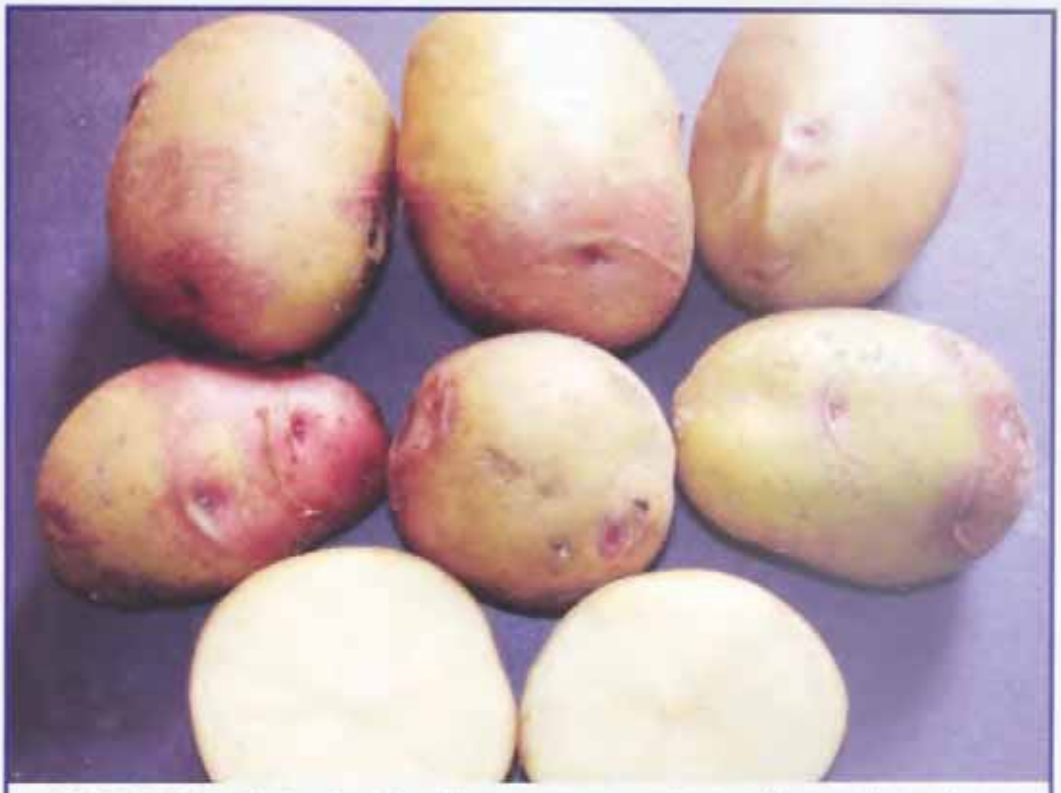
Annual Report

2068/69 (2011/12)

Nepal Agricultural Research Council
National Potato Research Programme
Khumaltar, Lalitpur, Nepal

2012



CIP 389746.2: A pipeline potato clone for releasing

L 235-4: A pipeline potato clone for releasing

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National Potato Research Program (NPRP)

Nepal Agricultural Research Council (NARC)

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Citation:

NPRP, 2012. Annual Report 2068/69 (2011/12). National Potato Research Program, NARC, Khumaltar, Lalitpur, Nepal.

Cover Page Photo:

Top left to right: Promisnig LB resistant potato clones PRP 85861.12 and PRP 266264.01.

Bottom left to tight: Endogenous potato clone Tharu Local and exogenous LB resistant promising potato clone LBr 40.

FOREWORD

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

NPRP is thankful to the CIP, Lima, Peru and its Regional Office New Delhi, India 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, 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

ABBREVIATIONS

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 Program
NPRP	National Potato Research Program
NS	Non-significant
OFSP	Orange fleshed sweet potato
PACT	Project Agriculture Commercialization and Trade
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

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१.१ आलुको जातिय उत्थान अध्ययन परिक्षण

- आ. व. २०६८।६९ मा पनि आलुका नयाँ तथा पुराना महत्वपूर्ण जातहरु संकलन, संरक्षण र बृद्धिकार्य राष्ट्रिय आलुवाली अनुसन्धान कार्यक्रम खुमलटारको हात्तिवन अनुसन्धान फार्ममा र कृषि अनुसन्धान केन्द्र (वागवानी), मालेपाटन, काश्कीमा निरन्तरता दिइयो । यस्तै जातिय अनुसन्धान परिक्षण अन्तर्गत प्रारम्भिक मुल्याङ्कन परिक्षण (IET), समन्वयात्मक जातिय परिक्षण र कृषकको खेतबारीमा जातिय परिक्षणहरु पनि कृषि अनुसन्धान केन्द्र (वागवानी) जुम्ला, कृषि अनुसन्धान केन्द्र (वागवानी) मालेमाटन पोखरा, कृषि अनुसन्धान केन्द्र डोटी, क्षेत्रिय कृषि अनुसन्धान केन्द, खजुरा, बाँके, क्षेत्रिय कृषि अनुसन्धान केन्द्र, तरहरा सुनसरी, कृषि अनुसन्धान केन्द्र, पाखिवास धनकुटा र राष्ट्रिय आलुवाली अनुसन्धान कार्यक्रम, खुमलटारमा सम्पन्न गरियो ।
- आर्थिक वर्षको नतिजालाई संश्लेषित गर्दा PRP 25861.1, CIP 385499.11 र PRP 25861.11 जातहरु पहाडमा, PRP 85861.11 र CIP 393385.39 जातहरु पहाड र तराई दुवै क्षेत्रमा डढुवा रोग सहन सक्ने, कृषकलाई मन पर्ने र उत्पादन पनि बढि दिने पाइयो । प्राप्त नतिजाका आधारमा उक्त आलुका जातहरुलाई आवश्यक औपचारिकता पुऱ्याई जातिय उन्मोचन प्रकृयामा लैजान पर्ने देखिन्छ ।

१.२ टि.पि.एस. जातीय अध्ययन परिक्षण

- आ.व. २०६८।६९ मा नर्सरी ब्याडमा सिडलिङ्ग ट्युबर उत्पादनको लागि गरिएको टि.पि.एस. परिवारको मुल्याङ्कन परिक्षणको नतिजा अनुसार खुमलटारमा टि.पि.एस. परिवारहरु C96H-02.4 x C98HT64.8 र TPS-7 x TPS-67 ले सबभन्दा बढी आलु उत्पादन क्रमशः ८.३७ र ८.१३ के.जी. प्रति वर्ग मिटरमा दिएको पाइयो । त्यस्तै नेपालगञ्ज र जुम्लामा गरिएको परिक्षणहरुमा क्रमशः HPS 7/67 र ९९४०१३ ले सबभन्दा बढी क्रमशः १.७९ के.जी. र ४.६९ के.जी. प्रति वर्ग मिटरमा उत्पादन दिएको पाइयो ।
- आ.व. २०६८।६९ मा नै गरिएको टि.पि.एस. परिवारको पहिलो पुस्ताहरुको मुल्याङ्कन परिक्षणको आँकडा अनुसार चेक जात कुफ्रि ज्योतिले खुमलटारमा सबभन्दा बढी आलुदाना (५२६) र बढी उत्पादन (२६.८३ के.जी.) प्रति ७.२ वर्ग मिटरमा दिएको पाइयो । त्यस्तै नेपालगञ्जमा गरिएको परिक्षण अनुसार टि.पि.एस. परिवार C96H-02.4 x C99HT2-32.17 ले सबभन्दा बढी आलु उत्पादन (१५.५० के.जी./७.२

वर्ग मिटर) गरेको पाइयो । जुम्लामा ९०३०२७ जातले सबभन्दा बढी उत्पादन (१६.३५ के.जी./७.२ वर्ग मिटर) र ९०३१३५ जातले सबभन्दा कम (९.६६ के.जी./७.२ वर्ग मिटर) आलु उत्पादन गरेको पाइयो ।

१.३ प्रशोधनको लागि आलुको जातिय अध्ययन परिक्षण

- मध्य पहाडको खुमलटार जस्तो हावापानीमा मुख्य मौसममा आलु लगाउँदा उत्पादन तथा आलु चिप्स बनाउको लागि एल-२३५.४, पि.आर.पी २५८६१.१, यागाना, वि.एस. यू. पि.ओ.-३ र खुमल सेतो-१ जातहरु राम्रा देखिएका छन् । तर यी जातहरु मध्ये पि.आर.पी. २५८६१.१ र वि.एस. यू. पि.ओ.-३ लामो समय सम्म भण्डारण गर्न कठिन पर्ने भएकोले बढी उत्पादन दिएतापनि खनेको दुई महिना भित्र चिप्स बनाउन पर्ने देखियो ।
- पि.आर.पि. २५८६१.१ जातमा बढी सुख्खा पदार्थ (१९.२%) भएता पनि यो जात २५.८±१.२° से र ८६.१% सापेक्षिक आर्द्रता भएको अध्यारो कोठामा भण्डारण गर्दा ४५ दिनमानै ५० प्रतिशत भन्दा बढी आलु टुसाउने हुँदा लामो समयसम्म भण्डारण गर्न नसकिने देखियो ।
- आलुका जातहरु कुफ्रीज्योति, यागाना र एल. २३५.४ माथि उल्लेखित तापक्रममा १२० दिनसम्म भण्डारण गर्दा पनि १०% भन्दा कम क्षति भएकोले लामो समयसम्म भण्डारण गर्न सकिने पाइयो ।
- विभिन्न मात्रामा नाइट्रोजन र पोटास मल प्रयोग गरि उत्पादन गरिएका आलु साधारण कोठामा भण्डारण गर्दा भण्डारमा खासै अन्तर पाइएन । तर १५० के.जी. नाइट्रोजन र ६० के.जी. पोटास प्रति हेक्टर राख्दा बढी उत्पादन र ९० दिनमा उम्रेका टुसाको तौल (५.३१ ग्राम/के.जी दानामा) कम र ५० के.जी नाइट्रोजन र ३० के.जी पोटास/हे. मा टुसाको तौल (८.६९ ग्राम/के.जी दाना) सबभन्दा बढी पाइयो ।
- मध्य पहाडको काठमाडौं र उच्च पहाडको दामनमा आलुलाई भण्डारण गर्नुपहिले र भण्डारण गरेको ४५ दिनमा सि.आई.पि.सी. (उर्जा) भन्ने औषधि ६० मि.ली १ लिटर डाइथेनोलमा मिसाई प्रति टन आलुमा उपचार गर्दा १२० दिन सम्म आलुमा टुसा रोक्ने र कम तौल ह्रास हुने पाईयो ।

१.४ बीउ आलु अध्ययन परिक्षण

- 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 ।
- पूर्व-मूल बीउ आलु (PBS) उत्पादनमा रोप्ने दुरी सम्बन्धमा दुरी बढि भएका बिरुवा अग्लो हुने, प्रति बोटमा मूल डाँठको संख्या 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 उत्पादन बढि हुने देखियो भने सानो बीउ रोप्नाले त्यसको विपरित परिणाम देखापर्‍यो ।
- हाइड्रोपोनिक प्रविधिद्वारा आलुको पूर्व-मूल बीउ उत्पादन गर्ने कार्यक्रम यो पहिलो वर्ष भएको खासै त्यति उत्साहजनक नभए तापनि नतिजा राम्रै रहेकाले अर्को एक दुई वर्ष कार्यक्रम पुनः गर्नु पर्ने आवश्यक देखिन्छ ।
- कृषकको खेतमा बेसिक बीउ आलु र कृषकको आफ्नै बीउ आलु रोपी उत्पादनमा तुलना गर्दा यदि कृषकसंग भएको बीउ पनि राम्रै भएमा उत्पादनमा खासै फरक नरहेको पाइयो ।

१.५ आलुबालीमा लाग्ने डढुवारोग सम्बन्धि अध्ययन परिक्षण

- डढुवा रोग अवरोधी जात छनोट परिक्षणमा समाबिष्ट ४८ वटा आलुका जातहरु मध्ये ११ वटा जातहरु पि.आर.पि. २२६२६५.१, पि.आर.पि. २२६२६७.११, सि.आइ.पि. ३९५०१७.२४२, पि.आर.पि. २६६२६५.१५, पि.आर.पि. १४६२६७.८, सि.आइ.पि. ३९५११२.३२, पि.आर.पि. ०५६२६७.१, पि.आर.पि. १४६२६७.११, पि.आर.पि. १४६२६७.६, सि.आइ.पि. ३९३६१७.२२९, र सि.आइ.पि. ३९१०५८.१७५ अत्याधिक डढुवा रोग अवरोधी पाइयो । यी जातहरु रोग अवरोधी हुनुको साथै अत्याधिक दाना उत्पादन (२०-३१ टन प्रति हेक्टर) क्षमता भएको पनि पाइयो ।
- तराई, मध्य पहाड तथा उच्च पहाडी क्षेत्रमा परिक्षणमा समाबिष्ट आलुका जातहरुमध्ये कुफ्रि ज्योति र जनकदेवको तुलनामा एल.बि.आर.४० लगायत अन्य जातहरु सि.आइ.पि. ३८४३२१.१५, पि.आर.पि. २६६२६४.०१, र पि.आर.पि. २५८६१.१ डढुवा रोग अवरोधी पाइए ।
- सिफारिसका लागि छनोट भएका जातहरु, एल. २३५.४ र सि.आइ.पि. ३८९७४६.२ ले मध्यम तहको डढुवारोग अवरोधी देखाए, जसलाई सेक्टिन नामक विषादी १.२ कि ग्रा./८०० लि. पानी/छराई/हेक्टरका दरले नौ दिनको अन्तरमा जम्मा चारपटक छर्दा आर्थिक दृष्टिले सबैभन्दा उपयुक्त पाइयो । यसका साथै सि.आइ.पि.

३८९७४६.२ ले कुफ्रि ज्योति, एल. २३५.४ र जनकदेवभन्दा बढि उत्पादकीय क्षमता देखायो ।

- सिन्धुपाल्चोकको निगालेमा ऐंजेरु रोग छनोट परिक्षणमा समाबिष्ट २५ आलुका जातहरु मध्ये १२ वटा जातहरु क्रमशः पि.आर.पि. ३५८६१.२, पि.आर.पि. २२५८६१.२, एल. २३५.४, पि.आर.पि. २७६२६४.०१, पि.आर.पि. २६६२६४.०१, वि.एस.यु.पि.ओ.३, सि.आइ.पि. ३८४३२१.१५, पि.आर.पि. २५८६१.१, सि.आइ.पि. ३९३२८०.५७, पि.आर.पि. २५८६१.११, पि.आर.पि. ८५८६१.११, सि.आइ.पि. ३८५४९९.११ हरु ऐंजेरु रोग अवरोधी पाइए । लोकल जात रोजिटामा सबैभन्दा बढी (७५% सम्म) ऐंजेरु रोगको लक्षण देखियो । उन्मोचन गरिएका जातहरु कुफ्रि ज्योति र जनकदेव भने ऐंजेरु रोगका अवरोधी नै पाइए ।

- चितवनको शारदानगरमा संचालन गरिएको धुले दाद व्यवस्थापन परिक्षणमा ८% ब्लिचिङ्ग पाउडरको घोलमा ३० मिनेट डुबाई बीउ उपचार गरि लगाईएको आलुको दाना र ब्लिचिङ्ग पाउडरको उक्त घोलबाटै माटो उपचार गरिएको प्लटमा सबैभन्दा बढि रोग नियन्त्रण (७८.२%) भएको पाइयो । स्वस्थ बीउ लगाउँदा (७२.८%) र बोरिक एसिड ३% को घोलमा डुबाई लगाउँदा (६९.२%) र यूथेन एम-४५ ८% ले उपचार गरि लगाउँदा (६८.४%) रोग नियन्त्रण भएको पाईयो । धुले दादको जिवाणुबाट संक्रमित भइसकेको माटोमा स्वस्थ आलुबीउ मात्र लगाउँदा रोग पूर्णतया नियन्त्रण हुन नसक्ने पनि देखियो ।

- बिभिन्न हावापानीमा कृषकको सहभागितामा सन्चालित डडुवारोग अवराधी जात छनोट परिक्षणमा संलग्न जातहरुमध्ये दाङ्गमा पि.आर.पि. २६६२६४.०१ बाट सबैभन्दा बढि दाना उत्पादन (४६.६७ टन/हेक्टर) तथा पि.आर.पि. २६६२६४.१५ बाट (४१.६७ टन/हेक्टर) उत्पादन भएको पाईयो । यसका साथै नुवाकोटमा एल.वि.आर.४० बाट (३७.१७ टन/हेक्टर) र सि.आइ.पि. ३८४३२१.१५ बाट (३१.८३ टन/हेक्टर) उत्पादन भएको पाइयो । धनुषामा पि.आर.पि. २६६२६४.१५ बाट १७.९ टन/हेक्टर उत्पादन भएको पाइयो । परवानीपूरमा पि.आर.पि. २५८६१.१ बाट २६.३७ टन/हेक्टर उत्पादन र पि.आर.पि. २६६२६४.०१ बाट २२.६६ टन/हेक्टर उत्पादन भएको पाइयो । यसैगरी दैलेखमा वि.एस.यु.पि.ओ.३ बाट ४७.०५ टन/हेक्टर र पि.आर.पि. २६६२६४.०१ बाट ४४.३३ टन/हेक्टर उत्पादन भएको पाइयो । वर्षौं देखिका स्थानिय आलुका जातहरुको उत्पादकत्व भने उन्नत एवं नयाँ जातहरुको तुलनामा अति नै न्युन (२.८ देखि १३.३ टन/हेक्टर) मात्र भएको पाइयो । यो परिक्षणमा बाली अवधि भर कुनैपनि स्थानमा कुनैपनि विषादी प्रयोग गरिएको थिएन ।

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

- राष्ट्रिय आलुवाली अनुसन्धान कार्यक्रम, खुमलटार ललितपुरमा गरिएको ३३ वटा आलुका जातहरु र असिंचित, छापो हालेको र सिंचित समेतका ३ वटा चिस्यानका अवस्थाहरुमा जातिय छनौट अध्ययन गरिएको थियो । सो अध्ययन परिक्षणमा आलुको उमार, क्षमता, बोटको उच्चाई, बोटको अवस्था, प्रतिबोट डाँठको संख्या, प्रति प्लट दाना उत्पादन र प्रत्येक जातको उत्पादन आदि आँकडा संकलन गरि सो को मुल्याङ्कन गर्दा विभिन्न जातहरुले विभिन्न चिस्यानको अवस्थामा विभिन्न खालको विशेषता प्रदर्शन गरे । कुनै जात जस्तै CIP 391011.47, CIP 391598.75, LB r 40, Ca x LB, 40.6 र NPI-106 ले तिनवटै अवस्थामा राम्रो उत्पादन दिए, तर CIP 394003.161, CIP 392243.17, CIP 391058.35, CIP 392242.25 र खुमल सेतो-१ जस्ता जातहरुको असिंचित प्लटमा राम्रो उत्पादन पाइयो । सिंचित प्लटहरुमा CIP 394003.161, Ca x LBr 40.6, CIP 391011.47 र कुफ्रिज्योति जस्ता जातहरु राम्रा पाइए । LBr-40 नामक जात छापो हालेको प्लटमा सबभन्दा राम्रो पाइयो ।
- यस्तै खालको अर्को एक परिक्षण क्षेत्रिय कृषि अनुसन्धान केन्द्र परावनीपुर, वारामा पनि रोपिएको थियो । उक्त परिक्षणमा कुल ४३ वटा जातहरु लगाइएको थियो । उक्त परिक्षणमा CIP 396011.47, CIP 388746.2, 386612.5 र BSU PO_3 नामक आलुका जातहरुको राम्रो नतिजा पाइयो । दुवै स्थानको नतिजाका आधारमा छनौट गरिएका उत्कृष्ट आलुका जातहरु समेटेर कम वर्षा हुने ठाउँहरुमा थप परिक्षण गर्नुपर्ने देखिन्छ ।

१.७ आलुमा जैविक मलको परिक्षण

- यो परियोजना जम्मा आठ प्रकारका जैविक मलहरु जनकदेव नामक आलुको जातमा खुमलटारमा परिक्षण गरियो । उक्त परिक्षणमा अध्ययन गरिएका विभिन्न उपचारहरु मध्ये पोषण नामक मलका साथमा NPK/FYM को प्रयोग अति उत्तम पाइयो । यस परिक्षणमा उत्कृष्ट देखिएको मात्रालाई अरु एक वर्ष परिक्षण गरी सिफारिश गर्नु पर्ने देखिन्छ ।

३.० सखरखण्ड अनुसन्धान

३.१ सखरखण्डको जातिय विकास सम्बन्धि अध्ययन परिक्षण

- यस कार्यक्रम अन्तर्गत सि.आइ.पि. पेरुबाट २१ जात र स्थानिय चार जात गरि जम्मा २५ जातहरुको सखरखण्ड संकलन गरि अध्ययन, संरक्षण र बृद्धि गर्ने कार्य खुमलटारमा भइरहेको छ ।

- सखरखण्डको जातिय विकास कार्यक्रम अन्तर्गत क्षेत्रिय कृषि अनुसन्धान केन्द्र, तरहरामा सि.आइ.पि. क्लोनहरु ४४०११२, ४४००१२, ४४००१४, ४४००२० र ४४०३२८ उत्कृष्ठ (१२.१ देखि १६.० टन/हे.) ठहरिएका छन् भने क्षेत्रिय कृषि अनुसन्धान केन्द्र, नेपालगञ्जमा सि.आइ.पि. क्लोनहरु ४०००३९, ४४०३२८, ४४००१५, ४४०१३५ र ४४०२६७ उत्कृष्ठ (११.४ देखि १७.२ टन/हे.) ठहरिएका छन् । त्यस्तै कृषि अनुसन्धान केन्द्र (वागवानी), पोखरामा सि.आइ.पि. क्लोनहरु ४४००२१, ४४००१५, ४४०१८५, ४०००३९ र ४४१६२४ उत्कृष्ठ (२७.६ देखि ४४.२ टन/हे.) ठहरिएका छन् ।

३.० बीउ उत्पादन

३.१ पूर्व-मूल बीउ आलु उत्पादन

- शरद सिजनमा १३,४३० र हिउँदे सिजनमा १२,३१० गरि जम्मा २५,७४० ईन भिट्रो विरुवाहरु प्रयोगशालामा उत्पादन भयो ।
- पूर्व-मूल बीउ आलु (PBS) उत्पादन सम्बन्धमा शरद सिजनमा ३५,७३३ दाना र हिउँदे सिजनमा २२,९९९ दाना गरि जम्मा ५८,७३२ दाना PBS उत्पादन भयो ।
- आ.व. २०६८/६९ को लागि PBS आलुको मूल्य निर्धारण सम्बन्धमा: सबैभन्दा ठूलाको (५ ग्रामभन्दा माथि) साइजको 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. -/७५ र सबैभन्दा सानो ०.२५ ग्रामको रु. -/२५ प्रति दाना मूल्य कायम भयो ।

३.२ मूल बीउ आलु उत्पादन

- आ.व. २०६८/६९ मा जम्मा ३,५६० केजी मूल बीउ आलु हात्तिवन फार्ममा उत्पादन भयो ।
- यस आ.व.को लागि पहिलो पुस्ताको मूल बीउ आलु (BS-1) रु. ३६/- प्रति के.जी.; दोश्रो पुस्ताको मूल बीउ आलु (BS-2) रु. ३४/- प्रति के.जी.तथा रु. १,५३०/- प्रति बोरा (५० के.जी.) र तेश्रो पुस्ताको बीउ आलु (BS-3) रु. ३२/- प्रति के.जी.तथा रु. १,४४०/- प्रति बोरा (५० के.जी.) को दरले मूल्य निर्धारण भएको छ ।

३.३ धान बीउ उत्पादन

- आ.व. २०६८/६९ मा जम्मा दुई टन धानको मूल बीउ उत्पादन भयो ।
- यस आ.व.को लागि धानको मूल बीउ रु. ६०/- प्रति के.जी. को दरले विक्रि वितरण गर्ने गरि मूल्य निर्धारण भएको छ ।

EXECUTIVE SUMMARY

1.0 Potato Research

1.1 Potato variety improvement

NPRP has been constantly working in variety development since 1980 with the focus on higher tuber yield, pest and disease resistance, consumers' preference as well as the processing, and industrial needs. In the year 2011/12 also several activities under this project were undertaken through the collaborators and results are summarized as following:

- Germplasm introduction, maintenance and multiplication activity was continued this year too. In-vitro materials are maintained in NPRP's Tissue culture laboratory and tubers from ARS (Hort.) Pokhara and NPRP Khumaltar's harvest was stored in the cold store and used as per the necessity of the project activities.
- IETs were planted at ARS (Hort.) Jumla, NPRP Khumaltar and ARS (Hort.) Malepatan Pokhara. Selected clones were CIP388676.1 and CIP377957.5 for CVT from Khumaltar, clones CIP399101.1, CIP397012.22, CIP396311.1, CIP394038.105, PRP35861.13, CIP394611.112 and CIP395195.7 from Jumla and clone CIP395192.1 from ARS Pokhara, respectively and remaining clones will either be tested in next year at the same on-station research sites or discarded from evaluation scheme.
- CVTs were conducted at NPRP Khumaltar, RARS Lumle, and ARS Pakhribas as the hill sites and at RARS Nepalgunj and RARS Tarahara as terai. At Khumaltar, clones MS 35.9, PRP35861.18 and CIP393574.61 performed better. In Lumle, no one clone was selected and all the clones will be retested for one year more. At ARS Pakhribas, clone CIP394050.110 performed better and has been promoted to CFFT for next year. From CVT terai, clones CIP384321.15, MS35.9, PRP35861.18, CIP393085.5, CIP394003.161, and CIP393077.159 are selected for famer's field trials (FFT) and remaining clones are recommended to repeat at the same research station for one year more. At Tarahara, eleven

different clones were evaluated and from the trials clones CIP384321.15, PRP225861.5, MS35.9, and CIP393085.5 are selected for farmer's field trials next year in this locality. From ARS Pakhribas CVT, clones CIP384321.15, PRP225861.5, MS35.9, and CIP393085.5 are selected for farmer's field experiment and remaining clones will be repeated in next year's experiment.

