigerator at 4°C for 3 months.

Multiplication of isolate on tuber slices

Medium size, healthy tubers (without rots or green coloration) of susceptible variety Kufri Jyoti were washed and surface sterilized as described earlier. Around 5-10 mm thick slices were made with sterilized sharp stainless steel knife. Transparent medium size (8 x 10 x 5 cubic inch) plastic boxes were made moist by lining water saturated two layers of blotting papers at 1.5 cm below and 3.0 cm above the slices.

Tuber slices were inoculated with the isolate of *P. infestans* (LPR-1) at the center of slices with 50 µl inoculum suspension having sporangial density of 6 x 10^3/ml using Eppendorf micropipette. Sporangia were washed from the upper side of a sporulating lesion with distilled water using plastic atomizer avoiding bacterial rots. The suspension was passed through 4 layers of cheese cloth to separate large clots of mycelia. Millipore filter was used to separate sporangia using 30 µm nylon filters to remove mycelium and other debris. The filtrate then passed though a 10 µm filter, which traps the sporangia. These sporangia were washed 3-4 times with distilled water and then collected from the filtering device with small amount of distilled water. Desired sporangial concentration (6 x 10^3/ml) was obtained using hemocytometer.

In-vitro evaluation of fungicides

A 100 ml buffer stock solution of 8000 ppm (active ingredient basis) for each fungicide was prepared and diluted in 1000, 2000, 3000 and 4000 ppm. Highly effective fungicides were further tested for lower concentrations, i.e. 500, 250, 200, 150, 100, 50, 40, 30 and 20 ppm. Tuber slices of susceptible variety Kufri Jyoti was prepared as described earlier. Tuber slices were treated by dipping into 50 ml of respective fungicides in different concentrations for 20 sec and the treatments were replicated three times. Slices were inoculated with *P. infestans* isolate (LPR-1) at the center of slices with 50 µl inoculum having sporangial density of 6 x 10^3 /ml suspension using Eppendorf micropipette. The inoculated slices were incubated as

described earlier. After 5 days of incubation percent tuber slice area covered by fungal colony was recorded by visual estimation.

Percent inhibition of colony growth was calculated by using formula as follows:

$$\text{Inhibition growth (\%)} = \frac{C - T}{C} \times 100$$

Where, C = Percent area covered by colony in untreated control
T = Percent area covered by colony in fungicide-applied slice

Results and Discussion

Colony growth of *P. infestans* (Isolate LPR-1) was found inhibited by 100% on tuber slices treated with Acrobat at 50 ppm and Sectin at 250 ppm, Metalaxyl at 500 ppm and Agrifos-400 at up to 4000 ppm concentration. Jatayu, Galaxy and Uthane-45 at 4000 ppm concentrations showed poor inhibition of colony growth on tuber slices ranging 18.3 to 33.3% (Table 5.3). None of these fungicides (Fluazinam, Jatayu, Galaxy, Antracol and Uthane) inhibited 100 percent colony growth even at 4000 ppm (Plate 1, Plate 2 and Plate 3). A mixture of microorganisms '*Jeebatu*' with 1:5 dilutions of commercial product did not show inhibition of colony growth of *P. infestans* on tuber slices (Table 5.3). Acrobat showed 50% efficacy even at lower concentration (20 ppm). Among the fungicides tested, Acrobat was found significantly effective in controlling *P. infestans* under laboratory conditions (Figure 5.4).

Table 5.3. Efficacy of fungicides against *P infestans* in tuber slice under lab conditions

Fungicides	Colony growth inhibition % at different fungicide concentrations (ppm)												
	20	30	40	50	100	150	200	250	500	1000	2000	3000	4000
Acrobat (50%)	50.0	70.0	80.0	**100.0**	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sectin (10+50 %)	0.0	5.0	12.7	24.3	50.0	65.0	90.0	**100.0**	100.0	100.0	100.0	100.0	100.0
Metalaxyl (35%)	0.0	0.0	0.0	3.3	2.0	10.0	50.0	85.0	**100.0**	100	100	100	100
Fluazinam (50%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	10.00	21.70	45.00
Jatayu (75%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	38.33	51.70	68.30
Agrifos-400 (40%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.33	83.33	91.70	**100.0**
Galaxy (35%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	3.33	15.00	33.30
Antracol (70%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	10.00	33.30	71.70
Uthane M-45 (75%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	6.70	18.30
Jeebatu (100%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
Check	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00

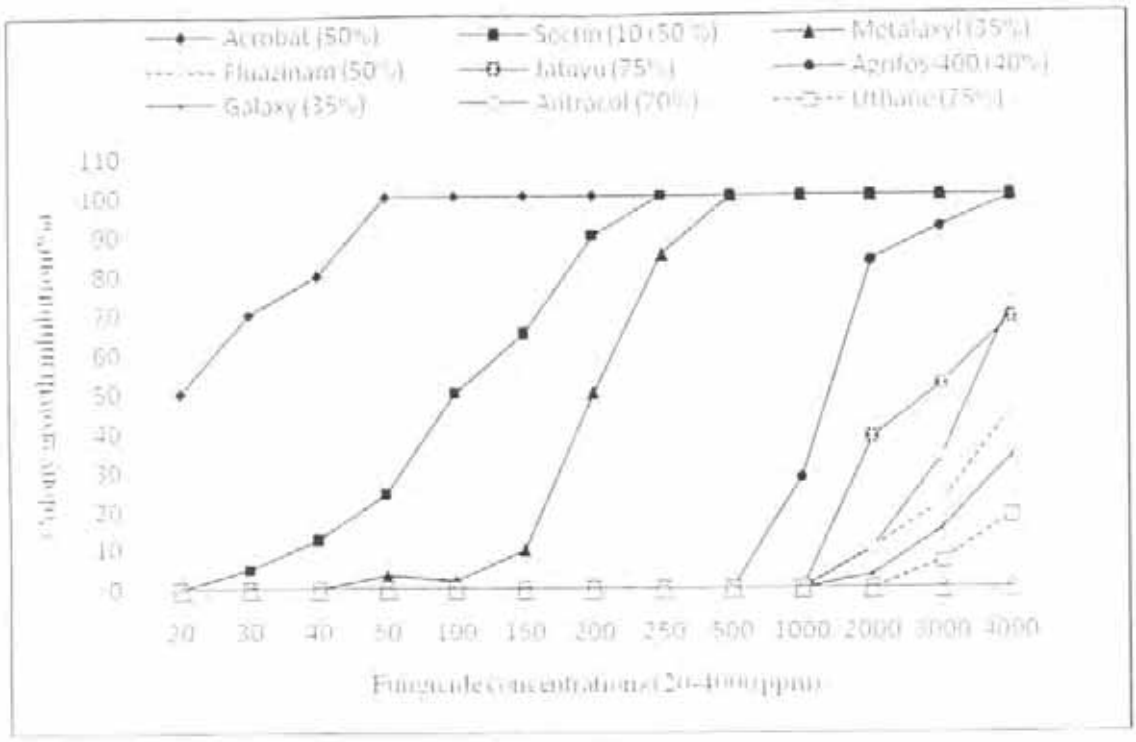

Figure 5.4. Fungicide concentration and its effects on *P. infestans* colony growth inhibition.

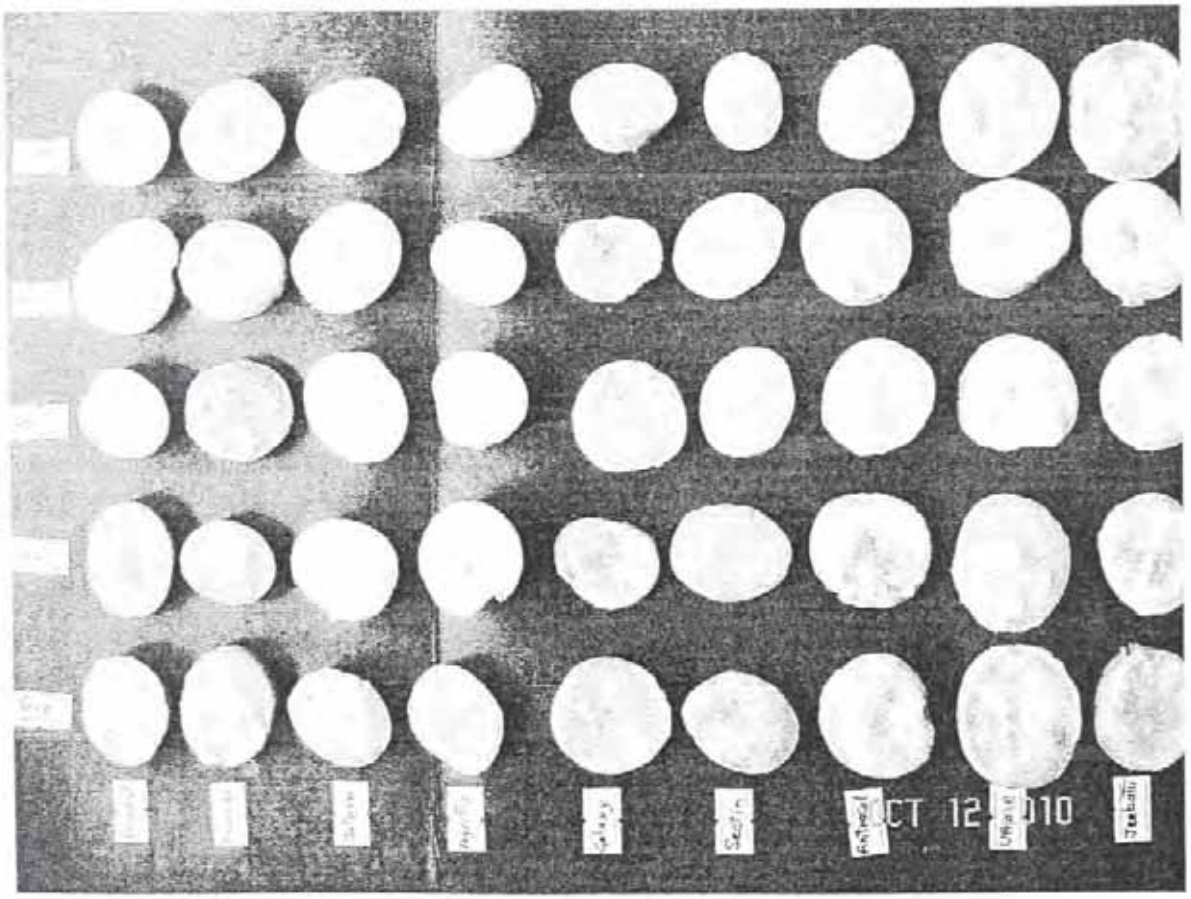

Plate 1. Efficacy of Acrobat, Fluazinam, Jatayu, Agrifos-400, Galaxy, Sectin, Antracol, Uthane M-45 and *Jeebatu* at 4000, 3000, 2000 and 1000 ppm

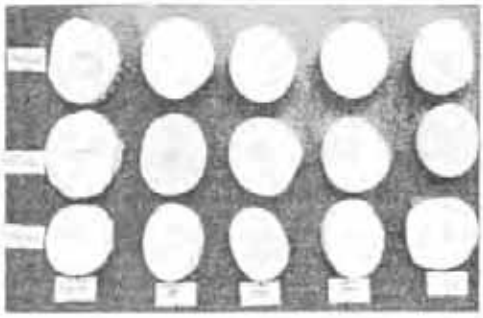

Plate 2 Efficacy of Acrobat, Secin and Metalaxyl at 1000,750,500 and 250 ppm

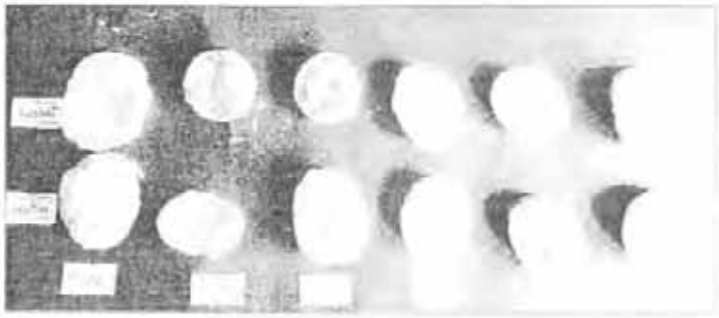

Plate 3 Efficacy of Acrobat and Secin at 60, 50, 40, 30 and 20 ppm

5.1.3 QUANTIFICATION OF HOST RESISTANCE OF POTATO TO LATE BLIGHT THROUGH DIFFERENT ASSAYS

Resistance in potato to *P. infestans* has been classified as immunity, general or durable, partial, and specific. Immunity implies no sign of the pathogen or symptom of disease on a potential host. General or durable resistance is effective against all races of a pathogen and remains effective during prolonged host plant resistance in potato (*Solanum tuberosum* L.) to the late blight pathogen, *Phytophthora infestans* (Mont.) de Bary, is a potentially important factor in controlling the disease in both the temperate zone and the tropics. Resistance and susceptibility are closely related terms but differ in their underlying assumptions and measurement. Screening of resistance to late blight has been an essential part of potato variety development in many other areas of the world.

Phytophthora infestans infect leaves, stems and tubers, and yield losses occur due to foliage damage in the field or tubers become infected during the growing season or at harvest or in storage. The purpose of this investigation was to review the methodologies reported for screening germplasms for late blight resistance and to employ some of the methods on a selected set of screening methods to determine the effective screening methods that are more reliable and validated under field and lab conditions in Nepal.

5.1.3.1 FIELD INOCULATION ASSAY

Twenty five potato clones including one susceptible checks were screened against late blight disease at Khumaltar (1,360 m asl), representing mid hills agro-climatic conditions. In Kathmandu valley potato is grown in two seasons autumn (September planting) and spring (January planting). Autumn season is more conducive for late blight disease development. Planting was done at second week of Sept at Khumaltar.

Eight to ten tubers of each potato clone were planted with the spacing of 60 x 25 cm in a 2.0 to 2.5 m long row with a plot size of 1.5 m^2 (0.6 x 2.5 m). Tubers apparently healthy and of same physiological conditions were planted. LBr-40 and Kufri Jyoti were used in the experiment as resistant and susceptible check respectively. Susceptible check variety 'Desiree' was planted around the border of the experiment to create *P. infestans* inoculum pressure on to the test clones. Prior to planting, fertilizer @100:100:60 kg NPK /ha along with 20 t/ha farmyard manure/compost were applied as basal dose. Intercultural operations and irrigation was applied as per recommendations. No control measures were taken against late blight through out the crop period.

On 25 days after planting (DAP), *P. infestans* isolate 'LPR-1' was artificially inoculated with the sporangial suspension of 6×10^3 /ml. Inoculum of equal amount was homogeneously

sprayed over the genotypes grown on rows using 0.5 liter size plastic atomizer during 4-5 pm. As soon as late blight symptoms were detected each test row having 8-10 plants within each plot was visually estimated for percent foliage area covered by late blight lesions at different time intervals. Evaluations continued until susceptible check variety reached 100 percent foliage area damaged. Late blight disease severity scoring was done based on foliage damage percent at different crop age 30, 41, 54, 60, 69 and 76 days after DAP. These observations in different days' intervals were used as key reference points for calculation of AUDPC and RAUDPC.

Results and Discussion

At 30 DAP, late blight symptoms observed on eight clones along with susceptible check variety 'Kufri Jyoti'. Observations at different time intervals continued up to 76 DAP. Kufri Jyoti showed 100% foliage damage at 69 DAP followed by CIP 394050.110 (70%), CIP 385499.11(62%) and Janakdev (55%). Similar trend of severity at 76 DAP was observed. LBr-40, PRP-266264.01 and PRP-266264.15 showed outstanding high resistance (Plate 4 and Plate 5) to *P. infestans* (LPR-1 isolate) under field inoculated conditions (Table 5.4). Regarding with AUDPC of individual clones highest value was (2361) observed in Kufri Jyoti. Sixteen clones showing less than 10% AUDPC value of susceptible check have been considered as highly resistant to late blight.

Table 5.4. Disease severity (%) at different crop age and AUDPC of potato clones due to *Phytophthora infestans* under Khumaltar conditions, 2010

Trt #	Clones	30 DAP	41 DAP	54 DAP	60 DAP	69 DAP	76 DAP	AUDPC
1	PRP 35861.2	0.00	1.00	1.33	3.33	3.67	8.33	94
2	PRP-85861.12	0.00	0.00	0.00	1.67	6.00	10.67	93
3	PRP-25861.10	0.00	0.00	0.67	1.33	3.00	7.67	61
4	PRP-225861.2	0.00	0.67	1.00	2.33	4.33	7.67	87
5	LBr 40	0.00	0.00	0.00	0.00	0.00	0.00	0
6	PRP-85861.8	0.00	0.00	0.67	1.67	4.67	8.00	77
7	L 235.4	4.33	8.67	12.33	21.67	50.00	60.00	916
8	PRP-276264.01	0.00	0.00	0.00	0.00	1.33	4.33	26
9	PRP-266264.01	0.00	0.00	0.00	0.00	0.00	0.00	0
10	BSUPO3	0.00	0.00	0.00	0.33	1.67	3.33	27
11	Kufri Jyoti (Check)	4.33	20.00	80.00	95.00	100.00	100.00	2361
12	CIP-384321.15	0.00	0.00	0.33	0.33	1.33	4.00	28
13	PRP- 25861.1	0.00	0.00	0.00	0.00	2.67	5.00	39
14	CIP-388580.6	2.68	6.33	15.00	36.67	53.33	78.00	1054
15	CIP-394050.110	3.68	7.00	25.00	40.00	70.00	80.00	1287
16	CIP-393385.39	0.00	0.00	0.00	0.67	1.33	5.00	31
17	PRP-266264.15	0.00	0.00	0.00	0.00	0.00	0.00	0
18	Janakdev (Check)	1.00	13.33	19.00	33.33	55.00	78.33	1153
19	CIP-393280.57	0.00	3.00	6.00	13.33	25.00	33.33	452
20	PRP-25861.11	0.00	0.00	0.33	3.33	6.00	10.67	103
21	PRP-85861.11	0.00	0.00	0.00	0.67	2.67	7.00	49
22	CIP-393077.54	1.68	6.67	11.00	18.33	38.33	46.67	713
23	CIP-392657.8	0.00	0.00	0.33	0.33	1.00	5.00	29
24	CIP-385499.11	1.00	13.00	30.00	43.67	62.00	81.67	1334
25	CIP-389746.2	2.33	5.00	12.67	25.00	33.33	45.00	692
	F value	14.52	29.75	95.1	76.66	93.58	117.53	137
	LSD (0.05)	1.06	2.65	4.86	7.02	8.5	7.98	134.46
	CV %	76.8	47	34.3	31.2	24.6	17.6	19.1

Plate 4. Resistant clones compared with Kufri Jyoti

Plate 5. Resistant clones compared with Janakdev

Green foliage (bio-mass) at harvest was highest in clone PRP-266264.15 (1.58 kg/1.5 m^2) followed by PRP-266264.01(1.37 kg), PRP-85861.8 (1.2 kg) and PRP-276264.01 (1.14 kg), whereas bio-mass of disease susceptible check Kufri Jyoti remained 0.12 kg/plot (Table 5.5).

Table 5.5. Performance of potato clones to vine mass, tuber number and yield under Khumaltar conditions

Trt	Clones	Vine mass (kg/1.5 m^2)	Tuber No	Tuber Yield (kg/1.5 m^2)
1	PRP 35861.2	0.677	92.3 def	3.837 de
2	PRP-85861.12	0.337	64 fg	3.25 ef
3	PRP-25861.10	0.313	120.7 cde	4.363 cd
4	PRP-225861.2	0.433	85 defg	4.663 c
5	LBr 40	0.693	79.7 efg	4.46 cd
6	PRP-85861.8	1.2	171.7 b	4.513 cd
7	L 235.4	0.25	52.7 fg	2.797 fgh
8	PRP-276264.01	1.137	121 cde	5.63 ab
9	PRP-266264.01	1.37	237 a	5.527 b
10	BSUPO3	0.6	91.7 def	2.367 ghi
11	Kufri Jyoti (Check)	0.117	55.7 fg	2.12 hi
12	CIP-384321.15	0.617	141.3 bc	4.24 cd
13	NPRP- 25861.1	0.693	100 edef	5.447 b
14	CIP-388580.6	0.28	67.7 fg	1.74 i
15	CIP-394050.110	0.24	83.3 efg	1.827 i
16	CIP-393385.39	0.613	116 cde	2.81 fgh
17	PRP-266264.15	1.583	167 b	6.24 a
18	Janakdev (Check)	0.207	86 defg	3.193 ef
19	CIP-393280.57	0.507	131.3 bcd	3.073 fg
20	PRP-25861.11	0.24	65.3 fg	3.173 ef
21	PRP-85861.11	0.437	88.3 defg	4.073 cd
22	CIP-393077.54	0.153	43.7 g	2.207 hi
23	CIP-392657.8	0.927	79.3 efg	3.24 ef
24	CIP-385499.11	0.407	64.7 fg	2.673 fgh
25	CIP-389746.2	0.98	65.3 fg	2.633 fgh
	F value	8.41	1023	30.30
	LSD (0.05)	0.3905	39.49	0.6533
	CV %	39.6	24.3	11.0

Highest tuber yield (6.24 kg/plot) was obtained from PRP-266264.15 followed by PRP-276264.01 (5.63 kg/plot), PRP-266264.01 (5.53 kg/plot) and PRP-25861.1 (5.45 kg/plot). Late blight susceptible check variety produced tuber yield 2.12 kg/plot and some clones produced even less yield than the check variety (Table 5.5).

5.1.3.2 WHOLE PLANT INOCULATION ASSAY

Twenty five potato clones, which were screened under field conditioned also grown in screen house using medium size plastic pots. Plants were grown in normal conditions temperature ranging 15-25^{0} C and 75-90% RH. When plants attain about to flowering stage each plant covered with transparent plastic bag to create and maintain the desired relative humidity for 24 h prior and continued 14 days after the inoculation. Humidity about 90% maintained for plants inside the plastic cover. *P. infestans* isolate 'LPR-1' was multiplied on tuber slices. Five days after inoculation sporangia were harvested. Inoculum of isolate (sporangial suspension 3 x 10^{5} sporangia/ml) was prepared using Millipore filter and hemocytometer. Sporangial suspension was sprayed through 100 ml size glass atomizer allocating 2 ml/plant. Late blight disease severity was recorded as percent foliage area damage on each individual test clones at 10, 20 and 30 days after inoculation.

Results and Discussion

In whole plant inoculation, foliage damage were comparatively high than in field inoculation, however genotypic responses were almost similar to field inoculation (Plate 4, Plate 5, Table 5.5). Of them sixteen clones showed highly resistant, two clones resistant, four clones moderately resistant, two clones susceptible and one clone showed highly susceptible to *Phytophthora infestans* 'LPR-1' isolate under screen house conditions (Table 5.6). Around 60% clones were HR, because majority of the genotypes were promising clones selected from 80 clones in the previous years.

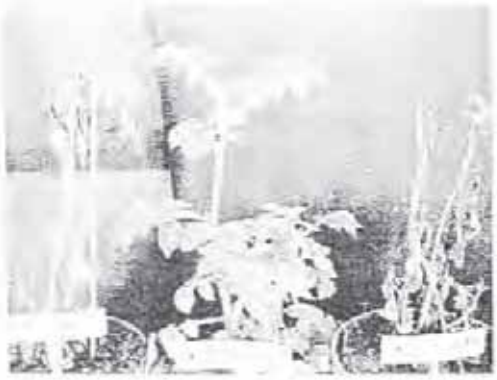

Plate 6. Test clones compared with Janak Dev

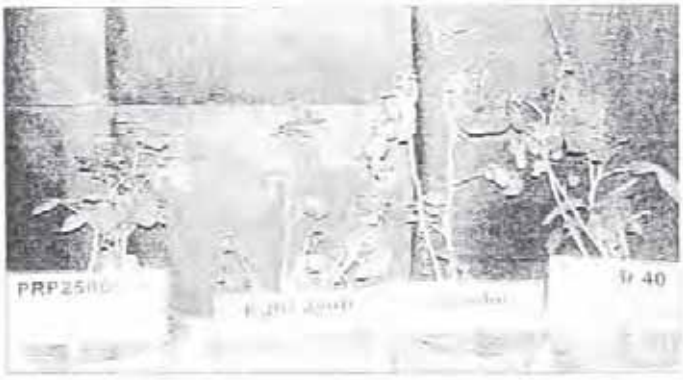

Plate 7. Test clones compared with Kufri Jyoti

5.1.3.3 DETACHED LEAF INOCULATION ASSAY

Near to flowering stage (6-7 week old) primary leaves of almost same position (middle part of stem) were detached from screen house-grown 25 potato genotypes. These leaves/leaflets were washed with sterilized distilled water and placed abaxial surface up in moist chambers, inoculated with 50 µl of 4x10^{3} sporangia/ml suspension of isolate 'LPR-1', plastic boxes are made air tight. Inoculum preparation was the same as for the whole plant inoculation. Same amount of sterile distilled water was applied in check. Inoculated leaflets were then incubated at 16±0.5°C in a 12 h light cycle regime. Lesion development was usually evident at 5 days after inoculation. On 7th day of inoculation, mean diameter of lesion on each leaflet was measured (Plate 6). Experiment was repeated twice.

Results and Discussion

Based on size of lesion area on detached leaflets due to host and pathogen (*P. infestans*) interaction, genotypes were categorized as HR, MR, R, S and HS. Largest lesion size were found in Kufri Jyoti (6.46 cm^2), followed by CIP-385499.11 (5.85 cm^2), Janak Dev (5.52 cm^2) and CIP-388580.6 (4.85 cm^2). Late blight resistant clones showed minimum lesion size. Based on these degrees of lesions development, 1 to 9 scale was developed for the categorization of clones into different levels of resistance (Plate 8). Lesion size was minimum ranging 0 to .48 cm^2 on the clones LBr40, PRP-25861.10, PRP-25861.11 and CIP-392657.8 (Table 8). If lesion size ranges between 0 to <=0.65 cm^2 considered as HR, >0.65 cm^2 to <=1.94 (R), >1.94 to <=3.23 cm^2 (MR), >3.23 to<=4.52 cm^2 (S) and >4.52 to 6.46 cm^2 (HS).

Plate 8. Clones showing different levels of susceptibility to *P infestans* (1-9 scale)

5.1.3.4 TUBER SLICE INOCULATION ASSAY

Medium size, apparently healthy, three tubers of each 25 clones were washed with tap water, soaked in 2% sodium hypochlorite for 5 min, rinsed with distilled water three times and shade dried. Five mm-thick sections from the middle of a tuber were sliced with a sterilized knife. The tuber slices were placed onto moistened transparent plastic boxes. Fifty micro liter *P. infestans* isolate 'LPR-1' having $4x10^3$ sporangia/ml was placed in the center of each tuber slice. Slices were placed in plastic boxes lined with moist paper towels and incubated at 16±0.5°C with 12 h light cycle 6 days. Treatments were replicated three times. Percent area of tuber slice colonized by *P. infestans* was estimated by visual observation on 6th days. Percentage data were transformed into arcsine values for statistical analysis. Experiment was repeated twice within 30 days under the same conditions.

Percent inhibition of colony growth was calculated by using formula as follows:

$$\text{Inhibition growth } (\%) = \frac{C - T}{C} \times 100$$

Where, C = Percent area covered by colony in control
T = Percent area covered by colony in fungicide applied slice

Results and Discussion

Tuber slice inoculated with *P. infestans* isolate (LPR-1) showed minimum area covered by fungal colony in the clones LBr-40, PRP-85861.12, PRP-85861.11, PRP-25861.11 ranging 4.0 to 9.45 percent. *P. infestans* colony was found fully developed on BSUPO3, L 235.4 and PRP 35861.2. Which were similar to the colony on Kufri Jyoti (Plate 9, Table 5.6).

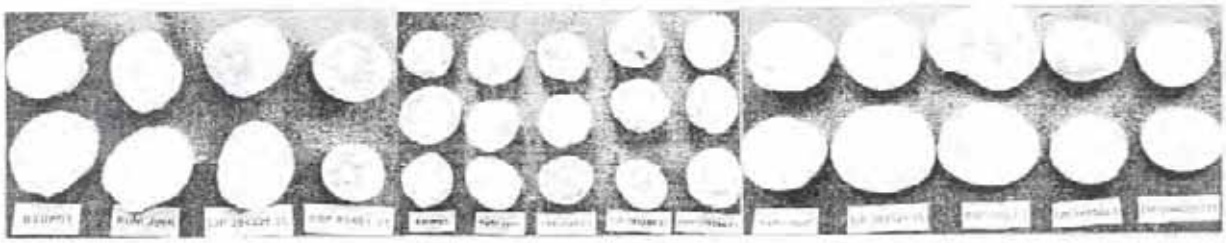

Plate 9a. Plate 9b Plate 9c

Plate 9 . BSUPO3, K. Jyoti, CIP 384321.15, PRP-85861.11 (Plate 9a); BSUPO3, K. Jyoti, PRP-85861.8, CIP-39328057, PRP_276264.01 (Plate 9b); K. Jyoti, CIP 384321.15, PRP-25861.1, CIP-393280.57CIP-394050.110 (Plate 9c).

Table 5.6. Reaction of *Phytophthora infestans* (LPR-1) isolate to whole plant, detached leaves and tuber slices under screen house and lab conditions

SN	Clones	Field assay		Whole plant assay		Detached leaf assay		Tuber slice assay	
		AUDPC	Category	% foliage damage	Category	Lesion size (cm^2)	Category	Area covered by colony (%)	category
1	PRP 35861.2	94	HR	11.7	R	0.78	R	78.89	HS
2	PRP-85861.12	93	HR	10.0	HR	1.23	R	4.44	HR
3	PRP-25861.10	61	HR	20.0	R	0.40	HR	12.78	R
4	PRP-25861.2	87	HR	43.3	MR	0.71	R	66.1	S
5	LBr.40	0	HR	0.0	HR	0.00	HR	4.00	HR
6	PRP-85861.8	77	HR	35.0	MR	3.60	S	15.89	R
7	L 235.4	916	MR	60	S	4	S	91.11	HS
8	PRP-276264.01	26	HR	5.0	HR	2.49	MR	65.00	S
9	PRP-266264.01	0	HR	0.0	HR	3.25	S	41.67	MR
10	BSUPO3	27	HR	5.0	HR	4.75	HS	96.11	HS
11	Kufri Jyoti (Check)	2361	HS	100.0	HS	6.46	HS	100.00	HS
12	CIP-384321.15	28	HR	5.0	HR	0.71	R	23.33	R
13	PRP-25861.1	39	HR	18.3	R	1.86	R	12.56	R
14	CIP-388580.6	1054	MR	50.0	MR	4.85	HS	22.78	R
15	CIP-394050.110	1287	S	58.3	S	4.71	HS	20.78	R
16	CIP-393385.39	31	HR	20.0	R	4.68	HS	11.33	R
17	PRP-266264.15	0	HR	11.2	R	4.85	HS	25.00	R
18	Janakdev (Check)	1153	MR	70.0	S	4.42	S	36.39	MR
19	CIP-393280.57	452	R	5.7	HR	0.83	R	65.00	S
20	PRP-25861.11	103	HR	11.7	R	0.42	HR	9.44	HR
21	PRP-85861.11	49	HR	16.7	R	4.85	HS	7.22	HR
22	CIP-393077.54	713	MR	26.7	R	4.77	HS	78.33	HS
23	CIP-392657.8	29	HR	15.0	R	0.48	HR	16.11	R
24	CIP-385499.11	1334	S	90.0	HS	5.85	HS	77.22	HS
25	CIP-389746.2	692	R	46.0	MR	4.24	S	67.78	S
	F value	137		92.670		83.590		155.70	
	LSD (0.05)	134.46		6.068		1.313		6.938	
	CV %	19.1		9.5		16.2		8.1	

5.1.3.5 RELATIONSHIPS BETWEEN THE ASSAYS

Late blight severity observed in whole plant inoculation under screen house conditions was found significantly correlated (r=89) with observed AUDPC value of clones under field condition (Figure 5.5). There were variations in the severity of some clones between the two assays. Of them two clones PRP-228561.2 and PRP-85861.8 showed significantly high variation (Figure 5.6).