- From the CFFT hills, clone PRP 25861.1 (red-skinned with round-flat shaped tubers), CIP 385499.11 (white skinned with oval shaped tubers) and PRP 25861.11 (red-skinned with oval shaped tubers), whereas the clone PRP 85761.11 (red-skinned with oval shaped tubers) from terai and clone CIP 393385.39 (red skinned with round) are found promising and recommended to propose for the releasing next year.

1.2 True potato seed (TPS) research

- Evaluation of TPS families for seedling tuber production in the nursery bed during 2068/69 showed that the TPS families C96H-02.4 x C98HT-64.8 and TPS-7 x TPS-67 produced the highest tuber yields of 8.37 and 8.13 kg per plot of 1 m^2, respectively in NPRP, Khumaltar. In case of RARS, Nepalganj, the highest tuber yield (1.79 kg/plot/m^2) was recorded in the family HPS-7/67. In Jumla, the genotype 994013 produced the highest tuber yield (4.69 kg/plot/m^2).

- Evaluation of F_1C_1 tuberlets of TPS for potato production during 2068/69 revealed that maximum tuber per plot (526.0) was recorded in Kufri Jyoti followed by LT-8 x TPS-67 (460.0) and highest yield (26.83 kg/plot) were in check variety Kufri Jyoti followed by LT-8 x TPS-13 (18.57 kg/plot) in NPRP, Khumaltar. However, maximum tubers (811.0) and yield (15.50 kg/plot) were recorded in Lal Gulab and C96H 02.4 x C99HT2-32.17, respectively in RARS, Nepalganj. The tuber yield was maximum (16.35 kg/plot) in 903027 and minimum tuber yield (9.66 kg/plot) in the family 903135 in Jumla condition. The yield per plot was statistically not significant.

1.3 Study on variety improvement of potato for processing

- Potato genotypes L-235.4, PRP-25861.1, Yagana and Khumal Seto-1 were promising for higher yield and good processing qualities for preparation of chips, when planted during main season in mid-hill at Khumaltar condition. However, the yield of Yagana was very low than other tested genotypes.
- The potato genotype PRP-28861.1 with the highest dry matter (19.92%) content was suitable only for 45-60 days storage in ambient room temperature (25.8±1.2°C and 86.1% RH). This genotype had significantly early sprouting and reaching >50% sprouting within 45 days after storage.
- The genotypes Kufri Jyoti, Yagana and L-235 could be successfully stored in ambient room temperature for maximum period of up to 120 days (16 June to 14 Oct.) with minimum total weight loss of less than 10%.
- No significant variation was observed due to different combination of nitrogen and potash on storability of potato. However, the combined application of 150: 60 kg N and K_2O produced higher yield and minimum sprouting weight (5.31 g per kg tubers) than 50:30 kg N: K_2O ha^{-1}, respectively (8.69 gram/kg tubers).
- Potato tubers fumigated with CIPC (Isopropyl N(3 chlorophenyl) carbamate) @ 40 ml/ lit ethanol/tons potato (before storage and 45 days after storage) was effective for inhibition of sprouting and reduction of postharvest losses up to 120 days storage in mid-hill at Khumaltar and high hills at Daman conditions.

1.4 Seed potato research

- In the use of natural light for incubation of *in vitro* plantlets, two weeks standard growth room (SGR) plus 2 weeks in natural light condition (NLC) showed good performance on most of the evaluated parameters. From this study it can predict that natural night can utilize for production of the *in vitro* plantlets.
- Among the evaluated four conditions for microtuber production, transfer to darkness after 60 days of sub-culture in standard light

condition produced the highest number and fresh weight of microtubers in different genotypes of potato.

- Performance of different size of PBS for basic seed production, the results revealed that larger the PBS size (>5g), the higher tuber yield with better parameters and smaller the size, the lower the tuber yield in the first generation.
- Hydroponic technique for PBS production showed the positive result, so the experiment needs to be continued two more years with some improvement in the basic system.
- In case of the performance of basic seed-1 and farmer's seed for potato production in farmers' field, if the farmer's seed stock is also good quality, similar performance of basic seed and farmer's seed were observed.

1.5 Potato pathology research

- Out of 48 potato genotypes evaluated for late blight resistance, 11 genotypes, viz., PRP 226265.1, PRP 226267.11, CIP-395017.242, PRP 266265.15, PRP 146267.8, CIP 395112.32, PRP 056267.1, PRP 146267.11, PRP 146267.6, CIP 393617.229 and CIP 391058.175 were found highly resistant with disease severity ranging from zero to 95 AUDPC along with the highest tuber yield ranging from 31.07 to 20.0 t/ha.
- In all the three agro climatic conditions, i.e. terai, mid hills and high hills, genotypes LBr-40 showed minimum AUDPC mean value (13.58) followed by CIP 384321.15 (24.8), PRP 266264.01 (36.4) and PRP 25861.1 (109.5) to late blight as compared to Kufri Jyoti (1,979) and Janakdev (753).
- Promising potato genotypes, i.e. L-235.4 and CIP- 389746.2 showed moderate level of resistance, which require only four sprays of Sectin (Fenamidon 10% + Mancozeb 50%) @ 1.2 kg/800 l water/spray/ha and was found optimum for attainable high yield. CIP-389746.2 showed high yield potential than Kufri Jyoti, L-235.4 and Janakdev.

- Twenty five potato genotypes were screened against wart (*Synchytrium endobioticum*) under inoculated pot culture, exposing natural environment conditions at Nigale (2450 m asl). Of them, 12 genotypes, PRP 35861.2, PRP 225861.2, L 235.4, PRP 276264.01, PRP 266264.01, BSU-PO_3, CIP 384321.15, PRP 25861.1, CIP 393280.57, PRP 25861.11, PRP 85861.11, CIP 385499.11 showed resistance to wart as compared to local cultivar 'Rosita'. Wart incidence was the highest in Rosita (74.8%). Released varieties Kufri Jyoti and Janakdev were found still resistant to wart infection.
- Seed and soil treatment with 8% bleaching powder showed the highest disease control (78.2%) followed by planting apparently healthy tubers (72.8%), 3% boric acid (69.2%) and 8% Uthane M-45 (68.4%). Once soils get infected with powdery scab pathogen, healthy seed alone could not control the disease completely.
- In participatory multi-location late blight varietal experiments, genotype PRP 266264.01 produced the highest tuber yield 46.67 t/ha followed by PRP 266264.15 (41.67 t/ha) in Dang; LBr-40 (37.17 t/ha) and CIP 384321.15 (31.83 t/ha) in Nuwakot; PRP 266264.15 (17.9 t/ha) in Dhanusa; PRP 25861.1 (26.37 t/ha) and PRP 266264.01 (22.66 t/ha) in Parwanipur; and BSUPO$_3$ (47.05 t/ha) and PRP 266264.01 (44.33 t/ha) in Dailekh. Tuber yields of these genotypes were significantly highest as compared to the yields of respective local check ranging from 2.8 to 13.33 t/ha.

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

Total of 33 advanced potato clones available at NPRP Khumaltar were assessed at Hattiban Research Farm Khumaltar and 43 clones at RARS Parwanipur, Bara, respectively. The treatments applied were completely rain-fed, mulching and irrigated conditions in both of the locations. Rice straw was used as the mulching material. Results are summarized as below:

- At Khumaltar, highest number of tubers per plot of 1.5 m^2 size was harvested in the clone CIP 391598.75 (157) followed by NPI 106 (146) in rainfed, whereas in irrigated plots, L 235-4 was the highest

tuber producing clone (194). In rainfed treatment, total tuber weight per plot was obtained highest (3.9 kg) from the clone CIP 391598.75 followed by NPI 106 (3.1), CIP 391011.47 (3.0 kg) and CIP 392242.25 (2.9 kg), respectively. In irrigated plot, clone CIP 391011.47 produced highest (4.7 kg) tuber yield. CIP 391011.47 and LBr 40 were highest yielding clones in mulching treatment. Clone CIP 391598.75 was found highest tuber yielder (25.7 t/ha) among all the clones tested in the trial in rainfed conditions followed by NPI 106 (22.6 t/ha) and CIP 391011.47 (20.7 t/ha), CIP 391058.35 (20.5 t/ha), respectively. In irrigated conditions, CIP 391011.47 produced highest yield (31.2 t/ha). Kufri Jyoti, one of the check varieties also gave satisfactory yield (24.7 t/ha). In mulching treatment, clone CIP 391011.47 was found highest yielder (26.9 t/ha). The average yields of all the clones tested were highest (17.7 t/ha) in irrigated treatment followed by mulching (16.6 t/ha) and lowest 14.3 t/ha) by rainfed treatment. The average yield of all 3 different treatments was highest (26.3 t/ha) in the clone CIP 391011.47 followed by CIP 391598.75 (24.5 t/ha), LBr 40 (22.8 t/ha), Ca x LBr 40.6 (22.6 t/ha) and NPI 106 (21.8 t/ha), respectively.

- At RARS Parwanipur, yield differed with treatments, however, in rain-fed treatment, clone CIP 395192.1 (25.1 t/ha), in mulching, BR 63.65 (27.2 t/ha) and in irrigated treatments, clone BR 63.65 (27.1 t/ha) yielded highest. Based on the results obtained, the best performing clones will be further assessed in multi-locational varietal trials of NPRP in the future.

1.7 Bio-fertilizer studies on potato

The treatments consisted bio-fertilizers namely Agrolive, Poshan, Poshan Liquid, Agrolive Liquid, Chelazin, Agrizyme, and Agri182 which are included in the experiment along with recommended NPK fertilizer (100:100:60 kg/ha) and farmyard manure (20 t/ha). In the trial, the highest (73) number of under-sized tuber was obtained in NPK+FYM applied plot, whereas the highest weight (8%) was obtained in control plot followed by NPK+FYM (7%) treatment. The highest number of seed size tuber was produced in the treatment of Agrolive+NPK+FYM (106) and Poshan+NPK+FYM (106) applied plot but the lowest (73) was in

control plot. Likewise, the highest (42%) seed weight was produced in Agrolive+NPK+FYM followed by NPK+FYM (40%). Application of agrolive liquid+NPK+FYM produced the highest tuber number (71) and weight (64%) of over-sized potato tuber. Total number of tuber per plot was highest (230) in Poshan+NPK+FYM applied plot and NPK+FYM, whereas the tuber weight per plot was highest (13.4 kg) in Poshan+NPK+FYM applied plot. The application of Poshan+NPK+FYM imparted the highest (30.9 t/ha) yield but the lowest (14.9 t/ha) yield was in control plot. For the further verification, the trial will be repeated one year more.

2.0 Sweet Potato

2.1 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 vivo* and some even under *in vitro* conditions at NPRP, Khumaltar.
- In the initial evaluation trial (IET), at RARS, Tarahara, CIP clones of 440112, 440012, 440014, 440020 and 440328 were found to be promising with the yield ranging from 12.1-16.0 t/ha. In case of RARS, Nepalgunj, CIP clones 400039, 440328, 440015, 440135 and 440267 produced the highest yield ranging from 11.4-17.2 t/ha, whereas in ARS (Horticulture), Pokhara the promising clones were CIP 440021, CIP 440015, CIP 440185, CIP 400039 and CIP 441624 with average yield ranging from 27.6-44.2 t/ha.

3.0 Seed Production

3.1 Pre-basic seed potato

- Overall 13,430 *in vitro* plantlets of eight potato cultivars in autumn season and 12,310 *in vitro* plantlets of 11 cultivars in spring season were produced in the tissue culture laboratory.
- In the F.Y. 2011/12, altogether 58,732 pre-basic seed potatoes (35,733 in autumn season and 22,999 in spring season) were produced.

- The per unit price of PBS fixed for 2011/12 were Rs. 6.00 for larger than 5 g sized, 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 sized and Rs. 0.25 for smaller than 0.25 g sized minitubers.
- Total of 74 potato germplasm have been maintained under *in vitro* condition at NPRP laboratory.

3.2 Basic seed potato

- In the basic seed production program, overall 3,560 kg of basic seed (BS-1, BS-2 and BS-3) potatoes were produced.
- The price of basic seed fixed for 2011/12 was Rs. 36.00 per kg for BS-1; Rs. 34.00 per kg and Rs. 1,530.00 per sack of 50 kg for BS-2, and Rs. 32.00 per kg and Rs. 1,440.00 per sack of 50 kg for BS-3.

33 Rice seed

- In the rice seed production program, overall two ton of rice foundation seed was produced, comprising of 1,400 kg Khumal-4 and 600 kg Khumal-11.
- The price of rice foundation seed fixed for the fiscal year 2011/12 was Rs. 60.00 per kg.

1. WORKING CONTEXT

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 2011/12 area under potato was reported 190, 250 ha and total production 2,584,301 tons with an average productivity of 13.584 t/ha (Table 1). 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 19% is in the high hills and mountains, 45% in the mid-hills and 36% in *Terai* (ABPSD, 2011).

Table 1. Area, production and productivity comparison of food crops in Nepal

Food crops	Area (ha)	Rank	Production (tons)	Rank	Productivity (t/ha)	Rank
Potato	190,250	V	2,584,301	II	13.584	I
Paddy	1,531,493	I	5,072,248	I	3.312	II
Maize	871,387	II	2,179,414	III	2.501	III
Wheat	765,317	III	1,846,142	IV	2.412	IV
Millet	278,030	IV	315,067	V	1.113	V

Source: Ministry of Agriculture Development, Agri-business Promotion and Statistics Division, Singh Durbar, Kathmandu, Nepal (2012) .

As compared to the three years average of 1987/88 to 1989/90, the area, production and yield of potato in 2011/12 is increased by 233, 412 and 177 times, respectively (Fig. 1).

Geographically, Nepal can be categorized into three geographical regions – southern lower belts Terai, central mid-hills and northern high-hills and mountains. Since eastern Nepal is humid and western Nepal is very dry, the country can, agro-ecologically, categorized into eastern wet hills and terai, central hills and terai, and western dry hills and terai. To cover up the almost all agro-ecological zones prevailing in the country, NPRP has been conducting its research projects, especially varietal improvement ones, in ARS, Pakhribas, Dhankuta (eastern wet hill), RARS, Tarahara, Sunsari (eastern wet terai), NPRP, Khumaltar, Lalitpur (central hill), RARS, Parwanipur, Bara (central terai), HRS, Malepatan, Kaski (western hill), HRS, Rajikot, Jumla (mid-western high hill), ARS, Surkhet (mid-western hill), RARS, Khajura, Banke (mid-western terai) and RARS, Bhagetada, Doti (far-western hill) (Annex 1.1).

This fiscal year the temperature of the Khumaltar, Lalitpur ranged from 1.6°C in January 2012 to the maximum 30.2°C in May 2012. Similarly, no rainfall at all was recorded in December 2011 and the highest of 377 mm in August 2011 (Annex 1.2).

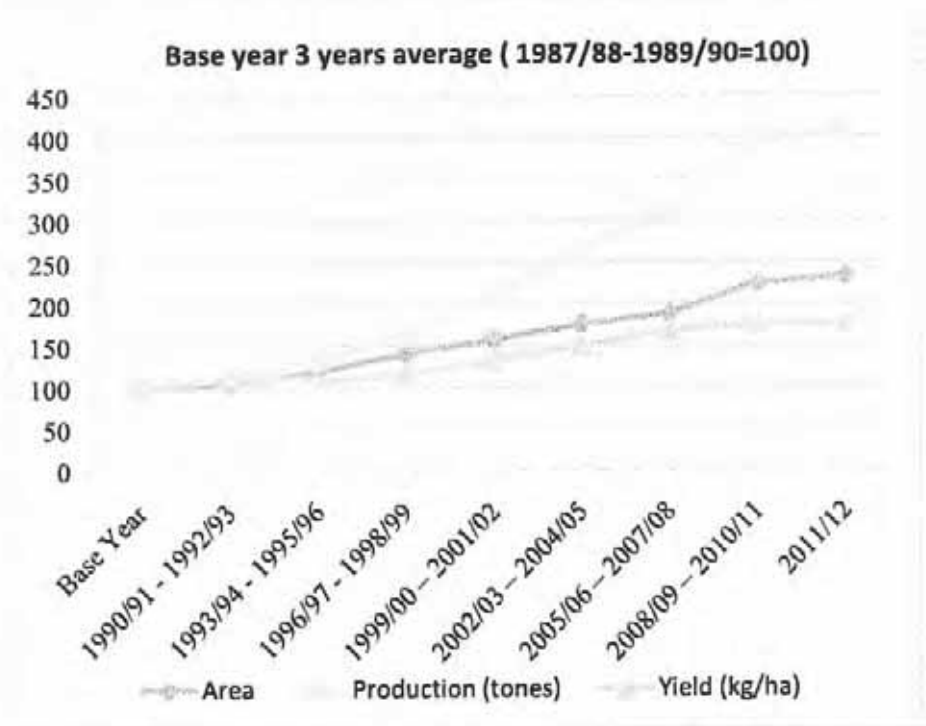


Fig. 1. Index of potato area, production and yield in Nepal.

2. INTRODUCTION

2.1 Introduction

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 with the farmers. Later on 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 the then Potato Development Section (PDS), now National Potato Development Programme (NPDP) 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.

2.2 Goal

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

2.3 Objectives

- Generate suitable and stable appropriate technologies to increase the production and productivity of root and tuber crops for different agro-ecological zones of the country through coordinated research approach,
- Identify and solve production constraints of seed and ware potatoes through on station and farmer's participatory multi location on-farm research,

- Produce high quality healthy source seed of released/recommended potato varieties,
- Establish coordination with potato stakeholders in the country,
- Develop and strengthen linkages between national and international potato R & D related organizations, and
- Identify and develop appropriate varieties for processing and storage under ordinary conditions.

To achieve above mentioned objectives following projects were conducted during the year 2011/12.

- Studies on management of late blight, wart and powdery scab diseases of potato in Nepal,
- Coping with climate change effects on potato through variety selection and crop management,
- Sweet potato variety development for food and nutrition security,
- Study on variety improvement of potato for processing,
- Potato variety development and improvement for different agro-ecologies of Nepal,
- Sustainability studies for pre-basic seed production of potato,
- Pre basic and source (basic) seed production of potato,
- Evaluation of true potato seed (TPS) families in the nursery beds and field conditions, and
- 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 distribute 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.

2.3 Strategies

The strategy of NPRP is to carry out the research activities and support quality seed potato production program for overall potato production improvement throughout the country.

2.4 Current thrust areas for research

- High yielding and late blight disease resistant potato variety development for different agro-ecologies of Nepal,
- High yielding and β-carotene enriched sweetpotato variety development for different agro-ecologies of Nepal, and
- Pre-basic and source (basic) seed production on potato.
- Determine the optimum practices of cultivation of potato in relation to the soil-cultivars-climate complex
- Identify and investigate on major diseases and pests of potato and devise their control measures
- Investigate on problems connected with post harvest and processing
- Develop system based soil fertility management practices
- Socio-economic studies on adoption of new technological and cost effectiveness in farming communities
- Develop improved farm equipment and implement on potato
- Make existing quality seed production activities sustainable
- Use of biotechnology in crop improvement

2.5 Infrastructure and facilities

The program has its own office building in Khumaltar, NARI complex; a glasshouse and screenhouse complex near Nakkhipot and a research farm in Hattiban (Annex 2.1).

Altitude:	1350 masl	Land type: Alluvial terraces
Dominant soil type:	Silty loam	Dominant soil pH: 5.5
Climate type:	Sub-tropical	

Area	Ropani
Total cultivated area	32
Area covered by Glasshouse complex	20
Area covered by office buildings & laboratories	5
Area covered by housing/quarters	¼
Area covered by irrigation & drainage channels	3

The office building is equipped with a tissue culture laboratory, a pathology laboratory, a postharvest laboratory, a plant physiology laboratory and a screen house (Annex 2.2).

2.6 Organization structure and human resource

The organization structure of NPRP (Fig. 2) explains the working modality and human resources strength that is adopted to help in achieving the objectives and strategies of the program. The program has altogether 28 staffs composed of scientists, technical officers, technicians, helpers, administration and account sections (Annex 2.3).

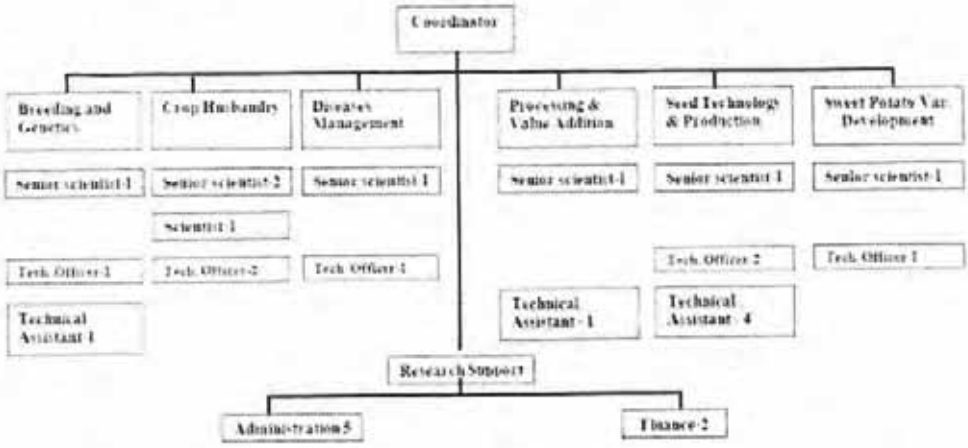


Fig. 2. Organogram of the National Potato Research Program

3. RESEARCH HIGHLIGHTS

3.1 Potato

3.1.1 Variety Improvement/Development

National Potato Research Programme (NPRP) has been constantly working in variety development since 1980 with the focus on higher tuber yield, pest and disease resistance, consumers' preference as well as the processing, and industrial needs. With the continuous effort of variety development, NPRP has succeeded in releasing eight potato varieties so far in different agro-ecological regions for commercial production and some more are in pipeline. Germplasm introduction and inter-varietal hybridization are employed to develop the variety on potato at NPRP.

The germplasm of potato has been regularly introduced in NPRP from International Potato Center (CIP), Lima, Peru since 1980s. The variety testing and selection are the fundamental processes which are followed in the variety improvement program in potato. NPRP follows a varietal evaluation scheme and the germplasm received from CIP 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 superior clones are bulked at both locations and the clones 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 tested in CFFTs as coordinated farmers' field trials (CFFTs) which is 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 farmers' preferences are additionally recorded. After two or more than two years' of farmers' acceptance test (FATs), the most farmers 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.

3.1.1.1 Initial evaluation trial (IET)

IET is the first step of variety screening of potato for selecting high yielding, disease resistant (particularly late blight) as well as pests' resistant and wider adaptability in different agro-ecological zones. To carry-out the initial evaluation trial, three sites namely; Hattiban Research Farm, Khumaltar, ARS (Hort.) Rajikot, Jumla ARS (Hort.) Pokhara, are selected as the representative sites for summer season and winter season, respectively.

At NPRP Khumaltar, 26 clones were evaluated for their vegetative and yield characteristics in the year 2068/69. Similarly, 29 clones were tested at ARS (Hort.) Pokhara and 19 clones at ARS (Hort.) Jumla with check varieties Desiree and Kufri Jyoti at Khumaltar, Desiree and Kufri Sindhuri at ARS

(Hort.) Pokhara and varieties Desiree, Janakdev, Kufri Jyoti, NPI-106 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. All the fertilizers and farm yard manure was applied at the time of planting 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:

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 5plants/clone in each replication)
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 in each replications), and
6. Late blight rating (using 1-9 scale)

Yield and Yield parameters

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

At NPRP, Khumaltar the initial evaluation trial of potato clones in Hattiban Research Farm, altogether twenty-six clones were tested and studied their plant and yield characters along with Desiree and Kufri Jyoti (Table 1.1). The highest (97%) plant emergence was recorded in CIP 391078.175 followed by CIP 391058.2 (95%), CIP 388676.1 (95%), CIP 393248.6 (95%), and Desiree (95%), and the lowest (53%) was in clone CIP 392740.4. Ground cover was highest (77%) in CIP 394611.112 and the lowest (31%) in PRP 15860.8. Highest uniformity in the plants was observed in PRP 56267.6 and PRP 56267.9 (5). The highest (5) plant vigor was observed in CIP 395192.1, CIP 394611.112, PRP 56267.6 and PRP 56267.9, respectively. Average number of main stems per plant was counted highest (4.0) in CIP 388676.1 followed by PRP 56267.1 (3.9), PRP 56267.9 (3.9), CIP 395017.242, CIP 390663.8 (3.8), and the lowest (2.2) was in CIP 397073.2. Tallest plants (79.8 cm) were measured in CIP 399101.1 followed by CIP 395195.7 (77.3 cm) and the shortest (33.9 cm) in CIP 393248.6.

The undersize tuber distribution varied among the clones. The highest (183)

number of undersize tuber was counted in the clone PRP 56267.9 followed by PRP 56267.1 (161) and the lowest (21) in PRP 85861.11 and PRP 25963.7. The weight of undersize tuber was highest (38%) in PRP56267.1 followed by PRP 56267.9 (32%) and the lowest (5%) in CIP 390663.8. Highest number of seed size tubers was produced (75) from the clone PRP 56267.6 followed by PRP 56267.9 (73) and the lowest (24) in PRP 85861.11 and PRP 25963.7. Similarly, the maximum number and weight of oversize tuber were produced in CIP 395192.1 (21 and 62%, respectively) followed by CIP 395195.7 (18 and 48%) and the minimum (2) tuber was in CIP 393248.6, PRP 15860.8, CIP 391058.175 and CIP 395017.242. Total number of tuber per plot was highest (260) in PRP 56267.9 and the lowest (50) in PRP 85861.11. The total tuber weight per plot was highest (5.7 kg) in CIP 395192.1 and the lowest (1.5 kg) in CIP 393382.44.

Total yield per plot was highly significant among the clones tested. Clone CIP 395192.1 gave the highest (23.5 t/ha) and CIP 393382.44 the lowest (5.3 t/ha) yield. Based on the results for 2 years, clones PRP 225861.2 and PRP 55861.8 are rejected from the variety evaluation scheme, whereas CIP 388676.1 and CIP 377957.5 are selected for CVT and remaining clones are placed in IET for testing in the second year.

Table 1.1: Plant and yield characters of potato clones tested in IET at Khumaltar, 2068/69

Clones	Emg (%)	Ground cover (%)	Pt. unif (1-5)	Plt vig (1-5)	Stem/plant (no.)	Pt. Ht. (cm)	Tuber size distribution (No. and % Wt.)						Total tuber/plot		Adj. yld (t/ha)
							US		SS		OS				
							No.	Wt.	No.	Wt	No.	Wt	No.	Wt (kg)	
PRP225861.2	77	46	2	3	2.9	52.7	38	14	34	59	7	27	80	2.5	10.4
CIP388676.1	95	54	4	4	4.0	38.6	44	17	42	61	5	22	92	2.4	10.9
CIP377957.5	93	42	4	4	3.0	42.8	47	15	46	65	5	20	98	2.5	11.5
CIP396311.1	88	70	4	4	3.3	46.4	47	8	50	50	14	42	111	4.6	19.6
CIP397073.15	80	42	2	2	2.2	56.8	22	8	32	74	4	18	58	1.9	8.1
CIP397077.16	85	53	4	4	2.7	48.3	31	6	34	48	12	46	77	3.3	13.8
CIP395192.1	77	67	4	5	3.4	64.2	52	5	44	33	21	62	117	5.7	23.5
CIP394611.112	90	77	5	5	3.4	59.5	83	17	46	66	9	17	169	4.1	18.7
CIP393248.6	95	41	2	2	2.8	33.9	38	21	36	70	2	9	76	2.6	7.0
CIP384866.5	88	65	4	5	3.6	58.2	57	13	45	59	8	28	111	2.9	12.8
PRP15860.8	84	31	3	3	2.6	39.3	33	12	36	77	2	11	70	1.7	7.1
PRP56267.1	72	59	3	3	3.9	55.8	161	38	46	52	3	10	211	2.6	9.2
PRP56267.6	90	72	5	5	3.4	55.8	69	14	75	66	8	20	152	4.4	18.4
PRP56267.9	90	57	5	5	3.9	60.1	183	32	73	61	4	7	260	3.8	16.0
PRP266265.1	85	60	4	4	3.2	76.2	68	27	44	55	4	18	115	2.2	9.8
CIP391058.175	97	56	3	4	3.4	49.6	73	28	42	64	2	8	117	2.2	9.6
PRP85861.11	92	35	2	2	2.3	38.9	21	12	24	58	5	30	50	1.6	7.0
CIP395017.242	85	60	4	4	3.8	51.8	104	25	63	70	2	5	169	2.8	12.6
CIP392740.4	53	46	2	2	2.6	43.6	58	18	41	56	6	26	105	2.6	8.8
CIP394613.139	87	69	4	4	3.5	48.8	67	19	53	67	5	14	124	2.9	12.6
CIP390663.8	92	67	4	5	3.8	52.9	27	5	44	51	14	44	85	3.9	17.3
PRP55861.8	82	53	3	3	2.6	68.9	24	8	40	64	6	28	70	2.3	10.0
CIP393382.44	63	51	2	3	2.5	70.3	44	8	32	64	3	15	80	1.5	5.3
CIP399101.1	72	55	3	3	2.7	79.8	40	12	39	65	5	23	83	2.3	10.2
PRP25963.7	85	47	3	3	2.5	55.2	21	7	24	50	10	43	55	2.5	10.6
CIP395195.7	80	72	4	4	2.5	77.3	48	9	52	43	18	48	119	5.1	22.4
Desiree (ch)	95	53	3	3	2.6	46.2	33	11	29	51	8	38	70	2.5	11.0
K. Jyoti (ch)	92	67	4	4	3.4	48.4	42	10	39	48	14	42	95	3.6	15.7
F-Test															**
LSD (0.05)															5.49
CV (%)															35.0

At ARS (Hort.) of ARS (Horticulture), Malepatan, Pokhara altogether twenty-nine clones were tested along with Desiree and K. Sindhuri as commercial checks (Table 1.2). The highest (100%) plant emergence was counted in the clones CIP 397073.15, PRP 35861.13, MS-42.3, CIP 397060.19, CIP 394613.139, CIP 393536.13, CIP 393073.179, CIP 393016.7, CIP 391058.175, CIP 392248.55 and variety Kufri Sindhuri. The ground cover observed highest (92%) in CIP 395195.7 followed by CIP 395017.242 (88%) and CIP 391058.175 (88%), respectively and the lowest (38%) in CIP 397060.19.

Table 1.2: Plant and yield characters of potato clones tested in IET at ARS, Malepatan, 2068/69

Clones	Emg. (%)	Ground cover (%)	Pl. unif. (1-5)	Stem/ plt (no.)	Plant height (cm)	LB Score (1-9)	Tuber size distribution (No. and % Wt.)						Total tuber/plot		Adj. yield (t/ha)
							LS		SS		OS				
							No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt. (kg)	
CIP396286.6	98	73	5	4	30.8	4	59	24	65	71	2	5	126	2.8	11.5
CIP399101.1	98	83	5	3	46.1	4	81	28	64	68	2	4	147	3.5	14.1
CIP397012.22	90	72	4	2	34.3	6	32	27	27	59	3	14	62	1.8	6.8
CIP396311.1	96	72	5	3	36.3	5	18	11	31	54	10	36	59	2.5	10.1
CIP397073.15	100	72	5	2	34.6	6	18	15	26	79	1	6	45	1.2	5.2
CIP394038.105	96	65	4	3	33.0	3	14	9	18	47	8	44	39	1.5	6.1
PRP35861.13	100	47	5	3	58.9	4	32	21	35	63	3	16	70	2.7	11.3
CIP394611.112	94	58	5	2	32.2	6	47	31	29	69	0	0	76	1.2	4.9
CIP395195.7	98	92	5	4	45.8	3	18	5	33	35	26	60	77	4.4	17.6
CIP390478.9	96	50	3	0	19.8	9	44	34	18	66	0	0	63	0.8	3.3
CIP399067.22	98	72	4	3	32.7	5	50	37	32	64	0	0	82	1.4	5.6
CIP395017.229	94	87	5	3	46.9	2	43	5	55	38	32	56	129	6.3	25.9
MS-42.3	100	73	5	4	34.6	5	52	38	26	62	0	0	78	1.1	4.7
CIP397060.19	100	38	3	2	29.4	6	18	24	13	56	10	20	40	0.9	4.1
CIP392740.4	92	58	3	0	21.1	9	37	67	5	33	0	0	42	0.5	1.9
CIP392820.1	96	50	3	0	18.5	9	10	24	10	76	0	0	29	0.4	1.7
CIP394613.139	100	50	3	1	13.3	6	47	39	16	46	2	15	64	1.3	5.5
CIP393536.13	100	50	3	0	24.0	9	41	79	4	21	0	0	45	0.4	1.6
CIP393073.179	100	63	5	2	35.3	3	17	6	27	52	11	42	55	2.4	10.1
CIP395112.32	96	72	5	2	26.5	2	33	8	45	49	16	43	93	4.1	16.2
CIP393342.44	98	63	5	3	21.6	5	26	19	40	78	1	3	67	1.5	6.3
CIP395017.242	98	88	5	4	35.1	4	31	6	46	35	32	59	109	5.9	24.1
CIP393016.7	100	45	5	4	35.7	4	51	25	42	58	6	17	99	2.5	10.3
CIP392227.15	96	80	5	2	30.7	3	15	8	35	73	4	19	55	1.9	8.1
CIP393617.1	96	80	5	3	36.3	4	53	24	47	58	5	17	105	3.2	12.8
CIP391058.175	100	88	5	4	41.9	2	37	15	42	45	14	39	93	4.0	16.9
CIP399092.116	96	78	5	3	43.5	4	18	11	37	72	3	17	58	2.1	8.1
CIP377957.5	98	78	5	3	40.5	6	59	32	43	63	1	5	103	2.6	10.9
CIP393348.55	100	60	4	2	8.5	7	44	37	24	63	0	0	68	1.1	4.6
Desiree (ch)	96	50	4	1	7.9	8	20	36	9	64	0	0	54	0.5	1.8
K. Sindhuri (ch)	100	77	5	3	40.2	4	68	42	37	59	0	0	105	1.7	7.7
F-Test															**
LSD (0.05)															3.2
CV (%)															21.9

The plant uniformity ranged from 3 to 5 in most of the tested clones in 1 to 5 scales. But the number of main stems per plant was counted the highest (4) in CIP 396286.6, CIP 395195.7, MS-42.3, CIP 395017.242, CIP 393016.7, and CIP 393617.1. The highest (58.9 cm) plant height was measured in PRP 35861.13 followed by CIP 395017.229 (46.9 cm) and CIP 399101.1 (46.1). Clones CIP 395017.229, CIP 395112.32 and CIP 391058.175 were found resistant to late blight disease, whereas CIP 394038.105, CIP 395195.7, CIP 393073.179 and CIP 392227.15 found the tolerant.

CIP 399101.1 produced highest number of undersized tuber (81) but the highest (79%) undersized tuber weight produced in clone CIP 393536.13. Likewise, the number of seed sized tuber produced the highest (65) in CIP 396286.6 followed

by CIP 399101.1 (64) but the highest (79%) weight was in CIP 397073.15 followed by CIP 393342.44 (78%). Likewise, the greatest (32) number of oversize tuber production was in MS-42.3 and CIP 395017.242 but the greatest (60%) weight were obtained in CIP 395195.7 followed by CIP 395017.242 (59%). Total number of tubers per plot was highest (147) in CIP 399101.1 and the lowest (29) in CIP 392820.1. But the total weight per plot was produced highest (6.3 kg) in CIP 395017.229 followed by CIP 395195.7 (4.4 kg) and CIP 395112.32 (4.1 kg). The total yield per hectare was highest (25.9 ton) in CIP 395017.229 followed by CIP 395017.242 (24.1 ton) and the lowest (1.6 t/ha) yield was in CIP 393536.13.

On the basis of the results obtained for two years, clones CIP 399101.1, CIP 397012.22, CIP 396311.1, CIP 394038.105, PRP 35861.13, CIP 394611.112 and CIP 395195.7 are promoted to coordinated varietal trial and remaining clones will be retested at the same research station in next year.

In ARS (Hort.), Jumla IET, nineteen potato clones were evaluated along with the recommended varieties (Desiree, Janak Dev, Kufri Jyoti, NPI-106 and Jumli Local) for their phenotypic and yield characters (Table 1.3). The highest (100%) tuber emergence was recorded in the clones Primicia, CIP 393248.55, CIP 394611.112, CIP 388676.1, Janak Dev and NPI-106 but the ground cover was highest (85%) in PRP 55861.6 and Janak Dev. Clone CIP 391598.75 produced the highest (6) number of main stem per plant followed by PRP 85861.6 and Desiree (5) and the lowest (2) in CIP 377957.5. The highest (54.3 cm) plant height was found in Janak Dev and the lowest (17.0) in CIP 393248.55.

Table 1.3: Plant and yield characters of potato clones tested in IET at Jumla, 2068/69

Clones	Emg (%)	Ground cover (%)	Stem/ plant (no.)	Plant height (cm)	Tuber size distribution (No. & % Wt.)						Total tuber/plot		Adjusted yield (t/ha)	Tuber color	Tuber shape
					US		SS		OS						
					No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt (kg)			
CIP391598.75	92	68	6	25.3	64	22	28	31	20	47	112	2.7	18.7	W	L
CIP391011.47	97	65	4	19.7	88	28	41	57	4	16	133	1.9	13.7	W	R
CIP391058.35	92	68	3	26.3	57	20	23	43	9	37	89	1.8	11.0	W	L
CIP392243.17	94	68	4	31.7	31	11	29	39	17	50	76	2.9	20.6	W	R
Primicia	100	65	4	21.0	74	26	38	47	12	26	123	2.2	14.9	W	R
CIP397077.16	92	68	3	24.0	36	13	22	43	13	44	72	2.0	14.8	W	R
PRP15860.8	97	68	3	18.7	44	31	22	54	3	15	68	1.3	8.8	W	L
PRP225861.2	92	75	3	35.7	52	19	28	47	9	34	89	2.1	15.9	R	R
CIP393248.55	100	65	3	17.0	58	35	23	44	5	22	86	1.3	9.1	R	R
CIP394611.112	100	68	3	27.7	73	27	60	52	10	22	143	3.4	23.2	R	R
CIP396311.1	89	68	3	20.3	51	21	26	47	11	32	88	1.9	14.9	R	R
CIP388676.1	100	65	4	15.3	56	23	31	40	11	37	99	2.0	13.5	W	L
CIP397073.15	72	65	3	27.0	17	9	18	32	10	58	45	1.2	12.2	W	L
CIP377957.5	97	68	2	22.3	72	36	20	35	8	29	100	1.9	13.8	W	L
CIP384866.5	92	78	4	34.0	46	24	31	56	5	20	83	1.9	14.0	W	R
PRP55861.6	94	85	4	41.7	44	13	40	42	19	45	102	4.0	28.3	W	L
CIP392242.25	69	82	3	32.3	53	23	31	48	9	29	93	2.1	19.7	W	R
CIP395192.1	97	82	3	36.3	26	12	23	39	13	50	62	2.7	18.7	W	R
PRP85861.6	95	72	5	25.0	60	17	37	51	10	32	107	2.9	20.6	R	R
Desiree (ch)	89	72	5	23.3	41	28	21	39	7	34	69	1.8	15.0	R	L
Janak Dev (ch)	100	85	3	54.3	31	12	22	29	18	59	71	2.8	19.3	R	L
K. Jyoti (ch)	97	75	4	29.7	58	15	35	41	18	44	110	3.8	26.6	W	R
NPI106 (ch)	100	73	3	31.0	47	15	37	47	15	38	99	3.0	20.3	W	R
J. Local (ch)	94	65	4	29.7	52	16	37	45	15	39	104	3.0	20.7	W	L
F-Test													**		
LSD (0.05)													7.475		
CV (%)													26.0		

The number of undersize tuber production was highest (88) in CIP 391011.47, whereas the highest (36%) tuber weight was observed in CIP 377957.5 followed by CIP 393248.55 (35). The number of seed size tuber was maximum (60) in CIP 394611.112 and weight (56%) in CIP 391011.47 and CIP 384866.5. the highest number of oversized tuber was counted in CIP 391598.75 but the oversize tuber weight (20) was highest (59%) in Janak Dev. Total number of tuber per plot was counted highest (143) in CIP 394611.112 but the lowest (45) in CIP 397073.15. Likewise, the total weight per plot was highest (4.0 kg) in Kufri Jyoti (3.8 kg). Total yield per plot was highest (28.3 t/ha) in PRP 55861.6 followed by Kufri Jyoti (26.6 t/ha) and the lowest (9.1 t/ha) in PRP 15860.8.

The tuber color varied from red to white in tested clones. Likewise, the tuber shape of tested clones also varied from round to long. Clone CIP 377957.5 is rejected from the variety testing and CIP 395192.1 is selected for CVT, and remaining clones will be tested in next year at the same on-station research site of Jumla.

3.1.1.2 Coordinated varietal trial (CVT)

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 research stations in 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).

In 2012/13 too, CVTs were conducted at NPRP Khumaltar, RARS Lumle, and ARS Pakhribas in the hills and at RARS Nepalgunj and RARS Tarahara in terai. In all the research stations, the trials were laid out in randomized complete block design (RCBD) with 4 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.

The data collected were:

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 in each replication)
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 in each replications), and
6. Late blight rating (using 1-9 scale)

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, shape and eye depth of the tubers

At NPRP Khumaltar, six potato clones were tested and compared for plant and tuber characters with commercial varieties Kufri Jyoti and Desiree at Hattiban Potato Research Farm, Khumaltar (Table 1.4). Plant emergence was highest (88%) in MS-35.9 and the lowest (19%) in CIP 393574.61. The ground cover was highest (91%) in PRP 55861.6 and the lowest (51%) in CIP 392228.66. Similarly, the plant uniformity was highest (5) in PRP 55861.6 and the lowest (3) in CIP 394034.65. The highest (5) plant vigor was recorded in PRP 55861.6 and the plant height was highest (93.1 cm) in PRP 35861.18 and the lowest (28.6 cm) in CIP 392228.66. The number of main stems per plant ranged from 3 to 4 in most of the tested clones in 1 to 5 scales.

Table 1.4: Plant and yield characters of potato clones tested at CVT in Khumaltar, 2068/69

ones	Emg. (%)	Ground cover (%)	Plant unif. (1-5)	Plant vig. (1-5)	Plant height (cm)	Stem/ plant (no.)	Tuber size distribution (No. and % Wt.)						Total tuber /plot		Adj. yield (t/ha)
							US		SS		OS				
							No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.(kg)	
P55861.6	59	91	5	5	78.2	3	174	16.3	177	55	35	29	387	12.8	17.9
35.9	88	85	4	4	78.0	4	453	22.3	380	71	11	7	844	17.8	24.8
P35861.18	57	83	4	4	93.1	3	91	5.5	153	39	76	56	319	17.9	24.8
P393574.61	90	84	4	4	53.4	3	114	4.8	182	41	81	54	376	21.5	29.9
P394034.65	62	60	3	3	36.1	3	288	17.5	237	70	16	13	541	12.1	16.8
P392228.66	84	51	4	3	28.6	4	252	15.5	228	61	32	23	511	14.2	19.7
Jyoti (ch)	49	91	4	4	54.5	4	130	6.0	208	41	95	54	433	22.3	30.9
siree (ch)	67	59	4	4	44.0	3	126	9.5	155	52	44	39	326	12.6	17.4
Test															**
D (0.05)															3.720
(%)															11.1

The number and weight of undersize tuber production was highest (453 and 22.3%, respectively) in MS-35.9 and the lowest (91 and 5.5%) in PRP 35861.18. Likewise, the seed size number and weight per plot was recorded highest (380 and 71%, respectively) in MS 35.9. The oversize tuber production was highest (95) in one of the check varieties Kufri Jyoti and the lowest (11) in MS 35.9. The weight of oversize tuber production was highest (56%) in PRP 35861.18 followed by CIP 393574.61 (54%) and Kufri Jyoti (54%). Total number of tuber per plot was counted highest (844) and the lowest (319) in clone PRP 35861.18. The total weight per plot was highest (22.3 kg) in Kufri Jyoti. Total yield per hectare was highly significant among the tested clones. The highest (30.9 t/ha) yield was obtained in check variety Kufri Jyoti followed by one of the tested clones CIP 393574.61 (29.9 t/ha).

Based on two year's data, clones MS 35.9, PRP 35861.18 and CIP 393574.61 are selected for farmers' field trial (FFT) whereas, PRP 55861.6 is rejected from the evaluation scheme and remaining clones are recommended for re-testing for one year more before discarding or selecting.

At RARS Lumle the coordinated varietal trial (CVT), ten clones were tested where Desiree, Kufri Jyoti and Farmer's Local were used as commercial check varieties (Table 1.5). The ground foliage was highest (63%) in CIP 385556.4 and the lowest

(43%) in CIP 392250.56. The tallest (26.4 cm) plants were measured in the plants of CIP 392617.54. Average numbers of main stems per plant were counted highest (5.8) in CIP 385556.4 followed by farmer's local (5.7).

CIP 393339.242 produced the largest (155) number of under size tuber and weight (64%) by CEZ-69-1. The seed sized tuber number produced highest (43) in CIP 385556.4, whereas the highest (34%) weight by CIP 392657.8. Similarly, CIP 385556.4 produced the highest number (27) and weight (42%) of oversize tuber. Total number of tubers per plot was highest (182) in CIP 393339.242 and farmer's local but the total tuber weight per plot was counted highest (5.7 kg) in CIP 385556.4. CIP 392657.8, CEZ-69-1, CIP 393574.61, CIP 392250.56, and CIP 393339.242 are rejected from the variety evaluation scheme and remaining clones are recommended to re-test at the same research station one year more.

Table 1.5: Plant and yield characters of potato clones tested in CVT at RARS Lumle, 2068/69

Clones	Ground cover (%)	Plant height (cm)	Stem/ plant (no.)	Tuber size distribution (No & % Wt.)						Total tuber /plot		Adj. yield (t/ha)
				US		SS		OS				
				No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt (kg)	
K. Sutlez	49	17.1	2.9	105	53	10	18	9	29	123	2.2	5.2
CIP392657.8	53	10.6	3.1	68	55	17	34	3	12	88	2.0	5.4
CEZ 69.1	49	11.7	4.9	148	64	17	25	5	11	170	2.8	7.1
CIP393574.61	48	8.4	2.6	85	53	17	29	7	18	109	2.7	6.9
CIP392250.56	43	12.6	2.3	91	43	18	26	13	31	118	2.8	6.9
CIP393339.242	45	15.9	4.2	155	59	17	21	10	20	182	2.8	6.8
CIP394051.4	50	11.5	4.4	68	47	11	26	8	27	88	2.0	4.8
CIP396010.42	55	13.9	5.3	140	61	14	22	6	18	160	2.5	5.7
CIP392617.54	45	26.4	2.6	72	41	21	29	13	31	106	3.4	9.2
CIP385556.4	63	14.3	5.8	76	27	43	32	27	42	146	5.7	15.5
Desiree (ch)	36	11.6	2.1	61	58	9	24	5	18	73	1.4	3.1
K. Jyoti (ch)	45	11.8	3.9	95	56	15	25	6	20	116	2.4	6.1
Farmers' local (ch)	56	18.2	5.7	136	44	26	26	20	30	182	4.8	11.6
F-Test												**
LSD (0.05)												5.087
CV (%)												44.1

At ARS, Pakhribas nine clones were planted along with commercial varieties (Desiree, Kufri Jyoti and Farmer's Local) and studied their plant and yield characters at ARS Pakhribas (Table 1.6). The highest (94%) plant emergence was recorded in PRP 55861.6, PRP 35861.18 and Desiree and the lowest (77) in farmers' local. Similarly, the ground cover was highest (63) in CIP 394050.110 followed by PRP 55861.6 (60). The plant uniformity varied from 3 to 4 among the clones. The average number of main stems per plant was counted highest (6) in MS 35.9 followed by CIP 394244.3 (5) and CIP 392228.66 (5). The tallest (55.2 cm) plants were measured in PRP 35861.18 whereas the shortest plants (28.3 cm) in CIP 394034.65. Clone CIP 394034.65 showed the resistance (2) to late blight disease whereas; PRP 35861.18, PRP 115963.5 and Desiree showed the tolerance (3).