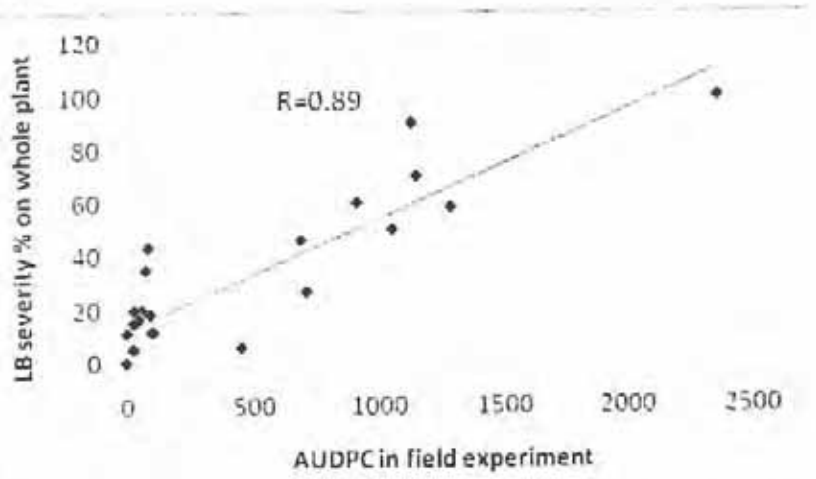

Figure 5.5. Correlation between AUDPC in field and LB severity on whole plant inoculation under screen house conditions

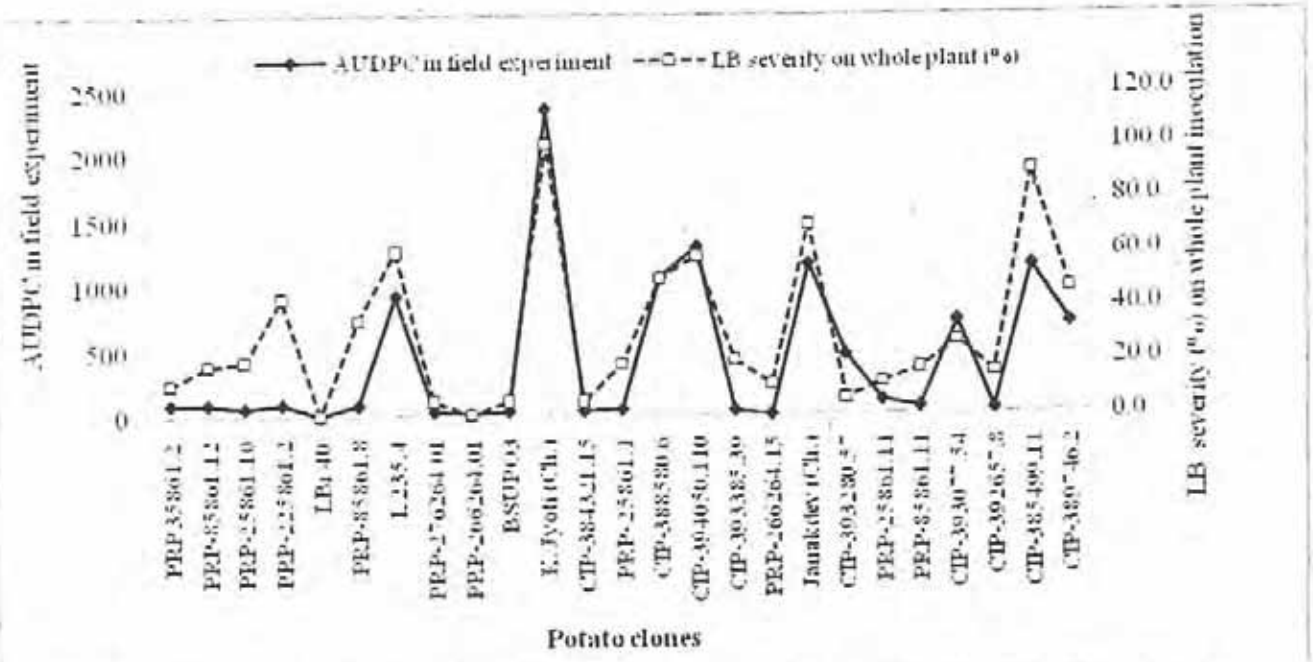

Figure 5.6. Host resistance level of clones to *P. infestans* in field and whole plant inoculation assays in screen house experiment

Detached leaf inoculation under laboratory moist box incubation conditions, late blight severity was found significantly correlated (r=63) with observed AUDPC value of clones under field condition (Figure 5.7). In this comparison, severity variation was observed high

between the two assays. Of them seven clones PRP-85861.8, PRP-276264,01, PRP-266264.01, BSUPO3, CIP-393385.39, PRP-266264.15 and PRP-85861.11 showed high variation (Figure 5.8).

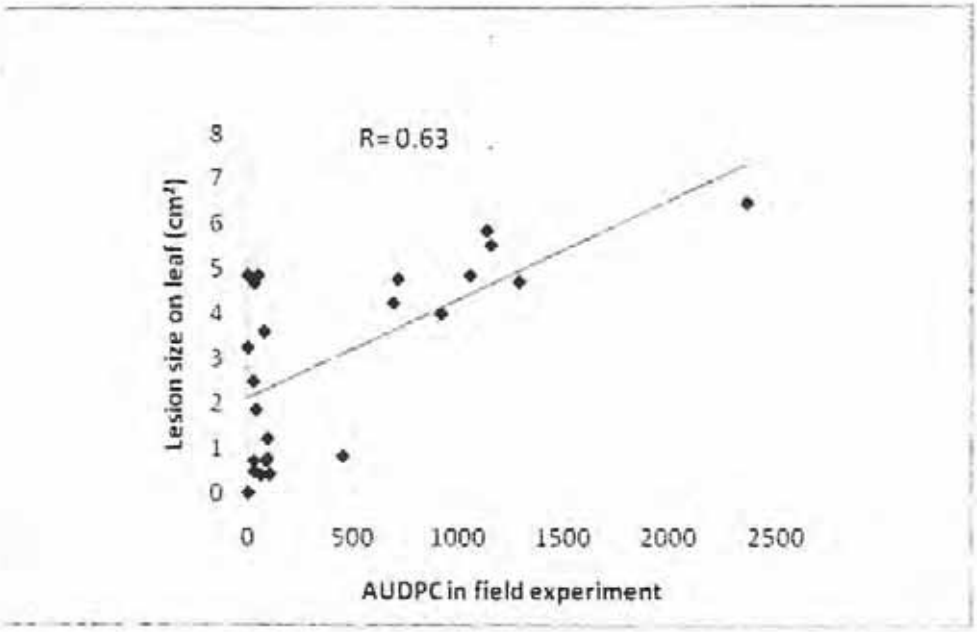

Figure 5.7. Correlation between disease severity AUDPC in field and LB severity on detached leaf assays under lab conditions.

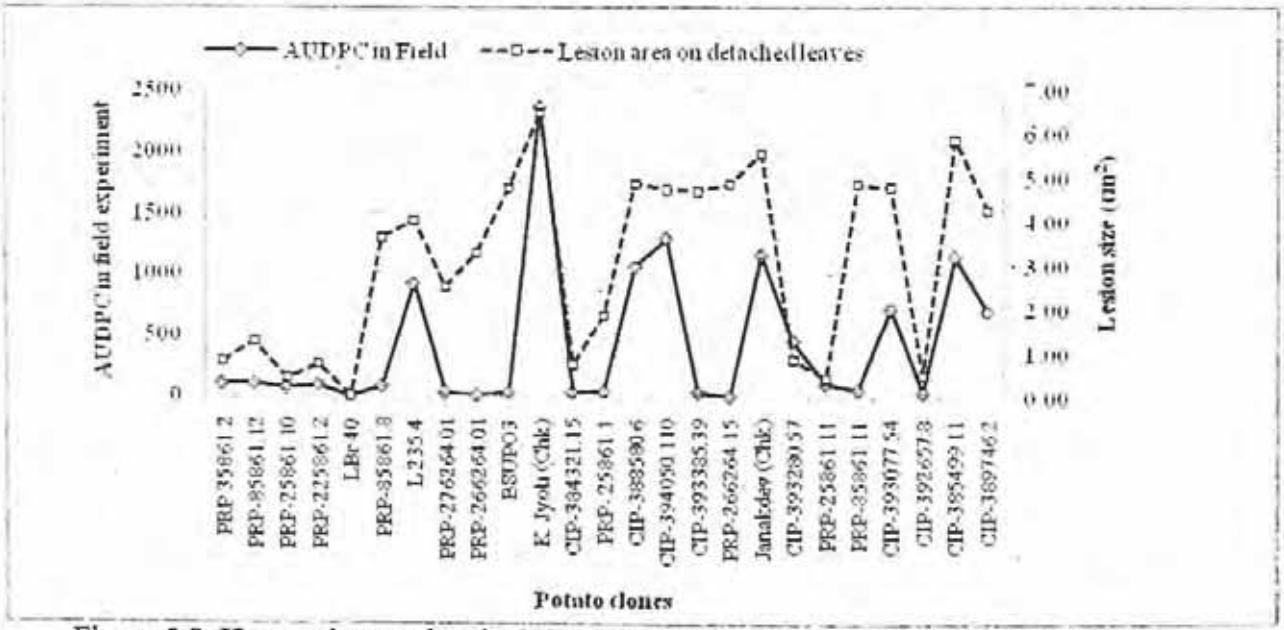

Figure 5.8. Host resistance level of clones to *P. infestans* in field and detached leaf inoculation assays under lab conditions.

Tuber slice inoculation under laboratory conditions, late blight severity was found poorly correlated (r=46) with observed AUDPC value of clones under field condition (Figure 5.9). In some of the clones, severity variation was observed in contradiction with the AUDPC of field inoculation. Of them five clones PRP-35861.2, PRP-225861.2, PRP-276264.01, PRP-266264.01 and BSUPO3, which were found resistant under field condition shoed susceptible reaction with higher colony development on tuber slice assays. In contrary, clones i.e. CIP-

388580.6 and CIP-394050.110 showing susceptible reaction under field conditions, shown comparatively resistant with less colony growth in tuber slice inoculation assays (Figure 5.10).

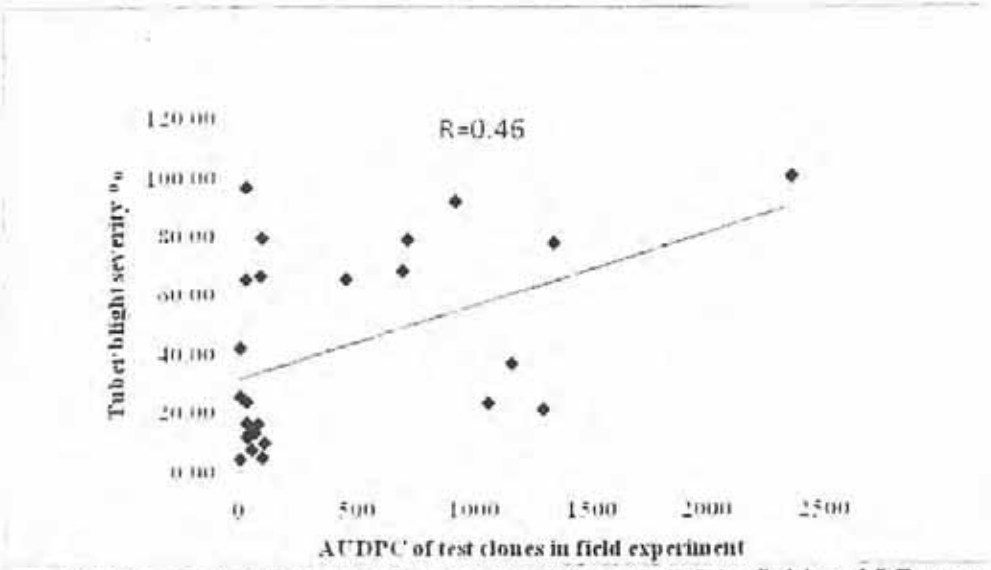

Figure 5.9. Correlation between disease severity AUDPC in field and LB severity on tuber slice inoculation assays under lab conditions.

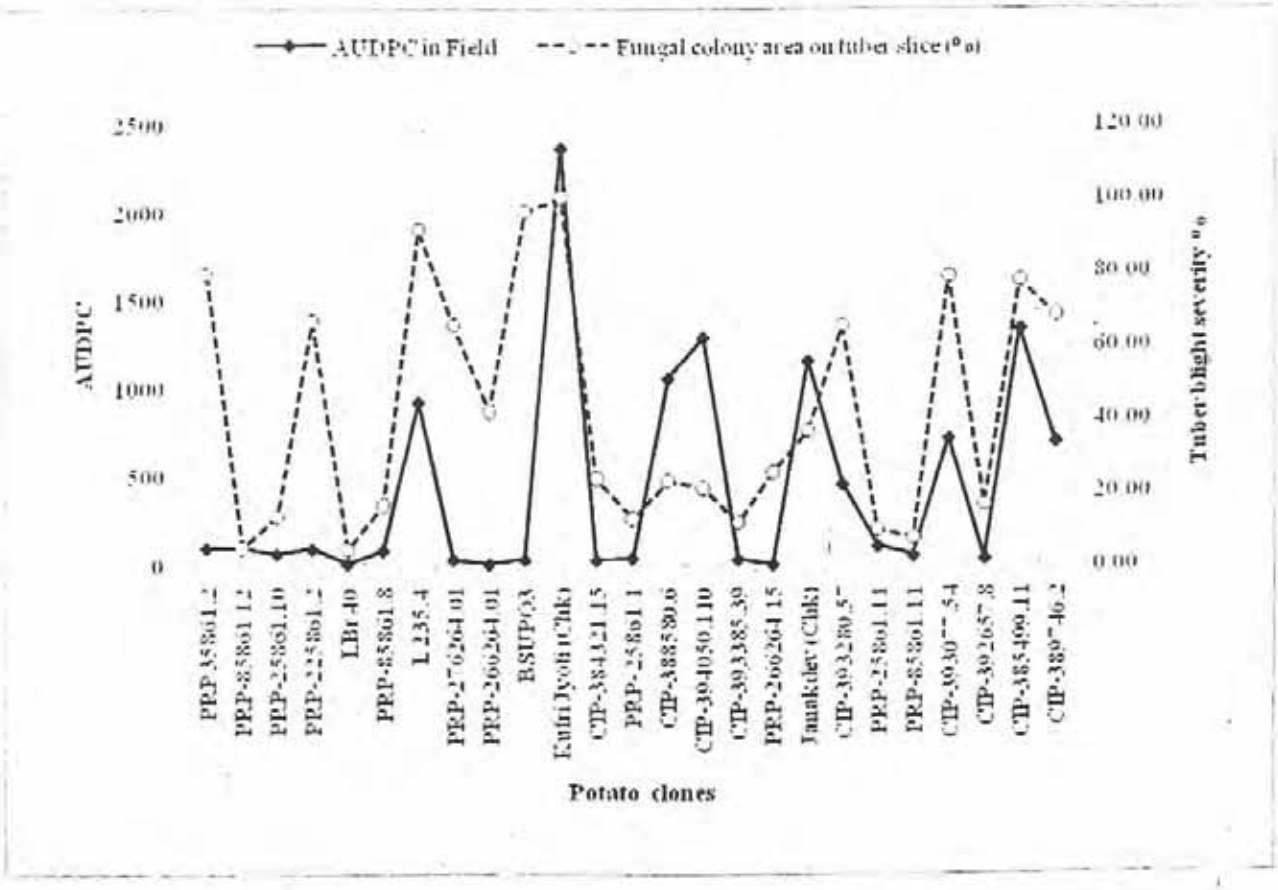

Figure 5.10. Host resistance level of clones to *P. infestans* AUDPC in field and tuber blight severity on tuber slice inoculation assays under lab conditions.

Detached leaf inoculation assay also gave similar results but susceptibility of genotypes behaved differently in lesion size development. Based on the size of lesion on susceptible genotype all 25 clones had been categorized into highly resistant (HR), resistant (R), moderately resistant (MR), susceptible (S) and highly susceptible (HS) by developing 1-9 scale. However, position of leaf affects on the resistance to pathogen. It is important to consider leaf position in tests for late blight resistance under detached leaf inoculation assays.

Some of the clones which are highly resistant (LBr-40) or highly susceptible (Kufri Jyoti) showed same reaction in all the assays, but some clones (BSUPO3, PRP-276264.01 and PRP-225861.2 behaved differently in field and tuber slice inoculation assays (Table 5.7).

Table 5.7. Grouping of test clones in different resistant category

Field inoculation	Whole plant inoculation	Detached leaf inoculation	Tuber slice inoculation
Highly resistant	**Highly resistant**	**Highly resistant**	**Highly resistant**
LBr-40	LBr-40	LBr-40	LBr-40
PRP-266264.01	PRP-266264.01	PRP-25861.10	PRP-85861.12
PRP-266264.15	PRP-276264.01	PRP-25861.11	PRP-85861.11
PRP-276264.01	BSUPO3	CIP-392657.8	PRP-25861.11
$BSUPO_3$	CIP-384321.15	**Resistant**	**Resistant**
CIP-384321.15	CIP-393280.57	PRP-225861.2	CIP-393385.39
CIP-392657.8	PRP-85861.12	CIP-384321.15	PRP- 25861.1
CIP-393385.39	**Resistant**	PRP 35861.2	PRP-25861.10
PRP- 25861.1	PRP-266264.15	CIP-393280.57	PRP-85861.8
PRP-85861.11	PRP 35861.2	PRP-85861.12	CIP-392657.8
PRP-25861.10	PRP-25861.11	PRP- 25861.1	CIP-394050.110
PRP-85861.8	CIP-392657.8	**Moderately resistant**	CIP-388580.6
PRP-225861.2	PRP-85861.11	PRP-276264.01	CIP-384321.15
PRP-85861.12	PRP- 25861.1	**Susceptible**	PRP-266264.15
PRP 35861.2	CIP-393385.39	PRP-266264.01	**Moderately resistant**
PRP-25861.11	PRP-25861.10	PRP-85861.8	Janakdev (Check)
Resistant	CIP-393077.54	L 235.4	PRP-266264.01
CIP-393280.57	**Moderately resistant**	CIP-389746.2	**Susceptible**
CIP-389746.2	PRP-85861.8	Janakdev (Check)	CIP-393280.57
Moderately resistant	PRP-225861.2	**Highly susceptible**	PRP-276264.01
CIP-393077.54	CIP-389746.2	CIP-393385.39	PRP-225861.2
L 235.4	CIP-388580.6	CIP-394050.110	CIP-389746.2
CIP-388580.6	**Susceptible**	BSUPO3	**Highly susceptible**
Janakdev (Check)	CIP-394050.110	CIP-393077.54	CIP-385499.11
Susceptible	L 235.4	CIP-388580.6	CIP-393077.54
CIP-394050.110	Janak Dev (Check)	PRP-266264.15	PRP 35861.2
CIP-385499.11	**Highly susceptible**	PRP-85861.11	L 235.4
Highly susceptible	CIP-385499.11	CIP-385499.11	BSUPO3
Kufri Jyoti (Check)	Kufri Jyoti (Check)	K. Jyoti (Check)	K. Jyoti (Check)

Conclusion

All four assays are effective in potato germplasm screening against *P. infestans*. Potato researcher can choose any one of the assays depending on the available physical facilities. resources and time and the specific problems to be addressed. Foliage blight and tuber blight due to *P. infestans* are the major problems in majority of the potato growing areas of the world. Since late blight is also the tuber borne disease, we need to select foliar blight resistance under the particular environment along with tuber blight resistant genotype. Screening of germplasm could be done either under natural infection or with artificially inoculated field conditions. For tuber blight resistant clone selection tuber slice inoculation assays was found to be the most effective and applicable even under minimum lab facilities.

5.1.4 PERFORMANCE OF POTATO CLONES RESISTANT TO LATE BLIGHT UNDER DIFFERENT AGRO-CLIMATES

5.1.4.1 PERFORMANCE OF POTATO CLONES AT INNER TERAI CONDITIONS

Twenty five potato clones including one susceptible checks were screened against late blight disease at National Maize Research Farm Rampur, Chitwan (260 m asl), representing inner Terai agro-climatic conditions. Planting was done 11 Nov 2010. Experiment was in RCBD replicated twice. Spacing, plot size, fertilizer dose, irrigation and intercultural operations were same as it was in Khumaltar. Fungicides were not applied. Late blight severity was recorded four times 50, 62, 72 to 86 DAP. Crop was harvested on Feb 2011. Evaluations continued until susceptible check variety reached 100% foliage area damaged. Late blight disease severity scoring was done based on foliage damage percent at different crop age 30, 41, 54, 60, 69 and 76 days after DAP. These observations in different days' intervals were used as key reference points for calculation of AUDPC.

Results and Discussion

Out of 25 clones LBr-40, CIP-384321.15, BSUPO3, PRP-25861.1, CIP-393280.57, CIP-392657.8, PRP-85861.12, PRP-25861.11 and PRP-85861.8 showed minimum disease severity (AUDPC <500) as compared to check variety Kufri Jyoti (AUDPC:1766). Three clones CIP-388580.6, PRP-266264.15 and CIP-394050.110 showed susceptible reactions to late blight giving > 1000 AUDPC. Janak Dev which was said to be resistant to late blight showed susceptible under Chitwan conditions (AUDPC:1254). However, it was still field tolerant as compared to Kufri Jyoti (Table 5.8). Disease symptoms appeared only after 50 DAP and severity increased by 72 DAP and reaches maximum at 86 DAP. LBr-40 showed highly resistant to *P. infestans* at inner terai conditions.

Among the disease resistant clones CIP-384321.15 produced highest yield (16.94 t/ha), followed by CIP-393280.57 (13.76 t/ha), PRP-25861.11 (13.57 t/ha), $BSUPO_3$ (13.27 t/ha) and PRP-25861.1 (12.71 t/ha) produced significantly better yield than the check varieties Kufri Jyoti (7.9 t/ha) and Janak Dev (7.88 t/ha).

Table 5.8. Performence of potato clones to late blight disease and tuber yield at inner terai climatic conditions in 2010/11

Trt #	Clones	LB severity % at				AUDPC	Tuber yield (kg/ 1.5m^2)
		50 DAP	62 DAP	72 DAP	86 DAP		
1	PRP 35861.2	0.0	1.5	12.5	85	762	1.927
2	PRP-85861.12	0.0	1.0	5	47.5	404	1.408
3	PRP-25861.10	1.0	1.0	6.5	96.5	771	1.552
4	PRP-225861.2	0.0	0.0	7.5	60	510	0.709
5	LBr-40	0.0	0.0	0	5	35	1.863
6	PRP-85861.8	1.0	2.0	12.5	42.5	476	1.753
7	L 235.4	1.5	9.0	17.5	62.5	756	1.188
8	PRP-276264.01	0.0	0.0	15	50	530	1.791
9	PRP-266264.01	0.0	0.0	10	62.5	558	3.562
10	BSUPO3	0.0	0.0	3.5	27.5	235	1.991
11	Kufri Jyoti (Check)	11.0	20.0	65	100	1766	1.182
12	CIP-384321.15	0.0	0.0	4.5	15	159	2.541
13	PRP- 25861.1	0.0	0.0	3.5	30	252	1.906
14	CIP-388580.6	1.5	12.5	22.5	85	1012	1.371
15	CIP-394050.110	15.0	37.5	57.5	82.5	1770	1.265
16	CIP-393385.39	0.0	4.0	10	75	689	1.587
17	PRP-266264.15	2.0	7.5	35	90	1145	2.134
18	Janak Dev (Check)	1.5	12.5	50	72.5	1254	1.185
19	CIP-393280.57	0.0	0.0	12.5	27.5	343	2.064
20	PRP-25861.11	1.0	3.5	12.5	32.5	422	2.036
21	PRP-85861.11	0.5	1.5	27.5	67.5	822	2.668
23	CIP-392657.8	0.0	1.0	5	45	386	1.633
24	CIP 385499.11	0.0	0.0	17.5	60	630	1.758
	F value	131.77	22.76	19.44	6.74	17.74	2.75
	LSD (0.05)	0.949	5.445	11.83	29.98	317.9	1.0535
	CV %	29.2	52.7	31.8	25.2	22.5	28.4

5.1.4.2 PERFORMANCE OF POTATO CLONES AT HIGH HILLS

Twenty five potato clones were screened against late blight disease at Potato Nucleus Farm Nigale, Sindhupalchok (2460 m asl) representing high hills. Planting was done 8 Feb 2011. Experiment was in RCBD replicated twice. Spacing, plot size, fertilizer dose, irrigation and intercultural operations were same as it was in Khumaltar. Fungicides were not applied. Late blight severity was recorded four times 100, 120, 130 to 145 DAP. Evaluations continued until susceptible check variety reached 100% foliage area damaged. Crop was harvested on 25 July 2011 (167 days after planting). These observations in different day intervals were used as key reference points for calculation of AUDPC and RAUDPC.

Results and Discussion

Twelve clones LBr-40, PRP-276264.01, PRP-266264.01, PRP-25861.1, PRP-85861.11, CIP-384321.15, PRP-225861.2, PRP-85861.8, CIP-392657.8, PRP-25861.11, CIP-393385.39 and PRP-85861.12 showed resistant to late blight (AUDPC <500) as compared to

local check cultivar 'Rosita' (AUDPC:1329). Four clones CIP-389746.2, L235.4, PRP-25861.10, CIP-385499.11, Kufri Jyoti (Check) showed high susceptibility to late blight ranging AUDPC 1710 to 2588 respectively (Table 10). It was interesting that late blight disease symptoms observed only after 90 days after planting second week of May when monsoon started. In susceptible cultivar 'Kufri Jyoti' disease severity reached up to 100 percent at 130 DAP. Crops usually get matured at 150 days, disease observation at 145 days may not require. This year crop was harvested late, and hence due to rainfall, few tubers were found rotted.

Regarding with the tuber yield, PRP-25861.11 (36.35 t/ha) followed by PRP-266264.01 (28.68 t/ha), CIP-389746.2 (27.9 t/ha), LBr-40 (27.02 t/ha) and PRP-225861.2 (26.95 t/ha) significantly produced the highest tuber yield as compared to local check cultivar 'Rosita' (20.89 t/ha). Genotype, CIP-389746.2 showing susceptible reaction to late blight at this altitude produced 33.5 percent higher yield than the Rosita, but their susceptibility to late blight disease was insignificant (Table 5.9).

Table 5.9. Performance of potato clones to late blight and tuber yield under high hills conditions

Clones	LB severity % at different crop age				AUDPC	Tuber yield (t/ha)
	100 DAP	120 DAP	130 DAP	145 DAP		
PRP 35861.2	3	12	27.5	40	862	25.53
PRP-85861.12	0	0	5	42.5	381	16.37
PRP-25861.10	7.5	30	67.5	87.5	2025	2.78
PRP-225861.2	1	4	5	12.5	226	26.95
LBr-40	0	0	0	0	0	27.02
PRP-85861.8	1	3.5	5	20	275	17.11
L 235.4	5	25	65	80	1838	18.72
PRP-276264.01	0	0	0	5	38	24.84
PRP-266264.01	0	0	0	5	38	28.68
BSUPO3	1	5	15	60	723	14.04
Kufri Jyoti (Check)	10	32.5	100	100	2588	5.61
CIP-384321.15	0	0	0	20	150	24.87
PRP- 25861.1	0	0	4	9	118	22.73
Rosita	1	10	42.5	85	1329	20.89
CIP-394050.110	0	3.5	17.5	55	684	9.38
CIP-393385.39	0	0	12.5	27.5	362	23.59
PRP-266264.15	2.5	10	27.5	32.5	763	22.57
Janakdev (Check)	1	10	40	80	1260	15.54
CIP-393280.57	3	10	47.5	60	1224	14.9
PRP-25861.11	1	5	10	17.5	341	36.35
PRP-85861.11	0	0	5	10	138	17.67
CIP-393077.54	0	5	15	40	563	15.28
CIP-392657.8	0	5	7.5	22.5	338	16.04
CIP-385499.11	3.5	22.5	82.5	95	2117	11.02
CIP-389746.2	3.5	22.5	57.5	82.5	1710	27.9
F value	10.01	15.59	147.9	14.35	44.64	21.8
LSD (0.05)	2.371	7.429	6.929	24.93	328.9	4.852
CV%	65.3	41.7	12.7	27.7	19.8	12.1

5.1.4.3 PERFORMANCE OF POTATO CLONES AT CENTRAL TERAI

Promising eight potato clones compared with Kufri Jyoti and Desiree for late blight resistance and tuber yield at central Terai, Parawanipur (160 m asl) field conditions. Treatments were replicated four times. Plot size was 2.5 m long single row. Planting spacing was 25 cm x 60 cm. Fertilizers as basal dose was applied @ 100:100:60 kg N, P, K /ha respectively. Irrigation was given twice. Early blight and late blight disease scoring was done at 70-80 days after planting using in 1-9 rating scale. Fungicide was not applied throughout the crop period.

Results and Discussion

Test clones CIP-384321.15, L235.4, PRP-85861.12, PRP-85861.8 and PRP-85861.18 showed resistance to late blight than the check variety Desiree and Kufri Jyoti. Two clones PRP-15860.8 and CIP-392657.8 were found susceptible and comparable with Desiree and Kufri Jyoti respectively (Table 5.10). Clones showed almost similar severity of early blight comparable with late blight (Table 10). Highest tuber yield was obtained from PRP-85861.12 (27.1 t/ha) followed by CIP-384321.15 (24.37 t/ha) and L235.4 (20.67 t/ha). Late blight severity was not so high even on late blight susceptible cultivars Kufri Jyoti and Desiree during the potato season in 2067/68.

Table 5.10. Performance of potato colnes to late blight and tuber yield under central Terai field conditions at Parawanipur, 2010 (2067/68).

Clones	Ground cover (%)	Early blight (1-9 scale)	Late blight (1-9 scale)	Tuber yield (kg/plot)	Tuber yield (t/ha)
PRP-85861.8	85.0	1.0	1.3	2.41	16.12
PRP-85861.18	81.3	1.0	1.5	2.65	17.67
PRP-85861.12	55.0	1.0	1.3	4.1	27.1
PRP-15860.8	78.8	3.3	3.0	2.03	13.55
CIP- 393385.39	73.8	1.3	2.5	2.19	14.58
CIP-384321.15	83.8	1.0	1.0	3.66	24.37
CIP 392657.8	83.8	2.8	5.2	1.8	12.00
L 235.4	71.3	1.3	1.0	3.1	20.67
K. Jyoti	90.0	3.0	3.3	2.02	13.48
Desiree	71.3	2.5	5.3	1.92	12.78
F Value	11.3	25.6	60.5	28.58	28.62
LSD (0.05)	8.1	0.5	0.6	0.4238	2.82
CV%	8.0	20.8	16.8	11.3	11.3

5.2 WART RESEARCH

Wart caused by *Synchytrium endobioticum* (Schilbersky) Percival is known as 'Aijeru' in Nepali. It is the second most important disease after late blight in Nepal particularly in high hill above 2400 m a s l. Disease has been reported from Ilam, Dolakha Sindhupalchok, and Gorkha districts. Assam, Sikkim and West Bengal are the major wart prone states of India. It is believed that disease was introduced from the above adjoining areas of India.

Plate 10 Wart symptoms on potato tuber.

S. endobioticum is an obligate parasite. It is also of quarantine significance disease and is transmitted through soil and seed tubers. No chemical control measures have been reported so far for the disease management. Use of wart resistant genotypes is only the effective and sustainable way of management. Keeping these points in view, potato clones are screened at high hill conditions, Nigale Sindhupalchok (>2450 m asl) where soils are naturally infested with *S. endobioticum*. Prior to recommendation of any potato variety for commercial production screening against wart is necessary.

Materials and Methods

Twenty five potato genotypes were planted in farmers wart infested field at Jethal VDC, Nigale of Sindhupalchok 2460 masl in 7th Feb 2010. Potato clones were planted into medium size plastic pots filled with 1:1 soil and compost. Resting spores of *Synchytrium endobioticum* were collected and stored for 7 months (Aug-Jan) in refrigerator. Resting spores along with warty tissues were macerated using mortar and pestle. Diluted with water maintaining 4×10^3 spores/ml suspensions. 8 ml of this suspension (32×10^3) resting spores were inoculated per pots just after planting. Pots were irrigated as and when required. No insecticide and fungicides were applied throughout the crop period. Crop was harvested on 25th July 2011. Wart incidence was recorded at the time of harvesting based on warty symptoms on tuber surface as shown in Plate 10.

$$\text{Wart incidence \%} = \frac{\text{No. of infected tubers}}{\text{Total tubers/plot}} \times 100$$

Results and Discussion

Out of 25 clones, thirteen clones were found resistant to wart. Three clones CIP-392657.8, CIP-393280.57, LBr-40 and Rosita showed highly susceptible reaction with the incidence percent ranging 70 to 100 percent. Whereas, clones BSUPO3, CIP-389746.2, PRP-225861.2, L235.4, CIP-384321.15, CIP-394050.110, PRP-25861.11 and CIP-393385.39 showed moderate level of resistance with incidence percent ranging 2.43 to 29 percent (Table 5.11). Susceptible check did not showed 100 percent wart incidence, which require additional inoculums pressure. Infected soil is kept for next year experiment.

Tuber yield per plant was highest in LBr-40 (311.3 g) followed by L235.4 (208.3g), PRP-276264.01, and CIP-389746.2 (171.3 g). There was high coefficient variation (CV 50 to 64 %) in the experiment with regard to tuber number and tuber yield (Table 5.11). It was due to damage of tuber by wild animals (*Dumsi*). This experiment needs to be repeated with better management.

Table 5.11. Performance of potato clones to the incidence of *S. indobioticum* and tuber yield under disease inoculated conditions at Nigale

Trt No	Clones	Wart incidence (%)	Tubers/plot (no.)	Tuber yield /plot (g)
1	PRP-35861.2	0.00	14.00	118.3
2	PRP-85861.12	0.00	7.33	70.7
3	PRP-25861.10	0.00	6.67	42.
4	PRP-225861.2	15.93	8.33	80.3
5	LBr-40	70.00	8.33	311.3
6	PRP-85861.8	0.00	27.00	101.3
7	L 235.4	13.57	12.33	208.3
8	PRP-276264.01	0.00	12.00	190.0
9	PRP-266264.01	0.00	10.00.	78.7
10	BSUPO3	2.43	11.33	65.7
11	K. Jyoti (Check)	0.00	16.67	117.3
12	CIP-384321.15	17.2	13.67	142.0
13	PRP-25861.1	0.00	6.67	80.7
14	CIP-388580.6	0.00	7.00	114.0
15	CIP-394050.110	22.2	8.00	68.0
16	CIP-393385.39	29.00	8.33	115.7
17	PRP-266264.15	0.00	4.67	70.7
18	Janakdev (Check)	0.00	10.00	130.7
19	CIP-393280.57	75.13	12.33	138.3
20	PRP-25861.11	26.17	11.00	117.3
21	PRP-85861.11	0.00	12.33	92.7
22	Rosita	76.57	5.67	85.3
23	CIP-392657.8	100.00	7.33	124.3
24	CIP-385499.11	0.00	3.67	72.0
25	CIP-389746.2	11.50	11.67	171.3
	F test	85.00	1.54	2.82
	LSD(0.05)	9.02	10.7	96.9
	CV%	28.80	64.0	50.8

5.3 POWDERY SCAB RESEARCH

Powdery scab caused by *Spongospora subterranea* (Wallr.) Lagerh. f.sp. *sunterranea* Tomlinson is the disease on tubers. It does not significantly reduce the yield losses but deteriorates the market quality and leads to decrease farmers' income. This disease has been reported from Chitwan, Nawalparashi, Kavrepalanchock, Banke and Bardiya districts. To find out the disease management options a none replicated farmers participatory experiment was carried out at Sharadanagar, Chitwan in 2067/68.

Plate 11. Powdery scab symptoms on tuber.

Four fungicides Acrobat (Dimethomorph), Sectin (Fenamidon 10% + Mancozeb 50%), Agrifos-400 (Phosphorus acid) and Antracol (Propineb) were tested against powdery scab disease. Previously harvested disease infected potato tubers were stored in cold store for 9 months. Prior to planting scab infected seed tubers were soaked for 30 minutes in fungicides as per recommended concentrations. Treatment tubers were shade dried and planted. Spacing, fertilizer, cultural practices were followed as per recommendations made by NPRP. Experiment was planted in Nov 2010 on previously selected powder scab infested sick plot. Observations were taken at harvest on incidence of powdery scab symptoms on tuber surface as shown in Plate 11.

$$\text{Disease incidence \%} = \frac{\text{No. of infected tubers}}{\text{Total tubers/plot}} \times 100$$

Powdery scab incidence was the maximum (46.67 %) in control plots where 100% infected seed tubers were planted. Whereas all the fungicides had significant effect on disease incidence, ranging 18-38 percent. Of them seed treatment with Antracol @4 g /lit showed high efficacy as compared to other test fungicides (Table 5.12). Result revealed that disease can be controlled to some extent with Antracol even if seed tubers are 100 % infected with powdery scab.

Results and Discussion

Tuber yield was highest in Agrifos-400 treated plots (2.19 kg/plot) as compared to untreated check plot (2.0 kg/plot). Yield differences observed were comparable each other. Under low inoculum pressure and infection at later stage of crop did not reduce the tuber yield (Table 5.12). For confirmation of the results experiment needs to be repeated with replicated trials under two soil conditions as irrigated and rain fed sandy loam soil conditions, where powdery scab pathogen exists. However participating farmers were highly convinced on the obtained results in their field.

Table 5.12. Efficacy of fungicides in controlling powdery scab disease of potato under field conditions at Sharadanagar, Chitwan in 2010/11

Treatments	Scab incidence %	Disease control over check (%)	Tuber yield (kg) /plot	Yield increase %
Sectin	22.93	50.88	2.12	6.0
Agrifos-400	28.14	39.71	2.19	9.5
Acrobat 50 WP	33.15	28.98	2.15	7.5
Antracol	18.94	59.42	2.09	4.5
Check	46.67	0.00	2.00	0.00
F test	**		NS	
$LSD_{(0.05)}$	10.34			
CV %	22.4		15.4	

6.0 ORGANIC POTATO PRODUCTION RESEARCH

Introduction

The present scenario of research on global organic farming is encouraging, however, in Nepal; there is limited research on this frontier. Organic potato production prohibits the use of synthetic chemical fertilizers, pesticides, growth regulators, or genetically modified varieties. The decision to grow organic potatoes may be based the demand in the organic market. The production costs for organic potatoes are higher and their yields are lower than for conventionally produced potatoes so it production is limited in small scale. Among the organic practices adopted in Nepal, green manuring, and bio-fertilizers are in lead. Success story of Dhaicha (*Sesbania* sps) in rice field is one of the sound and recommended practice to improve soil fertility. Improved quality FYM through covering dung pits with black plastic is highly successful technology disseminated in western hills. Other promising findings of research were strip cropping and hedge row practice. French bean as intercrop with potato contributed highest return per hectare (Rai et al., 1998a). Coriander was also beneficial when intercropped with potato (Rai et al., 1998b). The successfully adopted cropping patterns were potato-tomato-spinach-radish and potato-chilli-spinach-radish (Ahmed et al., 1998)

The world organic market, estimated over US$ 52 billion with compounded growth of 23% per annum (Newa, 2011). Asia (excluding Australia) alone worths at least US$ 400 million. The total Indian organic farming industry was estimated at around US$ 20 million in 2002. Although, there is no authentic data have been complied yet in Nepal but assumption is worth at least US$ 7 million (NRS 52, 00, 00,000) per annum including export. Till now only 10000 ha land is certified for organic production in Nepal. There is high demand of organic product for export and with in country due to increase awareness of consumers about organic products Newa (2011) reported that, at present 25 companies and 16 cooperatives are actively functioning organic business in Nepal. He further reported that, about 13500 families required organic foods in Katmandu, i.e.180 tones/day. For production of organic potato in India, bio-fertilizers, Azotobactor and Arbuscular mycorrhhizal fungi are used to improve soil and productivity of potato (Vignes et al., 2005). Among the bio-pesticides, Asuro, Khirro, Sisnu, Bakaino, Banmara etc. are valuable botanicals, which can be used for managing pests and diseases (Ranabhat and G.C., 2003). But, their quantification and actual effects are yet to be discovered. Neem oil contains high amount of pesticidal compounds and can be used to treat the seeds of various crops (at 2-5 ml/kg of seeds) (Neupane, 2003).

However, there is no fully recommended technology, policy and certified agencies for organic certification. Considering these facts, National Potato Research Program initiated organic potato research as nutrient management, inter-cropping with legumes, mulching trials, and their promotion activities in farmers' field. The detail of activity conducted since last three years and their results is presented in this report.

6.1 EVALUATE RESPONSES OF POTATO VARIETIES TO NON-CHEMICAL FERTILIZERS

Materials and Methods

The field experiment was conducted during summer season of 2008/09 at Lakuri Bhanjayan in Lalitpur district and during 2009/10 - 2010/11 at Muralikhola (1400 m asl) in Kavre

district. Three potato varieties namely 'Kufri Jyoti', 'Janakdev' and 'Khumal Seto-1' along with three non-chemical fertilizers namely Biozyme, Nitrobenzene (Indian products) and Kwian Thong (Thailand product) were used in the study (Table 6.1). Kufri Jyoti and Khumal Seto-1 were white skinned, whereas Janak Dev was the red skinned variety. The 'Nitrobenzene' contained 15 percent nitrogen while Biozyme was a mixture of several elements and Kwian Thong, contain NPK and other several micronutrients. The 'Kwian Thong' also contained two bacteria (*Lactobacillus* and *Bacillus subtilis*), which were active for decomposition of fertilizer.

All together there were ten treatments constituted with three varieties of potato, three types of fertilizers and an additional treatment of farmer's variety and farm yard manure combination as a check. The experiment was laid out in RCB design with four replications. The individual experimental plots of 3 m × 2 m size were planted with five rows of potato at 60 and 25 cm row and plant spacing, respectively. Farm yard manure at the rate of 10 tones/ ha was well mixed in each plot before planting. Along with FYM the half dose of Nitrobenzene at the rate of 50 kg/ha, Biozyme 20kg/ha and Kwian Thong 150 kg/ha were applied as basal dose based on the treatments. The remaining half doses were top-dressed at the time of first earthing up. Observations were recorded on growth and yield parameters. Analyses of variance were computed to determine significance among treatments using Genstat and MSTATC was used for mean separation.

Table 6.1. Description of treatment combinations

Treatment No.	Variety	Non-chemical fertilizers
1	K. Jyoti	Nitrobenzene @ 100 kg/ha
2	K. Jyoti	Biozyme @ 40 kg/ha
3	K. Jyoti	Kwian Thong @ 300kg/ha
4	Janakdev	Nitrobenzene @ 100 kg/ha
5	Janakdev	Biozyme @ 40 kg/ha
6	Janakdev	Kwian Thong @ 300kg/ha
7	Khumal Seto-1	Nitrobenzene @ 100 kg/ha
8	Khumal Seto-1	Biozyme @ 40 kg/ha
9	Khumal Seto-1	Kwian Thong @ 300kg/ha
10	Farmers variety	Farmer's practice (FYM @ 10t/ha)

Results and Discussion

Plant height (cm)

There were significant differences among treatments on plant height at seventy five days after planting in all three years. The highest plant height (28.3 cm, 54.6 cm and 31.0 cm) was recorded on the combination of variety Janak Dev and organic fertilizer Kwian Thong, in 2008/09, 2009/10 and 2010/11, respectively. However, their pooled analysis did not show any significant on plant height at 75 days after planting. This could be due to grate variation of plant height in different years; it might be due to climatic condition. The detail effect of combination of varieties and organic fertilizers on plant height in different years and pooled analysis data is presented in Table 6.2.

Table 6.2 Effect of organic fertilizers and varieties on plant height at 75 days after planting at Lalitpur and Kavre districts, 2008/09- 2010/11

Treatment combinations	Plant height (cm, days after planting)						
	2008/9	+	2009/10	+	2010/11		Mean
Kufri Jyoti + Nitrobenze	24.00	*ab*	25.0	*b*	26.3	*ab*	25.1
Kufri Jyoti + Biozyme	24.3	*ab*	22.3	*b*	27.0	*ab*	24.5
Kufri Jyoti + Kwian Thong	24.8	*ab*	22.9	*b*	26.8	*ab*	24.8
Janakdev + Nitrobenze	23.5	*ab*	56.00	*a*	25.8	*b*	35.1
Janakdev + Biozyme	25.5	*ab*	49.9	*a*	27.5	*ab*	34.3
Janakdev + Kwian Thong	28.3	*a*	54.6	*a*	31.0	*a*	38.0
Khumal Seto 1 + Nitrobenze	28.0	*a*	23.1	*b*	24.5	*b*	25.2
Khumal Seto 1 + Biozyme	17.5	*c*	24.4	*b*	23.8	*b*	21.9
Khumal Seto 1 + Kwian Thong	22.0	*bc*	22.8	*b*	25.5	*b*	23.4
Farmers' variety + FYM @10t/ha	23.5	*ab*	24.4	*b*	24.0	*b*	24.0
F-test	*		**		*		NS
LSD (0.05)	5.565		6.352		3.933		-
CV (%)	15.9		13.5		10.3		28.7

Ground coverage percentage

There was a non significant difference among treatments on ground coverage percentage at 75 days after planting in all years and their combined analysis. The ground coverage percentage was found more or less similar in first and second years but it was found very high in third years. It may be due to planting of more sprouted tubers and good rain fall in the third years. The detail effect of variety and organic fertilizers on ground coverage percentage is presented in Table 6.3. These data indicated that planting distance need to be tested for organic potato production, the recommended distance with chemicals fertilizers may not be appropriate with organic potato production in such soil and climatic condition.

Table 6.3. Effect of organic fertilizers and varieties on ground coverage percentage at 75 days after planting at Lalitpur and Kavre districts, 2008/09- 2010/11

Treatment combinations	Ground coverage (%, Days after planting)			
	2008/9	2009/10	2010/11	Mean
Kufri Jyoti + Nitrobenze	53.7	53.7	71.2	59.5
Kufri Jyoti + Biozyme	55.0	55.0	68.7	59.6
Kufri Jyoti + Kwian Thong	55.2	55.2	72.5	61.0
Janak Dev + Nitrobenze	57.5	57.5	65.0	60.0
Janak Dev + Biozyme	58.7	58.7	70.0	62.5
Janak Dev + Kwian Thong	57.5	57.5	53.7	56.2
Khumal Seto 1 + Nitrobenze	55.0	55.0	71.2	60.4
Khumal Seto 1 + Biozyme	53.7	53.7	72.5	60.0
Khumal Seto 1 + Kwian Thong	50.0	50.0	75.0	58.3
Farmers' variety + FYM @10t/ha	43.7	43.7	70.0	52.5
F-test	NS	NS	NS	NS
LSD (0.05)	-	-	-	-
CV (%)	13.4	13.4	14.5	8.5

Tuber yield (t/ha)

There was significant difference among treatments on tuber yield of potato in different years and combined analysis over the years. In first year the highest tuber yield (17.71 t/ha) was recorded on combination of Kufri Jyoti variety with Kwian Thong organic fertilizer followed by combination of Janak Dev with Kwian Thong fertilizers (17.21 t/ha). In 2009/10 and 2010/11, the highest tuber yield (23.83 t/ha and 16.75 t/ha) was recorded on combination of Janak Dev with Kwian Thong fertilizer, respectively. In first year, the lowest tuber yield (8.9 t/ha) was recorded on the treatment having Kufri Jyoti and Nitrobenzene fertilizer and it was found at par with farmers practices (Farmers' variety + FYM @10t/ha). In second, third years and combined analysis the lowest tuber yield (11.93 t/ha, 8.85 t/ha and 10.11 t/ha) on farmers practices (Table 6.4). Based on three years record Kwian Thong organic fertilizer was found effective for increase the production of potato. The increased in production due to application of Kwian Thong organic fertilizers could be due to present of major and minor nutrients. Asia Agro tech Co. LTD. reported that, Kwian Thong contain 1-3 % N, 1-2 % P_2O_5, 1.3 -3 % K_2O, 7.4 % Ca, 4.09 % Mg, 1.03 % Fe, 0.003 % Cu, 0.05 % Mn, 0.0075 % Zn, 0.0035 %B, 0.06 % Mo, 1.88 % S, 10-15 % O.M., 0.18 % humic acid and 0.17 % Na. The analysis report of soil management Directorate of MOAC reported that, Kwian Thong organic fertilizer contain 1.02 % nitrogen, 4 % phosphorus, 0.32 % potash, 145.7 ppm zinc, 1670.9 ppm manganese, 47.6 ppm copper and 162.5 ppm boron. The increased in production due to application of Kwian Thong was reported on rice and wheat in Kathmandu, Bhaktpur and many other places.

Table 6.4 Effect of organic fertilizers and varieties on tuber yields of potato at Lalitpur and Kavre districts, 2008/09- 2010/11

Treatment combinations	2008/9		2009/10		2010/11		Mean	
Kufri Jyoti + Nitrobenze	8.9	*d*	13.26	*de*	11.04	*cd*	11.08	*d*
Kufri Jyoti + Biozyme	11.88	*bcd*	18.79	*b*	9.66	*cd*	13.44	*bcd*
Kufri Jyoti + Kwian Thong	17.71	*a*	19.94	*b*	12.22	*bc*	16.62	*ab*
Janak Dev + Nitrobenze	11.67	*cd*	11.56	*e*	14.79	*ab*	12.67	*cd*
Janak Dev + Biozyme	11.63	*cd*	13.56	*de*	12.59	*bc*	12.59	*cd*
Janak Dev + Kwian Thong	17.21	*ab*	23.83	*a*	16.75	*a*	19.26	*a*
Khumal Seto 1 + Nitrobenze	10.94	*cd*	12.16	*e*	10.73	*cd*	11.28	*d*
Khumal Seto 1 + Biozyme	11.17	*cd*	15.33	*cd*	12.21	*bc*	12.90	*bcd*
Khumal Seto 1 + Kwian Thong	15.48	*abc*	17.71	*bc*	12.74	*bc*	15.31	*bc*
Farmers' variety + FYM @10t/ha	9.54	*d*	11.93	*e*	8.85	*d*	10.11	*d*
F-test	*		**		***		***	
LSD (0.05)	5.538		2.799		2.991		3.513	
CV (%)	30.2		12.2		16.9		15.1	

Economic analysis

Cost benefit analysis is very important before recommendation technology to the farmers. It helps to the farmers for convincing to adapt new technology. In this experiment, the economy analysis showed that the application of Biozyme and Kwian thong was found effective than farmers practices, while the application of Nitrobenzene showed negative result for benefit. Based on three years pooled result the maximum total extra benefit of NRs. 7,155.0/ropani was recorded by using Janak Dev variety and Kwian Thong organic fertilizer @ 15 kg/rop and it was followed by NRs. 4,212.0/ropani with combination of Kufri Jyoti and Kwian (Table 6.5).

Table 6.5 Economic analysis of variety x fertilizer trial of potato from 2008/09- 2010/11

Treatment combinations	Yield (kg/rop.)*	Total profit (Rs./rop)	Extra organic fertilizer (kg/rop) +	Extra org. fert. cost (Rs/rop)	Extra total cost (Fer +labour)	Total profit (Rs/rop)	Extra benefit over farmers practices (Rs/rop)
Kufri Jyoti + Nitrobenze	554	8310	5	1750	1850	6460	-1123
Kufri Jyoti + Biozyme	672	10080	2	100	200	9880	2297
Kufri Jyoti + Kwian Thong	831	12465	15	570	670	11795	4212
Janak Dev + Nitrobenze	634	10136	5	1750	1850	8286	703
Janak Dev + Biozyme	630	10012	2	100	200	9812	2230
Janak Dev + Kwian Thong	963	15408	15	570	670	14738	7155
Khumal Seto 1 +Nitrobenze	564	8460	5	1750	1850	6610	-973
Khumal Seto 1 + Biozyme	645	9675	2	100	200	9475	1892
Kh. Seto 1 + Kwian Thong	769	11543	15	570	670	10873	3290
Farmers' variety-FYM@10t/ha	505	7583	-	-	-	7583	-

* Price of Potato /kg: Rs 15 for white and Rs. 16 for red potato

\+ Price of organic fertilizers kg= Rs. 350for Nitrobenzene, Rs. 50 for Biozyme and Rs. 38 for Kwian Thong

6.2 MULCHING TRIAL ON POTATO

Materials and Methods

The experiment was conducted first year at Lakuri Bhanjayan (1400 m asl) in Lalitpur and second and third years at Muralikhola (1300 m asl) in Kavre district during spring-summer season and at Saltanda in Dailekh district during winter season. Variety Kufri Jyoti was used in the experiment. Four mulching materials viz. black plastic, white plastic, dry grass, cardboard paper and no mulching were included as the treatments (Table 6.6). The experiment was conducted in a Randomized Complete Block design with five treatments in four replicates. The individual experimental plots of 3 m × 2 m size were planted with five rows of potato at 0.60 and 0.25 m row and plant spacing, respectively. Farm yard manure at the rate of 20 tones/ ha was well mixed in each plot before planting. Observations were recorded on growth and yield parameters. Analyses of variance were computed to determine significance among treatments using Genstat and MSTAT-C was used for mean. Separation.

Table 6.6. Details of mulching materials

S. No.	Treatments
1	Dry grass
2	Paper
3	White plastic
4	Black plastic
5	No mulching

Results and Discussion

Kavre and Lalitpur

Plant height (cm) and ground coverage percentage

There was no significant difference among treatments for plant height at 75 days after planting. However, mulching materials showed the slight increased in plant height in all years and their pooled analysis. The detail result is presented in Table 6.7.

There was highly significant and significant difference on ground coverage percentage at 75 days after planting in first, second years and pooled analysis, respectively. The maximum ground coverage was observed on paper mulch (92.5 %) during 2008/09 and 87. 7 % in white plastic much during 2009/10. Two years combined analysis showed the maximum ground coverage (87.73 %) on white plastic much followed by paper much (86.25 %0 and black plastic mulch (82.50%). The minimum ground coverage percentage at 75 days after planting was observed on much treatment in both years and their combined analysis (Table 6.8). The ground coverage percentage was not observed in third years due to damage of crops by hail stone before 75 days after planting.

Table 6.7. Effect of mulching on plant height at 75 days after planting of potato at Lakuri Bhanjanyang and Muralikhola, 2008/09- 2010/11

Treatment combinations	2008/09	2009/10	2010/11	Pooled
Dry grass mulch	22.25	32.2	33.00	29.15
Black plastic mulch	20.75	38.5	34.00	31.08
White plastic mulch	19.75	37.5	39.70	32.32
Paper mulch	18.75	38.7	34.70	30.72
No mulch (check)	17.0	31.8	29.00	25.93
F-test	NS	**NS**	NS	NS
LSD (0.05)	-	10.11	-	-
CV (%)	11.8	18.4	15.5	8.4

Table 6.8 Effect of mulching on ground coverage percentage of potato at Lakuri Bhanjanyang and Muralikhola, 2008/09- 2009/10

Treatment combinations	2008/09	-	2009/10	-	Pooled	-
Dry grass mulch	80.0	b	76.2	*bc*	78.10	*bc*
Black plastic mulch	82.5	b	82.5	*ab*	82.50	*ab*
White plastic mulch	88.8	a	87.7	*a*	87.73	*a*
Paper mulch	92.5	a	80.0	*abc*	86.25	*ab*
No mulch (check)	68.7	c	72.5	*c*	70.63	*c*
F-test	***		**		*	
LSD (0.05)	4.040		9.06		9.79	
CV (%)	3.2		7.4		5.3	

Tuber yield (t/ha)

There was significant difference among mulching materials on yield of potato in all years and their combined analysis data. In pooled analysis, black plastic mulching produced significantly the highest tuber yield (28.06 t/ha) than other treatments, whereas the lowest yield (15.80 t/ha) was recorded on no mulching (control) treatment (Table 6.9). There was 21 to 62 % increased in tuber yield of potato due to mulching of different materials than control (Table 6.10). The highest yield increased (62.0 %) in black plastic mulch could be due to absorption of more sun light and control of weeds than other mulching materials. NRPR (2009 and 2010) also reported higher yield of potato in black plastic mulching. There was 98.6 % weeds control in Malepatan, Pokhara and 79.3 % weeds control in Hattiban farm due to mulching of black plastic than control treatment during 2008(Anonyms 2009) and 78.2 % in Malepatan, Pokhara and 78.2 % in Hattiban farm during 2009 (Anonyms 2010).

Table 6.9 Effect of mulching on tuber yields of potato at Lakuri Bhanjanyang and Muralikhola, 2008/09- 2010/11

Treatment combinations	2008/09		2009/10		2010/11		Pooled	
Dry grass mulch	15.14	*ab*	25.61	*ab*	16.79	*c*	19.18	*b*
Black plastic mulch	20.14	*a*	31.99	*a*	24.67	*a*	25.60	*a*
White plastic mulch	17.55	*a*	30.13	*a*	17.54	*bc*	21.74	*b*
Paper mulch	14.54	*ab*	28.24	*a*	20.67	*b*	21.15	*b*
No mulch (check)	9.49	*b*	21.84	*b*	16.08	*c*	15.80	*c*
F-test	*		*		***		***	
LSD (0.05)	6.016		6.065		3.421		3.098	
CV (%)	25.4		14.3		11.6		8.0	

Table 6.10 Effect of mulching on increase of tuber yields of potato over control at Lakuri Bhanjanyang and Muralikhola, 2008/09- 2010/11

Treatment combinations	Three years average yield (t/ha)	Yield increased percentage over control (No mulching)
Dry grass mulch	19.18	21.2
Black plastic mulch	25.60	62.0
White plastic mulch	21.74	37.6
Paper mulch	21.15	33.8
No mulch (check)	15.80	

ARS Dailekh

Plant height (cm) and ground coverage percentage

There were highly significant differences among mulching materials on plant height during 2008/09 and 2009/10 and non significant during 2010/11. The pooled analysis over years showed a non significant difference on plant height. However, the maximum plant height (33.4 cm) over years was observed on black plastic mulching treatment (Table 6.11). The non significant over years may be due to effect of third year result.

Table 6.11 Effect of mulching on plant height at 75 days after planting of potato at Dailekh, 2008/09- 2010/11

Treatment combinations	2008/09		2009/10	2010/11	Pooled
Dry grass mulch	30.75	*b*	28.20	35.45	31.5
Black plastic mulch	35.60	*a*	29.00	33.53	33.4
White plastic mulch	23.65	*c*	23.00	37.55	28.1
Paper mulch	34.40	*a*	17.65	37.95	30.3
No mulch (check)	20.35	*c*	14.80	33.15	22.8
F-test	**		**	NS	NS
LSD (0.05)	3.334		5.265	-	-
CV (%)	3.334		15.2	12.8	15.1

The ground coverage at 75 days after planting showed highly non significance and highly significant differences during 2008/9 and 2009/10, respectively. However, the pooled analysis of two year data showed significant difference on ground coverage percentage at 75 days after planting. The maximum ground coverage (50.25%) was observed on black plastic mulching and the minimum (36.15%) on no mulching treatment. The detail effect of mulching material on ground coverage percentage is presented in Table 6.12.

Table 6.12. Effect of mulching on ground coverage of potato at 75 days after planting of potato at Dailekh, 2008/09- 2010/11

Treatment combinations	2008/09	2009/10	2010/11	Pooled	
Dry grass mulch	67.5	33.0	-	50.25	*b*
Black plastic mulch	72.5	38.0	-	55.25	*a*
White plastic mulch	61.2	30.5	-	45.85	*c*
Paper mulch	67.5	24.3	-	45.90	*c*
No mulch (check)	55.0	17.3	-	36.15	*d*
F-test	NS	**	-	*	
LSD (0.05)	-	7.38	-	7.486	
CV (%)	12.8	16.7	-	7.1	

Tuber yield (t/ha)

There was highly significant and significant differences on yield of potato among the treatments during 2008/9, 2009/10 and pooled analysis, respectively. The maximum tuber yield was recorded on black plastic mulching treatment in all years and pooled analysis data except 2010/11. The pooled data showed that black plastic mulching was found superior than other treatments. This result is in same line of result of Kavre and Lalitpur. The detail data is presented in Table 6.13.

Table 6.13. Effect of mulching on tuber yields of potato at Dailekh, 2008/09- 2010/11

Treatment combinations	2008/09		2009/10		2010/11	Pooled	
Dry grass mulch	16.87	*c*	15.43	*b*	11.13	14.48	*ab*
Black plastic mulch	23.16	*a*	23.50	*a*	10.04	18.90	*a*
White plastic mulch	19.88	*b*	20.21	*ab*	8.96	16.35	*ab*
Paper mulch	18.27	*b*	15.56	*b*	12.88	15.57	*ab*
No mulch (check)	17.49	*b*	9.12	*c*	8.96	11.86	*b*
F-test	**		**		**NS**	*	
LSD (0.05)	2.424		5.081		-	5.782	
CV (%)	8.2		19.7		32.6	19.9	

There was 22.19 to 59.49 % increased in tuber yield of potato due to mulching of different materials than control (Table 6.14). The highest yield increased (59.59 %) in black plastic mulch could be due to absorption of more sun light and control of weeds than other mulching materials. This result showed the similar trend of results of Kavre and Lalitpur presented in Table 6.10.

Table 6.14. Effect of mulching on increase of tuber yields of potato over control at Dailekh, 2008/09- 2010/11

Treatment combinations	Three years average yield (t/ha)	Yield increased percentage over control (No Mulching)
Dry grass mulch	14.48	22.19
Black plastic mulch	18.9	59.49
White plastic mulch	16.35	37.97
Paper mulch	15.57	31.39
No mulch (check)	11.85	

6.3 STUDY ON POTATO-BASED CROPPING SYSTEMS

Materials and Methods

The experiment was conducted three years at Saltanda of Dailekh district during winter season. Potato variety Kufri Jyoti was used for the experiment. Four crop combinations were compared with additional sole potato plot (Table 6.15). The experiment was conducted in a Randomized Complete Block design with five treatments in four replicates. The individual experimental plots of 6 m × 2 m size were planted with five rows of potato at 0.60 and 0.25 m row and plant spacing, respectively. Intercrops were planted in alternate rows with the spacing of 0.45m for pea, cauliflower and tomato as well as 0.10 m for radish and turnip. Farm yard manure at the rate of 20 tones per ha was well mixed in each plot before planting. Observations were recorded on yields and economic data.