The number and weight of undersize tuber were found highest (631 and 58%, respectively) in MS 35.9, but the lowest number (126) and weight (15%) was

produced in farmers' local. The number of seed size tuber counted highest (33) in Kufri Jyoti and the lowest (10) in CIP 392228.66. However, the seed weight was highest (66%) in CIP 394034.65 and CIP 394050.110. The highest number (74) and weight (37%) of oversize tuber produced in Kufri Jyoti and the lowest number (1) and weight (0%) was in MS 35.9, respectively. The total number of tuber per plot counted highest (815) in MS 35.9. In contrast, the highest (23.5 kg) weight of oversize tuber was produced in variety Kufri Jyoti. Yield variation among the clones was highly significant. The highest (32.7 t/ha) yield was recorded in Kufri Jyoti followed by CIP 394050.110 (29.0 t/ha) and PRP 55861.6 (28.6 t/ha) and the lowest (10.2 t/ha) in CIP 392228.66.

Table 1.6: Plant and yield characters of potato clones tested in CVT at ARS Pakhribas, 2068/69

Clones	Emg (%)	Ground cover (%)	Pl unif (1-5)	Ste m/ pl (no.)	Plan t ht (cm)	LB scor e (1-9)	Tuber size distribution (No. and % Wt.)						Total tuber/plot		Adj yield (t/ha)	Ma turity
							US		SS		OS					
							No.	Wt	No	Wt	No	Wt	No.	Wt (kg)		
PRP55861.6	94	60	4	4	50.7	5	309	26	29	60	25	15	583	20.6	28.6	L
MS35.9	88	53	3	6	49.4	5	631	58	22	42	1	0	815	15.6	22.0	L
PRP35861.18	96	53	4	4	55.2	3	157	20	24	62	24	19	361	16.9	23.5	M
PRP393574.61	92	38	3	4	35.3	4	136	25	15	54	28	21	294	10.9	15.2	M
PRP115963.5	92	35	3	4	33.8	3	137	19	20	54	35	28	323	14.0	19.5	M
CIP392244.3	85	48	4	5	32.0	4	180	22	17	64	20	14	395	12.5	17.4	M
CIP392228.66	79	28	4	5	31.7	5	227	43	10	49	5	7	297	7.4	10.2	M
CIP394034.65	92	28	3	3	28.3	2	170	27	13	66	6	7	318	9.5	13.1	L
CIP394050.110	85	63	4	5	47.5	4	328	25	29	66	17	9	643	20.9	29.0	L
Desiree (ch)	94	38	3	4	29.1	3	142	26	16	55	21	20	317	11.2	15.6	E
K. Jyoti (ch)	92	58	4	4	38.9	4	168	17	33	46	74	37	453	23.5	32.7	M
Farmer's local (ch)	77	38	4	4	46.7	4	126	15	18	63	29	22	320	12.8	17.8	L
F-Test															**	
LSD (0.05)															6.61	
CV (%)															22.5	

The maturity of cultivar is important for the selection of particular clones. Most of the tested clones were identified as medium maturing type, whereas few of them (PRP 55861.6, MS 35.9, CIP 394034.65 and CIP 394050.110) were identified as late maturing clones. Based on this testing and evaluation, clone CIP 393574.61 is rejected and CIP 394050.110 is selected for farmer's field trial in next year, and remaining clones are recommended to repeat for one year more.

In CVT RARS Nepalgunj, altogether, twelve clones were tested at on-station site of RARS Nepalgunj and studied their phenotypic and yield characters along with Desiree, Kufri Sindhuri and local variety Lal Gulab (Table 1.7). Tuber emergence was highest (99%) in CIP 380606.6 followed by CIP 380606.6 (98%), PRP 225861.5 (98%), and CIP 393085.5 (98%). Likewise, the ground cover was highest (78%) in Lal Gulab and the lowest (41%) in Desiree. The highest plant uniformity was recorded in CIP 388676.1 (4), CIP 380606.6 (4), MS 35.9 (4), PRP 225861.5 (4), CIP 394003.161, CIP 393077.159 (4) and Lal Gulab (4). The plant height was measured tallest (75.8 cm) in MS 35.9 followed

by CIP 394003.161 (71.0) and the lowest (43.3 cm) in Desiree. The number of main stem per plant was highest (3.9) in MS35.9 and the lowest (1.6) in Desiree. Among all the tested clones, PRP 225861.2, CIP 384321.15, MS 35.9, and CIP 393085.5 were found resistant to late blight disease.

The highest number (499) and weight (21%) of under size tuber recorded in local variety Lal Gulab. Likewise, the highest (363) number and weight (79%) of seed size tuber produced by CIP 380606.6, whereas the lowest (84) number and weight (39%) of seed size tuber was produced in Desiree and PRP 35861.18, respectively. Similarly, the number of oversize tuber production (74) and the weight of oversize tuber produced was highest (60%) in PRP35861.18. Total number of tuber per plot was maximum (856) in Lal Gulab but the total weight per plot was highest (22.0 kg) in CIP 393085.5. The highest yield (31.0 t/ha) was obtained in CIP 393085.5 followed by CIP 388676.1 (29.3 t/ha) but the lowest (8.6 t/ha) was in Desiree. CIP 384321.15, MS 35.9, PRP35861.18, CIP 393085.5, CIP 394003.161, CIP 393077.159 and L 235-4 are selected for famer's field trial (FFT) and CIP 392244.3 is rejected from the evaluation, and remaining clones are recommended to repeat at the same research station.

Table 1.7: Plant and yield characters of potato clones tested at CVT Nepalgunj, 2068/69

Clones	Emg (%)	Ground cover (%)	Plant unif. (1-5)	Plant height (cm)	Stem/ plant (no.)	LB score (1-9)	Tuber size distribution (No. and % Wt.) US		SS		OS		Total tuber /plot		Yield (t/ha)
							No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	
CIP388676.1	92	74	4	45.5	2.9	8	60	2	151	42	74	56	285	20.8	29.3
PRP225861.2	90	54	3	32.0	2.2	2	57	3	216	75	26	22	299	15.2	21.4
CIP380606.6	99	65	4	52.0	2.5	6	119	5	363	79	24	16	506	16.7	23.3
CIP384321.15	95	49	2	30.5	1.7	2	71	3	210	50	70	47	351	20.9	28.9
MS 35.9	97	68	4	75.8	3.9	2	92	3	299	73	40	24	431	19.9	27.9
PRP 35861.18	96	51	3	36.5	1.8	2	13	1	95	39	56	60	164	17.2	24.2
PRP 225861.5	98	55	4	44.3	2.5	4	50	2	209	71	28	27	287	12.9	18.3
CIP393085.5	98	64	3	71.0	2.0	2	207	6	313	64	50	30	570	22.0	31.0
CIP394003.161	96	73	4	52.2	2.1	8	77	4	229	68	33	28	339	15.9	22.4
CIP393077.159	95	60	4	54.5	2.6	4	185	2	154	50	56	48	254	18.6	25.9
CIP392244.3	95	55	3	46.5	1.9	8	50	5	135	68	24	27	218	8.8	12.7
L235-4	97	66	3	61.0	2.1	0	133	5	289	76	30	19	452	15.8	22.2
Desiree (ch)	96	41	2	43.3	1.6	7	41	8	84	70	13	22	138	5.9	8.6
K. Sindhuri (ch)	93	69	3	62.8	2.3	7	143	11	216	72	20	17	379	10.6	15.1
Lal Gulab (ch)	95	78	4	69.0	2.6	8	499	21	337	68	20	11	856	13.9	19.3
F-Test															**
LSD (0.05)															4.93
CV (%)															15.7

At RARS Tarahara, eleven potato clones were evaluated and compared their plant and tuber characters with Desiree, Kufri Sindhuri and Lal Gulab (Table 1.8). The plant emergence was highest (87%) in the clone CIP 380606.6 followed by CIP 393077.159 (85%). The ground cover was recorded highest (78%) in CIP 384321.15 whereas the highest plant height was measured in CIP 393077.159 (38.5 cm) followed by CIP 380606.6 (38.2 cm). The average number of main stem per plant was counted highest (4) in CIP 380606.6, CIP 393077.159, CIP 388676.1, CIP 393085.5, and Desiree. The plant vigor of the tested clones ranged from 2 to 4 in 1-5 scales. Clones CIP 384321.15, CIP

393077.159, CIP 388676.1 and CIP 393085.5 showed the resistance (2) against late blight disease.

Undersize tuber number was counted highest (138) in PRP 225861.5 but the highest (27%) weight was observed in L 235-4. The number and weight of seed sized tuber was produced the maximum (143 and 82%, respectively) in Desiree whereas the highest number (17) and weight (23%) of oversized tuber produced in CIP 393077.159. Total number of tuber per plot was harvested the highest (227) in L 235-4 but the highest (8.4 kg) tuber weight was harvested from CIP 393077.159. Clone CIP 393085.5 was found highest yielding (13.2 t/ha) genotype whereas the lowest (2.1 t/ha) yielder in local. Based on the plant and yield performance, CIP 392244.3 is rejected whereas CIP 384321.15, PRP 225861.5, MS 35.9, and CIP 393085.5 are selected for farmer's field experiment and remaining clones are will be repeated in next year's experiment.

Table 1.8: Plant and yield characters of potato clones at CVT Tarahara, 2068/69

Clones	Emg. (%)	Ground cover (%)	Plant height (cm)	Stem/ plant (no.)	Plant vigor (1-5)	LB score (1-9)	Tuber size distribution (No. & % wt.)						Total tuber /plot		Adj. yield (t/ha)
							US		SS		OS				
							No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	
CIP380606.6	87	70	38.2	4	2	3	91	15	111	71	9	14	211	6.9	8.7
PRP35861.18	80	60	37.6	3	3	3	76	14	95	74	7	12	179	5.7	10.9
CIP392244.3	78	68	37.7	3	2	3	80	18	64	78	4	4	148	4.3	4.1
CIP384321.15	80	78	28.7	3	3	2	80	17	108	67	16	16	203	6.7	7.6
PRP225861.5	80	60	39.0	3	3	4	138	24	57	59	12	18	207	5.4	10.1
CIP393077.159	85	66	38.5	4	3	2	63	10	113	67	17	23	192	8.4	8.6
L-235-4	69	68	30.5	3	3	4	105	27	109	60	14	12	227	7.2	10.4
CIP388676.1	77	68	26.8	4	3	2	44	7	129	72	15	21	188	6.5	10.6
PRP225861.2	74	45	34.4	3	3	4	39	19	90	65	10	16	139	6.5	10.0
MS35.9	76	60	31.5	3	3	4	83	17	89	68	12	13	184	6.8	9.9
CIP393085.5	70	58	31.2	4	4	2	32	26	71	69	12	14	115	5.2	13.2
Desiree (ch)	79	73	24.1	3	4	4	71	14	143	82	2	4	217	6.9	5.3
K. Sindhuri (ch)	50	59	24.1	3	3	4	69	25	43	67	3	7	115	2.9	3.0
Lal Gulab (ch)	49	43	27.3	4	2	6	96	25	69	59	9	16	174	4.2	2.1
F-Test															**
LSD (0.05)															2.210
CV (%)															29

3.1.1.3 Co-ordinated farmers field trials (CFFTs)

Clones promoted from on-station IETs are tested as CFFTs in different outreach research sites by research partners throughout the country. In addition, 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 in all of these criteria in CFFTs are further verified under farmers' field conditions as farmer's acceptance tests (FATs) prior to release as the commercial varieties.

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 FYM per hector as basal dose in furrow. Seed

size used was 25 to 50 g. All other cultural practices were followed as per NPRP recommendations.

The data collected were:

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 5plants/clone in each replication)
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 in each replications), and
6. Late blight rating (using 1-9 scale)

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. Farmers' reaction
5. Color, shape and eye depth of the tubers

At Pakhribas, six potato clones were evaluated for their plant and tuber characters and compared with commercial varieties (Desiree, Kufri Jyoti and Farmer's Local) at the on-farm research sites of ARS, Dhankuta (Table 1.9). The tuber emergence was highest (96%) in PRP 25861.1 and CIP 389746.2 but the ground foliage was highest (76%) in PRP 25861.1. Similarly, the highest plant uniformity (4) and plant height (48 cm) was observed in PRP 25861.1. However, the main stem per plant was highest (5) in CIP 389746.2. Clones PRP 25861.11, PRP 25861.1 and CIP 389746.2 were found field tolerant (4) to late blight disease where other tested clones were found susceptible.

Table 1.9: Plant and yield characters of potato clones tested at CFFT, ARS Pakhribas, 2068/69

Clones	Emg (%)	Ground cover (%)	Plant uniformity (1-5)	Plant height (cm)	Stem/plant (no.)	LB score (1-9)	Tuber size distribution (No. and % Wt.) US No.	US Wt.	SS No.	SS Wt.	OS No.	OS Wt.	Total tuber/plot No.	Total tuber/plot Wt. (kg)	Adj yield (t/ha)
CIP385499.11	94	48	4	36.8	4	6	152	27	157	63	10.0	10	318	9.5	13.2
CIP393385.39	90	50	4	37.8	4	6	295	32	185	60	11.5	8	491	10.6	14.7
CIP388580.6	94	50	3	36.0	3	5	78	12	129	62	25.8	25	232	11.0	15.3
PRP25861.11	92	45	3	42.7	4	4	191	28	178	63	14.0	10	383	12.0	16.8
PRP25861.1	96	76	4	48.0	3	4	246	30	188	56	9.0	14	443	11.3	15.7
CIP389746.2	96	33	3	37.9	5	4	256	33	176	58	10.3	9	402	12.5	17.3
Desiree (ch)	94	30	3	30.2	4	6	220	32	165	62	6.7	6	391	12.2	16.8
K. Jyoti (ch)	81	28	3	30.3	4	7	118	33	72	57	5.2	10	194	5.0	6.9
F. local (ch)	94	58	4	39.1	3	7	171	38	61	57	3.5	5	235	6.4	8.9
F-Test															**
LSD															5.067
CV (%)															24.8

The number of undersized tuber was counted highest (295) in CIP 393385.39 and the lowest (78) was in CIP 388580.6. But the weight of undersize tuber was highest (38%) in Farmer's local. The number of seed size tuber was highest (188) but the highest weight (63%) of seed tuber was obtained in CIP 385499.11 and CIP 385499.11. Likewise, the maximum number (25.8) and weight (25.4%) of oversize tuber were produced in CIP 388580.6. Total number of tuber production per plot was highest (491) in CIP 393385.39 but the total weight of tuber per plot was obtained the highest (12.5 kg) in CIP 389746.2. CIP 389746.2 produced the highest (17.3 t/ha) yield followed by PRP 25861.11 (16.8 t/ha).

Clones CIP 385499.11, CIP 393385.39 and PRP 25861.11 are selected for farmers acceptance test (FAT) whereas CIP 388580.6 is rejected from the variety evaluation scheme and PRP 25861.1 will be repeated for one season more.

At RARS Lumle, five advanced clones were evaluated in farmer's fields. Different major plant and yield characters were compared with Desiree and Kufri Jyoti varieties (Table 1.10). The highest (100%) plant emergence was recorded in CIP 393233.64 and the lowest (67%) in Kufri Jyoti. Likewise, the ground foliage was highest (74%) in CIP 393280.64 followed by CIP 387115.8LB (73%). The tallest plants (28.4 cm) were measured in CIP 393280.64 and the lowest (11.3 cm) in Kufri Jyoti.

Table 1.10: Plant and yield characters of potato clones in CFFT at Lumle, 2068/69

Clones	Emg. (%)	Ground cover (%)	Plant Ht. (cm)	Tuber size distribution (No. and % Wt.)						Total tuber/plot		Adj Yield (t/ha)
				No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.kg.	
CIP388764.26LB	85	70	26.5	294	36	49	18	41	45	384	8.8	24.6
CIP387115.8LB	92	73	27.6	113	18	34	17	51	64	197	7.6	21.2
CIP393280.64	94	74	28.4	142	21	64	23	80	55	285	9.8	27.2
CIP393637.10	85	56	23.3	124	27	34	25	34	48	192	4.8	13.3
CIP393233.64	100	49	20.6	164	32	53	29	41	39	257	5.9	16.6
Desiree (ch)	88	39	18.8	97	27	24	22	30	51	151	4.1	11.5
K. Jyoti (ch)	67	55	11.3	113	25	23	18	39	57	174	5.1	14.1
F-Test												**
LSD (0.05)												6.247
CV (%)												22.4

The number and weight of undersize tuber was highest (294 and 36%, respectively) in CIP 388764.26LB. Similarly, seed size number was highest in CIP 393280.64 (64) but the highest weight was produced in CIP 393233.64 (29%), respectively. The number and weight of oversize tuber were produced in CIP 393280.64 (80) and CIP 387115.8LB (64%). Total number of tuber produced per plant was highest (384) in CIP 388764.26LB followed by CIP 393280.64 (285). However, the total weight per plot was highest (9.8 kg) in CIP 393280.64 followed by CIP 388764.26LB (8.8 kg).

CIP 393280.64 gave the highest (27.2 t/ha) yield and the lowest (11.5 t/ha) was in check variety Desiree. Based on the analysis of two year's data, CIP 388764.26LB, CIP 387115.8LB, CIP 393280.64 are selected for further test in

farmer's fields whereas CIP 393637.10 will be rejected and CIP 393233.64 is placed for re-testing in farmer's field for the next year.

At ARS Doti, seven advanced potato clones were tested and compared with commercial varieties Desiree and Kufri Sindhuri and local variety for their phenotypic characters (Table 1.11). The plant height was highest (58.5 cm) in Kufri Sindhuri followed by PRP 85861.8 (58.3 cm). The number of main stems per plant was varied from 2 to 4.

Table 1.11: Plant and yield characters of potato clones tested in CFFT at ARS Doti, 2068/69

Clones	Plant height (cm)	Stem plant (no.)	Tuber size distribution (No. and % Wt.)						Total tuber/plot		Adj. yield (t/ha)
			US		SS		OS				
			No	Wt	No	Wt	No	Wt	No	Wt (kg)	
CIP392206.35	49.7	3	140	24	45	23	56	53	241	7.4	8.7
CIP389746.2	57.5	2	68	6	37	9	67	84	216	13.5	16.2
CIP392271.58	52.0	3	77	13	70	32	60	55	207	7.7	8.4
CIP393619.8	45.7	2	74	16	61	28	58	56	193	7.6	8.7
CIP393385.39	52.6	3	114	19	39	23	56	59	209	6.5	6.8
PRP85861.8	58.3	2	200	25	52	21	82	54	334	9.2	10.6
PRP85861.11	57.1	3	155	18	68	27	66	55	289	9.6	12.6
Desiree (ch)	44.3	3	82	13	57	22	86	65	225	9.1	10.3
K. Sindhuri (ch)	58.5	2	163	23	68	30	49	47	279	6.9	8.1
Local (ch)	46.4	4	804	81	28	19	0	0	832	5.1	5.9
F-Test											**
LSD (0.05)											2.804
CV (%)											17.0

The number of undersize tuber was counted highest (804) in local variety and the lowest (74) in clone CIP 393619.8. The number and weight of seed size tuber was highest (70 and 32%, respectively) in CIP 392271.58. In contrast, Desiree gave the highest number (86) of oversize tuber but the highest weight (84%) of oversize tuber was produced by CIP 389746.2. Total tuber number per plot was highest (832) in local variety whereas the total weight per plot was highest (13.5 kg) in CIP 389746.2. CIP 389746.2 gave the greatest yield (16.2 t/ha) followed by PRP 85861.11 (12.6 t/ha) and the lowest (6.8 t/ha) was in CIP 393385.39. CIP 392271.58 and CIP 393619.8 are rejected and remaining clones are recommended for testing one year more in the same research station.

At RARS, Nepalgunj, five advanced potato clones selected from CVTs were tested at the outreach site of RARS Nepalgunj along with three check varieties (Kufri Sindhuri, Desiree and Lal Gulab) (Table 1.12). The plant emergence was highest (100%) in CIP389746.2 and Kufri Sindhuri. The ground cover was highest (48%) in CIP 393385.39 and the lowest (41%) in PRP 85861.11. The plant uniformity remained 2 to 3 (1-5 score) in most of the tested clones. The highest (54 cm) plant height was measured in Lal Gulab followed by Desiree (53 cm). The number of main stem per plant was counted highest (3.7) in PRP 85861.11. All the clones were found resistant to late blight disease in this testing site.

Table 1.12: Plant and yield characters of potato clones in CFFT at RARS Nepalgunj, 2068/69

Clones	Emg. (%)	Grou cov er (%)	Un if. (1-5)	Pl ht (cm)	Ste m/ pt.	LB (1-9)	Tuber size distribution (No. & % Wt.) US		SS		OS		Total tuber/plot		Adj. yield (t/ha)
							No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt(kg)	
PRP85861.11	99	41	3	46	3.7	2	211	21	167	71	7	9	367	9.0	12.4
PRP85861.8	99	43	3	45	3.4	2	147	16	160	78	6	6	313	9.8	13.1
PRP85861.12	99	47	3	44	2.9	2	131	16	175	82	1	3	307	9.7	13.3
CIP393385.39	98	48	2	43	2.7	2	38	4	108	46	47	51	182	14.0	19.9
CIP389746.2	100	47	2	47	3.0	3	76	10	126	89	1	2	196	7.2	10.0
K.Sindhuri (ch)	100	46	3	48	3.2	3	86	14	113	75	6	11	205	8.0	11.2
Desiree (ch)	99	44	3	53	3.0	2	103	16	126	80	3	5	232	7.6	10.4
Lal Gulab (ch)	98	43	3	54	2.5	3	371	33	200	66	1	1	552	10.2	14.0
F-Test															*
LSD (0.05)															5.11
CV (%)															0 26.9

Lal Gulab produced the highest number (371) and weight (33%) of undersize tuber. Likewise, the seed size tuber was produced highest (200) in Lal Gulab but the seed size weight was obtained the highest (89%) in CIP 389746.2. Likewise, CIP 393385.39 gave the maximum number (47) and weight (51%) of oversized tubers. The total number of tuber per plot was produced the highest (552) in Lal Gulab. In contrast, the total weight per plot was highest (14.0) in CIP 393385.39. Tuber yield was found highly significant among the clones. The highest (19.9 t/ha) yield was obtained in CIP 393385.39 and the lowest (10 t/ha) in CIP 389746.2. Clones PRP 85861.12 and CIP 389746.2 are recommended to repeat for next one year whereas the remaining clones are promoted to farmer's acceptance test (FATs).

In Outreach research sites of RARS Tarahara, six advanced potato clones were tested with Desiree, Kufri Sindhuri and Lal Gulab (Table 1.13). Plant emergence was varied from 94% to 100% in the tested clones. However, the highest ground foliage (89%) and plant height (43.8 cm) was observed in CIP 392271.58. The average number of main stem per plant was counted highest (3.2) in CIP 392271.58 followed by CIP 392206.35 (3.1).