Table 6.15. Detail of treatment combinations

S. No.	Treatments
1	Potato + pea
2	Potato + Cauliflower
3	Potato + tomato
4	Potato + radish
5	Potato + turnip
6	Potato sole

Results and Discussion

There was a no significant difference on yield of potato due to intercropping of different vegetables with potato. However, significant difference was observed on yield of intercrops (Table 6.16). The main crop yields remained non-significant which could be due to less influence of other crops on the potato crop. This effect might also be related with short crop duration of potato compared to cauliflower and tomato after planting and shallower root zone of turnip and radish than that of potato.

The best combination of crops was potato and radish for their economic significance. The highest cost benefit ratio was in the combination of potato and radish (1:3.89) followed by potato and turnip (1:3.61) and the lowest cost benefit ratio (1:1.19) on potato and tomato. Higher yield of potato and tomato was less important due to their higher cost of production than the other combinations. The detail cost benefit ratio is presented in Table 6.17.

Table 6.16. Yields of potato and vegetables with intercropping of vegetables with potato at Saltanda , Dailekh, 2008/09 - 2009/10

Treatment combinations	Potato yield (t/ha)		Vegetable yield (t/ha)		Pooled yield data (t/ha)	
	2008/9	2009/10	2008/9	2009/10	Potato	Vegetables
Potato +Cauliflower	17.1	17.0	19.37 ab	12.86 *c*	17.1	16.2
Potato +Pea	21.2	14.8	9.77 c	18.62 *ab*	18.0	14.2
Potato +Radish	21.33	15.4	17.00 b	18.87 *a*	18.4	18.0
Potato+ Turnip	18.8	16.9	11.04 c	17.20 *ab*	17.9	14.2
Potato +Tomato	18.9	15.5	19.79 a	13.63 *c*	17.2	16.7
Potato Sole	13.4	26.4	-	-	19.9	
F-test	**NS**	**NS**	**	**	NS	NS
LSD (0.05)	-	2.185	2.502	1.501	-	-
CV (%)	11.1	8.9	10.5	6.0	28.0	31.2

Table 6.17. Economic analysis of intercropping systems at Dailekh, 2009/10

Treatment combinations	Yields /rop.		Production Cost (Rs. /ropani)	Price of intercrops (Rs./kg)	Gross benefit (Rs./ropani)			Net benefit (Rs./ropani)	B:C ratio
	Main crop	Intercrop			Potato	Intercrop	Total		
Potato + Cauliflower	885	810	11663	17.0	12825	13770	26595	14932	1:1.28
Potato +Pea	900	710	6121	17.5	13500	12425	25925	19804	1:3.23
Potato + Radish	920	900	5311	13.5	13800	12150	25950	20639	1:3.89
Potato + Turnip	895	710	5373	16.0	13425	11360	24785	19412	1: 3.61
Potato + Tomato	860	835	13126	19.0	12900	15865	28765	15639	1: 1.19
Potato sole	995	-	5118	15.0	14925	-	14925	9807	1:1.92

C: B = Cost ratio: Benefit ratio

6.4 PUBLISH RESEARCH RESULTS IN BOOKLETS

This activity was proposed in third year of project to disseminate the finding in wider scale. This will help farmers, co-operatives and other concern agencies who are involve in organic potato production and marketing. The publication of booklets in Nepali language will help farmers to understand and adaptation of technology.

The results of three year trials on different aspect of organic potato production was compiled, analyzed and outs were published in booklets of Nepali language. A total of 1000 copies booklets were published for dissemination of technology in large scale. These booklets will help the farmers, NGOs/ INGOs and other related organization and entrepreneurs for production of organic potato. Some suggestion was given in booklets for further implementation of organic production and planning process.

Conclusion and Recommendation

- The combination of 'Janak Dev' of potato variety and 'Kwian Thong' non chemical fertilizer increased the yield up to 90.5% more than the farmers' practices (farmers' variety and farmers fertilizes practices, i.e., application of 10 tones FYM/ha) at Lakuri Bhanjanyang, Lalitpur and Muralikhola, Kavre conditions during the spring-summer season planting. In economic term, the combination of Janak Dev potato variety with 15 kg Kwian Thong/ropani gives extra income of NRs. 7,155/ropani.
- The mulching trial in Dailekh and Muralikhola, Lalitpur showed that black plastic mulch was effective for enhancing productivity in both locations. It increased 59.49 % yield in Saltanda, Dailekh for winter season planting and 62.0 % at Muralikhola, Kavre condition for spring-summer season planting.
- The intercropping of potato with radish followed by turnip was found profitable in Dailekh condition with 1: 1.389 cost benefit ratio in radish and 1: 1.3.61 in turnip.
- The intercropping of tomato with potato was not recommended due to low cost benefit ratio.
- Up-scaling and dissemination of these technologies is recommended for organic potato production in pocket areas.

7.0 STUDIES ON SEED PRODUCTION

7.1 SUSTAINABLE AND RAPID PROPAGATION OF POTATO PLANTLETS UNDER *IN VITRO* CONDITIONS

Introduction

Higher cost of *in vitro* plantlet production is one of the major constraints for pre-basic seed potato production. Chemicals like agar, sucrose, MS medium, plant growth regulators (PGRs) and glassware, and electricity charge to run the tissue culture laboratory are the major cost factors. Similarly, high mortality rate during acclimatization and transplantation at glasshouse /screen house is another factor for high cost PBS production. Since the establishment of tissue culture laboratory and the glasshouse in 1989, National Potato Research Program (NPRP) has been producing certain amount of PBS annually (NPRP, 2007/8). In spite of budgetary constraint, NARC is expending some budget for the production of valuable planting materials (PBS) each year. However, the program is providing the PBS to the farmers at subsidized price so as to make it affordable to the farmers. To sustain such a high cost pre-basic seed production program, there is no other alternative other than to reduce the cost of production and increase the efficiency of *in vitro* multiplication and PBS production under glasshouse condition. Selection of appropriate vessels and plant density for *in vitro* rapid multiplication with maximum branching, efficient production of microtubers under *in vitro* condition during off-season are the most important and basic works for sustainable and economic production of *in vitro* plantlets and PBS under glasshouse. In case of light supply under incubation room, it needs 16 h light of 2000 Lux per day, but during the dry season there is only 10-12 h power supply. To overcome these problems need to study about the use of natural light in some extent for the sustainability of the Tissue Culture Laboratory. Similarly, proper utilization of PBS is also the most important part in quality seed potato production program and in other hand it is also necessary to explore the important of quality seed (Basic seed) through farmer participation. The overall reduction in the cost of *in vitro* plantlets and maximum production of medium to large size PBS under glasshouse are prime importance in reducing cost per unit PBS. To solve the above mentioned various problems; the objectives of these studies were to efficient and rapid multiplication of *in vitro* plantlets and microtuber production in a sustainable way and to aware the farmers about the size of PBS and important of quality seed.

Materials and Methods

1. Laboratory activities

1.1 Incubation conditions on *in vitro* plantlets development

This study was conducted to evaluate the performance of *in vitro* plantlets cultured under different incubation conditions under laboratory for plant development and PBS production under screenhouse condition. The nine different incubation conditions used for the development of *in vitro* plantlets were: (i) four weeks in standard growth room (SGR), (ii) three weeks in SGR and one week in partial light condition (PLC), (iii) two weeks in SGR and two weeks in PLC, (iv) one week in SGR and three weeks in PLC, (v) four weeks in natural light condition (NLC), (vi) one week in SGR and three weeks in NLC, (vii) two weeks in SGR and two weeks in NLC, (viii) three weeks in SGR and one week in NLC and, (ix) four weeks in PLC (Table 3). Ten single nodal

explants were used per jar (400 ml) in MS solid medium at five replications on potato cv. Desiree at CRD design.

1.2 Incubation condition on microtuber production

This study was conducted to evaluate the performance of *in vitro* tuberization under four different culture conditions. Ten single nodal explants were used per jar in MS solid medium at five replications on potato cvs. Desiree and Kufri Jyoti. Four incubation conditions used as treatments were: (i) transfer to darkness immediately, (ii) transfer to darkness after one week in standard light condition, (iii) transfer to darkness after two weeks in standard light condition, and (iv) continuous incubation in standard light condition. *In vitro* culture of single nodal cuttings on MS solid media with 6% sucrose for seven weeks at 16 h photoperiod and 20±2°C temperature and then addition of 20 ml freshly prepared tuber induction media (½MS with 8% sucrose) and transferred the culture vessels under four different conditions until harvesting the microtuber (about two months).

2. Screen house conditions

At Nala, farmer's group constructed a screenhouse for PBS production and planted *in vitro* plantlets from the year 2065/66. The *in vitro* plantlets were supplied from NPRP, Khumaltar with technical support. In the F.Y. 2067/68, two experiments were carried out in the same screenhouse with the involvement of farmers. The experiments were: i) evaluation of *in vitro* plantlets and under-sized minitubers for PBS production, and ii) evaluation of different planting spacing of *in vitro* plantlets for PBS production under screenhouse condition. Before starting the experiments farmers were trained about the planting of the *in vitro* plantlets and production of PBS. Experiments were planted on 2067-4-27 and harvested on 2067-8-10. Two potato cultivars: Cardinal and Janak Dev, and eight rows of three replications were used for each variety in the study.

3. Farmers field conditions

Under this activity two experiments were designed and conducted at farmers field conditions at Shankhu, Kathmandu. The two experiments were: (i) Demonstrate performance of different size of PBS for basic seed production under farmers' field, and (ii) Demonstrate performance of basic seed -2 and farmer's seed for potato production under farmers' field. Experiments were planted on 2067-10-23 and harvested on 2068-2-4. Two potato cultivars: Cardinal and Janak Dev, and eight rows of three replications were used of each variety in the study. In the experiment no. 1, four different sized (>5 g, 1-5 g, 0.5-1 g and <0.5 g) of PBS of both varieties were supplied from NPRP, Khumaltar and planted in the farmers field at Sankhu, Kathmandu.

4. Data analysis

The experiments were conducted in a complete randomized design (CRD). In the case of different incubation conditions for the development of *in vitro* plantlets culture, plant growth, leaf size, branching, usable branch and plant vigor etc were recorded. Similarly, in the case of microtuber production, number and fresh weight of microtuber were recorded from each treatment. In the case of screenhouse experiment, plant height, number of main stem, tuber/plant and yield of PBS were recorded. In the case of field experiments, plant height, tuber yield and size distribution of PBS were recorded. Data were analyzed by analysis of

variance (ANOVA), and mean separation was done by Duncan multiple range test (DMRT) at 0.05 level using MSTATC (1986) package.

Results and Discussion

Use of natural light for the survival and development of *in vitro* plantlets for PBS production

Result indicated that incubation for four weeks under partial light condition (PLC) gave significantly the lowest plant height, nodal number, usable node, leaf size, branching, and rooting and plant vigor, and were better from the standard growth condition (SGC). However, 2 weeks SGR plus 2 weeks in natural light condition (NLC) also showed good performance on most of the evaluated parameters. The least efficiency was found in the PLC treatment among the evaluated treatments (Table 7.1). From this study it can predict that natural night can utilize for production of the in vitro plantlets.

Table 7.1. Performance of *in vitro* plantlets of potato cv. Desiree grown under different incubation conditions

Incubation conditions	Plant ht. (cm)	Leaf size (1-5)	Branch-ing (0-1)	Node (No.)	Inter-node length (cm)	Usable node (%)	Rooting (1-3)	Plant vigor (1-5)
4 weeks in natural light condition (NLC)	6.3 bc ‡	1.0	1.0	3.3 d	2.5	80.0	1.1	2.1 bc
1 week in standard growth condition (SGC) and 3 weeks in NLC	6.5 bc	2.0	0.9	4.5 cd	2.2	90.0	1.8	2.4 bc
2 weeks in SGC and 2 weeks in NLC	8.1 a	3.0	0.9	4.5 cd	1.6	95.0	2.5	4.2 a
3 weeks in SGC and 1 week in NLC	7.5 ab	2.6	0.8	5.8 bc	1.2	100	2.8	4.4 a
4 weeks in partial light condition (PLC)	5.8 c	1.3	1.0	3.5 d	1.7	60.5	1.1	1.5 c
1 week in SGC and 3 weeks in PLC	6.5 bc	3.4	0.4	4.5 cd	1.6	95.0	2.5	3.0 b
2 weeks in SGC and 2 weeks in PLC	7.5 ab	3.0	0.8	6.1 b	1.3	95.5	2.4	3.5 ab
3 weeks in SGC and 1 week in PLC	8.4 a	3.1	0.5	6.5 b	1.4	90.0	2.7	4.2 a
4 weeks in SGC (Check)	9.2 a	4.2	0.5	8.2 a	1.1	95.5	2.9	4.5 a

SGC = standard growth condition, PLC = partial light condition, NLC = natural light condition
‡ Means within column followed by the same letter (a, b or c) are not significant at 0.05 level.

Effect of incubation conditions on microtuber production

Result indicated that among the evaluated five conditions, transferred to darkness after 60 days in light produced the highest number and fresh weight of microtuber in early variety (Desiree) and in both of the evaluated potato cvs. 'Desiree' and 75 day in light produced the highest number with large size microtuber in medium maturing variety (Kufri Jyoti). (Table 7.2). The lowest yield and number of MT were produced from early transferred to dark condition. This result is also in agreement the finding of Dhital and co-workers that transferred to dark after 60 days of sub-culture produced the highest number and weight of microtuber (Dhital et al., 2005).

Table 7.2. Effect of culture conditions on number and yield of microtuber (MT) under different four incubation conditions

Incubation condition	Desiree			Kufri Jyoti		
	Microtuber/plantlet		Fresh wt. /microtuber (mg)	Microtuber/plantlet		Fresh wt. /microtuber (mg)
	No.	Fresh wt. (mg)		No.	Fresh wt. (mg)	
Transfer to darkness 45 days of sub-cultured	8.5 bc ‡	5.82 c	0.69	8.2 ab	6.85 ab	0.84
Transfer to darkness after 60 days of sub-cultured	14.8 a	10.08 a	0.68	8.5 ab	7.25 a	0.85
Transfer to darkness after 75 days of sub-cultured	7.4 c	6.35 b	0.86	9.5 a	7.25 a	0.76
Transfer to darkness after 90 days of sub-cultured	11.5 ab	6.95 b	0.60	7.5 bc	5.35 b	0.56
Continuous incubation in standard light condition	9.2 b	5.85 c	0.64	5.5 c	3.45 c	0.63

SGC = standard growth condition, PLC = partial light condition, NLC = natural light condition

‡ Means within column followed by the same letter (a, b or c) are not significant at 0.05 level.

Response of *in vitro* plantlets and undersized minitubers for pre-basic seed-1 production under control condition (screen house)

The experiment was conducted under farmer's screenhouse at Nala. Result showed that the in vitro plantlets gave higher in main stem and tuber per plant; however, minitubers produced the higher yield per plant with higher percentage of bigger sized minitubers in both of the tested cultivars (Table 7.3). This may be due to less number of eyes on undersized minitubers and high number of stolon produced by the in vitro plantlet. Lesser the number of eyes lesser the number of stolon and lesser the number of tuber and bigger the size, this is the phenomena of the potato plant.

Table 7.3. Response of *in vitro* plantlets and undersized minitubers for pre-basic seed -1 production under Farmer's screenhouse condition at Nala, Kavre

Treatment	Plant height (cm)	Main stem (No.)	Tuber /plant (No.)	Yield/ plant (g)	Size distribution by tuber number and yield (%)			
					>5 g	1-5 g	0.5-1 g	< 0.5 g
Cardinal								
Minituber	38 a‡	1.0	1.4 b	36.5 a	86 (97.4)	7.2 (1.7)	3.7 (0.8)	3.1 (0.2)
In vitro plantlet	39 a	1.2	3.3 a	28.1 b	43.8 (73.0)	26.3 (13.0)	21.7 (4.4)	7.4 (20)
Janak Dev								
Minituber	59.4 a	1.1	2.4 b	27.6 a	58 (83.6)	31.4 (15.1)	8.5 (1.2)	2.1 (0.2)
In vitro plantlet	37.4 b	1.3	3.9 a	21.6 a	24.2 (55.3)	53.1 (39.1)	14.1 (4.3)	8.6 (0.8)

‡ Means within column followed by the same letter (a, b or c) are not significant at 0.05 level.

Response of different plant spacing of *in vitro* plantlets for PBS under screen house condition

The experiment was conducted under farmer's screenhouse at Nala. Result showed that the wider the plant spacing higher the plant height, higher the main stem per plant, higher the tuber per plant and also higher the tuber yield per plant and vice versa in both of the evaluated potato cvs. Cardinal and Janak Dev. Similarly, in the case of size distribution of PBS, it was found that wider the plant spacing higher the percentage of bigger size PBS and lesser the smaller size of PBS. Similar trends were observed in both of the evaluated potato

cultivars during the study period (Table 7.4). This result indicated that PBS size could be manipulated by adjusting the plant spacing during the cultivation time.

Table 7.4. Response of different plant spacing of *in vitro* plantlets for PBS production under Farmer's screenhouse condition at Nala, Kavre

Treatment	Plant height (cm)	Main stem (No.)	Tuber/ plant (No.)	Yield/ plant (g)	Size distribution by tuber number and yield (%)			
					>5 g	1-5 g	0.5-1 g	< 0.5 g
Cardinal								
20 x 5	34.4 b‡	1.2	4.1	25.7 b	30 (65.8)	37.4 (26.6)	15.9 (4.8)	16.7 (2.7)
15 x 10	39.2 ab	1.3	3.8	31.5 ab	48.7 (81.4)	26.9 (14.6)	11.5 (2.5)	12.9 (1.5)
20 x 10	42.5 a	1.4	4.7	39.1 a	48.0 (75.0)	27.5 (19.5)	16.0 (4.4)	7.6 (1.6)
Janak Dev								
20 x 5	37.5 b	1.3	2.9	13.1	4.3 (14.4)	51.7 (66.0)	26.9 (15.5)	17.1 (4.1)
15 x 10	42.9. a	1.2	3.2	12.9	17.9 (38.0)	57.4 (50.0)	14.7 (6.0)	10.0 (2)
20 x 10	45.1 a	1.5	3.2	15.1	29.0 (52.1)	51.5 (41.2)	12.0 (5.2)	7.9 (1.5)

‡ Means within column followed by the same letter (a, b or c) are not significant at 0.05 level.

Demonstrate performance of different size of PBS for basic seed production under farmers' field

The experiment was conducted under farmer's field condition at Sankhu, Kathmandu and all cultural practices were similar in all plots and done by the farmer. Result showed that the bigger the size of PBS higher the plant height, higher the main stem per plant, higher the tuber per plant and also higher the tuber yield per plant and vice versa. Similarly, in the case of size distribution of minitubers, it was found that wider the plant spacing higher the percentage of bigger size tubers and lesser the smaller size of tubers. Similar trends were observed in both of the evaluated potato cultivars Kufri Jyoti and Janak Dev (Table 7.5). This result indicated that size of minitubers could be manipulated by the size of the PBS.

Table 7.5. Response of seed size on plant characters and tuber yield

Treatment (seed size)	Plant height (cm)	Main stem (No.)	Tuber/ plant (No.)	Yield/ plant (g)	Size distribution by tuber number and yield (%)		
					Over size	Seed size	Under size
Kufri Jyoti							
<0.5 g	42.1c	1.8	5.5	190 b	-	68.7 (87.6)	31.3 (11.3)
0.5 1 g	48.2 bc	2.0	4.4	220 ab	4.7 (11.2)	66.6 (78.5)	29.2 (10.3)
1-5 g	52.5 ab	2.5	5.5	200 ab	2.3 (4.1)	60.2 (85.7)	29.6 (10.2)
>5 g	58.5 a	2.6	5.8	270 a	5.1 (8.5)	71.1 (83.1)	23.9 (8.5)
Janak Dev							
<0.5 g	90.1	1.7	7.3	250 b	1.7 (5.1)	71.4 (84.7)	26.8 (10.2)
0.5 1 g	100.0	2.5	6.2	270 b	2.0 (4.7)	83.1 (89.9)	14.9 (5.4)
1-5 g	102.0	3.0	7.3	310 a	2.9 (5.4)	78.5 (86.5)	20.6 (8.5)
>5 g	105.0	2.5	7.0	310 a	3.5 (9.8)	74.4 (85.0)	31.4 (5.2)

‡ Means within column followed by the same letter (a, b or c) are not significant at 0.05 level.
Plot size : 1.2 x 3 m and 24 tubers/plot

Demonstrate performance of basic seed-2 and farmer's seed for potato production in farmers' field

The experiment was conducted under farmer's field condition at Sankhu, Kathmandu and all cultural practices were similar in all plots and done by the farmer. Result showed that there were not significant different between basic seed-1 from Khumal tar and farmer's seed in plant height, number of main stem and tuber per plant, however, tuber yield was observed higher in basic seed-1 than the farmer's seed in both of the evaluated potato cultivars Kufri Jyoti and Janak Dev. Similarly, basic seed-1 produced bigger size tuber than the farmer's seed. Similar trends were observed in both of the evaluated potato cultivars Kufri Jyoti and Janak Dev (Table 7.6). This result indicated that basic seed-1 is better in quality than the farmer's for higher yield.

Table 7.6. Response of basic seed and farmer's seed on plant characters and tuber yield

Treatment (seed size)	Plant height (cm)	Main stem (No.)	Tuber/ plant (No.)	Yield/ plant (g)	Size distribution by tuber number and yield (%)		
					Over size	Seed size	Under size
Kufri Jyoti							
Basic seed-1	50.5	2.8	7.6	490	18.7 (3.9)	61.3 (51.4)	19.8 (9.7)
Farmer's seed	45.8	2.5	7.6	450	26.8 (31.4)	14.7 (61.2)	58.6 (7.4)
Janak Dev							
Basic seed-1	105.5	2.5	6.4	420	16.7 (38.4)	53.9 (52.4)	29.5 (9.2)
Farmer's seed	100.2	2.5	7.1	360	6.5 (23.1)	61.4 (65.5)	32.2 (11.4)

Plot size: 3 m x 2.4 m and 48 tuber/plot.

8.0 POST HARVEST TECHNOLOGY RESEARCH

8.1 EVALUATION OF POTATO CULTIVARS FOR YIELD AND PROCESSING QUALITIES AT KHUMALTAR

Introduction

The area, production and productivity of potato have been increasing steadily over the last two decades and now Nepal produces 25, 17,693 tons of potatoes from about 18,53,42 hectares of land with an average productivity of 13.58 t/ha (MoAC, 2010). The increasing trend of potato production cannot be sustained without adequate processing support. Among the various processed product, potato chips has high demand and the most popular processed products in Nepal. Changing the food habits, urbanization and schooling create the high demand of chips as easy and ready to serve food. This is likely to increase further more in the future. The high demand of potato chips was presently fulfilled by exporting large quantity of chips especially from India. During 2009/10, Nepal imported 83,234.43 tons potato with value of NRS 898.15 million. Among them potato seeds 1614 ton with value NRS 15.36 million, fresh and chilled potato 81539.69 tons with value NRs. 874.66 million, preserved potato 49.03 tons with value 4.88 million and frozen French-fry 12.48 tons with value 3.25 million from other countries (MoAC, 2010). The higher share of fresh potato can be utilized for fresh consumption and processing in to chips.

First and only commercial production of chips started in Nepal by Chaudhary Group (CG foods (Pvt) Ltd, Nawalparashi in 2003 by using sophisticated plant and produced 5 brand of potato chips. It has capacity of producing 200 kg chips/hours and total potato used for chips making was 1500 t/year and increasing 10-15 % per year (Sah, 2010). Besides this, there were established large numbers of cottage industries for preparation of chips in different part of country to fulfill the high demand of chips. This clearly indicated that there is great scope of potato chips in Nepal.

For processing potato into chips, potato should have round or oval tuber shape and fleet eyes, high dry-matter and specific gravity and low reducing sugars. The dry matter content of about 18-20% and reducing sugar content up to 250 mg/100g fresh weight is considered acceptable for chips making (Ezekiel and Shekhawat, 1999). The DM content determines the yield of chips, oil uptake and crispness of fried product where as reducing sugars determines the color of chip. The brown color of chips which is undesirable is caused due to reaction of reducing sugars and amino acids while frying at high temperature. The preliminary results conducted in Khumaltar showed that chips prepared from the cold stored potato after 90 days storage from released varieties Kufri Jyoti, Janak Dev, Desiree and Khumal Rato were found all unacceptable due to dark brown color; which could be present of high reducing sugar (Thapa et al. 2004).

The tendency to contain a high or low level of total sugar or a particular sugar is a heritable trait (Cumninghan and Stevenson 1963) and is influenced by variety, cultural and environmental condition (Ezekiel *et al.*, 1999. The variety developed and grown in India may not be suitable for grown in Nepalese conditions. Therefore, this experiment was conducted to evaluate potato genotypes for higher yield and processing quality in Khumaltar, mid hills condition.

Materials and Methods

Nine potato genotypes, viz., PR 25861.1, HPS 11/67, L-235,4, BSU-PO$_3$, Yagana, HPS-7/67, Kufri Chipsona-2, Khumal Set-1 and Kufri Jyoti selected from last year trials were planted at Hattiban Farm, Lalitpur during summer season of 2011 for evaluation of yield and processing

qualities. Among tested genotypes Kufri Jyoti and Khumal Seto-1 were recommended varieties of potato by NPRP, TPS 7/67 and TPS -11/67 were true potato seed varieties received from Peru, Kufri Chipsona -2 was recommended variety for chips in India, BSU-PO3 was received from Philippines, L-235.4 was from INIA, Chilli, and Yagana from America. The PRP 25861.1 is promising variety developed by NPRP by crossing promising variety Disiree and late blight resistant LBr-40 clone received from CIP, Lima Peru (Anonymous 2008). Each genotype was planted in large plot (30 m^2) at a spacing of 0.60 x 0.25 m on 2nd February. Recommended dose of fertilizers @ 100:100:60 NPK kg plus 20 tons compost/ha were applied as basal dose. Potato tubers were planted in furrow over the chemical fertilizers and compost. The crop was harvested on 2nd June, 2011 (120 days after planting).

Observations were recorded on yield and quality parameters viz: tuber skin color, skin surface, tuber shape, eye depth (shallow, medium, and deep), flesh color, specific gravity, dry matter and reducing sugars. Dry matter content was determined by drying finely chopped 100 g tuber pieces in hot air oven at 80° C for first 6 hours and then at 65 ° C till constant weight was obtained. Specific gravity was determined by weighting potato in air and under water. Reducing sugars were determined by using di-nitrosalicyclic colorimetric method (Miller, 1959) in NAST laboratory after two week of harvesting. The data were analyzed by using Gen-stat 532-2 program.

Results and Discussion

Plant characteristics

Plant vigor at 90 days after planting was found good to very good in genotypes Yagana, PRP 25861.1 and Khumal-Seto-1 and medium in other genotypes (Table 8.1). Similarly, plant uniformity at 90 days after planting was found good to excellent in Yagana, BSU-PO3, PRP 25861.1and Khumal seto-1. Stem per plant was found the lowest in Yagana (3.6) and the highest (5.0) in K. Jyoti. The plant stand was found erect on genotypes (PRP 25861.1 and HPS-7/67), semi erect on (HPS-II/67, L-235.4 and K.Chipsona-2), prostrate on (PSU-PO-3, Yagana and Kufri Jyoti) and tall and prostrate on Khumal Seto-1. The maximum plant height was observed on PRP 25861.1 and Khumal Seto-1 (63 cm) and the minimum on K. Jyoti (32 cm). The maturity of genotypes was found medium in PRP25861.1, L-235.4, Yagana, Khumal Seto-1 and K. Jyoti and late in HPS-II/67, BSU-PO3, HPS-7/67 and K.Chipsona-2.

Table 8.1. Effect of potato genotypes on vegetative characteristics tested at Hattiban Farm, Khumaltar, 2066/67

Genotypes	Plant Vigor* (1-5 Scale)	Uniformity* (1-5 Scale)	Stem /plant	Posture #	Plant ht. at 90 DAP	Maturity♣
PRP 25861.1	4.5	4.5	4.0	E	63	M
HPS-11/67	3.5	3.5	4.5	SE	60	L
L-235.4	3.0	3.0	4.0	SE	40	M
BSU-PO3	3.5	4.5	4.0	P	53	L
Yagana	4.0	4.5	3.6	P	35	M
HPS 7/67	3.0	3.5	4.4	E	61	L
K.Chipsona-2	3.5	3.0	4.0	SE	55	L
Khumal Seto-1	5.0	5.0	4.5	TP	63	M
K. Jyoti	3.0	3.0	5.0	P	32	M

* 1= Very Poor, 2=Poor, 3=Medium, 4= Good and 5= Very good.
* 1= Very Poor, 2=Poor, 3= Fair , 4= Good and 5= Excellent.
# E= Erect, SE= Semi erect, P= Prostrate and TP= Tall and prostrate
♣ M=Medium (110-135 days) and L= Late maturity (>135 days).

Tuber Characteristics

All the tested genotypes were white in color except PRP 25861.1 (Table 8.2). The shape of tubers were found round in four genotypes and oval on five genotypes, general tuber appearance was found good in all genotypes except HPS-11/67. Eye depth was found shallow in six genotypes and medium in three genotypes. Flesh color was found light yellow in five genotypes, yellowish in two genotypes and white in two genotypes. Skin surface was found very smooth in Yagana, rough in Kufri Chipsona-2 and smooth in other tested genotypes. The detail of tuber characters is presented in

Table 8.2. Effect of potato genotypes on tubers characteristics tested at Hattiban Farm, Khumaltar, 2066/67

Genotypes	Skin color	Tuber shape	General appearance*	Eye depth*	Flesh color	Skin surface
PRP 25861.1	Red	Oval	3	M	L. yellow	Smooth
HPS-11/67	White	Round	2	S	L. yellow	Smooth
L-235.4	White	Oval	3	M	L. yellow	Smooth
BSU-PO3	White	Round	3	S	L. yellow	Smooth
Yagana	White	Oval	3	S	Yellowish	Very Smooth
HPS 7/67	White	Round	3	M	Yellowish	Smooth
K.Chipsona-2	White	Oval	3	S	L. yellow	Rough
Khumal Seto-1	White	Round	3	S	White	Smooth
K. Jyoti	White	Oval	3	S	White	Smooth

* 1=Poor, 2=Fair and 3= Good. * M= Medium and S= Shallow.

Number of tubers

There were significant and highly significant differences on less than 30 gram and 30-60 g, more than 60 gram tuber numbers among the genotypes. The maximum <30 g tubers (32.7/m^2) was produced by genotype Khumal Seto-1 and the minimum (17.7/m^2) on Yagana (Table 8.3).

Table 8.3. Effect of potato genotypes on different size tuber production (No/m^2) at Hattiban farm, Khumaltar, 2010/11

Treatments	Tuber Numbers / m^2							
	<30 g		30-60 g		>60 g		Total	
Kufri Chipsona-2	20.3	*bc*	25.67	*bc*	3.33	*c*	49.0	*bc*
HPS-7/67	17.0	*bc*	28.67	*b*	4.00	*c*	49.3	*bc*
PR 25861.1	17.3	*bc*	24.67	*bc*	7.33	*b*	49.3	*bc*
Yagana	13.7	*c*	19.00	*c*	3.33	*c*	36.0	*c*
BSU PO3	25.0	*abc*	23.67	*bc*	3.33	*c*	52.0	*bc*
L-235.4	26.3	*ab*	38.67	*a*	3.67	*c*	69.3	*a*
Khumal Seto-1	32.7	*a*	37.67	*a*	2.67	*c*	72.7	*a*
HPS-11/67	24.7	*abc*	25.33	*bc*	2.33	*c*	52.7	*b*
Kufri Jyoti	20.3	*bc*	36.33	*a*	11.33	*a*	68.0	*a*
Mean	21.9		28.85		4.59		55.4	
F-test	*		***		***		***	
LSD	10.84		6.488		1.751		14.75	
CV (%)	28.6		13.0		22.0		15.4	

The maximum highest 30-60 g tubers numbers (38.67/m^2) was produced by genotype L-235.4 and it was statistically at par with genotypes Khumal-Seto-1 and Kufri Jyoti and the minimum numbers (19.0/m^2) on genotype Yagana. More than 60 g tuber numbers was most important for

processing purpose. The maximum tuber numbers >60 g was produced by genotype Kufri Jyoti (11.33/m^2) followed by genotype PRP (7.33/m^2). The genotypes Khumal Seto-1, L-235.4 and Kufri Jyoti were found superior than other genotypes for total numbers of tuber production.

Yield of tubers

There is also significant difference on weight of different size tubers. The highest yield of >60 g tubers was produced by genotype Kufri Jyoti (1.028 kg/m^2) and it was found at par with genotype PRP 25861.1 (0.889 kg/m^2) (Table 8.4). Similarly, the highest tuber yield ((2.700 kg/m^2) was produced by genotype K. Jyoti followed by PRP 25861.1 (2.133kg/m^2). The recommended chips variety Kufri Chipsona-2 in India did not performed better for tuber size and yield purpose. It could be due to effect of environment and late maturity.

Table 8.4. Effect of potato genotypes on tuber production (kg/m^2) at Hattiban farm, Khumaltar, 2010/11

Treatments	Tuber weight (kg/m2)							
	<30 g		30-60 g		>60 g		Total yield	
Kufri Chipsona-2	0.133	*cd*	1.109	*bcd*	0.361	*b*	1.667	*cd*
HPS-7/67	0.100	*d*	1.021	*cd*	0.044	*c*	1.600	*cd*
PR 25861.1	0.617	*a*	1.070	*bcd*	0.889	*a*	2.133	*b*
Yagana	0.133	*cd*	0.898	*d*	0.287	*b*	1.333	*d*
BSU PO3	0.233	*bc*	0.970	*d*	0.375	*b*	1.567	*cd*
L-235.4	0.267	*b*	1.326	*ab*	0.340	*b*	1.933	*bc*
Khumal Seto-1	0.267	*b*	1.301	*abc*	0.308	*b*	1.900	*bc*
HPS-11/67	0.267	*b*	0.889	*d*	0.222	*bc*	1.400	*d*
Kufri Jyoti	0.233	*bc*	1.421	*a*	1.028	*a*	2.700	*a*
Mean	0.200		1.112		0.473		1.804	
F-test	*		***		***		***	
LSD	0.1099		0.2693		0.2027		0.3460	
CV (%)	31.7		14.0		25.3		11.1	

Chips color

There was no significant difference on color, texture, crispness, taste and over all acceptability of potato chips between two varieties K. Chipsona-2 and PRP 25861.1 immediately after harvesting. Chemical treatments showed highly significant differences on chips color, texture, taste and over all acceptability, but no significant on crispness. The interaction of varieties and chemical also showed significant differences on color and over all acceptability. Kufri Chipsona -2 treated for 15 minutes with potassium meta bi-sulphate for 15 minutes showed good color rating (9.09) and good acceptability (8.93) and was at par with PRP 28861.1 on color rating (8.64) and acceptability (8.77). The lowest color rating was observed on 0.5% NaCl treatment and was found not acceptable in both varieties (Table 8.5).

Table 8.5. Effect of chemical treatment on chips color and quality before storage at Khumaltar, 2010/11

Treatments	Colour (1-9scale)	Texture (1-4 scale)	Crispness (1-4 scale)	Taste (1-9 scale)	Overall Acceptability (1-9 scale)
Varieties					
PRP-25861.1	7.03	2.07	1.92	7.67	7.381
K. Chipsona-2	7.02	2.23	2.05	7.52	7.175
F-test	**NS**	**NS**	**NS**	**NS**	**NS**
LSD	-	-	-	-	-
Chemicals					
No chemicals (Only water)	8.32 *b*	2.41 *a*	2.12	8.69 *a*	8.93 *a*
NaCl (0.5%)	3.11 *d*	1.81 *b*	1.73	4.96 *c*	3.33 *c*
$K_2S_2O_5$ (0.25%)	8.83 *a*	2.05 *ab*	1.98	8.89 *a*	8.85 *a*
$CaCl_2$ (0.25%)	7.84 *c*	2.33 *a*	2.11	7.83 *b*	8.00 *b*
F-test	***	***	NS	***	***
LSD	0. 3399	0. 3496	-	0.5222	0. 3404
Interaction (Ax B)					
PRP-25861.1 + water	8.26 *bc*	2.31	2.12	8.70	8.91 *a*
K. Chipsona-2 + water	8.39 *b*	2.51	2.12	8.68	8.96 *a*
PRP-25861.1 + NaCl	3.39 *d*	1.80	1.64	4.73	3.48 *d*
K. Chipsona-2 + NaCl	2.82 *e*	1.81	1.82	5.19	3.18 *d*
PRP-25861.1+ $K_2S_2O_5$	8.64 *ab*	1.88	1.86	9.06	8.77 *ab*
K. Chipsona-2 + $K_2S_2O_5$	9.02 *a*	2.22	2.1	8.72	8.93 *a*
PRP-25861.1+ $CaCl_2$	7.84 *c*	2.30	2.07	8.18	8.37 *b*
K. Chipsona-2 + $CaCl_2$	7.83 *c*	2.36	2.14	7.48	7.63 *c*
Mean	7.03	2.15	1.985	7.592	7.278
F-test	*	**NS**	**NS**	**NS**	*
LSD	0.4807	-	-	-	0.4814
CV (%)	7.3	24.4	25.1	10.3	7.0

Quality parameters

For processing of potato in chips, dry matter, specific gravity and reducing sugars play an important role. Dry matter and specific gravity are directly proportional to the weight of chips and indirectly proportional to oil consumption of chips. The reducing sugar content of potato is responsible for color and quality of chips. Higher concentration of reducing sugars (glucose and fructose) produces brown color of chips, which is not acceptable. The reducing sugar content up to 150 mg/ 100 gram fresh weight is consider good and up to 250 g /100 g fresh weight is consider acceptable for chips making.

In this experiment, significant differences were observed on dry matter percentage, specific gravity and reducing sugars among tested genotypes. The highest dry matter percentage (19.92%) and specific gravity (1.0723) was observed on PRP 25861.1 genotype and the lowest dry matter percentage (15.80%) and specific gravity (1.0578) was observed on Kufri Jyoti (Table 8.6). The reducing sugar was found the lowest (17 mg/ 100 g. fresh weight) on genotype Yagana and it was found at par with genotype BSU-PO3 (18.33 mg/ 100 g fresh weight). The highest reducing sugars were observed on genotype HPS-II/67 (31.0 mg/ 100 g fresh weight). However, all tested genotypes showed with in limit of reducing sugars for processing in to chips.

Table 8.6. Effect of potato genotypes on tuber qualities before storage at Hattiban farm, Khumaltar, 2010/11

Treatments	Dry matter (%)		Specific Gravity		Reducing sugars (mg/100 g fresh wt)	
Kufri Chipsona-2	17.50	*ab*	1.0697	*b*	21.67	*bcd*
HPS-7/67	17.34	*ab*	1.0606	*e*	23.67	*bc*
PRP 25861.1	19.92	*a*	1.0723	*a*	25.33	*b*
Yagana	17.14	*ab*	1.0639	*d*	17.00	*d*
BSU PO3	18.69	*ab*	1.0676	*c*	18.33	*cd*
L-235.4	17.52	*ab*	1.0620	*e*	25.33	*b*
Khumal Seto-1	17.96	*ab*	1.0672	*c*	24.33	*b*
HPS-11/67	17.19	*ab*	1.0605	*e*	31.00	*a*
Kufri Jyoti	15.80	*b*	1.0578	*f*	22.00	*bcd*
Mean	17.673		1.0646		23.19	
T -test	***		***		***	
LSD	3.710		0.01564		3.079	
CV (%)	6.438		0.455		7.7	

8.2 EVALUATION OF STORABILITY OF POTATO IN ORDINARY AND COLD STORE CONDITIONS

8.2.1 EVALUATION OF STORABILITY OF POTATO IN ORDINARY CONDITION

Nine potato genotypes namely, Kufri Chipsona-2, HPS-7/67, PRP 25861.1, Yagana, BSU-PO_3, L-235.4, Khumal Seto-1, K., HPS-II/67 and K. Jyoti were stored in racks under ordinary condition at dark room. Five kilogram of tubers more than 60 g weight was stored by applying Completely Randomized Design (CRD) with three replications. Observation is continuing on per cent weight loss, sprouting percentage and quality parameters. Two genotypes PRP 25861.1 and K. Chipsona-2 will be tested for quality parameters and chips. Chips will be prepared at 30, 45, 60 and 90 days after storage and will be compared with cold stored potato for chips color, RS, DM and SG in each time of chips making.

8.2.2 EVALUATION OF STORABILITY OF POTATO IN COLD STORE

Nine potato genotypes namely, Kufri Chipsona-2, HPS-7/67, PRP 25861.1, Yagana, BSU-PO_3, L-235.4, Khumal Seto-1, K., HPS-II/67 and K. Jyoti were packed in nylon bags and stored in cold storage at Balaju Coldstorage, Kathmandu. Five kg tubers more than 60g weight was stored by applying Completely Randomized Design (CRD) with three replications. Observation is continuing on per cent weight loss, sprouting percentage and quality parameters. Two genotypes PRP 25861.1 and K. Chipsona-2 will be tested for quality parameters and chips. Chips will be prepared at 30, 45, 60 and 90 days after storage and will compared with dark stored potato for chips color, RS, DM and SG in each time of chips making.

8.3 IDENTIFY THE EFFECT OF NITROGEN AND POTASH ON YIELD AND PROCESSING QUALITIES FOR CHIPS

Introduction

The gradual and steady increase in potato production in last few years has created post -harvest problems for potato because of inadequate storage and processing facilities. The storability, post harvest handling and processing qualities of potato are important parameters for better uses of potato. In the developing countries of the tropics and sub tropics, post harvest handling and storage losses of seed and ware potatoes have been estimated to be 20-30% (Prasad et al., 1989; Satter *et al.*, 2002). The reducing post harvest losses is best option for increasing the same amount of food availability than by increasing the same amount of yield (Gautam and Bhattarai, 1996; Karki, 2002).

Mineral nutrients especially nitrogen and potassium play an important role for potato production as is evident from numerous studies conducted in different locations over the years. The intensive cropping year after year in same piece of land with out proper combination of manure and fertilizer create soil quality deterioration, causes severe nutrients deficiency, disturb the nutrients status of soil and may cause destructive soil if not replenish properly. Potato is a heavy feeder crop and requires a large amount of nutrients. The production of 20 ton crop extract 140: 140: 190 kg N, P_2O_5, K_2O, while the average application of 15-30 t/ha FYM would supply maximum of 35-50:50-100 and 35-70 kg of N, P_2O_5, K_2O, not enough to support the potential higher yield (Khatri and Shrestha, 1998). The response of fertilizers depends up on the nutrient level of soil, irrigation, climatic condition and purpose of crops grown. However, the response potassium and nitrogen was found more for potato production. Potato tubers remove 1.5 times much potassium than nitrogen and 4-5 times than phosphorus (Perrenoud, 1993). Potassium has a crucial role in the energy status of the plant, translocation and storage of assimilates and maintenance of tissue water relations. It helps on photosynthesis, maintains cell turgid, favors carbohydrate transport, enhances shipping quality, extends shelf life and improves chips color and decreases storage losses (Marschner, 1995). Similarly, nitrogen is the second most important nutrient which increases the vegetative growth, crop duration, tubers quality and decides the yield level. It excessive application resulted tuber with lower reducing sugar at harvest and accumulated less reducing sugar during storage (Iritani and Weller. 1978). The application of both nitrogen and potassium can increase dry matter if there is a yield response from their application and their specific response is partly dependent upon variety and field environment (Schippers, 1976).

National Potato Research Program (NPRP) recommended 80:80:60 Kg NPK/ha along with 20 tons FYM for on farm and 100:100:60 Kg NPK/ha along with 20 tons FYM for on-station experiment based on research review and trials (Khatri *et al.*, 1999) before a decay ago, which could not be same in present situation due to intensive cropping system and purpose of crop grown either for seed, fresh consumption or processing purpose. The requirement of nutrients for storage and processing grade potato may be different from table or seed potato. Research on these aspects has not been conducted or lacking in Nepalese situation. Therefore, present study was conducted to investigate the appropriate dose of nitrogen and potassium for higher production, good storability and better processing qualities potato in the mid hills condition.

Materials and Methods

Field experiment was conducted at Hattiban farm, Lalitpur during summer season of 2010 and 2011 at an elevation of 1340 m asl, clay type of soil and below 6.0 soil pH. The experiment was

laid out in RCB design with factorial arrangement of treatments. Total of 16 treatments involving combinations of four levels of nitrogen (50,100,150 and 200 kg /ha) and potash (30, 60, 90 and 120 kg/ha) were replicated three times. The recommended variety Kufri Jyoti was planted on 25 January, 2010 and harvested on 17 May (103 days after planting) in first year and planted on 18 January and harvested on 16 May 2011 (118 days after planting) in second year. The harvest tubers from different treatments were used for storage experiments

Storage experiments were conducted at storage house of NPRP, Khumaltar in ordinary dark room condition (28±0.6°C temperature and 88-89 % R.H) and cold storage at Balaju, respectively to assess the effect of different dose of nitrogen and potash on storability and processing quality of potato for chips Laboratory analyses were carried out in National Academy of Science and Technology (NAST) laboratory at Lalitpur before and after storage of potato in ordinary condition and before, immediately after removing from cold storage and 15 days after re-conditioning. A total of 16 treatments were laid out in CRD with three replications both in ordinary and cold storage. Five kilogram of potatoes of each treatment was stored in plastic rack under dark room for 90 days (21 May to 18 August). These plastic trays were kept in three layers and altered at 15 days intervals as upside down order. For cold storage, potatoes were packed in net bags and stored in wooden rack for 120 days (21 May to 27 September). Observations were recorded on yield and yield attributing parameters, storage losses, sprouting percentage, chips quality parameters like specific gravity (SG), dry matter (DM) and reducing sugar (RS) before storage and after storage. Storage loss and sprouting percentage was recorded at fortnight intervals in ordinary condition and before storage, immediately after removing from cold store and 15 days after reconditioned. Dry matter was determined by chopping and mixing of tubers in to small pieces and oven drying 100 gram sample at 80° C for six hours and then at 65° C until constant weight was obtained. Specific gravity was determined by using potato hydrometer (developed by Snack Food Association) by weighting 8 pound of potato sample before storage and by water displacement methods after storage. Reducing sugar was determined in NAST laboratory by using di-nitrosalicyclic colorimetric method (Miller, 1959) by recording the absorbance with spectro-photometer at 575 nm. The two years yield and yield attributing parameters was combining analyzed by using Gen-stat 532-2 program and DMRT of MSTAT C was used for mean comparison. First year storage data was analysis and second year trial is ongoing.

Results and Discussion

Emergence, ground coverage percentage and plant uniformity and vigor

The pooled analysis of emergence percentage showed non significant and significant differences at 30 days and 45 days after planting due to effect of nitrogen. The effect of K did not show any difference on emergence percentage at 30 and 45 days after planting. The interaction of N x K over years showed significant difference at 45 days after planting only the combined application of 50 kg N and 30 kg K/ha, respectively. Other treatments showed statistically similar results (Table 8.7). The ground coverage showed significant difference only due to effect of N at 75 days after planting. The application of 100 and 200 kg nitrogen/ha showed highest and statistically same ground coverage percentage at 75 days after planting (Table 8.8). Plant uniformity and vigor at 75 days after planting showed significant differences due to the effect of nitrogen while the effect of K and its interaction with N did not showed any effect (Table 8.9).

Plant height and number of stem/plant

The effect different doses of nitrogen showed highly significant difference on the height of plant at 75 and 90 days after planting. However, the application of 150 and 200 kg N/ha gave statistically same results. Similarly, the application of 50 and 100 kg N/ha also gave statistically same results. The effect of K and its interaction with N did not show significant differences on plant height at 75 and 90 days after planting (Table-8.10).

The number of stem per plant showed non significant difference due to individual effect of N, K and its combine effect on first years and pooled analysis. However, in second year, the effect of N and its interaction with K showed significant results (Table 8.11).

Tuber numbers and weight

There pooled analysis over showed non significant differences on <30, 30-60 and >60 gram tuber numbers distribution due to the effect of N, K and their interaction. It might be due to the varietal character of potato to produced same tuber numbers. The detail analysis data are presented in Tables 8.11 and 8.12.

The weight of <30 g tubers (t/ha) showed a significant effect due to the effect of N only in the second year. However its individual and interaction with K did not show any differences on first year and combined analysis. There was nearly double the <30 gram tuber weight in second year. It could be due to increased in crop duration 16 days in second year, which can help to increase the size of tubers. The effect of N showed significant differences on production of 30-60 g tubers in both years and their combined analysis. The maximum 30-60 g tuber yield (14.08 t/ha) was produced with 150 kg N/ha followed by 200 kg N/ha (13.45 t/ha) whereas the lowest yield (10.48 t/ha) was recorded in 50 kg N/ha. The effect of different doses of K and its interaction with N did not show significant difference for production of 30-60 g tubers. However, the maximum tuber weight (15.03 t/ha) was recorded on combination of 150 kg N and 60 kg K/ha and the lowest (9.83 t/ha) on combination of 50 kg N and 30 kg K/ha, respectively. The detail is presented in Table 8.13.

The yield of more than 60 g tubers, which is very important for processing purpose showed significant differences due to individual effect of N and K. The pooled analysis of two year data, showed that, the application of 200 kg N /ha produced the highest yield (13.11 t/ha) and it was found at par (12.92 t/ha) with 150 kg N /ha. The lowest of tuber yield (9.57 t/ha). The application of 60, 90 and 120 kg K/ha showed statistically same results and were found significantly difference with 30 kg K/ha. The interaction of N and K did not show significant difference on >60 g tuber yield. However, the maximum yield (14.76 t/ha) was recorded on combined application of 200 kg N and 120 kg K/ha and the minimum (8.39 t/ha) on application of 50 kg N and 30 kg K/ha. The detail data is presented in Table 8.14.

Tuber yield

The effect of nitrogen and potash showed the significant difference on tuber yield on individual years and pooled analysis. The interaction of N and K showed the significant difference in first and second year but non significant on pooled analysis. The application of 150 and 200 kg N and 60, 90 and 120 kg K showed non significant difference on tuber yield. Even though, there was non significant difference due to the combined effect of N and K, this could be due to higher yield in second years. There was great variation on tuber yield (23.74-34.28 t/ha) on pooled analysis. The yield was increased up to combination of 150 kg N and 60 kg K and then

start to decreased and again increased but not in constant order. This clearly indicated that the appropriate dose of N and K should be 150 and 60 kg/ha, respectively. The detail analysis data on individual effect of N, K and their interaction for total tuber yield is presented in Table 8.14.

Table 8.7. Effect of nitrogen, potash and their interaction on emergence percentage of plant at 30 and 45 days after planting at NPRP, 2009/10 and 2010/11

Treatments	30 DAP				45 DAP			
	2009/10		2010/11	Pooled	2009/10	2010/11	Pooled	
Nitrogen (kg/ha)								
50	22.0	*a*	65.9	44.0	97.1	99.4	98.28	*ab*
100	21.1	*a*	73.8	47.4	98.3	99.4	98.87	*a*
150	16.0	*ab*	63.8	39.9	98.5	99.5	98.99	*a*
200	12.6	*b*	66.7	39.6	96.4	98.6	97.51	*b*
F-test	*		NS	NS	*	NS	*	
LSD (0.05)	6.917		-	-	1.523	-	0.991	
Potash (kg/ha)								
30	20.0		71.5	45.8	97.3	99.4	98.33	
60	15.8		70.7	43.3	97.6	99.3	98.46	
90	18.2		63.8	41.0	98.1	99.3	98.70	
120	17.6		64.2	40.9	97.4	98.9	98.16	
F-test	NS		NS	NS	NS	NS	NS	
LSD (0.05)	-		-	-	1.518	-	-	
Interaction (N : K kg/ha)								
50 : 30	20.5		62.9	41.7	95.2	99.0	97.14	*ab*
50 : 60	23.8		53.8	38.8	96.7	99.5	98.10	*a*
50 : 90	24.8		74.8	49.8	98. 6	99.5	99.05	*a*
50: 120	19.1		72.4	45.7	98.1	99.5	98.81	*a*
100 : 30	29.0		81.9	55.5	99.1	100.0	99.52	*a*
100 : 60	15.7		80.5	48.1	98.6	99.1	98.82	*a*
100 : 90	21.4		53.8	37.6	96.7	99.1	97.87	*a*
100: 120	18.1		79.0	48.6	99.1	99.5	99.29	*a*
150 : 30	18.1		68.6	43.3	98.1	100.0	99.05	*a*
150 : 60	12.9		73.3	43.1	98.6	99.1	98.82	*a*
150 : 90	12.9		59.0	35.9	98.6	99.5	99.05	*a*
150: 120	20.0		54.3	37.1	98.6	99.5	99.05	*a*
200 : 30	12.4		72.9	42.6	96.7	98.6	97.63	*a*
200 : 60	11.0		75.3	43.1	96.7	99.5	98.10	*a*
200 : 90	13.8		67.6	40.7	98.6	99.1	98.82	*a*
200: 120	13.3		50.9	32.1	93.9	99.1	95.47	*a*
Mean	17.9		67.7	42.7	97.6	99.4	98.71	
F-Test	NS		NS	NS	NS	NS	*	
LSD (0.05)	-		-	-	-	-	1.981	
CV %	46.6		27.6	74.3	1.9	0.9	1.8	

NS = Not significantly different and * significant at 0.05 level

Same small letters in a column are not significantly different by DMRT at 0.05 levels

Table 8.8. Effect of nitrogen, potash and their interaction on ground coverage percentage at 45 and 75 days after planting at NPRP, 2009/10 and 2010/11

Treatments	45 DAP						75 DAP					
	2009/10		2010/11		Pooled		2009/10		2010/11		Pooled	
A. Nitrogen (kg/ha)		+		+				+		+		+
50	48.3	*ab*	24.6		36.5		64.4	*b*	60.0	*b*	62.2	*c*
100	52.1	*a*	29.2		40.6		75.2	*a*	62.3	*b*	68.8	*b*
150	51.3	*a*	27.5		39.4		79.0	*a*	70.4	*a*	74.7	*a*
200	43.9	*b*	30.4		37.2		80.0	*a*	73.7	*a*	76.9	*a*
F-test	*		NS		NS		***		***		***	
LSD (0.05)	5.655		-		-		6.77		6.57		5.183	
B. Potash (kg/ha)												
30	47.9		25.4		36.7		71.9		64.0		68.0	
60	49.6		27.9		38.7		79.6		66.7		73.1	
90	47.3		29.6		38.4		73.3		67.5		70.6	
120	50.8		28.8		39.8		73.4		68.3		70.9	
F-test	NS		NS		NS		NS		NS		NS	
LSD (0.05)	-		-		-		-		-		-	
C. Interaction (N : K kg/ha)												
50 : 30	43.3		23.3		33.3		62.7		56.7		59.7	
50 : 60	51.7		23.3		37.5		68.3		61.7		65.0	
50 : 90	50.0		23.3		36.7		61.7		56.7		59.2	
50: 120	48.3		28.3		38.3		65.0		65.0		65.0	
100 : 30	53.3		25.0		39.2		73.3		57.7		65.5	
100 : 60	53.3		26.7		40.0		81.7		58.3		70.0	
100 : 90	46.7		33.3		40.0		71.7		65.0		68.3	
100: 120	55.0		31.7		43.3		74.3		68.3		71.3	
150 : 30	50.0		25.0		37.5		75.0		68.3		71.7	
150 : 60	53.3		30.0		41.7		85.0		76.7		80.8	
150 : 90	50.0		31.7		40.8		78.3		75.0		76.7	
150: 120	51.7		23.3		37.5		77.7		61.7		69.7	
200 : 30	45.0		28.3		36.7		76.7		73.3		75.0	
200 : 60	40.0		31.7		35.8		83.3		70.0		76.7	
200 : 90	42.3		30.0		36.2		83.3		73.3		78.3	
200: 120	48.3		31.7		40.0		76.7		78.3		77.5	
Mean	48.9		27.9		38.4		74.7		66.6		70.65	
F-Test	NS		NS		NS		NS		NS		NS	
LSD (0.05)	-		-		-		-		-		-	
CV %	13.9		19.6		34.7		10.9		11.8		12.8	

NS = Not significantly different, * significant at 0.05 level

+ Same small letters in a column are not significantly different by DMRT at 0.05 levels

Table 8.9. Effect of nitrogen, potash and their interaction on plant uniformity and vigor at 75 days after planting (1-5 Scale, 1= v. poor & 5= v. good) at NPRP, 2009/10 and 2010/11

Treatments	Plant uniformity						Plant vigor					
	2009/10		2010/11		Pooled		2009/10		2010/11		Pooled	
Nitrogen (kg/ha)		-		+		+		-		-		+
50	3.18	*b*	3.48	*b*	3.33	*b*	2.90	*b*	3.62	*b*	3.26	*b*
100	3.75	*a*	2.98	*c*	3.37	*b*	3.72	*a*	2.93	*b*	3.33	*b*
150	4.01	*a*	3.98	*a*	3.95	*a*	4.03	*a*	4.32	*a*	4.18	*a*
200	3.96	*a*	3.96	*a*	3.96	*a*	3.98	*a*	4.50	*a*	4.24	*a*
F-test	**		***		***		***		***		***	
LSD (0.05)	0.436		0.397		0.3075		0.402		0.3667		0.3436	
Potash (kg/ha)												
30	3.67		3.29		3.48		3.50		3.71		3.60	
60	3.89		3.71		3.80		3.80		4.08		3.94	
90	3.61		3.57		3.59		3.69		3.79		3.72	
120	3.73		3.57		3.74		3.64		3.79		3.72	
F-test	NS		NS		NS		NS		NS		NS	
LSD (0.05)	-		-		-		-		-		-	
Interaction (N : K kg/ha)												
50 : 30	3.00		3.27		3.13		2.67		3.67		3.17	
50 : 60	3.23		3.50		3.37		2.77		3.70		3.23	
50 : 90	3.17		3.50		3.33		3.17		3.27		3.22	
50: 120	3.33		3.67		3.50		3.00		3.83		3.42	
100 : 30	3.50		2.33		2.92		3.50		2.67		3.08	
100 : 60	4.00		3.33		3.67		4.17		3.17		3.67	
100 : 90	3.50		3.10		3.30		3.50		3.07		3.28	
100: 120	4.00		3.17		3.58		3.70		2.83		3.27	
150 : 30	4.17		3.57		3.87		3.83		4.00		3.92	
150 : 60	4.00		4.00		4.00		4.17		4.77		4.47	
150 : 90	3.77		4.00		3.88		4.10		4.37		4.22	
150: 120	4.10		4.00		4.05		4.03		4.17		4.10	
200 : 30	4.00		4.00		4.00		4.00		4.50		4.25	
200 : 60	4.33		4.00		4.17		4.10		4.67		4.38	
200 : 90	4.00		3.67		3.83		4.00		4.50		4.25	
200: 120	3.50		7.17		3.83		3.83		4.33		4.08	
Mean	3.725		3.58		3.652		3.658		3.842		3.75	
F-Test	NS		NS		NS		NS		NS		NS	
LSD (0.05)	-		-		-		-		-		-	
CV %	14.0		13.5		14.6		13.2		11.4		0.3574	

NS = Not significantly different, ** significant at 0.01 and *** significant at < 0.001 levels

' Same small letters in a column are not significantly different by DMRT at 0.05 levels

Table 8.10. Effect of nitrogen, potash and their interaction on plant height (cm) at 75 and 90 days after planting at NPRP, 2009/10 and 2010/11

Treatments	Plant height (75 DAP)						Plant height (() DAP)					
	2009/10		2010/11		Pooled		2009/10		2010/11		Pooled	
Nitrogen (kg/ha)		+		+		+		+		+		+
50	39.35	*c*	43.07	*b*	41.21	*b*	42.01	*c*	42.70	*b*	42.35	*b*
100	48.32	*b*	39.98	*b*	44.15	*b*	51.17	*b*	40.28	*b*	45.72	*b*
150	53.16	*a*	48.35	*a*	50.75	*a*	57.23	*a*	52.14	*a*	54.69	*a*
200	53.08	*a*	50.43	*a*	51.76	*a*	60.10	*a*	54.89	*a*	57.50	*a*
F-test	***		***		***		***		***		***	
LSD (0.05)	3.995		3.675		3.061		4.856		2.129		3.794	
Potash (kg/ha)												
30	48.10		44.90		46.50		50.77		46.74		48.75	
60	49.69		45.20		47.45		54.82		47.04		50.93	
90	48.43		45.27		46.85		53.72		47.53		50.62	
120	47.68		46.47		47.08		51.2		48.69		49.95	
F-test	NS		NS		NS		NS		NS		NS	
LSD (0.05)	-		-		-		-		-		-	
Interaction (N : K kg/ha)												
50 : 30	39.60		39.67		39.63		41.60		41.73		41.67	
50 : 60	36.73		43.13		39.93		41.67		42.83		42.25	
50 : 90	42.80		42.73		42.77		44.00		42.20		43.10	
50: 120	38.27		46.73		42.50		40.77		44.03		42.40	
100 : 30	49.20		39.47		44.33		51.20		37.83		44.52	
100 : 60	51.13		40.80		45.97		56.60		41.80		49.20	
100 : 90	43.53		37.47		40.50		45.67		38.80		42.23	
100: 120	49.40		42.20		45.80		51.20		42.67		46.93	
150 : 30	50.67		49.13		49.90		53.60		53.73		53.67	
150 : 60	56.70		47.40		52.05		60.20		50.43		55.32	
150 : 90	53.20		49.20		51.20		61.27		52.60		56.93	
150: 120	52.07		47.67		49.87		53.87		51.80		52.83	
200 : 30	52.93		51.33		52.13		56.67		53.67		55.17	
200 : 60	54.20		49.47		51.83		60.80		53.10		56.95	
200 : 90	54.20		51.67		52.93		63.93		56.53		60.23	
200: 120	51.00		49.27		50.13		59.00		56.27		57.63	
Mean	48.48		45.46		46.97		52.63		47.50		50.06	
F-Test	NS		NS		NS		NS		NS		NS	
LSD (0.05)	-		-		-		-		-		-	
CV %	9.9		9.7		11.3		11.1		11.0		13.2	

NS = Not significantly different and *** significant at < 0.001 levels

* Same small letters in a column are not significantly different by DMRT at 0.05 levels

Table 8.11. Effect of nitrogen, potash and their interaction on number of stem/hill and percentage of <30 g tuber distribution at NPRP, 2009/10 and 2010/11

	Number of stem /hill (90 DAP)				No. of <30 g tuber distribution (%)			
Treatments	2009/10	2010/11		Pooled	2009/10		2010/11	Pooled
Nitrogen (kg/ha)								
50	3.76	5.02	*b*	4.39	41.42	*a*	53.20	47.31
100	3.82	4.98	*b*	4.40	40.33	*a*	54.38	47.36
150	4.10	5.23	*ab*	4.67	40.67	*a*	50.48	45.57
200	4.05	5.60	*a*	4.83	34.33	*b*	53.78	44.06
F-test	NS	*		NS	***		NS	NS
LSD (0.05)	-	0.418		-	3.506		-	-
Potash (kg/ha)								
30	3.92	4.97		4.44	38.58		53.90	46.24
60	4.24	5.32		4.48	38.67		52.0	45.33
90	3.83	5.22		4.53	39.75		53.41	46.58
120	3.73	5.33		4.53	39.75		52.53	46.14
F-test	NS	NS		NS	NS		NS	NS
LSD (0.05)	-	-		-	-		-	-
Interaction (N : K kg ha)								
50 : 30	3.67	4.53	d	4.10	41.67		55.38	48.53
50 : 60	4.10	5.93	a	5.01	41.67		52.48	47.07
50 : 90	3.93	4.73	bcd	4.33	42.67		54.33	48.50
50: 120	3.33	4.87	bcd	4.10	39.67		50.62	45.14
100 : 30	4.13	4.60	cd	4.37	41.00		54.10	47.55
100 : 60	4.13	4.73	bcd	4.43	40.33		51.74	46.04
100 : 90	3.40	5.33	abcd	4.37	40.00		56.06	48.03
100: 120	3.60	5.27	abcd	4.43	40.00		55.62	47.81
150 : 30	3.93	4.87	bcd	4.40	39.33		54.18	46.76
150 : 60	4.67	5.07	abcd	4.87	40.67		47.28	43.97
150 : 90	3.93	5.40	abcd	4.67	39.67		48.79	44.23
150: 120	3.87	5.60	ab	4.73	43.00		51.66	47.33
200 : 30	3.93	5.87	a	4.90	32.33		51.95	42.14
200 : 60	4.07	5.53	abc	4.80	32.00		56.48	44.24
200 : 90	4.07	5.40	abcd	4.73	36.67		54.46	45.56
200: 120	4.13	5.60	ab	4.87	36.33		52.23	44.28
Mean	3.931	5.208		4.57	39.19		52.96	46.07
F-Test	NS	*		NS	NS		NS	NS
LSD (0.05)	-	0.836		-	-		-	-
CV %	16.2	9.6		20.0	10.7		11.2	20.2

NS = Not significantly different and * significant at 0.05 levels
Same small letters in a column are not significantly different by DMRT at 0.05 levels

Table 8.12. Effect of nitrogen, potash and their interaction on percentage of tuber numbers distribution at NPRP, 2009/10 and 2010/11

	Tuber numbers 30-60 g. (%)			Tuber numbers >60 g. (%)		
Treatments	2009/10	2010/11	Pooled	2009/10	2010/11	Pooled
Nitrogen (kg/ha)						
50	40.42	35.80	38.11	18.17	11.00	14.58
100	39.08	33.94	36.51	20.33	11.68	16.00
150	39.83	34.86	37.35	19.67	14.66	17.16
200	43.17	32.75	37.96	22.75	13.47	18.11
F-test	NS	NS	NS	NS	NS	NS
LSD (0.05)	-	-	-	-	-	-
Potash (kg/ha)						
30	41.92	34.87	38.39	19.58	11.22	15.40
60	40.67	34.37	37.52	20.50	13.63	17.07
90	40.42	33.25	36.83	19.92	13.34	16.63
120	39.50	34.86	37.18	20.92	12.60	16.76
F-test	NS	NS	NS	NS	NS	NS
LSD (0.05)	-	-	-	-	-	-
Interaction (N : K kg/ha)						
50 : 30	40.67	34.29	37.48	17.67	10.33	14.00
50 : 60	39.33	36.45	37.89	18.67	11.08	14.87
50 : 90	41.00	34.34	37.67	16.67	11.33	14.00
50: 120	40.67	38.13	39.40	19.67	11.26	15.46
100 : 30	41.00	35.60	38.30	18.00	10.29	14.14
100 : 60	40.00	33.08	36.54	19.00	15.17	17.08
100 : 90	37.00	33.38	35.19	22.67	10.56	16.61
100: 120	38.33	33.68	36.01	21.67	10.69	16.18
150 : 30	43.00	34.90	38.95	17.67	10.92	14.29
150 : 60	39.33	37.79	38.56	20.00	14.93	17.46
150 : 90	41.00	33.11	37.05	19.67	18.11	18.89
150: 120	36.00	33.65	34.83	21.33	14.68	18.00
200 : 30	43.00	34.70	38.85	25.00	13.35	19.17
200 : 60	44.00	30.15	37.08	24.33	13.36	18.85
200 : 90	42.67	32.17	37.42	20.67	13.38	17.02
200: 120	43.00	33.98	38.49	21.00	13.78	17.39
Mean	40.63	34.34	37.48	20.23	12. 70	16.46
F-Test	NS	NS	NS	NS	NS	NS
LSD (0.05)	-	-	-	-	-	-
CV %	12.4	14.6	15.8	20.54	27.6	34.6

NS = Not significantly different.