Table 1.13: Plant and yield characters of potato clones in CFFT at RARS Tarahara, 2068/69

Clones	Emg. (%)	Ground cover (%)	Plant height (cm)	Stem/ plant (no.)	Tuber size distribution (# & % Wt.) US		SS		OS		Total tuber/plot		Adj yield (t/ha)
					No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	
PRP85861.8	99	66	39.0	2.6	182	47	121	47	11	7	312	7.7	16.1
CIP392206.35	100	76	36.5	3.1	194	47	77	53	0	0	270	4.3	8.8
PRP85861.12	100	69	43.1	2.9	99	24	85	58	13	18	197	6.5	13.5
CIP392271.58	100	89	43.8	3.2	100	35	88	65	0	0	212	6.0	12.6
PRP85861.11	100	73	39.1	2.4	206	21	170	74	8	6	384	9.2	19.2
CIP393619.8	99	70	41.2	2.7	158	88	10	12	0	0	168	1.9	4.0
Desiree (ch)	100	63	33.8	2.3	191	57	69	39	3	4	261	4.9	10.4
K.Sindhuri (ch)	99	50	31.9	2.1	169	82	27	18	0	0	195	2.6	5.5
Lal Gulab (ch)	94	11	24.2	1.2	255	82	21	18	0	0	277	2.4	4.9
F-test													*
LSD (0.05)													8.435
CV (%)													54.9

The undersize tuber number was counted highest (255) in variety Lal Gulab whereas its weight was harvested highest (88%) from CIP 393619.8. The highest number (170) of seed sized tuber and weight (74%) was harvested from PRP 85861.11 but the number and weight of over sized tuber production was

highest (13 and 18%, respectively) in PRP 85861.12. The highest total tuber number (384) and weight (9.2 kg) per plot was harvested in PRP 85861.11. Similarly, PRP 85861.11 was found the highest (19.2 t/ha) yielding genotype followed by PRP 85861.8 (16.1 t/ha). From the evaluation of two year's data, PRP 85861.8 and PRP 85861.11 are selected for farmer's acceptance test (FATs) and remaining clones will be repeated in farmer's field condition in next year.

In CFFT at Nigale, Sindhupalchowk, six potato clones were tested along with Janak Dev and Rosita as check varieties in farmer's fields of Nigale, Sindhupalchowk (Table 1.14). The plant emergence was recorded from lowest (63%) to highest (71%) in the tested clones. But the ground foliage produced in L 235-4 was highest (100%) followed by Rosita (99%). Most of the tested clones had good plant uniformity (5) except in CIP 389746.2 (4) and CIP 393385.39 (4). The tallest plants were measured in PRP 25861.1 (32.2 cm) followed by the Rosita (32.1 cm). The number of main stem per plant was counted the highest (6) in CIP 393385.39.

Table 1.14: Plant and yield characters of potato clones tested at CFFT Nigaley, 2068/69

Clones	Emg (%)	Ground cover (%)	Uni/f (1-5)	Plant ht. (cm)	Stem/ plant (no.)	Tuber size distribution (# & % wt.)						Total tuber/plot		Adj yield (t/ha)
						US		SS		OS				
						No	Wt	No	Wt	No	Wt	No	Wt (kg)	
PRP25861.11	63	95	5	29.8	5	55	4	107	31	100	61	270	18.5	16.7
CIP389746.2	70	84	4	15.9	4	41	4	100	27	78	67	224	18.4	17.1
CIP393385.39	71	89	4	23.2	6	108	8	169	45	65	45	345	16.7	15.8
CIP394050.110	71	95	5	25.3	5	112	8	218	53	66	38	723	17.6	16.5
PRP25861.1	70	98	5	32.2	5	51	4	143	30	98	63	306	21.8	20.4
L235-4	71	100	5	29.6	4	95	9	181	54	50	35	331	13.7	12.9
Janak Dev (ch)	71	93	5	28.8	4	36	4	89	27	84	68	213	16.6	15.3
Rosita (ch)	71	99	5	32.1	5	100	9	171	49	59	42	332	15.4	14.6
F-Test														**
LSD (0.05)														6.09
CV (%)														25.6

The highest (112) number of undersize tuber produced in CIP 394050.110 followed by CIP 393385.39 (108) but the highest (9%) weight was in L 235-4 and Rosita. But the number of seed size tuber produced the highest (218) in CIP 394050.110 but the highest (54%) weight was obtained in L 235-4. The highest number (100) of oversize tubers were produced in PRP 25861.11 but the highest (68%) weight was in Janak Dev. The total number of tuber and weight per plot produced were highest in CIP 394050.110 (723) and PRP 25861.1 (21.8 kg), respectively. Yield was found highly significant in the tested clones. The highest (20.4 t/ha) yield was recorded in PRP 25861.1 followed by CIP 389746.2 (17.1). Hence from the variety evaluation, PRP 25861.11 and CIP 393385.39 are selected for farmers' acceptance test and remaining clones will be repeated at the same research site in next year.

In CFFT at Bonch, Dolakha, five potato clones were planted in farmer's fields and evaluated for their tuber yield and characters along with the commercial

and local varieties in Bonch Farm, Dolakha (Table 1.15). The ground cover was highest (100%) in L 235-4, PRP 25861.1, and commercial varieties Kufri Jyoti and Khumal Laxmi. The plant uniformity remained 2 to 4 in 1-5 scales in all the tested clones but the highest (101.2 cm) plant height was measured in Khumal Laxmi and the lowest (69.7 cm) in L 235-4.

The weight of undersize tuber was obtained highest (57%) in L 235-4 and the lowest (27%) in Rosita. Likewise, the highest weight of seed and oversize tuber were produced the highest (48%) in Khumal Laxmi and Rosita and Kufri Jyoti (41), respectively. The maximum (474) number of tuber per plot was counted in L 235-4 followed by Kufri Jyoti (404). But the highest (18 kg) tuber weight per plot was obtained in Kufri Jyoti followed by PRP 25861.1 (17 kg).

Table 1.15: Plant and yield characters of potato clones tested at CFFT Bonch, 2068/69

Clones	Ground cover (%)	Plant unif. (1-5)	Plant ht. (cm)	Tuber distribution (% wt.)			Total tuber /plot		Adj. yield (t/ha)	Plant appearance (1-5)	Yield appearance (1-5)	Cooking quality (1-5)	Tuber appearance (1-5)
				US	SS	OS							
				Wt	Wt	Wt	No.	Wt					
L 235-4	100	4	69.7	57	33	10	474	12	18.3	3	2	2	2
PRP25861.1	100	4	93.5	32	32	36	281	17	23.8	3	3	3	4
CIP389746.2	95	4	80.9	35	41	24	181	12	14.2	4	4	4	3
CIP393385.39	99	2	74.7	28	47	25	274	14	18.4	3	3	3	3
PRP25861.11	93	4	87.5	33	44	24	239	14	19.5	3	4	3	3
K. Jyoti (ch)	100	4	72.5	20	40	41	404	18	21.6	4	4	3	3
K. Laxmi (ch)	100	4	101.2	45	48	8	251	8	8.0	4	3	2	2
Rosita (ch)	78	3	82.0	27	48	26	351	15	22.0	4	4	4	4
F-Test									**				
CV %									31.8				
LSD (0.05)									13.67				

Total yield per plant significantly varied among the clones. The highest (23.8 t/ha) yield was recorded in PRP 25861.1 and the lowest (8.0 t/ha) in Khumal Laxmi. The plant, yield and cooking quality assessment were good (4 in 1-5 score) in CIP 389746.2. However, the tuber appearance was good (4 in 1-5 score) in PRP 25861.1 which was similar to the tuber of Rosita (4 in 1-5 scales). Based on the evaluation, PRP 25861.11 is selected for farmers' acceptance test and remaining clones are recommended to test one year more in the same testing region.

In ARS Belachapi, four potato clones were tested along with the Kufri Jyoti and farmers' local. PRP 266264.15 showed the resistance to late blight disease as compared to Lal Gulab in the field condition (Table 1.16). PRP 266264.15 gave the highest tuber yield (17.8 t/ha) followed by Kufri Jyoti (17.3 t/ha).

Table 1.16: Yield characters of potato clones at ARS Belachapi, 2068/69

Clones	LB (1-5 scale)	Yield (kg/plot)	Adj. yield (t/ha)
PRP 25861.10	5	8.6	14.3
CIP 393280.57	8	3.8	6.3
PRP 266264.15	2	10.7	17.8
L 235-4	5	8.7	14.4
Kufri Jyoti (ch)	2	10.4	17.3
Lal Gulab (ch)	7	6.8	11.4

Seven promising potato genotypes were tested further at farmer's field trial, Humla where Janak Dev, Kufri Jyoti and Local were used as checks (Table 1.17). The tuber emergence was highest (91%) in CIP 388580.6 followed by CIP 393385.39 (86%). The ground cover was highest (90%) in PRP 25861.11 followed by PRP 25861.1 (89%) and the least was in Kufri Jyoti (60%). The plant uniformity was highest (5) in CIP 388580.6 but the number of main stem per plant was highest (5) in CIP 385499.11.

Variation on tuber size distribution was observed among the potato clones. The number and weight of undersize tuber was highest (195 and 27%, respectively) in CIP 394050.110. However, the number of seed size tuber produced the highest (171) in L 235-4 and the lowest (53) in PRP 25861.1. The highest (168) number of oversized tuber recorded in CIP 388580.6 but the highest (75%) weight was in Janak Dev. Total number and weight of tuber produced the highest (504 and 21.3 kg, respectively) in CIP 388580.6. Similarly, the highest yield (19.2 t/ha) was recorded in CIP 388580.6 and the lowest (5.6 t/ha) in Kufri Jyoti.

The farmers' preference on plant appearance, cooking qualities and taste was observed among the clones (Table 1.17). The plant appearance was good (1) in CIP 385499.1 and Kufri Jyoti. Likewise, the cooking qualities and tuber taste were good (1) in CIP 385499.1. As compared to improved potato clones, the local was rated as poor plant appearance, cooking and taste qualities. Based on this data, clones CIP 385499.11, PRP 25861.1 and CIP 388580.6 will be further tested in farmer's acceptance test (FATs) in similar agro-ecologies.

Table 1.17: Plant and yield characters of potato clones tested at CFFT, Jumla, 2068/69

Clones	Emg (%)	Grd cvr (%)	Unif (1-5)	St/pt (no.)	Tuber size distribution (No. and % Wt.)						Total tuber		Adj yield	Farmers' preference (1-3)		
					US		SS		OS							
					No	Wt	No	Wt	No	Wt	No	Wt (kg)	(t/ha)	Appearance	Cooking qualities	Taste
CIP385499.11	79	86	4	5	177	16	126	28	118	56	421	16.5	13.8	1	1	1
L235-4	73	80	2	3	193	16	171	33	109	52	472	16.5	15.0	2	2	3
PRP25861.11	78	90	4	5	179	14	134	31	96	55	409	17.2	13.3	2	2	2
CIP394050.110	44	66	3	4	195	27	91	38	51	35	372	10.1	6.1	2	1	2
CIP388580.6	91	75	5	4	173	14	71	27	168	59	504	21.3	19.2	2	1	2
PRP25861.1	80	89	4	4	157	13	53	22	106	66	351	16.5	15.2	2	2	2
CIP393385.39	86	76	4	4	154	19	126	26	103	55	376	15.1	13.7	2	1	2
Janak Dev (ch)	59	61	3	3	64	9	163	16	90	75	207	11.2	6.5	2	2	2
K. Jyoti (ch)	58	60	2	4	104	12	88	24	75	64	249	11.2	5.6	1	2	2
Local (ch)	46	68	3	3	145	18	119	27	88	56	324	12.1	7.9	3	3	3
F-Test													**			
LSD													5.8			
CV (%)													34			

3.1.2 True Potato Seed (TPS) Research

3.1.2.1 Evaluation of TPS families for seedling tuber production in the nursery bed

Introduction

This experiment was conducted at NPRP, Khumaltar; RARS Nepalgunj 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 Nepalgunj 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 29th January, 2012 and harvesting in June 13, 2012. After proper germination, hundred plants were maintained per plot in each treatment. The highest number of stems per plant (1.8) was recorded in the family C96H-13.29 x TPS-13 followed by C98HT-200.14 x C99HT-2-58.1(1.6) and HPS7/67 (1.6) (Table 2.1). The highest plant height (84.80 cm) was observed in the family C96H-02.7 x TPS-13, whereas the highest (66.47 cm) in

the family HPS-7/67. TPS family LT-8 x TPS-67 produced the maximum numbers of smallest (>20 g) seedling tubers (338.3) and highest tuber yield (>20 g) was (1.3 kg/plot).The lowest numbers (63) per plot and tuber yield (0.4 kg) was recorded in the family C96H-02.7 x TPS -13. It might be due to the more vegetative growth and plant height. The highest tuber numbers (300.3) and highest tuber yield (6.9 kg/plot) was in the family C96H-02.4 x C98HT-64.8 and the lowest numbers per plot (99) and tuber yield (2.8 kg) was recorded in the family C96H-02.7 x TPS-13 of 20-40 g seedling tubers.

The highest tuber yield (1.4 kg/plot) and tuber numbers (14.6) of tuber size <40 grams was recorded in the family C96H-02.4 x C99HT-2-58.1, whereas the lowest number (4) and yield (0.3 kg) in HPS-II/67. The highest tuber numbers (625/plot) was recorded in the family LT 8 x TPS-67, but the highest tuber yield (8.37 kg/plot) was in the family C96H-02.4 x C98HT-64.8. The lowest tuber numbers (172) and tuber yield (4.03 kg) was in the family C96H-02.7 x TPS–13. The tuber numbers among the TPS genotypes were statistically significant whereas yield was not significant.

Table 2.1: Yield and yield attributing parameters in TPS Family of potato at Hattiban, 2068/69

Treatments	Emerge per %	Stem / plant	Plant ht (cm)	Undersized (<20 g) tubers/plot		Seed sized (20-40 g) tubers/plot		Over sized (>40 g) tubers/plot		Total yield	
				No.	Yield	No	Yield	No	Yield	No	Kg/plot
C96H-02.7 x TPS - 13	100	1.5	84.80	63.00	0.4	99.00	2.8	9.67	0.8	172	4.03
C96H-13.29 x TPS - 13	100	1.8	79.00	140.7	0.6	225.7	6.1	14.3	1.4	381	8.10
C96H-02.4 x C98HT-64.8	100	1.4	77.07	215.0	0.9	300.3	6.9	8.33	0.6	524	8.37
C96H-02.4 x C99HT -2-32.17	100	1.5	71.80	164.0	0.5	249.0	5.4	12.3	1.0	425	7.0
C96H-02.4 x C99HT-2-58.1	100	1.4	81.33	180.0	0.7	232.7	5.4	14.6	1.4	427	7.53
C98HT-2(0.14 x C99HT-2-58.1	100	1.6	70.73	151.0	0.6	182.3	4.5	11.6	0.9	345	6.07
LT 8 x TPS-13	83.33	1.4	74.20	179.7	0.7	198.7	4.7	8.6	0.8	387	6.20
LT 8 x TPS-67	100	1.4	70.27	338.3	1.3	284.0	6.4	4.2	0.3	625	7.88
MT II x TPS - 67	100	1.4	72.67	230.7	0.7	272.3	6.0	10.6	1.0	514	7.67
TPS 7 x TPS -67	100	1.4	71.80	334.3	1.3	265.0	6.4	5.6	0.4	605	8.13
HPS II/67	100	1.4	70.87	205.3	0.8	166.7	3.7	4.0	0.3	376	4.77
HPS 7/67	100	1.6	66.47	267.7	1.1	244.0	5.4	6.0	0.4	518	6.87
F-value	0.003	0.001	0.032	<.001	<.001	0.012	0.037	0.23	0.02	<.1E-0	0.073
LSD(0.05)	7.467	0.204	9.787	74.99	0.348	95.64	2.235	9.08	0.71	148.6	2.832

Nepalgunj

Seeds of twelve hybrid TPS families namely C96H-02.7x TPS-13, C96H-13.29 x TPS-13, C96H-02.4x C98HT-64.8, C96H-02.4 x 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 28 Kartik, 2068 and harvested on 22 Falgun, 2068. Other cultural practices were adopted as recommendation made by NPRP. The highest percent of germination (100) was recorded in the family LT8× TPS-13, HPS II/67 and HPS 7/67, whereas the lowest (34) was in C96H 02.7 x TPS-13 (Table 2.2).

The highest percentage of ground coverage (55) was in C96H-02.4 x C98HT-64.8 and the lowest (41.7) was in C98HT 200.14 x C99HT 2-58.1. Uniformity was found different among the families. Plant height was maximum (38.0 cm) in the family C96H-02.4x C99HT-2-32.17 and the minimum (19.0 cm) was recorded in C96H-13.29 x TPS-13. The highest tubers (422) and yield (1.79 kg) were produced in family HPS 7/67. The lowest tubers (78/plot) and yield (0.180 kg/plot) was recorded in the family C96H-13.29x TPS-13. The total number of tubers and yield per plot was statistically significant among the TPS families.

Table 2.2: Yield and yield attributing parameters in TPS Family of potato at Nepalgunj, 2068/69

Treatments	Potato Emerg. %	G.Cov erage %	Unifer mity (1-5)	Stem /plant	Plant ht (cm)	Late blight	Yield per plot	
							No	Yield (kg)
C96H 02.7 x TPS-13	34.0	45.0	1.7	1.3	28.7	1.0	95.3	0.837
C96H 13.29 x TPS-13	58.0	43.3	2.3	1.5	19.0	2.0	78.0	0.180
C96H 02.4 x C98HT 64.8	76.0	55.0	2.7	1.5	30.7	1.0	169.7	1.190
C96H 02.7 x C99HT 2- 32.17	69.3	45.0	3.3	1.7	38.0	1.0	302.3	1.792
C96H 02.4 x C99HT 2-58.1	42.7	46.7	2.0	1.7	24.3	1.3	169.0	0.675
C98HT 200.14 x C99HT 2-58.1	59.7	41.7	2.0	1.4	33.3	1.6	179.7	0.398
LT-8 x TPS-13	100.0	51.7	4.0	1.3	37.3	2.3	252.3	1.481
LT-8 x TPS-67	70.0	45.0	3.7	1.5	42.7	3.3	403.7	1.384
MF-II x TPS-67	82.0	46.7	3.3	1.5	28.7	2.0	242.7	0.815
TPS-7 x TPS-67	81.7	51.7	3.3	1.5	23.3	2.3	372.3	1.143
HPS-II/67	100.0	51.7	4.0	1.2	30.0	2.6	329.0	1.147
HPS-7/67	100.0	51.7	4.0	1.2	36.7	2.6	422.0	1.792
F-value	0.014	0.128	<.001	0.493	0.152	<.001	<.001	<.001
LSD(0.05)	37.09	9.350	0.747	0.446	15.71		98.12	0.5007
CV %	30.1	11.5	14.6	18.0	29.9		23.1	27.8

Jumla

Seed sowing was done on 3rd Chaitra, 2068 and harvesting was on 8th Aswin, 2069. 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 90 percent in germination of TPS families except genotype 902007 and crop stand was good due to regular rain fall.

Results of total tubers per plot showed that family number 994014 produced the highest numbers (231.7/m^2) of tubers followed by 903051 (217.3/m^2), but in tuber yield, 994013 produced the highest tuber yield (4.69 kg/plot) followed by 994014 (4.19 kg/plot) (Table 2.3). The lowest tuber numbers (87.3/m^2) and tuber yield (1.86 kg/m^2) was in 902007. It might be due to the poor germination. Tuber yield and tuber number both were statistically significant among TPS families evaluated in the trial.

Table 2.3: Evaluation of TPS families for seedling tuber production at ARS Jumla, 2068/69

Entries	Emer-gence %	Unif Rmity	GC (%)	Plant ht (cm)	Main stems /plant	Plant Type	Flowering catagory	Tuber shape	Tuber color	Total tubers /plot	Tuber wt /plot (kg)
902007	47.3	3.3	64.3	77.0	3.3	E	M	Round	W	87.3	1.86
902014	91.7	4.7	81.7	80.7	2.3	E	M	Round	W	152.0	2.54
903027	83.3	4.0	95.0	71.0	2.0	E	M	Round	W	189.7	2.86
903035	98.3	5.0	98.3	50.3	2.0	E	M	Round	W	157.7	2.83
903051	98.3	4.3	95.0	89.7	2.0	E	M	Round	W	217.3	3.74
903135	85.0	4.3	88.3	65.0	2.0	E	M	Round	W	149.3	2.52
994013	100.0	5.0	98.3	77.7	3.0	E	M	Round	W	190.7	4.69
994014	100.0	5.0	98.3	76.0	2.3	E	M	Round	W	231.7	4.19
988141	100.0	5.0	95.0	64.3	2.7	E	M	Round	W	180.7	3.08
988143	95.0	5.0	96.7	68.0	2.7	E	M	Round	W	181.0	2.41
HPS 2/67	93.3	4.7	95.0	66.0	2.3	E	M	Round	W	148.7	2.54
HPS 7/67	95.0	5.0	96.7	61.3	2.7	E	M	Round	W	187.0	2.46
F-value	0.004	<.001	<.001	0.076	0.054					<.001	<.001
LSD 0.05	22.46	0.653	7.083	21.32	0.855					46.07	1.064
CV %	14.6	8.4	4.6	17.8	20.7					15.7	21.1

3.1.2.2 Evaluation of F_1C_1 tuberlets of TPS for potato production

Introduction

This experiment was conducted at NPRP, Khumaltar; RARS, Nepalganj, 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, Janak Dev, Lalgulab and Jumla local were used as check varieties. Size of each plot was 3 m x 2.4 m (7.2 m^2). Seed tubers 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 1st Feb, 2012 and harvesting was done in 4th June, 2012. The emergence count was not significantly different among TPS tuber lets. Percent of ground coverage was the highest (83.33) on both C96H-02.4 x C98HT-64.8 and MF-II× TPS-67, but the lowest (71.67) was recorded in the family TPS-7 × TPS-67. The plant uniformity was good in most of the genotypes (Table 2.4).

Table 2.4: Yield and yield attributing parameters in TPS F_1C_1 generation of potato at Khumaltar, Hattiban, 2068/69

Treatments	Emer-gence Count	Ground covera ge %	Unifor mity (1-5)	Stem/ plant (No.)	Plant height (cm)	Tuber no./ plot	Tuber yld (kg) /plot
1. C96H-02.7x TPS - 13	41.33	76.67	4.3	2.1	81.67	340	14.20
2. C96H-13.29x TPS - 13	41.67	75.00	4.3	2.5	86.13	322	16.60
3. C96H-02.4x C98HT-64.8	42.33	83.33	5.0	2.3	71.40	381	15.10
4. C96H-02.4x C99HT -2-32.17	42.67	75.00	4.0	2.3	97.00	272	11.83
5. C96H-02.4x C99HT-2-58.1	40.33	78.33	4.3	2.1	96.00	336	16.40
6. C98HT-200.14xC99HT-2-58.1	40.67	75.00	3.3	3.0	81.80	212	9.10
7. LT 8x TPS-13	42.00	81.67	5.0	2.5	93.13	454	18.57
8. LT 8 xTPS-67	38.67	76.67	4.7	2.5	74.73	460	14.90
9. MF II x TPS - 67	42.00	83.33	5.0	2.3	92.40	408	15.33
10.TPS 7 x TPS -67	43.00	71.67	3.3	3.0	78.40	406	11.57
11.HPS II/67	40.33	78.33	4.7	2.4	83.67	329	12.60
12. HPS 7/67	39.33	76.67	4.0	3.0	79.40	432	12.63
13. Janak Dev	42.00	81.67	4.0	3.5	74.33	321	15.73
14 Kufri Jyoti	42.67	73.33	4.0	3.0	67.80	526	26.83
F-value	0.630	0.001	0.010	<.001	<.001	0.001	<.001
LSD(0.05)	4.189	5.315	0.9447	0.410	8.978	118.3	5.675
CV %	6.0	4.1	13.1	9.5	6.5	19.0	22.4

The highest plant height (97.0 cm) was recorded in C96H-02.4x C99HT -2-32.17 and the lowest (67.80 cm) in check variety Kufri Jyoti. The highest tuber per plot (526.0) was recorded in Kufri jyoti followed by LT 8 x TPS-67 (460.0) and highest yield (26.83 kg/plot) were in check variety Kufri jyoti followed by LT 8 x TPS-13 (18.57 kg/plot). But, family C98HT-200.14 x C99HT-2-58.1 produced the lowest tubers (212.0) and yields (9.10 kg/plot). Both tubers and yield per plot were statistically significant.

Nepalgunj

In Nepalgunj, more than 75 percent emergence count was recorded in different genotypes. (Table 2.5). It was found statistically significant. Percent of ground coverage (80.0) was significantly highest on TPS-7xTPS-67 followed by Lalgulab (76.7), but the lowest (53.3) was recorded in the familiy C96H 13.29 x TPS-13.