Table 8.13. Effect of nitrogen, potash and their interaction on < 30 and 30-60 g tuber yield (t/ha) at NPRP, 2009/10 and 2010/11

	<30 g. tuber distribution (t/ha)				30-60 g tuber distribution (t/ha)					
Treatments	2009/10	2010/11		Pooled	2009/10		2010/11		Pooled	
Nitrogen (kg/ha)										
50	3.50	6.08	*b*	4.79	9.83	*b*	11.13	*b*	10.48	*c*
100	3.46	7.21	*ab*	5.34	11.28	*a*	13.56	*a*	12.42	*b*
150	3.08	7.85	*a*	5.47	13.71	*a*	14.44	*a*	14.08	*a*
200	3.15	8.29	*a*	5.72	12.39	*a*	14.51	*a*	13.45	*ab*
F-test	NS	***		NS	***		***		***	
LSD (0.05)	-	1.199		-	1.206		1.437		1.102	
Potash (kg/ha)										
30	3.25	7.30		5.27	11.32		12.27		11.80	
60	3.49	7.25		5.37	11.69		13.66		12.67	
90	3.16	7.33		5.24	12.52		13.61		13.07	
120	3.29	7.55		5.42	11.68		14.11		12.89	
F-test	NS	NS		NS	NS		NS		NS	
LSD (0.05)	-	-		-	-		-		-	
Interaction (N : K kg/ha)										
50 : 30	3.43	6.85		5.14	8.85		10.81		9.83	
50 : 60	3.42	6.23		4.83	9.55		11.11		10.33	
50 : 90	3.30	5.87		4.59	11.21		10.99		11.10	
50: 120	3.83	5.37		4.60	9.72		11.61		10.66	
100 : 30	3.43	6.79		5.11	11.77		13.46		12.62	
100 : 60	3.89	6.73		5.31	11.48		13.15		12.32	
100 : 90	3.28	7.04		5.16	9.72		13.95		11.84	
100: 120	3.27	8.27		5.77	12.15		13.70		12.93	
150 : 30	3.39	8.46		5.93	13.83		12.22		13.03	
150 : 60	3.48	7.65		5.57	13.94		16.11		15.03	
150 : 90	2.72	7.78		5.25	15.00		13.95		14.48	
150: 120	2.71	7.53		5.12	12.05		15.50		13.77	
200 : 30	2.73	7.10		4.92	10.84		12.59		11.72	
200 : 60	3.18	8.39		5.79	11.78		14.26		13.02	
200 : 90	3.32	8.64		5.98	14.16		15.56		14.86	
200: 120	3.36	9.01		6.19	12.79		15.62		14.20	
Mean	3.297	7.36		5.33	11.80		13.41		12.16	
F-Test	NS	NS		NS	NS		NS		NS	
LSD (0.05)	-	-		-	-		-		-	
CV %	19.6	19.5		48.0	12 .3		12.8		15.2	

NS = Not significantly different and *** significant at < 0.001 levels
Same small letters in a column are not significantly different by DMRT at 0.05 levels

Table 8.14. Effect of nitrogen, potash and their interaction on > 60 gram tuber distribution and total yield (t/ha) at NPRP, 2009/10 and 2010/11

	>60 g. tuber distribution (t/ha)						Total yield (t/ha)					
Treatments	2009/10		2010/11		Pooled		2009/10		2010/11		Pooled	
Nitrogen (kg/ha)		+		+		+		+		+		+
50	9.80	*b*	9.34	*b*	9.57	*c*	23.13	*c*	26.54	*c*	24.84	*c*
100	12.40	*a*	10.57	*b*	11.49	*b*	27.15	*b*	31.34	*b*	29.25	*b*
150	12.84	*a*	12.99	*a*	12.92	*a*	29.62	*a*	35.29	*a*	32.46	*a*
200	13.46	*a*	12.76	*a*	13.11	*a*	29.00	*a*	35.56	*a*	32.28	*a*
F-test	***		***		***		***		***		***	
LSD (0.05)	1.319		1.596		1.062		0.741		1. 365		1.850	
Potash (kg/ha)			+									
30	11.30	*b*	9.37	*b*	10.33	*b*	25.87	*c*	28.93	*b*	27.40	*b*
60	11.83	*b*	12.02	*a*	11.92	*a*	27.01	*b*	32.93	*a*	29.97	*a*
90	12.02	*b*	12.28	*a*	12.15	*a*	27.70	*ab*	33.22	*a*	30.46	*a*
120	13.35	*a*	11.99	*a*	12.67	*a*	28.32	*a*	33.64	*a*	30.98	*a*
F-test	*		***		***		***		***		***	
LSD (0.05)	1.319		1.596		1.062		0.741		1.365		1.850	
Interaction (N : K kg/ha)												
50 : 30	9.14		8.39		8.77		21.43	*h*	26.05	*d*	23.74	
50 : 60	9.84		9.14		9.49		22.81	*gh*	26.48	*d*	24.65	
50 : 90	9.35		9.75		9.55		23.86	*fg*	26.60	*d*	25.23	
50: 120	10.86		10.06		10.46		24.41	*e*	27.04	*d*	25.73	
100 : 30	11.47		8.83		10.15		26.67	*e*	29.07	*cd*	27.87	
100 : 60	11.52		12.35		11.93		26.89	*e*	32.22	*b*	29.56	
100 : 90	13.52		10.80		12.16		26.52	*e*	31.79	*bc*	29.16	
100: 120	13.11		10.31		11.71		28.53	*cd*	32.29	*b*	30.41	
150 : 30	11.54		9.51		10.52		28.76	*bcd*	30.19	*bc*	29.48	
150 : 60	12.79		13.02		12.91		30.22	*ab*	36.79	*a*	33.51	
150 : 90	12.12		14.82		13.47		29.84	*abc*	36.54	*a*	33.19	
150: 120	14.90		14.63		14.76		29.67	*abcd*	37.66	*a*	33.66	
200 : 30	13.05		10.74		11.89		26.61	*e*	30.43	*bc*	28.52	
200 : 60	13.17		13.58		13.37		28.12	*de*	36.24	*a*	32.18	
200 : 90	13.11		13.77		13.44		30.59	*a*	37.96	*a*	34.28	
200: 120	14.53		12.96		13.75		30.69	*a*	37.59	*a*	34.14	
Mean	12.13		11.42		11.77		27.23		32.18		29.71	
F-Test	NS		NS		NS		**		*		NS	
LSD (0.05)	_		-		-		1.483		2.731		-	
CV %	13.0		16.8		15.7		3.3		5.1		10.8	

NS = Not significantly different, * significant at 0.05 and *** significant at < 0.001 levels

+ Same small letters in a column are not significantly different by DMRT at 0.05 levels

Weight loss percentage

The effect of nitrogen on weight loss percentage was found only significant difference at 15 days after storage. The minimum weight loss percentage (3.65 %) was observed on application of 100 kg N and it was at a par with 50 kg N (4.09%). Since there is no significant effect of N on weight loss percentage in different dates after storage, but 50 kg N /ha has minimum weight loss (11.61%) than higher doses of nitrogen (Fig. 8.1). The effect of potash on weight loss percentage was found non significant up to 15 days storage and then showed significant and highly significant differences at 30, 45 and 60, 75, 90 days, respectively (Fig. 8.2). However, the application of 60 kg and higher dose of potassium showed similar results. The detail effect of N and K on weight loss percentage at different dates of storage in ambient temperature under dark condition is presented in Table 8.15.

The interaction effect of N and K showed a significant effect on weight loss percentage at 15 days storage and thereafter did no show any different on weight loss percentage. However, there was linear decrease on the weight loss percentage with the increasing trend of K (Figs. 8.1 and 8.2).

In cold stored potato, the effect of N, K and their interaction showed non significant results on weight loss percentage among different treatments stored for 120 days and after 15 days reconditioned (Table 8.16)

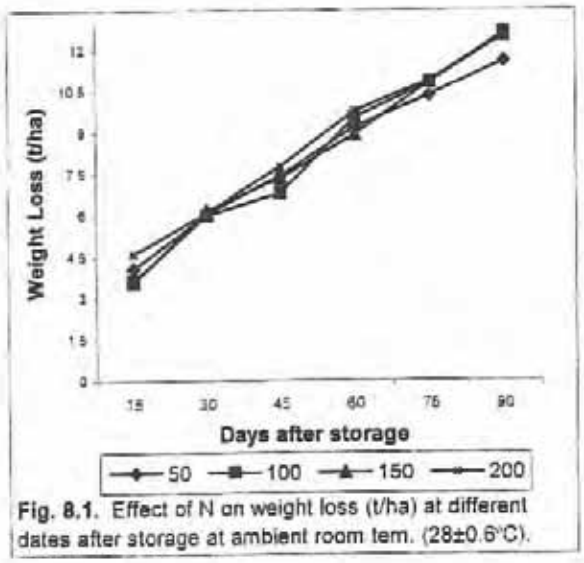

Fig. 8.1. Effect of N on weight loss (t/ha) at different dates after storage at ambient room tem. (28±0.6°C).

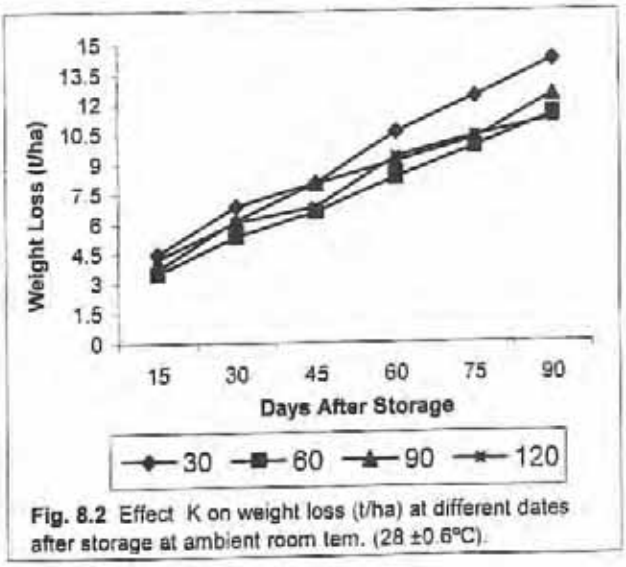

Fig. 8.2 Effect K on weight loss (t/ha) at different dates after storage at ambient room tem. (28 ±0.6°C).

Table 8.15. Effect of N, K and their interaction on weight loss percentage of potato tubers at different days after storage in ambient temperature (28±0.6°C) under dark room at Khumaltar, 2010/11

Treatments	Percent weight loss at different dates											
Nitrogen (kg/ha)	15 Days	+	30 Days		45 Days		60 days		75 days		90 days	
50	4.09	*ab*	6.06		7.46		9.20		10.36		11.61	
100	3.65	*b*	6.02		6.82		9.53		10.82		12.63	
150	3.57	*b*	6.20		7.37		8.93		10.83		12.53	
200	4.62	*b*	6.12		7.80		9.77		10.90		12.58	
F-test	*		NS		NS		NS		NS		NS	
LSD (0.05)	0.795		-		-		-		-		-	
Potash (kg/ha)								+		+		
30	4.48		6.85	*a*	8.05	*a*	10.59	*a*	12.38	*a*	14. 22	*a*
60	3.70		6.14	*ab*	8.01	*a*	9.13	*b*	10.26	*b*	*12.46*	*b*
90	3.50		5.33	*b*	6.57	*b*	8.33	*b*	9.87	*b*	11.44	*b*
120	4.23		6.07	*ab*	6.82	*ab*	9.37	*ab*	10.40	*b*	11.23	*b*
F-test	NS		*		*		***		***		***	
LSD (0.05)	-		1.034		1.315		1.241		1.245		1.466	
Interaction (N: K kg/ha)												
50 : 30	3.60	*bc*	6.67		7.73		9.60		10.80		12.47	
50: 60	3.55	*bc*	5.11		*7.89*		8.67		*9.78*		11.78	
50: 90	3.87	*bc*	6.00		6.93		8.93		10.07		11.0	
50: 120	5.33	*ab*	6.47		7.27		9.60		10.8		11.20	
100: 30	3.67	*bc*	7.13		8.40		12.20		13.60		15.73	
100: 60	3.60	*bc*	5.60		6.40		8.27		9.47		11.53	
100: 90	3.73	*bc*	5.20		5.87		8.13		9.87		11.47	
100: 120	3.60	*bc*	6.13		6.60		9.53		10.33		11.80	
150 : 30	4.27	*bc*	5.73		6.40		8.90		11.60		12.93	
150: 60	2.93	*c*	7.33		9.53		10.33		11.53		14.47	
150: 90	2.93	*c*	5.60		6.73		7.73		10.0		11.97	
150: 120	4.13	*bc*	6.13		6.80		8.73		10.20		10.73	
200: 30	6.40	*a*	7.87		9.67		11.67		13.53		15.73	
200 : 60	4.73	*abc*	6.53		8.20		9.27		10.27		12.07	
200: 90	3.47	*bc*	4.53		6.73		8.53		9.53		11.33	
200: 120	3.87	*bc*	5.53		6.60		9.60		10.27		11.20	
Mean	3.98		6.10		7.36		9.36		10.73		12.34	
F-test	*		NS		NS		NS		NS		NS	
LSD (±0.05)	1.590		-		-		-		-		-	
CV (%)	24.0		20.4		21.5		15.9		14.0		14.3	

+ Common small letters in a column are not significantly different by DMRT at 0.05 levels.
NS and *,**, *** represent non significant and significant differences at 0.05, 0.01 and <0.001 levels, respectively.

Table 8.16. Effect of N and K and their interaction on weight loss percentage of cold stored potato at 120 days and after 15 days recondition at Khumaltar, 2010

Treatments	Weight loss Percentage	
Nitrogen (kg/ha)	120 days cold store	15 days after recondition
50	7.25	10.02
100	7.08	9.63
150	6.60	9.32
200	6.87	9.49
F-test	NS	NS
LSD (0.05)		
Potash (kg/ha)		
30	6.90	9.97
60	6.827	9.35
90	7.24	9.78
120	6.85	9.35
F-test	NS	NS
LSD (0.05))	-	-
Interaction (N:K kg/ha)		
50 : 30	6.83	10.0
50 : 60	7.83	9.77
50 : 90	6.83	9.87
50 :120	7.50	10.43
100: 30	7.17	9.97
100: 60	7.42	10.0
100: 90	7.17	9.40
100:120	6.58	9.13
150: 30	7.33	10.47
150: 60	5.33	8.40
150: 90	7.75	10.17
150:120	6.0	8.23
200: 30	6.25	9.43
200:60	6.69	9.23
200: 90	7.71	9.69
200: 120	7.33	9.60
Mean	6.95	9.61
F-test	NS	NS
LSD (± 0.05)	-	-
CV (%)	16.8	11.0

NS represent non significant difference.

Quality Parameters

Dry matter content

The application of different dose of nitrogen and potassium alone and their combined effect showed the significant effect on dry matter percentage of potato before storage. The application of 50 kg (17.39 %) and 100 kg N (16.99 %) produced the statistically same results on dry matter percentage. The lowest dry matter, which is not desirable for processing was observed in treatment of 150 kg N (16.58 %) and it was at a par with 200 kg N/ha (16.48%). The application of K showed mixed results and did not show any increasing or decreasing trends on dry matter percentage. The storage of potato for 90 days in ambient room temperature (28.1±0.6°C) had no effect on dry matter percentage among treatments due to effect of N, K alone and their interaction. However, there was increased on the dry matter percentage from 0.94 to 1.6 % due to effect of N and 0.82 to 2.15 % due to effect of K and nearly 1.37 % due to their interaction (Fig. 8.3) after 90 days storage. It might be due to evaporation of water while storing.

In cold stored potato, the effect of N and K did not show any differences on dry matter percentage at 120 days and 15 days after reconditioned in room temperature after removing from cold store. However, the combined effect of N and K showed significant and highly significant differences at 120 days and after reconditioning (Table 8.17).

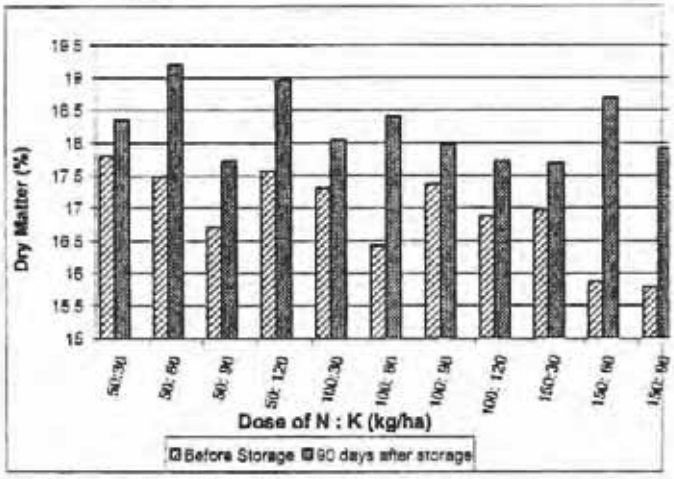

Fig. 8.3 Combined effect of N and K on dry matter % of potato before & 90 after storage in ambient room temp. at Khumaltar, 2010.

For processing of potato in chips, dry matter is an important parameter. It is directly proportional to the weight of chips and indirectly proportional to oil consumption of chips. In this experiment increased dose of N, K and their interaction decreased the DM content of potato. This finding is agreement with findings of other authors' results. Khatri and Shrestha, 1998 reported that, the increased amount of nitrogen and potassium reduced the dry matter content in Jumla condition. Other authors also reported that K has very important effect on DM content, which is normally inversely proportional to K content of soil (White *et al.*, 1974; Beukena and Van dev Zaag, 1979).

Specific gravity

The specific gravity of potato was significantly the highest with 50 kg N (1.067) and it was found at a par with 100 kg N (1.065). The lowest specific gravity was recorded on 150 and 200 kg N /ha (1.062). However, after 90 days of storage there is non significant effect of N on specific gravity (Table 4). The effect of K also showed a significant effect on specific gravity. The application of 30 kg and 120 kg K produced same specific gravity (1.065) and which is higher than 60 kg (1.062) and 90 kg (1.063) K /ha, respectively. There is increased in specific gravity after 90 days stored in ambient room temperature before storage in all treatments. It could be due to evaporation of water at high temperature storage for 90 days.

Table 8.17. Effect of N, K and their interaction on Dry Matter (%) of potato tubers before storage, at 90 day dark storage (28.1± 0.6°C), at 120 days cold storage and 15 days after recondition, 2010/11

Treatments	Before storage		90 days dark storage		120 days cold storage		15 days after Recondition	
Nitrogen (kg/ha)								
50	16.39	*b*	18.56		17.2		17.63	
100	16.99	*a*	18.03		17.57		17.68	
150	16.27	*b*	18.06		16.83		17.14	
200	16.40	*b*	17.95		17.04		17.07	
F-test	***		**NS**		**NS**		**NS**	
LSD (0.05)	0.4414		-		-		-	
Potash (kg/ha)								
30	17.12	*a*	17.94		16.97		17.38	
60	16.76	*ab*	18.58		17.29		17.17	
90	16.72	*ab*	17.87		17.05		17.19	
120	16.47	*b*	18.22		17.47		17.78	
F-test	*		**NS**		**NS**		**NS**	
LSD (0.05))	0.4414		-		-		-	
Interaction (N:K kg/ha)								
50 : 30	17.80		18.35		17.97	*a*	18.80	*a*
50: 60	17.73		19.20		17.25	*abc*	17.43	*bcdef*
50: 90	17.17		17.73		16.42	*c*	16.47	*ef*
50: 120	16.87		18.96		17.38	*abc*	17.81	*abcd*
100: 30	17.30		18.04		17.01	*abc*	17.67	*abcde*
100: 60	16.44		18.41		17.38	*abc*	16.83	*def*
100: 90	17.37		17.97		18.12	*a*	18.30	*ab*
100: 120	16.87		17.72		17.77	*ab*	17.90	abcd
150 : 30	16.97		17.69		16.75	*bc*	16.80	*def*
150: 60	16.33		18.68		17.32	*abc*	17.50	*bcdef*
150: 90	15.87		17.91		16.73	*bc*	17.07	*bcdef*
150: 120	15.93		17.97		16.73	*bc*	17.20	*bcdef*
200: 30	16.40		17.68		16.14	*c*	16.23	*f*
200 : 60	16.53		18.02		17.23	*abc*	16.91	*cdef*
200: 90	16.47		17.87		*16.92*	*abc*	16.94	*cdef*
200: 120	16.20		18.22		18.00	*ab*	18.20	*abc*
Mean	16.765		18.15		17.195		17.379	
F-test	NS		NS		*		***	
LSD (± 0.05)			-		1.0832		1.138	
CV (%)	3.2		4.7		3.8		3.9	

* Common small letters in a column are not significantly different by DMRT at 0.05 levels.
NS and *,**, *** represent non significant and significant differences at 0.05, 0.01 and <0.001 levels, respectively.

The interaction effect of N and K showed a non significant differences on specific gravity before storage of potato but significant after 90 storage in ambient room temperature. The application of 200 kg N and 30 kg K showed the highest specific gravity (1.0885) and it was found at par with 100 : 90 (1.0786) and 100 : 60 (1.0758), kg N and K/ha respectively.

The main effect of N and K was found significant after storage in cold store for 120 days. The higher dose of N (200 kg /ha) produced the lowest specific gravity (1.0645), but application of 60 kg K showed significantly lower specific gravity than other treatments (Table 8.18). The interaction effects of N and K showed non significant and significant effect on specific gravity

after 120 and 15 days reconditioning. It is reported that high specific gravity has positive role on the processing quality of tuber. As a rule, high specific gravity means high dry matter content and high recovery percentage of chips.

Table 8.18. Effect of N, K and their interaction on Specific Gravity of potato before storage, at 90 day dark storage (28.1±0.6°C), at 120 days cold storage and 15 days after recondition, 2010/11

Treatments	Before storage		90 days dark storage		120 days cold storage		15 days after recondition	
Nitrogen (kg/ha)								
50	1.067	*a*	1.0730		1.0694	a	1.0702	
100	1.065	*a*	1.0731		1.0702	a	1.0706	
150	1.061	*b*	1.0667		1.0668	a	1.0695	
200	1.062	*b*	1.0742		1.0645	b	1.0704	
F-test	***		NS		*		NS	
LSD (0.05)	0.00197		-		0.0042		-	
Potash (kg/ha)								
30	1.065		1.0732		1.0707	a	1.0699	
60	1.064		1.0701		1.0643	b	1.0709	
90	1.063		1.0713		1.0696	a	1.0708	
120	1.065		1.0724		1.0667	a	1.0691	
F-test	NS		NS		*		NS	
LSD (0.05))			-		0.0042		-	
Interaction (N:K kg/ha)								
50 : 30	1.068		1.0745	*bc*	1.0740		1.0665	*b*
50: 60	1.069		1.0694	*bc*	1.0611		1.0766	*a*
50: 90	1.065		1.0740	*bc*	1.0728		1.0744	*b*
50: 120	1.064		1.0741	*bc*	1.0695		1.0634	*c*
100: 30	1.067		1.0651	*bc*	1.0734		1.0663	*b*
100: 60	1.062		1.0758	*ab*	1.0668		1.0709	*b*
100: 90	1.067		1.0786	*ab*	1.0721		1.0728	*b*
100: 120	1.064		1.0727	*bc*	1.0687		1.0724	*b*
150 : 30	1.065		1.0646	*c*	1.0665		1.0750	*a*
150: 60	1.061		1.0651	*bc*	1.0682		1.0651	*b*
150: 90	1.059		1.0678	*bc*	1.0659		1.0651	*b*
150: 120	1.059		1.0692	*bc*	1.0668		1.0728	*b*
200: 30	1.062		1.0885	*a*	1.0690		1.0720	*b*
200 : 60	1.062		1.0699	*bc*	1.0611		1.0710	*b*
200: 90	1.062		1.0647	*c*	*1.0677*		1.0708	*b*
200: 120	1.062		1.0736	*bc*	1.0600		1.0677	*b*
Mean	1.0637		1.0717		1.06773		1.0702	
F-test	NS		*		NS		***	
LSD (± 0.05)	-		0.01287		-		0.00727	
CV (%)	0.3		0.7		0.5		0.4	

[+] Common small letters in a column are not significantly different by DMRT at 0.05 levels.
NS and *,**, *** represent non significant and significant differences at 0.05, 0.01 and <0.001 levels, respectively.

Reducing sugars

There is highly significant effect of N, its interaction with K and significant effect of K on the reducing sugars of potato before storage. The increasing dose of N and K and their interaction showed the decreasing trend of reducing sugars. However, the content of reducing sugars was

found acceptable level due to treatment effect. It could be due to varietal characters and due to the increase in water uptake and turgidity of cells. The effect of K and its interaction with N showed non-significant effect on reducing sugar after 90 days storage in room temperature. However, N showed a significant result (Table 8.19) on reducing sugar content.

Table 8.19. Effect of N, K and their interaction on Reducing Sugar (mg/100 g fresh wt.) content of potato tubers before storage, at 90 day dark storage (28.1± 0.6°C), at 120 days cold storage and 15 days after recondition, 2010/11

Treatments	Before storage		90 days dark storage		120 days cold storage		15 days after recondition	
Nitrogen (kg/ha)		-		-				
50	182.86	*a*	156.8	*a*	202.0	*a*	164.3	
100	169.27	*b*	143.7	*ab*	183.4	*b*	164.1	
150	158.45	*c*	144.1	*ab*	208.4	*a*	170.5	
200	157.68	*c*	136.3	*b*	179.8	*b*	155.6	
F-test	***		*		***		NS	
LSD (0.05)	4.399		13.69		14.38		NS	
Potash (kg/ha)								-
30	170.94 *a*		149.1		183.5	*b*	153.8	*b*
60	167.81 *ab*		146.8		199.7	*a*	166.8	*a*
90	165.70 *b*		146.0		190.1	*ab*	164.3	*a*
120	163.80 *b*		139.0		200.3	*a*	169.3	*b*
F-test	*		NS		*		*	
LSD (0.05))	4.399		-		14.38		11.12	
Interaction (N : K kg/ha)		-				+		+
50 : 30	197.46	*a*	154.8		184.0	*cd*	141.3	*d*
50: 60	185.14	*b*	162.7		190.0	*cd*	156.7	*cd*
50: 90	173.25	*c*	160.0		193.7	*cd*	172.3	*abc*
50: 120	175.57	*c*	149.8		240.3	*a*	186.7	*a*
100: 30	170.34	*cd*	154.6		183.7	*cd*	167.0	*abcd*
100: 60	166.44	*cde*	140.1		193.7	*cd*	174.7	*abc*
100: 90	169.71	*cd*	147.3		182.3	*cd*	158.7	*cd*
100: 120	170.58	*cd*	132.7		174.0	*d*	156.0	*cd*
150 : 30	159.17	*ef*	149.9		190.7	*cd*	152.7	*cd*
150: 60	163.14	*def*	148.0		225.7	*ab*	175.7	*abc*
150: 90	157.84	*ef*	141.4		207.0	*bcd*	169.0	*abc*
150: 120	153.65	*f*	137.1		210.3	*abc*	184.7	*ab*
200: 30	156.79	*ef*	137.2		175.7	*d*	154.3	*cd*
200 : 60	156.50	*e*	136.3		189.3	*cd*	160.2	*bcd*
200: 90	162.00	*def*	135.5		177.6	*cd*	157.1	*cd*
200: 120	155.42	*f*	136.3		176.7	*d*	151.0	*cd*
Mean	167.06		145.2		193.4		164.3	
F-test	**		NS		**		***	
LSD (± 0.05)	8.798		-		28.76		22.24	
CV (%)	3.2		27.37		8.9		8.1	

+ Common small letters in a column are not significantly different by DMRT at 0.05 levels.
NS and *,**, *** represent non significant and significant differences at 0.05, 0.01 and <0.001 levels, respectively.

In cold store potato, the reducing sugars increased at 120 days storage and drastically decreased after 15 days reconditioning. The effect of N was found highly significant on reducing sugars content immediately after 120 days cold store. The application of 200 kg N showed the lowest (179.8) reducing sugars. Similarly, the application of different dose of K showed the significant differences on reducing sugars both after 120 cold storage and 15 days after reconditioning

(Table 8.19). The interaction of N and K also showed highly significant effect on reducing sugars content of the potato at 120 days storage and after 15 days reconditioning.

The reducing sugar content of potato is an important parameter for chips quality. It higher concentration produces brown color of chips, which is not acceptable. The reducing sugar content up to 150 mg/ 100 gram fresh weight is consider good and up to 250 g/100 g fresh weight is consider acceptable for chips making. The finding of this research is not in agreement with the finding of Banu et al. (2007) in India, but in agreement with Herlihyand 1969, Sharma and Arora 1988, 2010 and Chapman et.al. 1992.

Sprouting percentage

The sprouting of potato causes relatively the height weight losses. First of all, the sprouting itself is a direct weight of fresh potato and second it losses intensive evaporation of water from the sprout surface, which caused shrunken of tubers and peeling losses while processing. The effect of N showed highly significant differences on sprouting after 75 and 90 days storage in ambient room temperature. The application of 100 kg N/ha recorded the maximum sprouting percentage (43 %) and it was observed minimum in 200 kg N/ha at 75 days after storage. Similarly, the minimum sprouting percentage (85.64%) was observed 90 days after storage in application of 200 kg N /ha. The application of 50,100and 150 kg N/ha showed a similar result on sprouting after 90 days storage. The application of different dose of potash showed a highly significant effect on sprouting at 60 and 75 days and non significant thereafter. The minimum sprouting percentage (8.9 % and 24.9 %) was observed in application of 90 kg K/ha at 60 and 75 days, respectively. The detail effect of N and K on sprouting percentage is given in Table 8.20.

The interaction effect of N and K showed a significant effect of sprouting only at 75 days after storage. However, it was found maximum (100%) with the application of 100 kg and 120 kg K /ha at 90 days after storage.

Conclusions and Recommendation

- The effect of nitrogen and potassium have found positive role for production of processing grade tuber and total yield of potato. The application of 150 kg nitrogen and 60 kg potassium along with 100 kg phosphorus and 20 t FYM /ha is recommended for production of processing grade tubers and higher yield of potato in Khumaltar and similar soil and environment condition.

- Potato can be safely stored in ambient room temperature (28±0.6°C temperature and 88-89% R.H) under dark with minimum storage losses (15%) up to 90 days. These potatoes were found suitable for processing due to increase in dry matter, specific gravity and decrease the amount of reducing sugars. The weight loss percentage ranges from 10.73 to15.73% at 90 days stored at ambient room temperature. The dry matter content increased from 16.785 to 18.15%, reducing sugars decreased from 167.06 to 145.2 mg/ 100 fresh weight and specific gravity increased from 1.0637 to 1.0717 after 90 days storage.

- There was 7% weight loss of cold stored potato for 120 days and it was increased up to 9.63% after 15 days reconditioning in ordinary condition. There was only mean increase of 15.76% reducing sugars after cold storage. It could be due to high reducing sugars before storage of immature tubers due to continuing raining and stagnation of water in potato field for 3-4 days.

Table 8.20. Effect of N, K and their interaction on Sprouting Percentage of potato at 60, 75 and 90 days of storage in ambient temperature (28.1± 0.6°C) under dark room at Khumaltar, 2010/11

Treatments	Sprouting percentage at different days after storage					
Nitrogen (kg/ha)	60 days		75 days		90 days	
50	12.7		36.9	b	92.9	*a*
100	17.4		43.0	a	96.0	*a*
150	14.2		31.9	c	91.1	*a*
200	10.7		19.5	d	85.6	*b*
F-test	NS		***		***	
LSD (0.05)	-		8.51		5.093	
Potash (kg/ha)						
30	15.1	*ab*	41.6	*a*	93.0	*a*
60	11.4	*b*	27.8	*b*	88.6	*b*
90	8.9	*b*	24.9	*b*	90.2	*ab*
120	19.6	*a*	37.1	*a*	83.9	*a*
F-test	*		***		NS	
LSD (0.05)	6.99		8.51		7.84	
Interaction (N :K kg/ha)						
50 : 30	13.1		44.4	*b*	91.8	
50 : 60	15.9		46.3	*b*	97.3	
50 : 90	7.70		27.1	*cde*	91.2	
50 : 120	14.1		29.9	*cd*	91.3	
100 : 30	14.3		50.1	*b*	99.2	
100 : 60	9.5		19.1	*efg*	87.5	
100 : 90	18.6		45.1	*b*	97.2	
100 : 120	27.2		45.7	*a*	100.0	
150 : 30	16.9		42.0	*b*	92.7	
150 : 60	15.8		32.9	*c*	89.1	
150 : 90	4.1		16.9	*fg*	90.5	
150 : 120	20.1		36.0	*cd*	92.1	
200 : 30	16.4		29.9	*cd*	88.1	
200 : 60	4.3		12.7	*g*	80.3	
200 : 90	5.0		10.7	*g*	82.0	
200 : 120	17.0		24.6	*def*	92.1	
Mean	13.8		32.8		91.4	
F-Test	NS		***		NS	
LSD (0.05)	-		17.02		-	
CV (%)	61.1		31.2		6.7	

+ Common small letters in a column are not significantly different by DMRT at 0.05 levels.
NS and *,**, *** represent non significant and significant differences at 0.05, 0.01 and <0.001 levels, respectively.

9.0 SEED POTATO PRODUCTION

9.1 ACTIVITIES UNDER TISSUE CULTURE LABORATORY

Since the establishment of tissue culture laboratory and glasshouse facility in 1989, National Potato Research Program has been producing disease-free pre-basic seed potatoes each year during autumn and spring seasons. For pre-basic seed potato production, disease-free *in vitro* plantlets are produced in the tissue culture laboratory and transplanted under aphid-proof glasshouse and screen house under sterile conditions. Following activities were carried out during 2010/11.

9.1.1 GERMPLASM MAINTENANCE

A total of 100 potato germplasms has been maintained under *in vitro* condition in the laboratory (Appendices I) Out of them twelve cultivars had been used for PBS production program.

9.1.2 RAPID PROPAGATION

Virus-free mother plantlets are propagated by subcultures using single nodal cutting technique and grown in a growth chamber under 2000 Lux light intensity, 22±2°C temperatures and 16 hr photoperiod. Depending on the cultivar, a fully grown plantlet is obtained after three to six weeks of culture. Five to ten single nodal segments are harvested from each plantlet in the laminar flow cabinet under sterile condition. This process is continued until sufficient plantlets are produced for transplanting in the glasshouse and screen house. A total of 22,920 *in vitro* plantlets of eleven cultivars were supplied to the glasshouse/screenhouse in autumn season planting (August 2010), and 13,330 *in vitro* plantlets of ten cultivars to the glasshouse/screenhouse for Spring season (January 2011). Similarly, total 4,450 *in vitro* plantlets of seven cultivars were supplied to Nala, Kavre farmers group for autumn and spring season planting (Table 9.1).

Table 9.1. *In vitro* plantlets supplied for plantation in the glass/screen houses and farmers group 2067/68 (2010/11)

Cultivars	Autumn, 2010	Spring, 2011	Nala, Kavre	Total
Cardinal	4600	3330	380	8310
Desiree	3830	2120	1600	7550
Janak Dev	4030	3250	850	8130
Kufri Jyoti	6250	3130	1000	10380
Khumal Seto -1	1420	500	120	2040
Khumal Rato -2	450	-	350	800
Kufri Sindhuri	1130	-	-	1130
Khumal Laxmi	450	340	150	940
IPY-8	410	270	-	680
MF II	200	240	-	440
TPS 67	150	130	-	280
TPS 7	-	20	-	20
Total	22,920	13,330	4,450	40,700

9.2 GLASSHOUSE ACTIVITIES FOR PRE-BASIC SEED PRODUCTION

9.2.1 SOIL MIX PREPARATION

About one month before the initiation of transplanting in each season, the sand soil mixture of each bench in the glasshouse and screen house were mixed thoroughly and drenched uniformly with water until the benches were well drained. The soil surface was then gently raked and partitions of one meter were marked along the benches.

9.2.2 SOIL STERILIZATION

Formaldehyde solution (1%) was drenched thoroughly over the partitioned area to treat the sand soil mixture thoroughly. Immediately after the chemical application, each bench was covered with polythene sheets. Polythene sheets were removed after one week and the sand soil mixture was turned over several times with the help of clean spades to get rid of the volatile chemical residues, which otherwise are phyto-toxic to *in vitro* plantlets.

9.2.3 TRANSPLANTING

In August 2010, a total of 22,920 plantlets of eleven cultivars were transplanted in the glasshouse/screenhouse for autumn season for pre-basic seed production. Likewise 13,330 plantlets of ten cultivars were transplanted in the glasshouse/screenhouse for spring season pre-basic seed production. The total 36,250 *in vitro* plantlets were produced during the F.Y. 2010/11 and used for PBS production at Khumaltar (Table 9.1).

9.2.4 PRE-BASIC SEED (PBS) PRODUCTION

PBSs were produced during two seasons, the first one during autumn 2010 and the second one during spring 2011. During autumn 2010, total of 33,308 PBS comprising eleven cultivars were produced in glasshouse and screenhouse. The cultivars were Cardinal, Desiree, Janak Dev, Khumal Seto-1, Kufri Jyoti, Kufri Sinduri, Khumal Rato-2, IPY-8, Khumal Laxmi, TPS 67 and MF-II. In spring 2011, altogether 58,358 pre-basic seed potatoes comprising ten cultivars, viz. Cardinal, Desiree, Janak Dev, Khumal Seto-1, Kufri Jyoti, IPY-8, Khumal Laxmi, TPS 7, TPS 67 and MF-II were produced. So, altogether 91,666 pre-basic seed potatoes were produced during the F.Y. 2010/11 (Table 9.2).

Table 9.2. PBS production in the glasshouse/screenhouse during the F.Y. 2067/68 (2010/11)

Cultivars	Autumn 2010	Spring 2011	Total
Cardinal	9897	12001	21898
Desiree	3628	13300	16928
Kufri Jyoti	6367	13480	19847
Janak Dev	7990	5322	13312
Kufri Sinduri	295	-	295
Khumal Seto-1	2030	10422-	12452
Khumal Laxmi	835	40	875
I.P.Y.- 8	576	2150	2726
Khumal Rato-2	880	-	880
TPS 67	500	186	686
MF-II	310	1450	1760
TPS 7	-	47	47
Total	33,308	58,358	91,666

Table 9.3. Pre-basic seed produced during Autumn, 2010/11 (2067/68 1st Lot) (to be distributed during terai season, 2068/69)

Variety	PBS size distribution (No.)					Total No.
	>5 g	1-5 g	0.5-1	<0.25-0.5 g	<0.25 g	
Cardinal	1735	3412	2595	1485	670	9897
Desiree	625	1165	880	633	325	3628
Janak Dev	975	2740	2150	1235	790	7990
Khumal Seto-1	215	500	580	520	215	2030
Kufri Jyoti	1670	1935	1472	950	340	6367
Khumal Rato-2	160	350	265	80	25	880
IPY-8	150	158	148	80	40	576
Khumal Laxmi	100	295	135	120	185	835
TPS 67	90	135	100	90	85	500
MF-II	100	115	35	25	35	310
Sub-total	5,855	10,805	8,450	5,348	2,850	33,308
%	17.6	32.4	25.4	16.1	8.6	100.0

Table 9.4. Pre-basic seed produced during Spring, 2010/11 (2067/68 2nd Lot) (To be distributed during hill season, 2068/69)

Variety	PBS size distribution (No.)					Total No.
	>5 g	1-5 g	0.5-1	<0.25-0.5 g	<0.25 g	
Cardinal	269	1985	3122	4325	2300	12001
Desiree	989	2368	3665	3338	2940	13300
K. Jyoti	365	2455	4410	4085	2165	13480
Janak dev	40	347	1125	1770	2040	5322
K.Sinduri	-	-	-	-	-	-
K. Seto	161	1193	3335	3343	2390	10422
K. Laxmi	-	-	-	-	-	-
I.P.Y8	125	370	840	570	245	2150
TPS 67	13	27	45	61	40	186
TPS 7	10	25	-	12	-	47
MF II	85	90	375	425	475	1450
Sub-total	2,057	8,860	16,917	17,929	12,595	58,358
%	3.5	15.2	29.0	30.7	21.6	100.0

Table 9.5. Overall pre-basic seed production during 2067/68 (2010/11)

Plant season	PBS size distribution (No.)					Total No.
	>5 g	1-5 g	0.5-1	<0.25-0.5 g	<0.25 g	
Autumn season	5,855	10,805	8,450	5,348	2,850	33,308
Spring season	2,057	8,860	16,917	17,929	12,595	58,358
Grand total	7,912	19,665	25,367	23,277	15,445	91,666
%	8.6	21.5	27.7	25.4	16.9	100.0

9.3 BASIC SEED PRODUCTION IN HATTIBAN FARM

Total 3,015 kg basic seeds of Cardinal, Desiree, Janak Dev, Khumal Rato-2, Khumal Seto-1, Kufri Jyoti, NPI-106, IPY-8 and Khumal Laxmi had been produced at Hattiban Farm for further seed multiplication for the succeeding year (Table 9.6).

9.4. COLD STORAGE

As in the last year, PBS were graded into five categories, viz. <0.25 g, 0.25-0.5 g, 0.5-1.0 g, 1.0-5.0 g, and >5.0 g size. The PBS were packed in nylon net bags and then stored in

Kohinoor Coldstore, Balaju on rent. PBS potatoes harvested in winter have to be stored for about nine months, whereas those harvested in summer have to be stored for about five months. These pre-basic seeds are distributed to the seed growers and other agencies during the succeeding fiscal year 20010/11 (2067/68).

Table 9.6. Basic seed at Hattiban Farm during F.Y. 2067/68 (2010/11)

Variety	BS 1		BS 2		BS 3		Total		Total (Kg)
	Bag	Kg	Bag	Kg	Bag	Kg	Bag	Kg	
White-skinned	-								
K.Jyoti	-	2.0	3	25.0	21	-	24	27.0	1227.0
NPI 106	-		-		2	40.0	2	40.0	140.0
Khumal Seto	-	0.5	-	-	6	-	6	0.5	300.5
Sub-total		2.5	3	25.0	29	40.0	32	67.5	1,667.5
Red-skinned	-	-	-	-	-	-			
Cardinal	-	3.0	2	15.0	2	-	4	18.0	218.0
Janakdev	-	-	5	-	6	-	11	-	550.0
IPY 8	-	-	2	-	2	-	4	-	200.0
Khumal Rato	-	-	-	-	1	-	1	-	50.0
Desiree	-	-	-	15.0	3	40.0	3	55.0	205.0
K. Laxmi	-	-	2	25.0	-	-	2	25.0	125.0
Sub-total		3.0	11	55.0	14	40.0	25	98.0	1,348.0
Total	-	5.5	14	80.0	43	80.0	57	165.5	3,015.5

Note: 1 bag = 50 kg

About 50 per cent of the PBS potatoes produced in autumn 2010 were larger than one gram sized. In case of spring 2011 production, only about 18.7 per cent tubers were larger than one gram sized (Tables 9.3 and 9.4). In the overall production of 91,666 pre-basic seed potatoes this year, about 30% were larger than one gram sized and about 42% were smaller than 0.5 g sized (Table 9.5).

9.5. PRICING AND DISTRIBUTION OF PRE-BASIC SEEDS

The per unit price of the pre-basic seed potatoes fixed for the F.Y. 2010/11 was Rs. 6.00 for larger than five gram sized minituber, Rs. 5.50 for 1-5 g sized, Rs. 3.00 for 0.5-1 g sized, Rs. 0.75 for 0.25-0.5 g and Rs. 0.25 for smaller than 0.25 g sized minitubers (Table 9.7).

In the Fiscal Year 2009/10, total 19,862 pre-basic seeds produced during autumn season and 79,379 PBS produced during spring season were stored in Kohinoor Cold store, Balaju Industrial Area, Kathmandu for terai season and hill season distribution, respectively. During 2010/11, all PBS produced in 2009/10 were distributed to seed potato growers through District Agriculture Development Offices, Horticulture Farms/Agriculture Research Stations, NGOs and others throughout the country in coordination with the National Potato Development Program, Department of Agriculture, Khumaltar.

Table 9.7. Pre-basic seed potato pricing of the last fifteen years

PBS Grade (size)	Per unit PBS price (Rs.)														
>5 g	-	-		-	-	-	-	-	-	3.75	4.00	5.00	5.00	5.50	6.00
1-5 g	1.00	1.00	1.25	1.40	1.50	1.00	2.00	3.00	3.00	3.50	3.75	4.50	4.00	5.00	5.50
0.5-1 g	0.25	0.50	0.50	0.60	0.70	0.60	1.50	1.70	2.00	2.00	2.00	2.00	2.00	2.50	3.00
0.25-0.5 g	0.00	0.00	0.20	0.25	0.30	0.40	0.75	1.00	1.00	0.50	0.50	0.50	0.50	0.75	0.75
<0.25 g	-	-	0.00	0.05	0.05	0.05	0.75	1.00	-	-	-	-	-	0.25	0.25

10.0 SWEET POTATO VARIETY IMPROVEMENT

10.1 SWEET POTATO VARIETY DEVELOPMENT IN NEPAL FOR FOOD AND NUTRITION SECURITY

Sweet potato (*Ipomoea batatas* Lam.) is among the world's most important and underexploited food crops. World's sweet potato production is more than 133 million tons in more than 100 countries and China is the largest sweet potato producing countries in the world (http://www.sweetpotato.org). Sweet potato is regarded as poor man's crop or small farmer's crop because of its low input requirements, ease of production and ability to produce under adverse weather and soil conditions (Ndolo *et al.*, 2001). It is a short duration crop. In the flood prone and marginalized areas of eastern and western Terai the food crop production and food and nutrition security role of sweet potato would be currently important.

In Nepal, sweet potato is grown throughout the mid hills and terai region in kitchen garden (Gautam, 1991). It is grown up to 1800 m asl (Sah, 1991 and Gautam, 1998). From the production point of view, Nepal still lacks reliable statistics on areas and production of sweet potato. Sweet potato thrives best in well-drained sandy loam to clay loam soil with 5.5-6.5 pH. Sweet potato does not require large amount of water during the growth period and fits well in existing cropping systems. Tuber skin color varies from white, to light orange, red and tan; while the tuber flesh color varies from white to orange, yellow and purple (Woolfe, 1992). In Nepal, it is one of the neglected crops. It has also religious value and tubers are mainly harvested for Makar Sankranti. Most of the middle hill districts including Kathmandu and Terai are main sweet potato growing areas of the country (Lohani, 1981).

Sweet potato is utilized mostly as food in traditional forms (i.e., boiled, roasted, fried, etc.) and as unprocessed feeds. At present, sweet potato can be made into semi-processed products, flour/starch, ketchup, jam, snack chips, and beverage. Semi-processed products are further processed into other food products while flour is used as material for cakes, pastries and noodles. Sweet potato starch is used for the manufacture of paper, ink, paint, chemical products, feed stuff and accelerant. The by-products from starch processing can also be used for alcohol and organic fertilizer production.

10.1.1 GERMPLASM COLLECTION, MAINTENANCE AND EVALUATION

Germplasm collection, maintenance and evaluation are one major research activities. Germplasms are collected mainly for International Potato Centre (CIP), Lima, Peru and different part of the country. In vitro plantlets received from CIP were maintained under *in vitro* and glasshouse conditions (Appendix II). Collection and maintenance of local as well as exotic germplasms of sweet potato will be continued for several years in the program.

In the case of sweet potato evaluation, NPRP is trying to follows similar varietal evaluation scheme as followed in potato evaluation scheme. Collected germplasms are multiplied in *in vitro* and/or screenhouse conditions, followed preliminary evaluation in observation trials under field conditions at Khumaltar and or appropriate locations. The best performing materials are further tested as Initial Evaluation Trial (IET), and later as Coordinated Varietal Trial (CVT) in different collaborative farms and stations. Promising lines from CVT are further promoted to Coordinated Farmers' Field Trial (CFVT) carried out at out-reach research sites of different stations and further one time under farmers' acceptance test (FAT)

and the most performing clone are recommended for commercial cultivation in respective locations.

10.1.2 INITIAL EVALUATION TRIAL (IET)

Introduction

IET is the initial testing of new clones for yield potentiality, adoptability in different agro-climatic zones and major diseases and pest response. During the year 2067/68, one set of IET materials was planted at RARS Tarahara, one set at ARS (Hort.) Pokhara and one set at NPRP, Khumaltar as the representative sites.

Materials and Methods

Total 21 genotypes of sweet potatoes collected from International Potato Center (CIP), Lima, Peru; three local cultivars, i.e. Dhankuta1-, Dhankuta-2 and Sunsari-1 collected from eastern part of Nepal and one Japanese cultivar collected from Horticulture Research Division, Khumaltar were assessed for their vegetative and yield characteristics. In all three locations, trials were laid out in RCBD with three replications. The plots were fertilized @ 40:40:50 kg NPK together with 10 tons of compost per hectare as basal dose. Plants were planted in a two rows design with 60 x 30 cm row to row and plant to plant spacing.

Observations taken were:

- Incidence of pest and diseases will be recorded (scale 1-5)
- Plant type (spreading, compact, semi compact, elliptical, semi elliptical, broad teeth, semi-circular, lanceolate).
- Vine growth rate (fast, slow, medium).
- Vine pigmentation.
- Vine diameter.
- Vine internodes length.
- Skin color of tuber.
- Flesh color of tuber.
- Tuber number per plant.
- Grading tuber numbers and weight plot wise.
- Marketable and total tuber yield t/ha.

Results and Discussion

At NPRP Khumaltar condition a total 25 sweet potato clones were evaluated for various plant characteristics and tuber yield. Result revealed that local clones showed less performance and CIP clones performed better mainly in ground cover, plant uniformity and vine growth (Table 10.1). Similarly, in the case of tuber characteristics and yield, all CIP clones were found yellow in skin color and also orange or red in flesh color. Among the 25 clones, 400039 produced the highest yield (739 g/plant) followed by 440021 (559 g/plant) and 440015 (483 g/plant), and lowest yield produced by local clones (Table 10.2). Most of the CIP clones were produced attractive size, shape and also very good in raw eating. All sweet potato varieties imported from CIP were found light orange to dark orange color of skin as well as flesh of the tubers.

At RARS, Tarahara, plant stand was found good and most of the evaluated clones showed good plant performances in all of the evaluated parameters, however, the lowest ground cover was 65% in 440014 (Table 10.3). Regarding the tuber yield, 440039 produced the highest yield (826 g/plant) followed by 440328 (527 g/plant) and the lowest from 441538 (182 g/plant) (Table 10.4). Similar to Khumaltar, all sweet potato varieties imported from CIP were found light orange to dark orange color of skin as well as flesh of the tubers.

At ARS (Hort.), Pokhara, better plant performances were observed in most of the CIP clones in most of the evaluated parameters. The highest yield was observed in the clone 400039 (636 g/plant) followed by 440015 (305 g/plant) and 440021 (265 g/plant). All major plant and tuber characteristics collected from the experimental plots are presented in Table 10.5 and Table 10.6. CIP clone 400039 produced the highest yield under all tested sites (Tarahara, Khumaltar and Pokhara) and clones 440015 and 440021 second and third highest yield under Khumal and Pokhara conditions.

For more confirmation and accuracy on major evaluated characteristics of the tested clones, IET will be repeated once using all 25 clones and other collected local clones in the same locations in the F.Y. 2068/69.

Table 10.1. Plant and foliar characteristics of sweet potato clones under Initial Evaluation Trial (IET) at NPRP, Khumaltar, 2009/10

Clones	Plant unif. (1-5)	Ground cover (%)	Plant vigor (1-5)	Plant type	Vine growth rate (1-5)	Vine pigmentation	Vine thickness	Vine internode length	Leaf shape	Flowering
400039	5	95	4	Semi-compact	4	Pigmented	Thick	Short	Medium round, pigmented	No
400917	4	100	5	Spreading	5	Pigmented	Thin	Long	Pointed cut, pigmented	No
440001	5	100	5	Spreading	5	Pigmented	Medium	Long	Small, pigmented, pointed	Yes
440007	5	100	5	Spreading	5	Node Pigmented	Medium	Long	Medium round pointed	No
440008	4	95	4	Spreading	4	Pigmented	Thin	Long	Small, round, pigmented	No
440012	3	90	3	Semi-compact	4	No	Thick	Short	Medium round pointed	Yes
440014	4	95	4	Spreading	4	No	Thin	Medium	Small, pointed pigmented	Yes
440015	4	95	4	Semi-compact	5	Pigmented	Medium	Short	Small, Serrated Pigmented	Yes
440020	4	95	5	Semi-compact	5	Node Pigmented	Thick	Short	Small pointed, pigmented	Yes
440021	5	100	5	Semi-compact	5	No	Medium	Medium	Small round pointed	Yes
440047	5	100	5	Spreading	4	No	Thin	Long	Small pointed pigmented	No
440099	5	100	4	Spreading	5	Pigmented	Thin	Long	Medium round pointed	Yes
440112	4	90	4	Semi-compact	4	Pigmented	Thick	Long	Large round pointed	No
440135	4	95	4	Semi-compact	4	Pigmented	Thick	Short	Large round pointed green	No
440185	5	100	5	Spreading	5	Pigmented	Medium	Medium	Medium round pigmented	No
440267	5	95	5	Spreading	5	Pigmented	Medium	Medium	Medium round pointed pigmented	No
440287	4	95	4	Spreading	3	Pigmented	Thin	Long	Small oval, pointed	No
440328	4	100	4	Semi-compact	4	No	Medium	Short	Medium round pointed	No
440513	5	95	5	Spreading	5	No	Medium	Medium	Large round oval	No
441538	5	95	4	Spreading	5	Node Pigmented	Thin	Long	Small pointed pigmented	No
441624	4	95	5	Spreading	5	No	Medium	Medium	Large pointed pigmented	No
Dhankuta-1	4	85	4	Spreading	3	Pigmented	Medium	Medium	Serrated, pointed	No
Dhankuta-2	4	80	4	Elliptical	4	Pigmented	Thin	Medium	Serrated, pointed	No
Sunsari-1	3	80	3	Semi-compact	3	Pigmented	Medium	Medium	Serrated, pointed	No
Japanese Red	4	95	5	Spreading	5	Pigmented	Thick	Medium	Medium round	Yes

Plant uniformity (1-5): 1= very poor, 5= very good; Plant vigor (1-5): 1= very poor, 5= very good vigor.; Vine growth rate (1-5): 1= very poor, 5= very good growth.

Table 10.2. Yield and tuber characteristics of sweet potato clones under Initial Evaluation Trial (IET) at NPRP, Khumaltar, 2009/10

Clones	Tuber character			Flesh color	Tuber uniformity	Tuber yield Wt./pt (gm)	Remarks (Raw taste)
	Skin color	Shape	Size				
400039	Light yellow	Medium long	Large	Orange	4	739	Cracking, Sweet
400917	Light yellow	Long	Medium	Light orange	3	304	Light sweet
440001	Light orange	M. long	Small	Orange	3	140	Sweet
440007	Light yellow	Long	Small	Orange	3	130	Sweet
440008	Light red	Long	Small	Orange	4	158	Sweet
440012	Light yellow	Round	Medium	Orange	3	321	Light sweet
440014	Light yellow	Long	Medium	Light orange	4	198	Very sweet
440015	Yellow	Long	M. large	Orange	4	483	Light sweet
440020	Orange	M. long	Medium	Orange	4	152	Very sweet
440021	Purple red	Round	Large	Dark orange	5	559	Light sweet
440047	Orange	Long	Medium	Orange	3	145	Light sweet
440099	Light red	M long	Medium	Orange	4	165	Sweet
440112	Light yellow	Round	M. small	L orange	4	198	Sweet
440135	Orange	Long	Small	Orange	3	150	Light sweet
440185	Light yellow	V. Long	M. small	L orange	3	265	Light sweet
440267	Light red	Long	Medium	Orange	3	195	Sweet
440287	Red	M. long	Medium	Orange	4	150	Light sweet
440328	Light orange	Long	Small	Orange	3	160	Sweet
440513	Light red	Narrow long	Small	Orange	3	265	Sweet
441538	Light red	Long	Medium	Orange	3	130	Light sweet
441624	Orange	Round	Medium	Orange	4	160	Sweet
Japanese red	Dark red	Long	M. large	Yellow	4	198	Sweet
Dhankuta 1	Red	Long	Small	White	3	115	Sweet
Dhankuta 2	Light purple	M. long	Medium	White	3	115	Light sweet
Sunsari 1	Light purple	Long	Medium	White	3	112	Light sweet

Skin color (orange, light yellow, yellow), Shape (long, round, medium long, oval)
Flesh color (orange, light orange, yellow), Size (small, medium, large),
Tuber uniformity (1-5) (1= poor, 5= very poor)

Table 10.3. Plant and foliar characteristics of sweet potato clones under Initial Evaluation Trial (IET) at RARS Tarahara, 2009/10

Clones	Plant unif. (1-5)	Ground cover (%)	Plant vigor (1-5)	Plant type	Vine growth rate (1-5)	Vine Pigmentation	Vine thickness	Vine internode length	Leaf shape	Flowering
400039	5	95	4	Semi-compact	3	2	Medium	Short	Medium round, pigmented	No
400917	4	90	3	Spreading	4	2	Thin	Medium	Pointed cut, pigmented	No
440001	4	80	4	Spreading	4	3	Medium	Medium	Small, pigmented, pointed	Yes
440007	4	75	4	Spreading	4	3	Medium	Long	Medium round pointed	No
440008	4	80	5	Spreading	5	3	Thin	Long	Small, round, pigmented	No
440012	4	90	4	Semi-compact	4	1	Thick	Short	Medium round pointed	Yes
440014	3	65	3	Spreading	4	2	Medium	Medium	Small, pointed pigmented	Yes
440015	4	95	5	Semi-compact	5	3	Medium	Medium	Small, Serrated Pigmented	Yes
440020	4	80	4	Semi-compact	3	2	Thick	Short	Small pointed, pigmented	Yes
440021	4	70	5	Semi-compact	5	2	Medium	Medium	Small round pointed	Yes
440047	4	95	4	Spreading	4	2	Thin	Long	Small pointed pigmented	No
440099	3	80	4	Spreading	5	2	Thin	Medium	Medium round pointed	Yes
440112	4	95	5	Semi-compact	4	3	Thick	short	Large round pointed	No
440135	5	90	5	Semi-compact	4	3	Thick	Short	Large round pointed green	No
440185	4	90	4	Spreading	5	3	Medium	Medium	Medium round pigmented	No
440267	3	60	4	Spreading	5	3	Medium	Medium	Medium round pointed pigmented	No
440287	4	90	4	Spreading	3	3	Thin	Long	Small oval, pointed	No
440328	5	80	4	Semi-compact	4	2	Medium	Short	Medium round pointed	No
440513	5	90	5	Spreading	5	1	Medium	Medium	Large round oval	No
441538	3	60	3	Spreading	5	2	Thin	Long	Small pointed pigmented	No
441624	4	70	4	Spreading	5	3	Thin	Medium	Large pointed pigmented	No
Dhankuta-1	3	85	4	Spreading	3	2	Medium	Short	Serrated, pointed	No
Dhankuta-2	4	80	4	Elliptical	4	2	Thin	Short	Serrated, pointed	No
Sunsari-1	4	80	3	Semi-compact	3	2	Medium	Short	Serrated, pointed	No
Japanese Red	5	90	4	Spreading	5	3	Thick	Medium	Medium round	Yes

Plant uniformity (1-5): 1= very poor, 5= very good: Plant vigor (1-5): 1= very poor, 5= very good vigor.: Vine growth rate (1-5): 1= very poor, 5= very good growth.