Table 2.5: Yield and yield attributing parameters in TPS F_1C_1 generation of potato at Nepalgunj, 2068/69

Treatments	Emergence count	Ground coverage %	Uniformity (1-5)	Stems/plant (No)	Plant height (cm)	Tubers/plot	Tuber yield (kg)/plot)
TPS 7 x TPS 67	42.67	80.0	3.3	1.8	56.0	433.0	10.87
MF II× TPS 67	35.67	63.3	3.0	1.7	53.3	336.7	11.90
C96H 02.4 x C99HT	38.00	63.3	3.3	2.0	58.7	246.3	14.37
C96H 13.29 x TPS 13	33.67	53.3	2.7	1.7	47.3	265.0	9.87
C96H 02.4 x C99HT2-	40.67	60.0	3.7	1.5	58.7	270.0	15.50
LT 8 x TPS 13	45.33	65.0	4.0	2.0	65.3	288.7	13.47
LT 8 x TPS 67	41.67	71.7	3.7	2.4	57.7	330.7	11.60
HPS II/67	41.67	73.3	3.3	2.0	52.3	334.3	12.50
C98HT 200.14 x	31.00	43.3	2.7	1.3	54.7	156.3	6.93
C96H 02.4 x C99HT	30.67	48.3	2.0	1.4	47.0	259.3	12.73
C96H 02.7 x TPS 13	38.67	58.3	3.3	2.1	54.7	320.7	14.63
HPS 7/67	37.00	73.3	3.3	1.7	42.3	448.0	12.00
Lal Gulab	46.00	76.7	4.0	2.3	67.3	811.0	12.73
F-value	0.004	<.001	0.020	0.027	0.004	<.00	<.001
LSD(0.05)	7.708	10.63	1.006	0.608	10.89	51.05	2.981
CV %	11.8	9.9	18.3	19.5	11.7	8.8	14.5

Uniformity was highest (4.0) on LT 8 x TPS 13 and Lalgulab. The highest stems per plant (2.4) were in LT 8 x TPS 67 and minimum (1.3) on C98HT 200.14 x C99HT 2-32.17. Plant height differences among the TPS families were statistically significant (Table 4.5). Plants of Lal Gulab were the tallest (67.3 cm) followed by LT 8 × TPS-13 (65.3 cm). The shortest (42.3 cm) was on HPS7/67. Late blight disease was not observed till 90 days. The highest tubers (811.0) and yield (15.50 kg /plot) was recorded in Lal Gulab and C96H 02.4 x C99HT2-32.17, repectively, but family C98HT 200.14 x C99HT 2-32.17 produced the lowest tubers (156.3) and yield (6.93 kg/plot). The tuber number and yield per plot were found statistically significant.

ARS, Jumla

More than 80 percent germination was found in genotypes planted in Jumla condition (Table 2.6). Uniformity was highest (5.0) in genotypes 903027, 902007 and Desiree and the lowest (3.7) were in 994014. The highest percent of ground coverage (91.67) was in 994013, 903027 and 902007, but the lowest

(78.33) was recorded in Jumli Local. The highest stems per plant (5) were in Jumli Local and the lowest (2.3) in the family 903135.

Table 2.6: Yield and yield attributing parameters in TPS F_1C_1 generation of potato at ARS, Jumla, 2068/69

Entries	Emergence count	Uniformity (1-5)	GC (%)	Pt ht (cm)	Stems /plant (No)	Pt type	Flowering cata.	Tuber color	Total tubers /plot	Tuber wt /plot (kg)
988141	43.33	4.3	88.33	41.7	3.7	E	M	W	306.7	13.37
994013	46.67	4.7	91.67	43.0	3.7	E	M	W	284.7	14.79
903051	40.67	4.7	88.33	50.0	3.7	E	M	W	280.7	15.71
988143	37.67	4.7	88.33	31.7	3.3	E	M	W	329.7	12.90
903135	41.67	4.0	85.00	35.0	2.3	E	M	W	205.0	9.66
994014	38.00	3.7	85.00	28.0	3.3	E	M	W	293.3	11.53
HPS-II/67	43.67	4.7	88.33	39.3	3.0	E	N	W	302.3	13.62
903035	41.00	4.3	88.33	47.0	4.3	E	M	W	227.0	12.67
903027	43.33	5.0	91.67	56.0	4.0	E	N	W	332.3	16.35
902007	39.00	5.0	91.67	50.3	3.0	E	M	W	309.0	15.44
J. Local	47.00	4.0	78.33	39.0	5.0	E	M	W	371.7	15.01
Desiree	47.00	5.0	85.00	31.0	3.7	E	F	R	329.0	12.68
F-value	0.011	0.019	0.305	<.001	0.273				0.002	0.389
LSD (0.05)	5.546	0.765	9.887	10.51	1.738				66.44	5.326
CV %	7.7	10.1	6.7	15.1	28.6				13.2	23.1

Plant height was the highest (56 cm) in the family 903027 and the lowest (28 cm) in 994014. Late blight disease was not observed till 90 days. The highest tubers per plot (371.7) was recorded in Jumli Local followed by 903027 (332.3), whereas the lowest numbers was in 903135 (205.0). The tuber yield was the highest (16.35 kg/plot) in 903027 and the lowest tuber yield (9.66 kg/plot) in the family 903135. The yield per plot was statistically not significant.

3.1.3 Study on Variety Improvement of Potato for Processing

3.1.3.1 Evaluation of potato cultivars for yield and processing qualities at Khumaltar

Processing is an important value addition function of marketing. In most of the developed and developing countries, potato is now processed prior to consumption. More than 50% potato crop is processed in USA and nearly 30% in the United Kingdom (Pandey *et al.*, 2000). Among various processed products, the demand of potato chips are most important and gaining popularity in Nepal due to changing the food habits, urbanization and easy and ready to serve food. This is likely to increase further more in the future. The estimated supply of potato chips in Nepalese market is approximately 48% from Indian product, 32% from Chaudhary group and 20 % from local cottage industries. The imported quantity and value of potato chips was about 885.38 tons with worth NRs. 336.52 million during 2010/11 (MoAC, 2011).

For processing potato into chips in commercial scale, Nepal imports potato varieties Kufri Jyoti and Atlanta from India. But large numbers of cottage industries use local potato whenever available for the preparation of chips, resulting to the poor quality, color and low market price. For the preparation of chips, potato should have round or oval shaped tubers and fleet eyes, high dry-matter content and specific gravity and low reducing sugars. These quality parameters get affected by growing conditions, locations and season. Amoros *et. al.*, 2000 reported that genotypes and environment (G x E) interaction affects dry matter, glucose content and chips color significantly. In Nepal, no any study was conducted on variety for processing purpose in the past. So this study was carried out to evaluate promising genotypes for yield, storability and processing quality of potato into chips.

The experiment was laid out in Randomized Complete Bloch Design (RCBD) with three replications. Nine potato genotypes were planted in third week of January at Hattiban Farm (1340 m asl), Lalitpur, 2012. Tubers were planted in 10 m^2 (3.0 m x 3.5m) plot size at a spacing of 60 x 25. Fertilizers were applied @ 150:100:60 kg NPK ha^{-1} plus with 20 t/ha FYM. All doses of manure and fertilizers were applied before planting the crops. Irrigation was given at 10, 45, 65 and 85 days after plating and while earthing –up was done at 47 and 67 days after planting. The crop was harvested 122 days after planting (24th May). Observations were recorded on tuber characters, yield and yield attributing parameters. Chips quality parameters as dry matter, specific gravity and reducing sugar were also recorded for selection of genotypes.

Plant and tuber characteristics

Significant variation was recorded on emergence percentage at 30 days after planting among the genotypes (Table 3.1). However, no significant variation was observed at 45 days after planting. Similarly, there was significant variation on plant vigor at 75 and 100 days, plant uniformity at 100 days, plant height at 75 days and ground covers at 100 but no variation was recorded on ground

covers at 75 days, plant height at 100 days and numbers of stems at 100 days after planting (Table 3.1 and 3.2). Genotypes PRP 25861.1 and HPS-7/67 had erect plant; HPS-II/67, L-235.4 and Kufri Chipsona-2 had semi erect; Kufri Jyoti, BSU-PO_3 and Yagana had profuse and Khumal Seto-1 had tall and prostrate plant type. Four genotypes showed late maturity and five genotypes were medium maturity. The detail is given in Table 3.3.

Table 3.1: Effect of potato genotypes on emergence, plant vigour and uniformity at different days after planting at Hattiban Farm, Khumaltar, 2011/12

Treatments	Emergency (%)		Plant vigour (1-5 scales)		Plant uniformity (1-5 scales)	
	30 DAP	45 DAP	75DAP	100DAP	75DAP	100 DAP
Kufri Jyoti	53.9 *ab*	88.3	5.00 *a*	4.67*ab*	4.50	4.83 *ab*
HPS-II/67	60.0 *a*	88.4	3.67 *bc*	4.67 *ab*	3.67	3.83 *c*
Khumal Seto-1	48.3 *abc*	93.3	4.67 *a*	4.67 *ab*	4.67	4.50 *abc*
L-235.4	29.4 *e*	86.1	3.67 *bc*	4.33 *ab*	3.67	4.50 *abc*
BSU-PO_3	25.0 *e*	84.4	3.67 *bc*	4.0 *bc*	4.00	4.33 *abc*
Yagana	49.4 *abc*	77.2	3.00 *c*	3.33 *c*	4.33	4.17 *bc*
PRP 25861.1	41.1 *cd*	87.8	5.00 *a*	5.0 *a*	4.67	4.83 *ab*
HPS-7/67	32.8 *de*	93.3	4.00 *b*	4.67 *ab*	3.33	4.17 *bc*
K. Chipsona-2	42.2 *bcd*	91.7	4.00 *b*	4.67 *ab*	4.33	5.00 *a*
F-test	***	NS	***	*	NS	*
LSD	11.10	13.37	0.6662	0.8654	1.157	0.6740
CV (%)	15.1	8.8	9.4	11.3	16.2	8.7

Table 3.2: Effect of potato genotypes on ground coverage, plant height and stem no. at different days after planting at Hattiban Farm, Khumaltar, 2011/12

Treatments	Ground cover (%)		Plant height (cm)		Stem no. /plant
	75 DAP	100 DAP	75 DAP	100 DAP	
Kufri Jyoti	81.7	91.7 *a*	50.5 *abc*	80.8	4.60
HPS-II/67	76.7	88.3 *ab*	52.5 *ab*	86.1	4.80
Khumal Seto-1	80.0	91.7 *a*	58.6 *a*	79.5	4.27
L-235.4	58.3	63.3 *d*	40.2 *c*	58.1	4.33
BSU-PO_3	55.0	78.3 *bc*	46.8 *bc*	75.9	4.43
Yagana	61.7	90.0 *a*	41.1 *c*	76.5	4.20
PRP 25861.1	68.3	73.3 *cd*	44.9 *bc*	72.2	4.33
HPS-7/67	75.0	83.3 *abc*	49.8 *abc*	72.8	4.50
K. Chipsona-2	76.7	86.7 *ab*	45.1 *bc*	71.9	5.27
F-value	NS	***	*	NS	NS
LSD	26.45	10.03	9.61	20.52	1.152
CV (%)	21.7	7.0	11.6	15.8	14.4

Table 3.3: Effect of potato genotypes on vegetative characteristics tested at Hattiban Farm, Khumaltar, 2011/12

Genotypes	posture #	maturity♦	General appearance*
Kufri Jyoti	P	M	3
HPS-II/67	SE	L	2
Khumal Seto-1	TP	M	3
L-235.4	SE	M	3
BSU-PO3	P	L	3
Yagana	P	M	3
PRP 25861.1	E	M	3
HPS 7/67	E	L	3
K.Chipsona-2	SE	L	3

E= Erect, SE= Semi erect, P= Prostrate andTP= Tall and prostrate
♦ M=Medium (110-135 days) and L= Late maturity (>135 days). * 1=Poor, 2=Fair and 3= Good.

Tuber Characteristics

Except PRP 25861.1, all other genotypes have white skin color. Variation was recorded on the shape of tubers. Four genotypes had round and five genotypes had oval tuber shape. General tuber appearance was observed well in all genotypes except HPS-II/67. Eye depth was recorded shallow in six genotypes and medium in three genotypes. Despite white skin color, variation was observed on flesh color among the genotypes. The flesh color was observed 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 characteristics of tubers are displayed in Table 3.4.

Tuber distribution and yield

There was no variation on percentage of tuber numbers on less than 30 g and 30-60 g, but showed variation on numbers of more than 60g tubers. The maximum tuber number percentage (2.97%) was recorded in Kufri Jyoti followed by PRP 25861.1 (2.23%), whereas the minimum (0.97%) in L-235.4. The weight of 30-60 g. and more than 60 g. grades tubers yield showed significant differences among the genotypes. Kufri Jyoti produced the maximum yield (27.61 t ha^{-1}) of more than 60 g tubers whereas it was the minimum (11.0 t ha^{-1}) on Yagana. The genotypes showed the significant variation on total yield of potato (Table 3.5). The highest yield (49.52 t ha^{-1}) was recorded on genotype L-235.4 and it was at par with Kufri Jyoti. The lowest tuber yield (30.56 t ha^{-1}) was observed on genotype Yagana.

Table 3.4: Effect of potato genotypes on tubers characteristics tested at Hattiban Farm, Khumaltar, 2011/12

Genotypes	Skin color	Tuber shape	Eye depth*	Flesh color	Skin surface
Kufri Jyoti	White	Oval	S	White	Smooth
HPS-II/67	White	Round	S	L. yellow	Smooth
Khumal Seto-1	White	Round	S	White	Smooth
L-235.4	White	Oval	M	L. yellow	Smooth
BSU-PO_3	White	Round	S	L. yellow	Smooth
Yagana	White	Oval	S	Yellowish	Very Smooth
PRP 25861.1	Red	Oval	M	L. yellow	Smooth
HPS-7/67	White	Round	M	Yellowish	Smooth
K.Chipsona-2	White	Oval	S	L. yellow	Rough

* S= Shallow and M= Medium

Table 3.5: Effect of potato genotypes on percentage of tuber size distribution and weight (t/ha) at Hattiban Farm, Khumaltar, 2011/12

Treatments	Tuber size distribution (%)			Tuber weight (t ha^{-1})			Adj. yield (t/ha)
	<30 g	30-60 g	>60 g	<30 g	30-60 g	>60 g)	
Kufri Jyoti	54.7	42.4	2.97 *a*	5.76	16.12 *bc*	27.61 *a*	49.49 *a*
HPS-II/67	62.6	35.8	1.57 *cd*	7.40	16.04 *bc*	18.08 *bc*	41.52 *bc*
Khumal Seto-1	56.5	41.7	1.73 *bc*	8.20	17.96 *bc*	15.92 *cd*	42.08 *bc*
L-235.4	64.3	34.7	0.97 *d*	11.48	22.52 *a*	15.52 *cd*	49.52 *a*
BSU-PO_3	57.7	40.8	1.53 *cd*	6.08	17.64 *bc*	15.00 *cd*	38.72 *c*
Yagana	63.8	34.9	1.33 *cd*	7.60	11.96 *d*	11.00 *d*	30.56 *d*
PRP 25861.1	55.6	42.2	2.23 *b*	7.52	18.88 *b*	22.44 *b*	46.84 *ab*
HPS-7/67	59.5	39.0	1.57 *cd*	6.28	15.60 *bc*	16.52 *c*	38.40 *c*
K. Chipsona-2	62.8	35.8	1.50 *cd*	8.20	14.88 *cd*	15.36 *cd*	38.44 *c*
F- value	NS	NS	***	NS	***	***	***
LSD	13.62	13.39	0.625	0.029	3.338	4.482	5.173
CV (%)	13.2	20.0	21.1	3.193	11.4	14.8	7.2

Processing Qualities

For processing of potato into chips, dry matter, specific gravity and reducing sugars play important role. The DM content determines the yield of chips, oil uptake and crispness of fried product where as reducing sugars (glucose and fructose) content of potato is responsible to color and quality of chips. 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 dry matter, specific gravity and reducing sugars showed significant variation among the genotypes.

The highest dry matter (19.92%) and specific gravity (1.0723) was observed on genotype PRP 25861.1 and the lowest (16.50 and 1.0580) on North Indian processing variety Kufri Chipsona-2 (Figure 3.1 and 3.2). It could be due to inadaptability of this variety in hill condition.

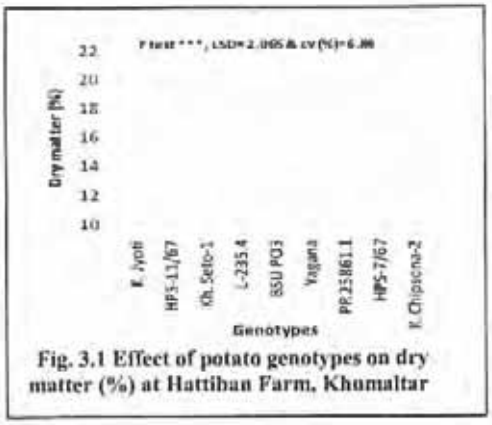


Fig. 3.1 Effect of potato genotypes on dry matter (%) at Hattiban Farm, Khumaltar

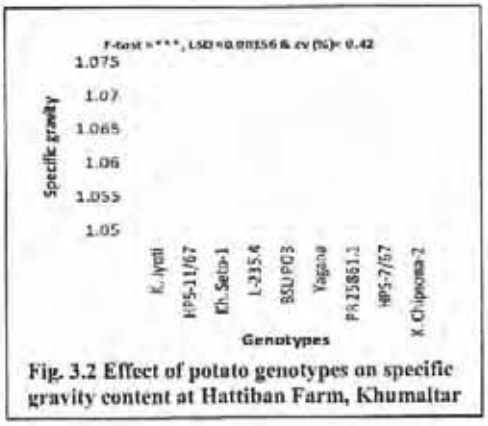


Fig. 3.2 Effect of potato genotypes on specific gravity content at Hattiban Farm, Khumaltar

It has been already proved that, the growing condition, locations and seasons showed great variation on dry matter, specific gravity and reducing sugars. Amoros *et. al.*, (2000) reported that genotypes and environment (G x E) interaction affected significantly for dry matter, glucose content and chips color. So the variety Kufri Chipsona-2 suitable in north Indian plain was not suitable for processing in hills of Nepal.

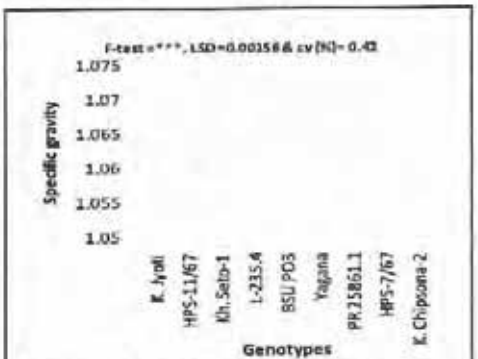


Fig. 3.3. Effect of potato genotypes on reducing sugars (mg/ 100 g fresh wt.) at Hattiban Farm, Khumaltar

Even though there is significant variation in reducing sugars, all genotypes showed minimum and within limit of reducing sugars processing in to chips (Figure 3.3).

The low levels of reducing sugars in all genotypes could be due to favorable soil and environment condition. Similar finding was reported Ezekiel *et al.*, (1999). Based on the yield and quality parameters L-235.4, PRP 25861.1 and Khumal Seto-1 were found promising for chips making.

3.1.3.2. Evaluation of storability of potato in ordinary condition

In the mid hills of Nepal, potato is mainly planted during January - February and harvested during June – July in the beginning of hot and rainy season. At this time the market price is low and farmers are compelled to sell their harvest at minimum price, whereas the market price increases rapidly and reaches

maximum during October-November (NPDP, 2010), but storing of potato for this period under on-farm conditions causes great losses due to the sprouting and rotting. The storage losses of potato have been estimated about 10-40 % under on-farm storage (Mehta and Ezekiel, 2010). Storability of potato is genetically controlled and significant differences exist between cultivars with respect to this character. For study the genetic variability, nine potato genotypes harvested at 120 days were used for storage. Before storage, tubers were kept for 15 days in room temperature for wound healing and curing of skin. Un-damaged and apparently healthy tubers with > 60 g weight were selected for experimentation. Experiment was laid out in Complete Randomized Design (CRD) with three replications. Five kilogram of healthy tubers of each genotype were kept in plastic trays (two third portion of tray remaining empty) and placed at ambient room temperature (25.8± 1.2° C and 86.1% RH) under dark condition from 16 June to 14 October (Fig 3.4). Kufri Jyoti a recommended variety suitable for the chipping industry in India (Rana, 2011) and commonly grown in Nepal was taken as control. Observation were recorded on weight loss percentage , sprouting at different days after storage and processing qualities like dry matter, specific gravity and reducing sugars before storage and 120 days after storage. A tuber was considered sprouted when it had at least one sprout measuring ≥0.2 cm.

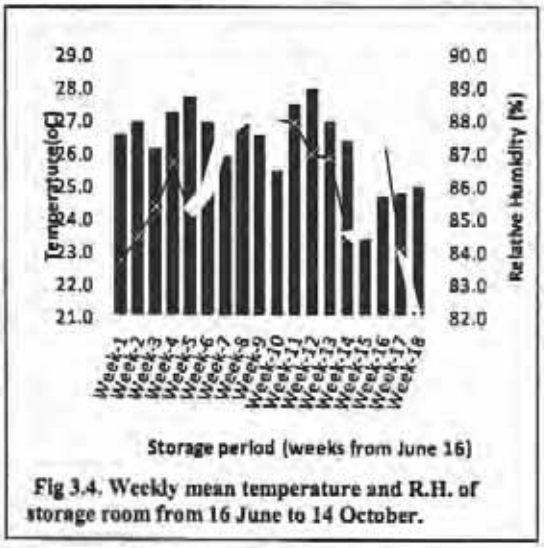


Fig 3.4. Weekly mean temperature and R.H. of storage room from 16 June to 14 October.

Dry matter was determined by chopping and mixing of tubers in to small pieces and oven drying 100 g sample at 80°C for 6 hours and then at 65°C till constant weight. Reducing sugars was determined by using di-nitrosalicyclic colorimetric method (Miller, 1959) by recording the absorbance in spectrophotometer at 575 nm.

Weight loss percentage

No significant variation was observed on physiological, rotting and total weight loss percentage among the genotypes up to 45 days storage at ordinary room temperature. At 60 days and on-ward significant variations were noticed on physiological weight loss (PWL) percentage and total weight loss (TWL) percentage (Tables 3.6, 3.7 & 3.8).

At 60 days of the storage, rotting of few tubers were noticed on Kufri Chipsona-2, BSU-PO_3, HPS-II/67, while no rotting was observed on HPS-7/67, PRP 25861.1, Yagana and L-235.4. RWL percentage was negligible in all the

genotypes after 75 days storage. The genotypes Yagana and L-253.4 had the minimum weight loss of 7.88% and 8.30% respectively, followed by Kufri Jyoti (9.90%) and Khumal Seto-1(10.04%) after 120 days storage period. However, the highest (24.19%) total weight loss percentage was observed on genotype BSU-PO_3.

Table 3.6: Effect of potato genotypes on weight loss percentage at 15, 30 and 45 days after storage (DAS) under dark ambient temperature, Khumaltar, 2011/12

Treatments	15 DAS			30 DAS			45 DAS		
	PWL*	RWL	TWL	PWL	RWL	TWL	PWL	RWL	TWL
Kufri Jyoti	1.64	0.626	2.27	3.62	0.00	3.62	4.30	0.00	4.30
HPS-II/67	1.57	0.00	1.57	2.96	1.87	4.82	5.78	0.51	6.29
Khumal Seto-1	2.00	0.00	2.00	2.83	0.00	2.83	3.42	0.00	3.42
L-235.4	1.44	0.00	1.44	2.41	0.00	2.41	2.96	0.00	2.96
BSU PO3	1.77	0.517	2.29	3.34	0.53	3.86	4.96	2.96	7.92
Yagana	1.06	0.515	1.06	1.77	0.00	1.77	2.47	0.00	2.47
PRP 25861.1	0.70	0.00	0.70	1.69	0.00	1.69	2.42	0.00	2.42
HPS-7/67	1.61	0.00	1.61	2.74	0.00	2.74	3.48	1.40	4.88
Kufri Chipsona-2	1.72	0.00	1.72	2.91	0.00	2.91	3.60	0.59	4.43
F-test	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	49.5	369.2	44.6	33.8	308.0	43.8	38.7	234.8	58.8

* PWL = physiological weight loss, RWL = rotting weight loss, TWL = total weight loss

Table 3.7: Effect of potato genotypes on weight loss percentage at 60, 75 and 90 days after storage (DAS) under dark at ambient temperature, Khumaltar, 2011/12

Treatments	60DAS			75 DAS			90 DAS		
	PWL*	RWL	TWL	PWL	RWL	TWL	PWL	RWL	TWL
Kufri Jyoti	5.14 *b*	0.52 *b*	5.66*bd*	5.58	0.75	6.33 *cd*	7.38*cd*	0.00	7.38 *cd*
HPS-II/67	7.46*ab*	1.03 *ab*	8.49 *bc*	9.42	1.10	10.52 *bc*	14.04ab	0.49	14.53*ab*
Khumal Seto-1	3.98 *b*	0.00 *b*	3.98 *d*	3.76	1.03	4.79 *d*	4.29*ab*	0.00	4.29 *d*
L-235.4	3.45 *b*	0.00 *b*	3.45 *d*	4.01	0.00	4.01 *d*	5.57*d*	0.33	5.90
BSU PO3	10.42*a*	2.37 *a*	12.80*a*	15.07	0.40	15.47 *a*	17.6 *a*	0.88	18.55 *a*
Yagana	3.31 *b*	0.00 *b*	3.31 *d*	2.89	1.20	4.09 *d*	4.65*d*	0.47	5.12 *d*
PRP 25861.1	3.32 *b*	0.00 *b*	3.32 *d*	4.62	0.54	5.16 *d*	7.19*cd*	0.00	7.19 *cd*
HPS-7/67	5.88*ab*	0.00 *b*	5.88 *cd*	8.19	0.53	8.72*bcd*	10.64*bc*	0.00	10.64*bc*
K. Chipsona-2	7.04*ab*	2.82 *a*	9.86*ab*	11.64	1.11	12.75*ab*	14.43*ab*	0.53	14.96*ab*
F-test	*	**	***	***	NS	***	***	NS	***
LSD	4.372	1.651	3.710	5.094	-	4.424	4.539	-	4.510
CV (%)	45.9	128.4	34.3	41.0	167.5	32.3	27.7	199.0	26.7

* PWL = physiological weight loss, RWL = rotting weight loss, TWL = total weight loss

Sprouting percentage

The sprouting of potato in the storage was started after 30 days on genotype HPS-7/67 (18.9%). At 45 days, sprouting was observed on HPS-II/67. At 60 days, except L-235.4 and Kufri Jyoti, all other genotypes were sprouted. More than 50% sprouting in order of highest to lowest was recorded on PRP 25861.1, HPS-7/67, Khumal Seto-1, Kufri Chipsona-2, HPS-II/67 and BSU-PO_3 (6.6%), respectively at 75 days after storage. At 90 days after storage, the genotypes

Table 3.8: Effect of potato genotypes on weight loss percentage at 105, 120 and grand total rotting percentage at 120 days after storage (DAS) at Khumaltar, 2011/12

Treatments	105 DAS			120 DAS			Grand total rotting (%) at 120 DAS
	PWL*	RWL	TWL	PWL	RWL	TWL	
Kufri Jyoti	8.30 *d*	0.00	8.30 *de*	9.90 *cd*	0.00	9.90 *cd*	1.90 *bc*
HPS-II/67	16.69 *ab*	2.52	19.21 *ab*	21.63*ab*	0.00	21.63 *ab*	7.51 *ab*
Khumal Seto-1	7.77 *d*	0.00	7.77 *de*	10.04*cd*	0.00	10.04 *cd*	1.03 *c*
L-235.4	6.83 *d*	0.00	6.83 *de*	8.30 *d*	0.00	8.30 *d*	0.33 *c*
BSU PO_3	20.05 *a*	2.29	22.34 *a*	24.19 *a*	0.00	24.19 *a*	9.93 *a*
Yagana	6.30 *d*	0.00	6.30 *e*	7.88 *d*	0.00	7.88 *d*	1.67 *c*
PRP 25861.1	10.53 *cd*	1.73	12.26 *cde*	15.36*bc*	0.00	15.36 *bc*	2.27 *bc*
HPS-7/67	12.98 *bc*	0.34	13.32 *bcd*	16.02 *b*	0.593	16.61 *b*	2.86 *bc*
K.Chipsona-2	17.07 *ab*	0.80	17.87 *ab*	19.83*ab*	0.00	19.83*ab*	5.84 *abc*
F-test	*	NS	*	***	NS	***	*
LSD	4.427	-	5.959	6.184	-	6.234	5.099
CV (%)	21.8	193.8	27.4	24.4	519.6	24.5	80.2

* PWL = physiological weight loss, RWL = rotting weight loss, TWL = total weight loss

were categorized into three groups on the basis of sprouting. The genotypes PRP 25861.1, Khumal Seto-1, HPS- 7/67, Kufri Chipsona-2 and HPS-II/67 were placed on the first group (83.3-100% sprouting), BSU-PO_3, L-235.4 and Yagana on the second group (52.4-64.1% sprouting), and the Kufri Jyoti on the third group (20.1% sprouting) (Table 3.9). At the end of storage period (120 days), Kufri Jyoti had only 68.43% sprouting while it was 100 % in all the genotypes. The minimum sprouting percentage on Kufri Jyoti could be due to its genotypic characters associated with its skin thickness.

Sprout number and weight

The genotypes differed significantly on sprout number and weight after 120 days storage (Fig. 3.5). The highest number of spouts per tuber was observed on genotype PRP 25861.1(3.90). Kufri Jyoti showed significantly the lowest number of sprout per tuber (1.37) and it was at par with Yagana (1.47).

Similarly, the sprout weight also differed significantly among the genotypes. The highest sprout weight (28.70 g/kg tuber) was recorded on PRP 25861.1 and it was at par with HPS-7/67 (27.87 g/kg tuber) and genotype HPS-II/67 (20.30

g/kg tubers), whereas the lowest sprout weight (8.67 g//kg tuber) was recorded on Kufri Jyoti and it was at par with L-235.4 (9.03 g/kg tuber) and Yagana (10.17 g /kg tuber).

Table 3.9: Effect of potato genotypes on sprouting percentage at different days after storage (DAS) under dark at ambient temperature, Khumaltar, 2011/12

Treatments	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	120 DAS
Kufri Jyoti	0.0 *b*	0.0 *d*	0.0 *e*	13.1 *e*	20.1 *c*	38.4 *c*	68.4*b*
HPS-II/67	0.0 *b*	11.6 *c*	38.0 *c*	70.2 *b*	83.3 *a*	90.2 *ab*	100.0 *a*
Khumal Seto-1	0.0 *b*	0.0 *d*	45.0 *c*	83.5 *ab*	90.8 *a*	97.7 *ab*	100.0 *a*
L-235.4	0.0 *b*	0.0 *d*	0.0 *e*	32.4 *cd*	59.2 *b*	91.7 *ab*	100.0 *a*
BSU PO_3	0.0 *b*	0.0 *d*	6.6 *de*	45.7 *c*	52.4 *b*	94.1 *ab*	100.0 *a*
Yagana	0.0 *b*	0.0 *d*	0.0 *e*	22.9 *de*	64.1 *b*	88.5 *b*	100.0 *a*
PRP 25861.1	0.0 *b*	53.0 *a*	84.7 *a*	100.0 *a*	100.0 *a*	100.0 *a*	100.0 *a*
HPS-7/67	18.9 *a*	39.7 *b*	63.9 *b*	87.4 *ab*	90.5 *a*	97.3 *ab*	100.0 *a*
Kufri Chipsona-2	0.0 *b*	9.7 *c*	17.4 *d*	73.1 *b*	83.6 *a*	92.1 *ab*	100.0 *a*
F-test	***	***	***	***	***	***	***
LSD	0.712	5.804	12.74	17.32	16.99	9.60	3.253
CV (%)	19.8	26.7	26.2	17.2	13.8	6.4	2.0

NS = Not significantly different, *, ** and *** significant at 0.05, 0.01 and <0.001 levels respectively. Same small letters in a column are not significantly different by DMRT at 0.05 levels

Processing Qualities

Dry matter percentage

The dry matter content varied significantly among the genotypes before and after 120 days storage (Fig. 3.6). The genotype PRP 25861.1 had the highest dry matter content (19.92 and 20.63%) respectively before and after storage.

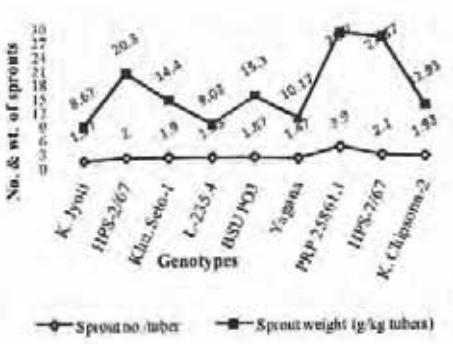


Fig. 3.5. Effect of potato genotypes on sprouting number and weight at different days after storage at room temperature

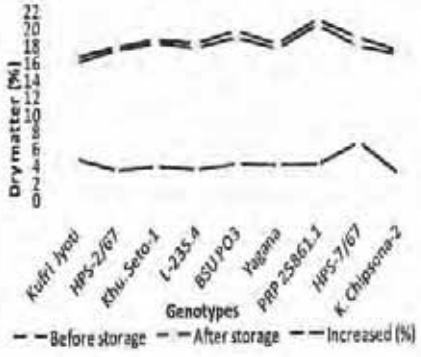


Fig. 3.6. Effect of potato genotypes on dry matter content before and after storage at room temperature

The lowest dry matter (15.80 & 16.53 %) was recorded on Kufri Jyoti respectively, before and after storage. After 120 days storage, there was

increment of dry matter in all genotypes but the ranged of increased percentage was varied from 2.42% in Kufri Chipsona-2 to 6.11% in HPS-7/67. The increment of dry matter after storage could be due to loss of water from tubers through respiration and evaporation. Low dry matter content on Kufri Jyoti and Kufri Chipsosa-2 before and after storage than India could be due to difference of environment and growing conditions. The increased in dry matter after storage was also reported in India when potato was stored in heap and pits at 25-35°C for 135 days (Ezekiel *et al.*, 2004).

Specific gravity

Like as dry matter, specific gravity also showed the significant differences among genotypes. The genotype PRP 25861.1 had the highest specific gravity (0.072 and 0.0792), whereas Kufri Chipsona-2 had the lowest value (1.058 and 1.0621), respectively before and after storage. The increased in the specific gravity after storage ranged from 0.13 % in Khumal Seto-1 to 0.67 % in PRP 25861.1. The detail is presented in Figure 3.7.

Reducing sugars

The reducing sugar content up to 150 mg/ 100 gram fresh weight is considered good and up to 250 g/100 g fresh weight is considered acceptable for chips making. In this experiment, the reducing sugars showed significant variation among genotypes before storage, while no variation was recorded at 120 days after storage. Increased in reducing sugars was observed after 120 days storage in all genotypes. The increased percentage was varied from 66.65 % to 205.88% (Fig. 3.8). The increment of reducing sugars after storage could be due to aging and sprouting of tubers. Even though, all genotypes remained within limit of reducing sugar for chips making. This finding is in agreement with the finding of Ezekiel *et al.*, (2004), he reported that the potato stored in heap and pits of temperature range 25-35°C showed reducing sugar within the acceptable limit and stored potato produced chips of acceptable color in both methods.

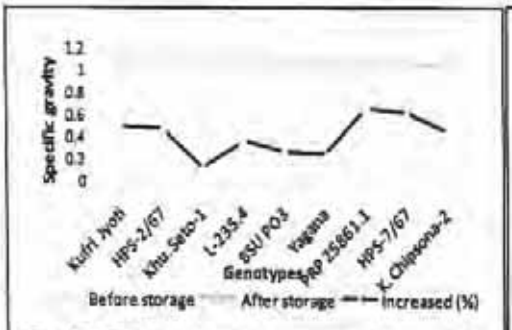


Fig 3.7. Effect of potato genotypes on specific gravity before and after storage at room temperature

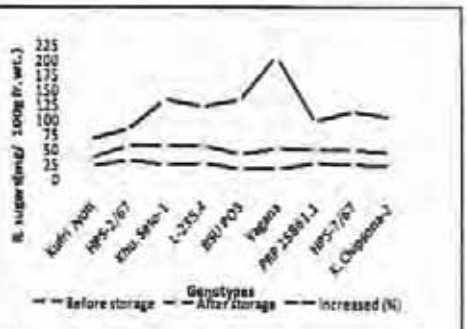


Fig. 3.8. Effect of potato genotypes on reducing sugars before and after storage at room temperature

From the study, it can be concluded that the genotype PRP 28861.1 with the highest dry matter content was suitable for only 45-60 days storage in ambient

room temperature (25.8±1.2°C and 86.1% RH). This genotype had significantly early sprouting and reaching > 50 % sprouting within 45 days after storage. The genotypes Kufri Jyoti, Yagana and L-235.4 could be successfully stored in ambient room temperature for maximum period of up to 120 days (16 June to 14 Oct.) with minimum total weight loss of less than 10%. However for early preparation of chips, the genotypes PRP 25861.1 and BSU-PO_3 are suitable than the other tested genotypes due to higher yield and high dry matter Content.

4.1.3.3. Identify the effect of nitrogen and potash on storability and processing quality

Potato is a heavy feeder crop and responds very well to major nutrients for higher production of processing quality tubers. Among various nutrients, potassium plays an important role in translocation and storage of assimilates in intact plant. It enhances storage, shipping quality of potatoes and extends shelf life. Similarly, nitrogen is the second most important nutrient after potassium, which increases the vegetative growth, crop duration, quality of tubers and decides the yield level of crops. Potato tubers removed 1.5 times much potassium than nitrogen and 4-5 times than phosphorus (Perrenoud, 1993). On the other hand, the excessive use of these nutrients causes the negative effect on storability and processing qualities especially, reducing the dry matter content and specific gravity of potato. The research on the effect of nitrogen and potassium on storability and processing qualities has not been done in Nepalese condition. Therefore storage experiment was conducted in ambient room temperature to find out the effect of nitrogen and potash on storability and processing qualities of potato into chips.

Potato grown with combinations of 4 levels of nitrogen (50, 100, 150 and 200 kg /ha) and potash (30, 60, 90 and 120 kg/ha) were used for storage experiment. The experiment was conducted in RCD with three replications at ambient room temperature at Khumaltar, mid hill condition. More than 60 g tubers of each treatment were selected for experimentation after 15 days curing of tubers. Five kg of potato tubers of each treatment were placed in plastic tray and stored under dark for 90 days (31 May to 28 August, 2011).

Observations were recorded on storage temperature and relative humidity and weight loss percentage, sprouting at different days after storage. Quality parameters like dry matter, specific gravity and reducing sugar were also recorded. The observed data were analyzed by using Gen-stat 532-2 program and DMRT of MSTATC used for mean comparison.

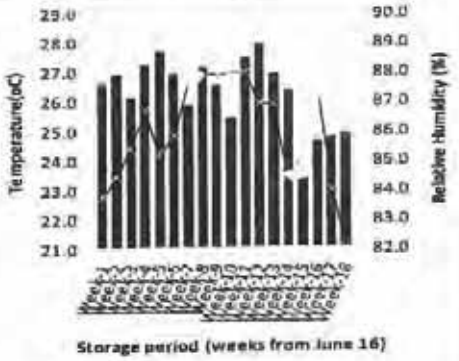


Fig. 3.9. Mean temperature and RH of storage room from 16 June to 14 October.

Temperature and relative humidity

The mean data on temperature and RH during storage period is presented in Fig. 3.9. The storage temperature ranged from 25.2° C in five week of storage to maximum 27.9°C in the seventh week of storage. The mean relative humidity ranged from 84.9 % in 3rd week to 88.1% in 12 week of storage. The high RH during storage periods could be due to use of wet and dry bulb thermometer for recording and calculating this parameter.

Weight loss Percentage

The main of nitrogen showed not significant differences on weight loss percentage throughout the storage period, except rotting weight loss percentage at 30 days of storage (Table 3.10 to 3.12).

The main effect of K_2O showed significant variation on physiological weight loss (PWL) percentage on 45, 60, 75 and 90 days, rotting weight loss (RWL) percentage on 30 days and total weight loss (TWL) percentage at 45, 60, 75 and 90 days of storage. However, the interaction of N and K_2O showed significant variation only on PWL at 60 days and RWL on 30 days after storage.

Sprouting percentage

Main effect of nitrogen showed not significant and significant differences on sprouting percentage, respectively, at 60 days; and 75, 90 days after storage. The maximum sprouting percentage was recorded (96.51%) was recorded at 50 kg/ha and the minimum (93.41%) at 200 kg/ha N treatment (Table 3.13). The main effect of K_2O showed only significant variation on sprouting at 75 DOS. The interaction effect of N and K_2O showed significant variation on sprouting at 60 and 75 days of storage. However, at 90 days no variation was observed among the treatments. This clearly showed that low levels of N and K_2O enhanced sprouting in earlier period of storage.

Number and weight of sprouts

The application of different levels of N and K_2O alone and their combination had no effect on numbers of sprouts per tubers. However, the main effect of K and its interaction with N showed significant variation on weight of sprouts. The maximum weight of sprouts (8.69 g/kg tubers) was recorded with combination of 50 and 30 kg/ha N and K_2O, respectively. However, there was no any consistency in other combinations (Table 3.14).

Quality Parameters

Dry matter content

The main effect of N and K_2O showed significant differences on dry matter percentage after 90 days storage but their interaction showed no significant variation on dry matter content. However, the maximum dry matter (20.37%) was observed in combination of 100 kg/ha N and 30 kg/ha K_2O and the lowest (18.20%) in 200 kg/ha N and 120 kg/ha K_2O. The increase dose of K has more pronounced effect for reduction of DM content of potato tubers than N. The

decrease in dry matter percentage with increase in potash level might be due to consistent increase in water content and turgidity of cells. This finding is agreement of the finding of (White *et al.*, 1974; Beukena & Van der Zaag, 1979).

Table 3.10: Effect of nitrogen, potash and their interaction on weight loss percentage of potato storage at ambient room temperature for 15 and 30 days, NPRP, 2011/12

Treatments	15 days			30 day		
	PWL	RWL	TWL	PWL	RWL	TWL
A. Nitrogen (kg/ha)						
50	1.76	0.00	1.76	2.65	0.10 *b*	2.66
100	1.74	0.00	1.74	2.53	0.00 *b*	2.53
150	2.07	0.00	2.07	2.82	0.00 *b*	2.82
200	1.88	0.00	1.88	2.73	0.41 *a*	3.22
F-test	NS	-	NS	NS	*	NS
LSD (0.05)	-	-	-	-	0.2982	-
B. Potash (kg/ha)						
30	1.99	0.00	1.99	2.97	0.42 *a*	3.47 *a*
60	1.86	0.00	1.86	2.54	0.00 *b*	2.54 *b*
90	1.81	0.00	1.81	2.59	0.00 *b*	2.59 *b*
120	1.80	0.00	1.80	2.63	0.00 *b*	2.63 *b*
F-test	NS	-	NS	NS	*	*
LSD (0.05)	-	-	-	0.611	0.2982	0.611
C. Interaction (N:K kg/ha)						
50 : 30	2.03	0.00	2.03	3.87	0.04 *b*	3.91
50 : 60	1.53	0.00	1.53	2.01	0.00 *b*	2.01
50 : 90	1.83	0.00	1.83	2.51	0.00 *b*	2.51
50: 120	1.66	0.00	1.66	2.21	0.00 *b*	2.21
100 : 30	2.03	0.00	2.03	2.92	0.00 *b*	2.92
100 : 60	1.66	0.00	1.66	2.36	0.00 *b*	2.36
100 : 90	1.55	0.00	1.55	2.44	0.00 *b*	2.44
100: 120	1.72	0.00	1.72	2.38	0.00 *b*	2.38
150 : 30	1.90	0.00	1.90	2.64	0.00 *b*	2.64
150 : 60	2.27	0.00	2.27	3.11	0.00 *b*	3.11
150 : 90	2.02	0.00	2.02	2.83	0.00 *b*	2.83
150: 120	2.08	0.00	2.08	2.69	0.00 *b*	2.69
200 : 30	2.0	0.00	2.0	4.40	1.65 *a*	4.40
200 : 60	1.96	0.00	1.96	2.69	0.00 *b*	2.69
200 : 90	1.83	0.00	1.83	2.56	0.00 *b*	2.56
200: 120	1.74	0.00	1.74	3.24	0.00 *b*	3.24
F-test	NS	-	NS	NS	**	NS
LSD (0.05)	-	-	-	-	0.5964	-
CV (%)	19.3	-	19.3	26.2	338.8	26.2

NS = Not significantly different, * significant at 0.05 and ** significant at 0.01 levels

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

Table 3.11: Effect of nitrogen, potash and their interaction on weight loss percentage of potato storage at ambient room temperature for 45 and 60 days, NPRP, 2011/12

Treatments	45 DAS			60 DAS		
	PWL	RWL	TWL	PWL	RWL	TWL
Nitrogen (kg/ ha)						
50	3.28	0.00	3.28	4.09	0.20	4.29
100	3.31	0.19	3.50	4.40	0.20	4.59
150	3.42	0.00	3.42	4.25	0.00	4.25
200	3.88	0.17	4.05	4.87	0.00	4.87
F-test	NS	NS	NS	NS	NS	NS
LSD (0.05)	-	-	-	-	-	-
Potassium (kg/ ha)						
30	4.19 *a*	0.28	4.47 *a*	5.70 *a*	0.20	5.90 *a*
60	3.25 *b*	0.00	3.25 *b*	3.81 *b*	0.20	4.00 *b*
90	3.15 *b*	0.08	3.23 *b*	4.07 *b*	0.00	4.07 *b*
120	3.29 *b*	0.00	3.29 *b*	4.04 *b*	0.00	4.04 *b*
F-test	*	NS	***	***	NS	***
LSD (0.05)	0.733	-	0.652	0.763	-	1.757
Interaction (Nx K2O kg /ha)						
50 : 30	4.68	0.00	4.68	5.71 *ab*	0.80	6.49
50 : 60	2.59	0.00	2.59	3.28 c	0.00	3.28
50 : 90	3.0	0.00	3.00	3.83 *c*	0.00	3.83
50: 120	2.86	0.00	2.86	3.55 *c*	0.00	3.55
100 : 30	4.04	0.77	4.81	6.77 *a*	0.00	6.77
100 : 60	3.09	0.00	3.09	3.13 *c*	0.00	3.91
100 : 90	2.98	0.00	2.98	3.74 *c*	0.00	3.74
100: 120	3.11	0.00	3.11	3.95 *bc*	0.00	3.95
150 : 30	3.18	0.00	3.18	3.98 *bc*	0.00	3.98
150 : 60	3.77	0.00	3.77	4.59 *bc*	0.00	4.59
150 : 90	3.42	0.00	3.42	4.37 *bc*	0.00	4.37
150: 120	3.33	0.00	3.33	4.07 *bc*	0.00	4.07
200 : 30	4.87	0.37	5.23	6.34 *a*	0.00	6.34
200 : 60	3.57	0.00	3.57	4.22 *bc*	0.00	4.22
200 : 90	3.20	0.30	3.51	4.33 *bc*	0.00	4.33
200: 120	3.88	0.00	3.88	4.60 *bc*	0.00	4.60
F-test	NS	NS	NS	*	NS	NS
LSD (0.05)	-	-	-	1.526	-	-
CV (%)	25.4	435.6	22.0	20.8	400.0	23.5

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

Table 3.12: Effect of nitrogen, potash and their interaction on weight loss percentage of potato storage at ambient room temperature for 75 and 90 days, NPRP, 2011/12

Treatments	75 DAS			90 DAS		
	PWL	RWL	TWL	PWL	RWL	TWL
Nitrogen (kg/ ha)						
50	5.12	0.00	5.12	6.05	000	6.05
100	5.74	0.00	5.74	6.83	0.17	7.00
150	5.08	0.23	5.31	6.30	0.00	6.30
200	5.83	0.00	5.83	6.88	0.00	6.88
F-test	NS	NS	NS	NS	NS	NS
LSD (0.05)	-	-	-			
Potash (kg/ ha)						
30	6.93 *a*	0.12	7.05 *a*	8.21 *a*	0.17	8.37 *a*
60	5.07 *b*	0.11	5.17 *b*	6.11 *b*	0.00	6.11 *b*
90	4.82 *b*	0.00	4.82 *b*	5.90 *b*	0.00	5.90 *b*
120	4.95 *b*	0.00	4.95 *b*	5.85 *b*	0.00	5.85 *b*
F-test	***	NS	***	***	NS	***
LSD (0.05)	1.002	-	-	0.938	-	0.938
Interaction (Nx K2O kg /ha)						
50 : 30	7.65	0.00	7.65	8.51	0.00	8.51
50 : 60	3.94	0.00	3.94	4.88	0.00	4.88
50 : 90	4.52	0.00	4.52	5.58	0.00	5.58
50: 120	4.38	0.00	4.38	5.24	0.00	5.24
100 : 30	7.78	0.00	7.78	9.04	0.67	9.69
100 : 60	5.73	0.00	5.73	6.59	0.00	6.59
100 : 90	4.50	0.00	4.50	5.70	0.00	5.70
100: 120	4.93	0.00	4.93	6.01	0.00	6.01
150 : 30	4.72	0.47	5.20	6.22	0.00	6.22
150 : 60	5.44	0.43	5.86	6.80	0.00	6.80
150 : 90	5.11	0.00	5.11	6.32	0.00	6.32
150: 120	5.05	0.00	5.05	5.86	0.00	5.86
200 : 30	7.59	0.00	7.59	9.07	0.00	9.07
200 : 60	5.16	0.00	5.16	6.15	0.00	6.15
200 : 90	5.13	0.00	5.13	6.02	0.00	6.02
200: 120	5.43	0.00	5.43	6.29	0.00	6.29
F-test	NS	NS	NS	NS	NS	NS
LSD (0.05)	-	-	-	-	-	-
CV (%)	22.2	490.2	22.8	18.0	692.8	17.2

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 3.13: Effect of nitrogen, potash and their interaction on sprouting percentage of potato at 60 and 75 days storage at ambient room temperature, NPRP, 2011/12

Treatments	Days after Storage		
	60 Days	75 days	90
Nitrogen (kg/ ha)			
50	19.40	40.74 *a*	96.51 *a*
100	14.76	42.56 *a*	98.23 *a*
150	18.22	40.62 *a*	95.49 *ab*
200	17.24	33.75 *b*	93.41 *b*
F-test	NS	**	*
LSD (0.05)	-	4.713	2.898
B. Potash (kg/ha)			
30	19.69	44.60 *a*	96.30
60	15.57	37.98 *b*	96.23
90	16.57	38.73 *b*	94.66
120	15.79	36.36 *b*	96.46
F-test	NS	**	NS
LSD (0.05)	-	4.713	-
C. Interaction (Nx K_2O kg /ha)			
50 : 30	23.73 *a*	47.67 *abc*	98.70
50 : 60	10.97 *de*	26.63 *g*	98.13
50 : 90	20.73 *abc*	41.97 *bcde*	95.10
50: 120	22.17 *abc*	46.70 *abcd*	94.10
100 : 30	14.63 *bcde*	49.10 *ab*	99.41
100 : 60	24.50 *a*	56.30 *a*	97.09
100 : 90	10.47 *de*	32.37 *efg*	97.50
100: 120	9.43 *e*	32.47 *efg*	98.93
150 : 30	18.07 *abcd*	43.90 *bcd*	95.58
150 : 60	17.43 *abcd*	38.43 *cdef*	94.35
150 : 90	20.83 *abc*	50.23 *ab*	95.05
150: 120	16.53 *abcde*	29.90 *fg*	97.00
200 : 30	22.33 *ab*	37.73 *cdef*	91.52
200 : 60	17.37 *abcd*	30.53 *fg*	95.33
200 : 90	14.23 *cde*	30.37 *fg*	91.00
200: 120	15.03 *bcde*	36.37 *defg*	95.80
F- test	***	***	NS
LSD	6.538	9.462	-
CV (%)	23.6	14.4	3.6

NS = Not significantly different, * significant at 0.05, ** highly significant at 0.01 and *** highly significant at <0.001 levels respectively.