Table 10.4. Yield and tuber characteristics of sweet potato clones under Initial Evaluation Trial (IET) at RARS, Tarahara, 2009/10

Clones	Tuber character			Tuber yield wt./plant (gm)
	Skin color	Shape	Size	
400039	Light red	Irregular	Large	826
400917	Light yellow	Long	Medium	297
440001	Dark red	M. long	Medium	200
440007	Red	Long	Medium	227
440008	Red	Long	Medium	232
440012	Dark orange	Round	Medium	271
440014	Dark yellow	M. long	Medium	228
440015	Light red	Long	Large	313
440020	Light red	M. long	Medium	240
440021	Purple	Round	Large	288
440047	Red	Long	Small	284
440099	Red	M long	Medium	235
440112	Yellow	Round	Large	271
440135	Orange	Long	Medium	417
440185	Light yellow	Long	M. small	295
440267	Light red	Long	Medium	388
440287	Red	M. long	Medium	308
440328	Light orange	Long	M. small	527
440513	Dark red	Narrow long	Medium	388
441538	Red	Long	Medium	182
441624	Orange	M. long	Large	403
Japanese Red	Purple	Long	M. large	317
Dhankuta 1	Light purple	Long	Small	250
Dhankuta 2	Light purple	M. long	Medium	257
Sunsari 1	Light purple	Long	Medium	271

Skin color (orange, light yellow, yellow), Shape (long, round, medium long, oval)
Size (small, medium, large),

Table 10.5. Plant and foliar characteristics of sweet potato clones under Initial Evaluation Trial (IET) at ARS (Hort.) Pokhara, 2009/10

Clones	Plant unif. (1-5)	Ground cover (%)	Plant vigor (1-5)	Plant type	Vine growth rate (1-5)	Vine Pigmentation	Vine thicknes	Vine internode length	Leaf shape	Flower color
400039	4	100	4	Semi-compact	3	Pigmented	Thick	Short	Medium round, pigmented	No
400917	5	95	4	Spreading	3	Pigmented	Thin	Long	Pointed cut, pigmented	Yes
440001	4	85	4	Spreading	4	Pigmented	Medium	Long	Small, pigmented, pointed	No
440007	4	80	4	Spreading	4	Node Pigmented	Medium	Long	Medium round pointed	No
440008	5	90	8	Spreading	4	Pigmented	Thin	Long	Small, round, pigmented	No
440012	4	90	4	semi-comp	4	No	Thick	Short	Medium round pointed	Yes
440014	3	75	3	Spreading	4	No	Thin	Medium	Small, pointed pigmented	Yes
440015	4	95	4	Semi-compact	5	Pigmented	Medium	Short	Small, Serrated Pigmented	Yes
440020	4	80	4	Semi-compact	4	Node Pigmented	Thick	Short	Small pointed, pigmented	Yes
440021	4	80	5	Semi-compact	5	No	Medium	Medium	Small round pointed	Yes
440047	5	95	4	Spreading	4	No	Thin	Long	Small pointed pigmented	No
440099	5	80	4	Spreading	5	Pigmented	Thin	Long	Medium round pointed	Yes
440112	5	95	5	Semi-compact	4	Pigmented	Thick	Long	Large round pointed	No
440135	5	90	5	Semi-compact	4	Pigmented	Thick	Short	Large round pointed green	No
440185	4	85	5	Spreading	5	Pigmented	Medium	Medium	Medium round pigmented	No
440267	3	60	3	Spreading	5	Pigmented	Medium	Medium	Medium round pointed pigmented	No
440287	4	90	4	Spreading	3	Pigmented	Thin	Long	Small oval, pointed	No
440328	3	50	3	Semi-compact	4	No	Medium	Short	Medium round pointed	No
440513	5	95	5	Spreading	5	No	Medium	Medium	Large round oval	No
441538	4	65	3	Spreading	5	Node Pigmented	Thin	Long	Small pointed pigmented	No
441624	4	80	4	Spreading	5	No	Medium	Medium	Large pointed pigmented	No
Dhankuta-1	4	85	4	Spreading	3	Pigmented	Medium	Medium	Serrated, pointed	No
Dhankuta-2	4	50	4	Elliptical	4	Pigmented	Thin	Medium	Serrated, pointed	No
Sunsari-1	3	50	3	Semi-compact	3	Pigmented	Medium	Medium	Serrated, pointed	No
Japanese Red	5	90	4	Spreading	5	Pigmented	Thick	Medium	Medium round	Yes

Plant uniformity (1-5): 1= very poor, 5= very good; Plant vigor (1-5): 1= very poor, 5= very good vigor,; Vine growth rate (1-5): 1= very poor, 5= very good growth.

Table 10.6. Yield and tuber characteristics of sweet potato clones under Initial Evaluation Trial (IET) at ARS (Hort.) Pokhara, 2009/10

Clones	Tuber character			Flesh color	Tuber uniformity	Tuber yield Wt./pt (gm)	Remarks (Raw taste)
	Skin color	Shape	Size				
400039	Light red	Irregular	Large	Light orange	4	636	Sweet
400917	Light yellow	Long	Medium	Light orange	1	228	Light sweet
440001	Dark red	M. long	Medium	Orange	4	160	Sweet
440007	Red	Long	Medium	Light red	4	194	Sweet
440008	Red	Long	Medium	Orange	4	160	Sweet
440012	Dark orange	Round	Medium	Orange	5	158	Light sweet
440014	Dark yellow	M. long	Medium	Light orange	3	168	Very sweet
440015	Light red	Long	Large	Orange yellow	5	305	Very sweet
440020	Light red	M. long	Medium	Orange	3	145	Light sweet
440021	Purple	Round	Large	Dark orange	5	265	Very sweet
440047	Red	Long	Small	Light orange	4	115	Light sweet
440099	Red	M long	Medium	Light red	3	165	Sweet
440112	Yellow	Round	Large	Light orange	4	236	Sweet
440135	Orange	Long	Medium	Orange	3	180	Light sweet
440185	Light yellow	Long	M. small	Light orange	4	125	Light sweet
440267	Light red	Long	Medium	Dark orange	4	195	Sweet
440287	Red	M. long	Medium	Orange	3	120	Light sweet
440328	Light orange	Long	M. small	Orange	4	225	Sweet
440513	Dark red	Narrow long	Medium	Orange	4	198	Sweet
441538	Red	Long	Medium	Orange	4	165	Light sweet
441624	Orange	M. long	Large	Orange	5	228	Sweet
Japanese red	Purple	Long	M. large	Light yellow	5	198	Light sweet
Dhankuta 1	Light purple	Long	Small	White	3	115	Sweet
Dhankuta 2	Light purple	M. long	Medium	White	4	125	Light sweet
Sunsari 1	Light purple	Long	Medium	White	4	115	Light sweet

Skin color (orange, light yellow, yellow), Shape (long, round, medium long, oval)
Flesh color (orange, light orange, yellow), Size (small, medium, large),
Tuber uniformity (1-5) (1= poor, 5= very poor)

11.0 PUBLICATION AND PRESENTATION

11.1 PUBLICATIONS

Ahamad, S., B.B. Khatri and D.K. Chaudhary, 2011. Evaluation of potato (*S. tuberosum* L.) genotypes for mid and far-western Terai of Nepal, *In* Proceedings of The National Potato Working Group (NPWG) Workshop, April 4-5, 2011. Nepal Agricultural Research Council, National Potato Research Programme, Khumaltar, Lalitpur, Nepal.

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11.2 BOOK/FOLDERS/BOOKLETS

Books

Dhital, Shambhu and Lim Haktae. 2010. Virus Elimination and Seed Production of Potato (Solanum tuberosum L.). LAP LAMBERT Publishing Academic GmbH & Co. Germany.

Folders

- राष्ट्रिय आलुवाली अनुसन्धान कार्यक्रम: एक संक्षिप्त परिचय
- National Potato Research Programme: A brief introduction
- आलुको डढुवारोग व्यवस्थापन प्रविधि
- आलु उत्पादन प्रविधि
- शखरखण्ड उत्पादन प्रविधि
- वियाँबाट आलु उत्पादन प्रविधि

Booklets

- प्राङ्गारिक आलुखेती प्रविधि
- तन्तु प्रजनन् प्रविधिबाट पूर्व मूल बीउ आलु उत्पादन प्रविधि
- आलुबालीमा एकिकृत झार व्यवस्थापन
- आलु उत्पादन तथा उत्पादनोपरान्त वार्षिक कार्यतालिका

11.3 WORKSHOP/TRAINING

Workshop

A two days National Potato Working Group Workshop (NPWGM) was organized during 21-22 Chaitra, 2067 (April 4-5, 2011). Scientists and technicians involved in potato research and development from RARS/ ARS, potato seed producing farmers, representatives from potato processing industries and Senior Potato Development Officers from NPDP/DOA were actively participated in the workshop.

- Research results were presented by respective scientists working in different disciplines of potato research.
- Feed backs regarding with potato production and processing collected from stakeholders and discussed for finding practical solutions.
- Farmers problems regarding potato cultivation listed, categorized and prioritized for researchable and development issues.
- Recommendation was made to incorporate farmers' problems in the NARC research project for FY 2068/69.
- National potato working group workshop proceedings of FY 2066/67 and of this FY 2067/68 were published.
- Potato R&D linkages strengthened

Training

Four days training on potato research and development was organized for research and extension collaborators (Officers/ Scientist level, working in RARS and ARS of NARC and seed production farms of DOA. Travel cost of extension participants was beard by their own concern office. There were 19 participants working in different disciplines in Horticulture Farms. Training was held during 13-16 Baisakh 2068. Pre and post training test was taken for training impact assessment. Training was found fruitful as the trainees feed back to the organization. Certificates were distributed by chief guest the then ED, NARC, Dr. Bhartendu Mishra.

Topics covered in the training:

- Techniques and methodologies in variety improvement
- Weed management on potato
- Organic potato production
- TPS technology an option of potato production
- Potato disease management
- Insect pest management on potato
- PBS production technology
- Seed plot techniques for potato seed production at farmers level
- Potato seed certification scheme proposal: An interaction
- Soil fertility management for sustainable potato production
- Experimental designs and statistical procedures: An introduction.

Appendix I. List of *in vitro* potato germplasms maintained in NPRP, 2010/11

S.N.	CIP Number	*Code*	Clones	Received Date	Source
1	-	-	BSU-PO_3	1997	BSU, Phillipines
2	-	063-1	Dasom Valley	2006	KNU†, Korea
3	-	063-3	Golden Valley	2006	KNU, Korea
4	-	063-5	Juicy Valley	2006	KNU, Korea
5	388578.2D	-	-	-	-
6	381379.9LB	-	-	-	-
7	388580.6D	-	-	-	-
8	-	-	Lumle Red	-	-
9	388572.1	062-1	**Khumal Laxmi**	-	Cleaned in NPRP
10	388572.4	062-2	**IPY-8**	-	Cleaned in NPRP
11	-	063-7	Winter Valley	-	-
12	800258	-	**Kufri Jyoti**	1989 Aug.	CIP, Peru
13	800265	-	**Kufri Sindhuri**	1990/3/28	CIP, Peru
14	381065.5	-	BW – 9	1992/4/28	CIP, Peru
15	380013.12	-	Andinita	1995/10/31	CIP, Peru
16	800982	-	RW 8201.19	1995/10/31	CIP, Peru
17	800947	-	AL – 575	1998/12/2	CIP, Peru
18	720123	-	**Janak Dev**	1998/12/2	CIP, Peru
19	676008	-	**Khumal Rato -2**	1998/12/2	CIP, Peru
20	720088	-	**Khumal Seto-1**	1998/12/2	CIP, Peru
21	84007.67	-	TPS - 67	2000/5/9	CIP, Peru
22	385524.9	058-1		2001 April	CIP, Peru
23	720110	061-13	Baronesa	2004/10/27	CIP, Peru
24	800926.1	061-20	MS 35.22R	2004/10/27	CIP, Peru
25	800934	061-21	MS 35.9	2004/10/27	CIP, Peru
26	800048	061-4	**Desiree**	2004/10/27	CIP, Peru
27	-	061-22	**Cardinal**	2004/11/26	SASA, UK
28	800928	061-11	MS 42.3	2004/9/20	CIP, Peru
29	370116	064-1	MF-I	Oct. 30, 2007	CIP, Peru
30	370120	064-2	MF-II	Oct. 30, 2007	CIP, Peru
31	370123	064-3	TPS-13	Oct. 30, 2007	CIP, Peru
32	374080.5	064-4	Perricholi	Oct. 30, 2007	CIP, Peru
33	377957.5	064-5	Meva	Oct. 30, 2007	CIP, Peru
34	378711.5	064-6	Muziranzara	Oct. 30, 2007	CIP, Peru
35	380606.6	064-7	Enfula	Oct. 30, 2007	CIP, Peru
36	381379.9	064-8	Kisoro	Oct. 30, 2007	CIP, Peru
37	381406.6	064-11	Tubira	Oct. 30, 2007	CIP, Peru
38	384866.5	064-13	Amarilis - INIA	Oct. 30, 2007	CIP, Peru
39	390663.8	064-16	-	Oct. 30, 2007	CIP, Peru
40	391004.18	064-17	B3C1	Oct. 30, 2007	CIP, Peru
41	393248.55	064-19	B3C1	Oct. 30, 2007	CIP, Peru
42	394034.65	064-20	-	Oct. 30, 2007	CIP, Peru
43	394611.112	064-21	-	Oct. 30, 2007	CIP, Peru
44	395195.7	064-24	-	Oct. 30, 2007	CIP, Peru
45	396286.6	064-25	-	Oct. 30, 2007	CIP, Peru
46	396311.1	064-26	-	Oct. 30, 2007	CIP, Peru
47	397012.22	064-27	-	Oct. 30, 2007	CIP, Peru
48	397073.15	064-29	-	Oct. 30, 2007	CIP, Peru
49	397077.16	064-30	-	Oct. 30, 2007	CIP, Peru
50	399101.1	064-31	-	Oct. 30, 2007	CIP, Peru

†Kangwon National University, Korea.
Bold cultivars are recommended for commercial cultivation.

Appendix I. Cont...

S.N.	CIP Number	Code	Clones	Received Date	Source
51	575015	064-32	I-1124	Oct. 30, 2007	India
52	390478.9	066-1		Feb. 6, 2010	CIP, Peru
53	391085.175	066-2		Feb. 6, 2010	CIP, Peru
54	392740.4	066-3		Feb. 6, 2010	CIP, Peru
55	392820.1	066-4		Feb. 6, 2010	CIP, Peru
56	393073.179	066-5		Feb. 6, 2010	CIP, Peru
57	393083.2	066-6		Feb. 6, 2010	CIP, Peru
58	393382.44	066-7		Feb. 6, 2010	CIP, Peru
59	393536.13	066-8		Feb. 6, 2010	CIP, Peru
60	393614.3	066-9		Feb. 6, 2010	CIP, Peru
61	393617.1	066-10		Feb. 6, 2010	CIP, Peru
62	394611.112	066-11		Feb. 6, 2010	CIP, Peru
63	394613.139	066-12		Feb. 6, 2010	CIP, Peru
64	395017.229	066-13		Feb. 6, 2010	CIP, Peru
65	395017.242	066-14		Feb. 6, 2010	CIP, Peru
66	395112.32	066-15		Feb. 6, 2010	CIP, Peru
67	397060.19	066-16		Feb. 6, 2010	CIP, Peru
68	399004.19	066-17		Feb. 6, 2010	CIP, Peru
69	399067.22	066-18		Feb. 6, 2010	CIP, Peru
70	399078.11	066-19		Feb. 6, 2010	CIP, Peru
71	399079.22	066-20		Feb. 6, 2010	CIP, Peru
72	399092.116	066-21		Feb 6, 2010	CIP, Peru
73	370121	067-1		Aug 12, 2010	CIP, Peru
74	370122	067-2		Aug 12, 2010	CIP, Peru
75	380389.1	067-3		Aug 12, 2010	CIP, Peru
76	381406.6	067-4		Aug 12, 2010	CIP, Peru
77	387233.24	067-5		Aug 12, 2010	CIP, Peru
78	391011.17	067-6		Aug 12, 2010	CIP, Peru
79	393280.64	067-7		Aug 12, 2010	CIP, Peru
80	394034.65	067-8		Aug 12, 2010	CIP, Peru
81	396018.241	067-9		Aug 12, 2010	CIP, Peru
82	396029.250	067-10		Aug 12, 2010	CIP, Peru
83	399002.38	067-11		Aug 12, 2010	CIP, Peru
84	399002.52	067-12		Aug 12, 2010	CIP, Peru
85	399054.16	067-13		Aug 12, 2010	CIP, Peru
86	399062.115	067-14		Aug 12, 2010	CIP, Peru
87	399072.11	067-15		Aug 12, 2010	CIP, Peru
88	399072.2	067-16		Aug 12, 2010	CIP, Peru
89	399072.21	067-17		Aug 12, 2010	CIP, Peru
90	399075.7	067-18		Aug 12, 2010	CIP, Peru
91	902007	067-19		Aug 12, 2010	CIP, Peru
92	902014	067-20		Aug 12, 2010	CIP, Peru
93	903027	067-21		Aug 12, 2010	CIP, Peru
94	903035	067-22		Aug 12, 2010	CIP, Peru
95	903051	067-23		Aug 12, 2010	CIP, Peru
96	903135	067-24		Aug 12, 2010	CIP, Peru
97	988141	067-25		Aug 12, 2010	CIP, Peru
98	988143	067-26		Aug 12, 2010	CIP, Peru
99	994013	067-27		Aug 12, 2010	CIP, Peru
100	994014	067-28		Aug 12, 2010	CIP, Peru

Appendix II. List of *in vitro* and *in vivo* sweet potato germplasms maintained in NPRP, 2010/11

S.N.	CIP Number	Code	Variety	Origin	Received Date	Source
1	400039	SP 066-1	10-C-1	DOM	Feb. 6, 2010	CIP, Peru
2	400917	SP 066-2	Comal	ECU	Feb. 6, 2010	CIP, Peru
3	440001	SP 066-3	Resisto	USA	Feb. 6, 2010	CIP, Peru
4	440007	SP 066-4	W-208	USA	Feb. 6, 2010	CIP, Peru
5	440008	SP 066-5	W-213	USA	Feb. 6, 2010	CIP, Peru
6	440012	SP 066-6	W-217	USA	Feb. 6, 2010	CIP, Peru
7	440014	SP 066-7	W-219	USA	Feb. 6, 2010	CIP, Peru
8	440015	SP 066-8	W-220	USA	Feb. 6, 2010	CIP, Peru
9	440020	SP 066-9	W-225	USA	Feb. 6, 2010	CIP, Peru
10	440021	SP 066-10	W-226	USA	Feb. 6, 2010	CIP, Peru
11	440047	SP 066-11	Bugsbunny	PRI	Feb. 6, 2010	CIP, Peru
12	440099	SP 066-12	TIS 9101	NGA	Feb. 6, 2010	CIP, Peru
13	440112	SP 066-13	Centennial	USA	Feb. 6, 2010	CIP, Peru
14	440135	SP 066-14	Travis	USA	Feb. 6, 2010	CIP, Peru
15	440185	SP 066-15	L 0-323	USA	Feb. 6, 2010	CIP, Peru
16	440267	SP 066-16	Hung Loc 4	VNM	Feb. 6, 2010	CIP, Peru
17	440287	SP 066-17	VSP 3	PHL	Feb. 6, 2010	CIP, Peru
18	440328	SP 066-18	AVRDC-CN 1840-284	TWN	Feb. 6, 2010	CIP, Peru
19	440513	SP 066-19	Koganesengan	JPN	Feb. 6, 2010	CIP, Peru
20	441538	SP 066-20	Tenian	USA	Feb. 6, 2010	CIP, Peru
21	441624	SP 066-21	L 4-13	USA	Feb. 6, 2010	CIP, Peru
22	Japanese Red	SP 066-22	-	JPN	2010	HRD, Nepal
23	Dhankuta-1	SP 066-23	-	Dhankuta	2010	NPRP, Nepal
24	Dhankuta-2	SP 066-24	-	Dhankuta	2010	NPRP, Nepal
25	Sunsari-1	SP 066-25	-	Sunsari	2010	NPRP, Nepal

Appendix III. Revenue Collection in F.Y. 2010/11

S.N.	Sources of Revenue	Rs.
A.	RESEARCH	
	1. Seed Potato	38,464.00
B.	PRODUCTION	
	1. Pre basic potato seed (PBS)	220,552.26
	2. Basic potato Seed	69,956.79
	3. Foundation and certified rice seed	45,360.00
	4. Ware Potato and mixed rice	10,560.80
	Subtotal	346,429.85
C.	Others	
	1. Last year credit	39,904.00
	2. Admin. income	45,400.00
	3. Others	-
	Subtotal	85,304.00
	Total	470,197.85

Appendix IV. Annual Budget Allocation and Expenditure, 20010/11

Code Account Budget Heads	Budgets approved	Budget Received	Budget Expenditure	Balance
40 JK STAFF EXPENSES	**6,413,000.00**	**6,477,900.00**	**6,188,763.39**	**289,136.61**
4000 Staff Salary	4,847,000.00	4,847,000.00	4,663,619.33	183,380.67
4010 Staff Allowance	389,000.00	397,200.00	397,200.00	0.00
4020 Provident Fund	485,000.00	485,000.00	466,361.73	18,638.27
4030 Medical Fund	-	-	-	0.00
4040 Uniform Expenses	20,000.00	202,500.00	202,500.00	0.00
4050 Dashain Expenses	607,000.00	480,106.67	392,989.00	87,117.67
4060 Overtime Expenses	-	-	-	0.00
4080 Insurance	65,000.00	66,093.33	66,093.33	0.00
41JK OPRER. EXPENSES	**5,715,000.00**	**5,598,000.00**	**5,533,616.34**	**64,383.66**
4100 Travel Expenses	685,000.00	631,000.00	615,497.50	15,502.50
4110 Vehicle Fuel	325,000.00	325,000.00	314,562.21	10,437.79
4120 Wages	1,430,000.00	1,218,000.00	1,193,305.00	24,695.00
4130 Lab Supplies	380,000.00	380,000.00	368,086.75	11,913.25
4140 Farm Supplies	760,000.00	813,000.00	812,522.60	477.40
4150 Book & Journals	250,000.00	271,500.00	271,142.50	357.50
4160 Training/Seminar	305,000.00	325,500.00	325,123.00	377.00
4170 Contract Res. Expenses	-	-	-	-
4180 Farm Repair	1,580,000.00	1,634,000.00	1,633,376.78	623.22
42 JK ADMIN. EXPENSES	**2,215,000.00**	**2,332,000.00**	**2,178,613.86**	**153,386.14**
4200 Rent, Utilities	650,000.00	650,000.00	579,822.90	70,177.10
4210 Commun. Expenses	125,000.00	117,000.00	54,198.98	62,801.02
4220 Repair/ Maintenance	1,320,000.00	1,439,500.00	1,439,112.98	387.02
4230 Stationary & Printing	60,000.00	65,500.00	63,306.50	2,193.50
4240 Board & Panel Meeting	-	-	-	-
4250 Recruitment Expenses	-	-	-	-
4260 Contingency Expenses	60,000.00	60,000.00	42,172.50	17,827.50
43 JK CAPITAL EXPENSES	**4,000,000.00**	**4,000,000.00**	**3,982,282.96**	**17,717.04**
4300 Freehold Land Cost	3,000,000.00	3,000,000.00	2,991,276.36	8,723.64
4310 Land & Land Dev. Cos	100,000.00	100,000.00	98,583.00	1,417.00
4320 Building & Other Cost	700,000.00	700,000.00	692,985.10	7,014.90
4330 Furniture & Fixture	100,000.00	100,000.00	100,000.00	0.00
4340 Machinery & Equip.	100,000.00	100,000.00	99,438.50	561.50
4350 Vehicles Cost	-	-	-	-
4360 Computer & Accessory	-	-	-	-
4370 Other Fixed Assets	-	-	-	-
Grand Total	**18,343,000.00**	**18,407,900.00**	**17,883,276.55**	**524,623.45**

Appendix V. Existing Manpower Situation in NPRP, Khumaltar, 2009/10

S.N.	Designation	Level	Name	Qualification	Remarks
1.	Senior Scientist	S-4	Mr. Buddhi Prakash Sharma	M.Sc.Ag. (Pathology)	Co-ordinator
2.	Senior Scientist	S-4	Mr. Janardan Ghimire	M.Sc.Ag. (Veg. Crops)	
3.	Senior Scientist	S-4	Mr. Ishwori Prasad Gautam	M.Sc.Ag. (Horticulture)	
4.	Senior Scientist	S-4	Mr. Ram Chandra Adhikari	M.Sc.Ag. (Horticulture)	On study leave
5.	Senior Scientist	S-4	Dr. Shambhu Prasad Dhital	Ph.D. (Horticulture)	Deputation from RARS, Lumle
6.	Senior Scientist	S-4	Mr. Binesh Man Sakha	M.Sc.Ag. (Veg. Crops)	On study leave
7.	Senior Scientist	S-4	Dr. Bhim Bahadur Khatri	Ph. D. (Horticulture)	
8.	Scientist	S-1	Mr. Binod Prasad Luintel	M.Sc.Ag. (Horticulture)	On study leave
9.	Technical Officer	T-6	Mr. Ram Bharosh Nepal	SLC	
10.	Technical Officer	T-6	Mr. Kalika Prasad Upadhyay	M.Sc.Ag. (Horticulture)	
11.	Technical Officer	T-6	Mr. Prakash Bhattarai	B.Sc.Ag.	On deputation from RARS, Tarahara (Study leave)
12.	Technical Officer	T-6	Mr. Hari Bdr. KC	SLC	On deputation from Entomology Div.
13.	Technical Officer	T-6	Mr. Krishna Chandra Upreti	SLC	On deputation from ARS, Pakhribas
14.	Technical Officer	T-6	Mr. Duryodhan Chaudhary	I.Sc.Ag.	On deputation from ABD, Khumaltar
15.	Admin. Officer	A-6	Mr. Sitaram Ojha	B.A.	
16.	Accountant	A-5	Mrs. Sumanna Shrestha	B.Com.	
17.	Technician	T-5	Mrs. Niru Tripathi	B.Sc.Ag	Till 2067/11/14
18.	Typist	A-5	Mrs. Anjali Bajracharya	B.Com.	On deputation from RARS, Tarahara
19.	Technician	T-5	Mr. Sanubhai Knuwar	Test Pass	
20.	Technical Helper	TH-3	Mrs. Bhawani Thapaliya	I.A.	
21.	Technical Helper	TH-3	Mr. Ramesh C. Khatiwada	7 Class	
22.	Technical Helper	TH-3	Mr. Yadav Kumar Shrestha	I.A.	
23.	Technical Helper	TH-3	Mr. Tej Prasad Ghimire	S.L.C.	
24.	Technical Helper	TH-3	Mr. Pancha Maharjan	8 Class	
25.	Technical Helper	TH-3	Mrs. Sharda Thapamagar	7 Class	
26.	Admin Helper	AH-3	Mr. Shiva Bahadur Sapkota	Literate	
27.	Admin Helper	AH-3	Mr. Bidur Pokharel	Literate	
28.	Admin Helper	AH-3	Mr. Shyam Bahadur Bhlon	I.A.	

Appendix VI. Log Frame of National Potato Research Programme, Khumaltar, 20010/11

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS (OVI)	MEANS OF VERIFICATION (MOV)	IMPORTANT ASSUMPTIONS
GOAL: To improve the food security and livelihoods of Nepalese farmers	• Health and living standard upgraded and measured	Economic status report	Government realizes important role in food security
PURPOSE: To increase the productivity of potato and sweet potato and farmers income	• Productivity increased by 25% with the adoption of ICM by the end of 2015	Agriculture statistics report from MoAC	All the stake holders of potato production jointly work
OUTPUTS: 1. High yielding and economically important diseases and insect pest resistant potato and sweet potato varieties developed for major agro climatic conditions. 2. Losses caused by diseases and insect pest minimized. 3. Package of practices for higher yield, safe storage & processing technology developed for potato and sweet potato. 4. Appropriate seed production technology developed and high quality potato seed produced. 5. NPRP efficiently managed, National and International linkages strengthened for potato R & D.	1. At least two late blight resistant varieties and two TPS families and one OPSP variety released for commercial production by the end of 2015. 2. Low cost and environment friendly management technology developed for economically important diseases, weeds and insect pests of potato by the end 2015 3. Package of practices developed for conventional and TPS potato production and post harvest losses minimized by 15 percent. 4. Low cost PBS production technology developed and hand over to private sector to fulfill the demand of high quality seeds by 2015. 5. Programme implemented to achieve the expected out puts by strengthening national and international linkages	1. Report of variety release committee 2. PRP Annual reports/ Project completion report 3. PRP Annual reports/ Project completion report 4. PRP Annual reports/ Project completion report 5. Germplasms and Scientist visit exchanged	• Resource allocation for potato research improved as per it's importance to address the food security • Climatic and edaphic factors remain congenial.

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ACTIVITIES:

1.1 Variety improvement on potato for higher tuber yield
1.2 Sweet potato variety development for food and nutrition security
1.3 Evaluation of TPS families in the nursery beds and field conditions
1.4 Preliminary screening of stress resistant potato clones

2.1 Studies on economically important potato diseases (late blight, scab, wart, viruses and bacterial wilt)
2.2 Studies on economically important insect pests (PTM, leaf minor fly, white grub and red ants)

3.1 Weed management study in potato
3.2 Evaluation of organic potato production practices in the hills
3.3 Soil fertility management
3.4 Studies on minimization of post harvest losses and value addition
3.5 Development of appropriate package of practices for potato and sweet potato as per climatic conditions

4.1 Sustainability studies for pre-basic seed production
4.2 Pre basic and source seed production on potato

5.1 Organize national potato working group meetings
5.2 Publication of research findings (Annual reports, booklets, leaflets)
5.3 Technology dissemination through radio, TV and print media
5.4 Coordinate National and International collaborative research projects

Budget Expenses (Budget for year 2067/68)

Budget Heads		Rs.
4000	Staff expenses	6,413,000
4100	Operational Expenses	5,715,000
4200	Admin Cost	2,215,000
4300	Capital Item cost	4,000,000
Total Rs.		18,343,000

Project wise budget for 2067/68

Project #		Rs. '000
40467002	Genetic diversity of *P. infestans*	200.0
40467001	Coping with climate change	145.0
40466001	Sweet potato variety develop.	185.0
40465002	Weed mgnt. study on potato	155.0
40465001	Evaluation of organic potato	140.0
40463001	Variety imp. for processing	150.0
40457003	Variety improvement	520.0
40457002	Sustain. studies on PBS prod.	200.0
40455002	PBS & source.seed prod.	840.0
40454002	TPS evaluation	235.0
40400001	FMP	2,945.0
Total Operational		**5,715.0**

Project monitoring and evaluation report

Project leader get empowered to perform their research projects effectively.