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

Specific gravity

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. The main effect of N and its combination with K_2O had no significant effect on specific gravity. However, there was decreasing trend of specific gravity with increasing levels of K_2O (Table 3.15).

Table 3.14: Effect of nitrogen, potash and their interaction on number and weight of sprouts of potato at 75, 90 and 90 days after storage at ambient room temperature, NPRP, 2011/12

Treatments	Numbers of sprouts/ tuber		Sprout weight g/ kg tubers
	75	90	90
Nitrogen (kg/ ha)			
50	1.28	1.90	7.02
100	1.12	1.71	6.37
150	1.33	1.78	6.46
200	1.33	1.85	6.97
F-test	NS	NS	NS
LSD (0.05)	-	-	-
B. Potash (kg/ha)			
30	1.38	1.83	7.43 *a*
60	1.26	1.83	6.28 *b*
90	1.18	1.85	6.95 *ab*
120	1.23	1.68	6.16 *b*
F-test	NS	NS	**
LSD (0.05)	-	-	0.794
C. Interaction (Nx K_2O kg /ha)			
50 : 30	1.47	2.00	8.69 *a*
50 : 60	1.17	1.83	4.78 *f*
50 : 90	1.13	1.90	6.86 *bcde*
50: 120	1.33	1.70	7.75 *abcd*
100 : 30	1.0	1.60	6.68 *bcde*
100 : 60	1.30	1.87	8.10 *abc*
100 : 90	1.03	1.77	5.40 *ef*
100: 120	1.33	1.60	5.29 *ef*
150 : 30	1.53	1.87	6.57 *cdef*
150 : 60	1.23	1.63	5.31 *ef*
150 : 90	1.37	1.80	8.43 *ab*
150: 120	1.20	1.80	5.53 *ef*
200 : 30	1.53	1.87	7.78 *abcd*
200 : 60	1.33	1.97	6.92 *abcde*
200 : 90	1.20	1.93	7.12 *abcde*
200: 120	1.23	1.63	6.05 *def*
F-test	NS	NS	***
LSD (0.05)	-	-	1.587
CV (%)	19.3	15.8	14.2

NS = Not significantly and ** highly significant different at 0.05 levels.

Reducing sugars

The main effect of N, K_2O and their interaction showed significant variation on reducing sugar after 90 days storage. Even though all treatments had within limit of reducing sugars for chips making (<150 mg/ 100 gram fresh weight), the increased dose K_2O exhibited more effect for decreasing reducing sugars (Table 3.15). It could be due to increase water uptake and turgidity of cells.

Table 3.15: Effect of nitrogen, potash and their interaction on dry matter and specific gravity after 90 days storage at ambient room temperature, NPRP, 2011/12

Treatments	Dry matter (%)	Specific gravity	Reducing sugars (mg/ 100 g fresh wt.)
. Nitrogen (kg/ ha)			
50	19.44 *ab*	1.0704	32.29 *b*
100	19.61 *ab*	1.0701	35.88 *ab*
150	19.17 *b*	1.0711	37.91 *a*
200	19.87 *a*	1.0686	38.98 *a*
F-test	*	NS	*
LSD (0.05)	0.4985	19.001	4.886
B. Potash (kg/ha)			
30	19.88 *a*	1.0725 *a*	40.77 *a*
60	19.33 *b*	1.0699 *b*	39.25 *a*
90	19.20 *b*	1.0696 *b*	33.00 *b*
120	18.68 *c*	1.0683 *c*	32.04 *b*
F-test	***	**	***
LSD (0.05)	0.4958	0.00195	4.886
C. Interaction (Nx K_2O kg /ha)			
50 : 30	19.50	1.0716	48.10 *a*
50 : 60	19.63	1.0709	24.90 *c*
50 : 90	19.37	1.0700	25.03 *c*
50: 120	19.27	1.0692	31.13 *bc*
100 : 30	20.37	1.0734	48.10 *a*
100 : 60	19.77	1.0698	24.90 *c*
100 : 90	19.60	1.0694	25.03 *c*
100: 120	18.70	1.0678	31.13*bc*
150 : 30	19.87	1.0751	48.10 *a*
150 : 60	19.37	1.0701	24.90 *c*
150 : 90	18.90	1.0710	25.03 *c*
150: 120	18.53	1.0684	31.13*bc*
200 : 30	19.77	1.0699	38.77 *ab*
200 : 60	18.57	1.0688	40.23 *ab*
200 : 90	18.93	1.0682	37.87 *ab*
200: 120	18.20	1.0677	39.07 *ab*
F- test	NS	NS	***
LSD	-	-	9.733
CV (%)	3.1	0.2	16.2

NS= Not significantly different, * significant at 0.05, ** highly significant at 0.01 and *** highly significant at <0.001 levels respectively.

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

3.1.3.4. Effect of Chemical Treatment on Storability and Post Storage Behaviors of Potato in Ordinary Storage

For storing potatoes, cold store is ideal for holding long period. But this is not possible in Nepalese situation due to the lack of sufficient cold stores, separate compartments for storing different purpose potatoes and high storage charge. At present, there are only 41 cold stores with storage capacity of 80,400 tons potato (NPDP, 2010), which is not sufficient even for seed tubers. Furthermore, the storage of potato at low temperature causes excessive accumulation of reducing sugars and making them unsuitable for processing. Chips and French fries prepared from cold stored potatoes turn dark brown colors during frying at high temperature due to Millard's reaction (Ezekiel *et al.*, 2007; Thapa *et al.*, 2004; Gautam and Bhattarai, 2006). To overcome these problems, storage experiments were conducted under ordinary room conditions in the mid hill, Khumaltar (1350 m asl) and high hills, Daman (2200 m asl) of Nepal during the summer season of 2011 to find out the effect of chemical treatments and their time of applications on storability and chips qualities of potato cv. Kufri Jyoti. Chemicals treatments were CIPC, hydrogen peroxide and calcium chloride, which were applied as a single dose (before storage) and double dose (before and at 45 days in storage). Ordinary water treated potatoes served as control. Experiments were laid out in Completely Randomized Design (CRD) with three replications. The detail of treatments is presented as follows:

Treatments details:

1. Fumigation with CIPC (Isopropyl N-(3-Chlorophenyl) Carbamate) @ 40 ml ton^{-1} potato before storage.
2. Fumigation with CIPC @ 40 ml ton^{-1} potato before storage and 45 days in storage.
3. Fumigation with hydrogen peroxide @ 40 ml ton^{-1} potato before storage.
4. Fumigation with hydrogen peroxide @ 40 ml ton^{-1} potato before storage and 45 days after storage.
5. Fumigation with calcium chloride @ 40 ml ton^{-1} potato before storage.
6. Fumigation with calcium chloride @ 40 ml ton^{-1} potato before storage and 45 days after storage.
7. Control (Fumigation with fresh water @ 40 ml ton^{-1} potato before storage

Forty milliliter of each chemical was first mixed with one liter of methanol and fumigated with one ton of potato. Five kilogram potato (>60 g) of each treatment were fumigated inside close plastic chamber by the given chemicals with the help of small hand operated fumigators and hold air-tied for 48 hours. After 48 hours treated tubers were placed in bamboo racks at Khumaltar and wooden trays at Daman up to 120 days, i.e. from 20 June to 18 October at Khumaltar and 8 July to 5 November at Daman at ambient room temperature under dark condition. Observations were recorded on temperature, relative

humidity, weight loss percentage (WLP), sprouting weight and sprouting percentage at different days after storage. Similarly, observations were made on dry matter, specific gravity and reducing sugars and fresh chips qualities. Temperature was recorded at half an hour's interval by using temperature data logger (Hobo). Relative humidity was calculated by using temperature recorded on wet and dry bulb thermometer daily at 9.30 am. Cumulative weight loss percentage was calculated at every 30 days intervals.

For determination of chips qualities, randomly selected 10 potato tubers were peeled and cut into slices of 1.4 mm thickness with a hand operated slicer. Good and undamaged slices were washed thoroughly in cold water to remove the surface starch and sugars. These slices were spread in paper towel to remove surface water and then fried immediately in palm oil at 180° C till stopping of the bubbles. Chips qualities were evaluated on the basis of hedonic rating by group of scientists for color, taste and overall acceptability using 1- 9 scale and crispness; 1-3 scale (higher the number better the color, taste and acceptability). Data were statistically analyzed using Genstat-3.2, while MSTAT C was used to separate treatment means.

Storage environment

The maximum and minimum temperature ranged from 23.7 to 29.6°C, and 21.9 to 28.6°C, respectively. The average temperature ranged from 22.8 to 29.1°C during the storage period in mid hill at Khumaltar. The relative humidity on storage remained consistently high (78.8 to 88%). Both temperature and Relative humidity declined at later stage of storage (Figure 3.10 and 3.11). The decline in temperature and relative humidity was as associated with the fluctuation in the outer environment.

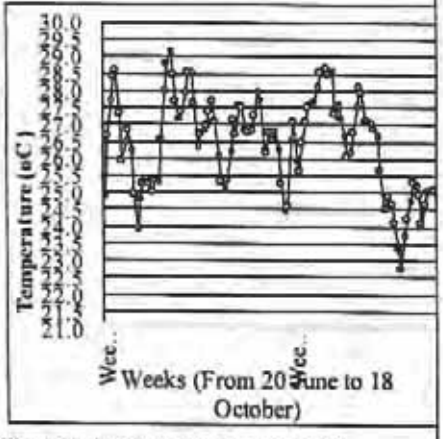


Fig 3.10 Average temperature of storage room in mid hill, Khumaltar, 2011

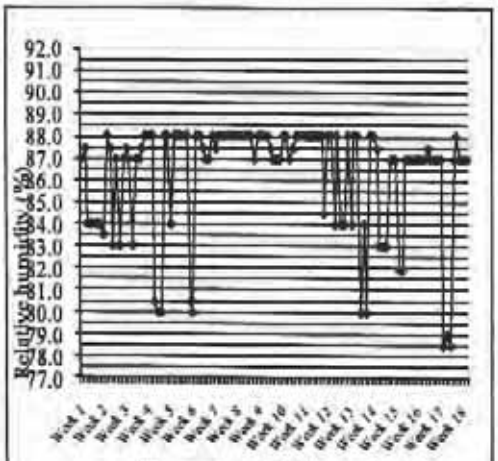


Fig 3.11. Relative humidity of storage room in mid hill, Khumaltar, 2011

Weight loss percentage

There was no significant variation on the weight loss of the potatoes up to 30

days by the effect of chemical treatments. At 60 days of storage, control treatment had the highest weight loss percentage (13.22 %) at Khumaltar while there was no variation on weight loss at Daman (Table 3.16). At 90 days of storage, treatments differed significantly on weight loss percentage at both locations. The maximum weight loss percentage of 16.56% and 5.98% was recorded on control treatment at Khumaltar and Daman, respectively. After 120 days of storage, weight loss percentage significantly differed among the treatments in both locations. At Khumaltar, the maximum WLP (22.89%) was on control treatment and it was at par with one time fumigation with CIPC (20.15%) and the minimum (9.40%) on one time fumigation with hydrogen peroxide (H_2O_2) treatment, which was at par with two times fumigation with CIPC (10.94%). At Daman, the maximum WLP (8.77%) was also observed on control treatment and it was at par with two times fumigation with H_2O_2 (8.01%) and the minimum (4.49%) on one and two times fumigation with CIPC (5.62%).

Table 3.16: Effect of post harvest chemicals treatment on weight loss percentage of potato on different days after storage at Khumaltar and Daman, 2011/12

Treatments	At Khumaltar				At Daman			
	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS
CIPC one time	2.55	7.81 *b*	14.12 *ab*	20.15 *ab*	1.68	2.98	4.34 *bc*	5.62 *cd*
CIPC two times	2.51	5.16 *b*	7.88 *b*	10.94 *cd*	1.43	2.67	3.45 *c*	4.49 *d*
H_2O_2 one time	2.47	4.43 *b*	7.83 *b*	9.40 *d*	1.86	2.95	4.50 *bc*	6.33 *bc*
H_2O_2 two times	2.99	5.41 *b*	8.35 *b*	13.59 *bcd*	2.02	3.62	4.41 *bc*	7.24 *abc*
$CaCl_2$ one time	1.66	7.33 *b*	11.21 *ab*	17.40 *abc*	1.60	2.68	3.77 *c*	7.12 *abc*
$CaCl_2$ two times	3.77	7.84 *b*	8.50 *b*	14.43 *bcd*	1.61	3.62	5.36 *ab*	8.01 *ab*
Control	2.97	13.2 *a*	16.56 *a*	22.89 *a*	2.0	3.79	5.98 *a*	8.77 *a*
F-test	NS	*	*	**	NS	NS	**	**
LSD	-	4.557	6.094	6.598	-	-	1.248	1.667
CV (%)	33.7	35.6	32.7	24.2	24.28	24.1	15.7	14.0

DAS =Days after storage

NS = Non significant different, * and ** significant at 0.05 and highly significant at 0.01 levels, respectively. Same small letters are not significantly different by DMRT at 0.05 levels

Sprouting and sprout weight

The sprouting was noticed after 60 days of storage at Khumaltar and after 90 days at Daman. Treatments differed significantly on sprouting percentage at 60, 90 and 120 days after storage in mid hill i.e., at Khumaltar (Fig. 3.12). At 60 days, control treatment had the maximum sprouting (52.9%) while there was no sprouting on other treatments. At 90 days the maximum sprouting percentage (59.50%) was also observed on control treatment and it was the minimum (2.60%) on two times fumigation with CIPC. At 120 days of storage, sprouting percentage differed significantly among the treatments at Khumaltar. At Daman, sprouting was significantly differed at 90 and 120 days of storage. The maximum sprouting was observed 45% and 100 % on control treatment at 90 and 120 days of storage, respectively. Control treatments had the maximum sprouting (96.07%) and (100%) at Khumaltar and Daman, respectively. The

minimum sprouting percentage (8.03%) and no sprouting (0%) was observed on two times fumigation with CIPC at Khumaltar and Daman, respectively.

Weight of sprout recorded at 120 days of storage in both locations differed significantly among the treatments (Fig. 3.13). The maximum weight of sprouts (24.72 g kg^{-1} tuber) was produced by control tubers at Khumaltar. In Daman the maximum weight of sprouts (9.77 g^{-1} kg tuber) was recorded on one time fumigation with calcium chloride against no sprouting on T_2 treatment. The delay sprouting and minimum weight of sprouts at Daman was due to due to low temperature than Khumaltar. Among different chemical, CIPC is found most effective to control sprouting in both locations. Moreover, the effect was more at higher altitude which was as because of the lower temperature. Mehta *et al.*, (2010) had also reported reduced sprouting of potato by CIPC treatment in heap storage and no sprouting in pits.

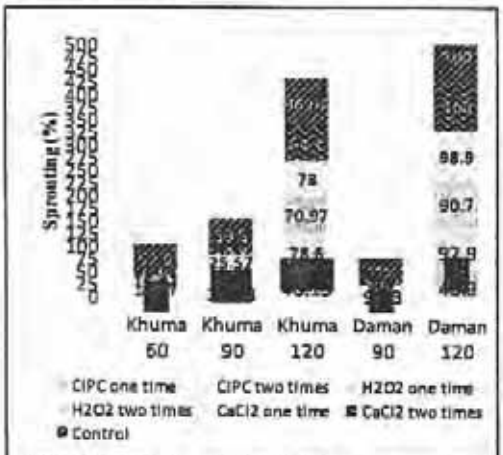


Fig. 3.12 Effect of chemical on sprouting percentage at different DAS at Khumaltar and Daman, 2011

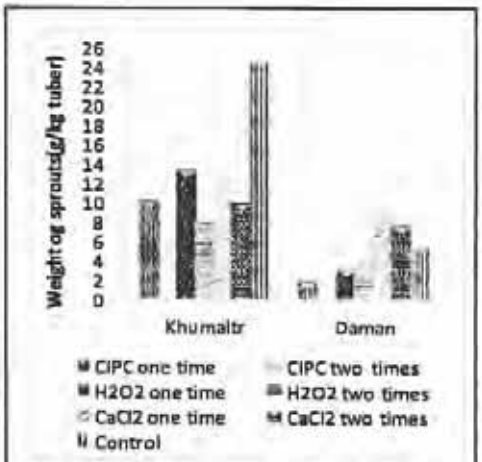


Fig. 3.13 Effect of chemical on weight of sprout (g/kg tubers) at 120 DAS at Khumaltar and Daman, 2011

Quality Parameters

There was increased in dry matter percentage, specific gravity and reducing sugars during storage (Table 3.17). The mean increment of dry matter, specific gravity and reducing sugars was 4.04%, 0.26% and 26.57% in mid hill at Khumaltar and 8.72%, 0.018% and 57.66 % in high hill at Daman, respectively after 120 days storage. However, the level of change varied among the treatments in both locations. Control treatment had highest dry matter percentage (19.47%) and specific gravity (1.071) than other treatments at Khumaltar, whereas no difference was observed on dry matter at Daman. There was no variation on reducing sugars among various treatments at Khumaltar, while it was significantly different at Daman. The highest RS (88.6 mg 100^{-1} g fresh wt. of potato) was observed on one time calcium chloride fumigated potatoes followed by (78.3 mg 100^{-1} g) one time fumigated with CIPC and the lowest 34.4 mg 100^{-1} g) on control treatment. Despite of some differences, all treatments in both locations had the acceptable limit of reducing sugars for

chips making. Similar findings have been made by Kumar and Ezekiel (2005) and Ezekiel *et. al.*, (2007).

Table 3.17: Effect of post harvest chemicals treatment on dry matter, specific gravity and reducing sugars of potato at 120 DAS at Khumaltar and Daman , 2011/12

Treatments	At Khumaltar			At Daman		
	Dry Matter (%)	Specific gravity	R. sugars (mg 100^{-1} g. f. wt.)	Dry Matter (%)	Specific gravity	R. sugars (mg 100^{-1} g. f. wt.)
Before storage	15.83	1.0587	35.0	16.85	1.0648	35.33
CIPC one time	16.37 *b*	1.0612 *c*	45.7	18.87	1.0657	39.2 *bc*
CIPC two times	16.53 *b*	1.0581 *f*	36.0	17.90	1.0638	78.3 *a*
H_2O_2 one time	14.77 *b*	1.0603 *d*	43.0	16.50	1.0614	47.4 *bc*
H_2O_2 two times	16.03 *b*	1.0585 *e*	39.7	19.33	1.0678	44.4 *bc*
$CaCl_2$ one time	15.90 *b*	1.0628 *b*	47.7	19.87	1.0673	88.6 *a*
$CaCl_2$ two times	16.23 *b*	1.0594 *a*	53.0	17.87	1.0644	57.7 *bc*
Control	19.47 a	1.0706 *a*	45.3	17.90	1.0643	34.4 *c*
F-test	*	**	NS	NS	NS	***
LSD	2.184	0.005	-	-	-	18.24
CV (%)	7.6	0. 3	13.9	8.5	0.2	18.7

NS = Non significantly different, * and ** significant at 0.05 and highly significant at 0.01 levels, respectively. Same small letters in a column are not significant different by DMRT at 0.05 levels

Chips Qualities

Chips color of two times hydrogen peroxide fumigation potatoes stored at Khumaltar differed significantly with other treatments and had the highest chips colour scores of 7.25 scales (Table 3.18). However, crispness, taste and overall acceptability did not vary among the treatments. In high hill at Daman, color 7.43 scales and overall acceptability 7.57 scales had the highest scores on one time fumigated with hydrogen peroxide potatoes (Table 3.19). No variation was observed on crispness and taste among the treatments.

The results of present study concluded that post harvest treatment with different chemicals have positive role for reduction weight loss and sprouting than control treatment. However, two times fumigation with CIPC, before storage and 45 days after storage was the best for inhibition of sprouting and reduction post harvest losses up to 120 days storage than other treatments both in mid and high hills. Due to high temperature, the fumigation with CIPC one time before storage is not effective for reducing weight loss at Kumaltar as compared to Daman. In spite of more weight loss than CIPC, the two times hydrogen peroxide treated potatoes produced better chips color after 120 days storage.

Table 3.18: Effect of post harvest chemicals treatment on chips qualities of potato at 120 DOS at Khumaltar, 2011/12

Treatments	Color (1-9 scale)	Crispness (1-3 scale)	Taste (1-9 scale)	Overall acceptability (1-9 scale)
CIPC one time	6.25b *b*	1.90	6.08	6.17
CIPC Two times	6.00 *b*	2.08	5.33	5.92
H_2O_2 One time	6.42 *b*	2.00	6.33	6.08
H_2O_2 two times	7.25 *a*	2.08	6.83	7.33
$CaCl_2$ One time	6.42 *b*	2.12	6.67	6.50
$CaCl_2$ two times	5.75 *b*	2.07	6.17	5.75
Control	6.25 *b*	2.0	6.00	5.75
F-test	*	NS	NS	NS
LSD	0.803	-	-	-
CV (%)	10.8	11.3	16.1	17.0

Color (1-9 scale): 1-6 none accepted, 7 accepted rather, 8 accepted & 9 accepted completely. Crispness (1-3 scales: 1 too crisp, 2 not crispy enough and 3 Ideal . Taste (1-9 scales): 1-3 poor, 4-5 moderate, 6-7 good, and 8-9 = V. good. Overall acceptability (1-9 scales): 1–3 poor, 4-5 moderate, 6-7 good, 8-9 V. good.

Table 3.19: Effect of post harvest chemicals treatments on chips qualities of potato at 120 DOS at Daman, 2011/12

Treatments	Color (1-9 scale)	Crispness (1-3 scale)	Taste (1-9 scale)	Overall acceptability (1-9 scale)
CIPC one time	6.21 *b*	2.03	6.86	6.36 *bc*
CIPC Two times	5.86 *b*	2.00	6.29	6.14 *c*
H_2O_2 One time	6.36 *b*	2.07	6.93	7.14 *ab*
H_2O_2 two times	7.43 *a*	1.87	7.29	7.57 *a*
$CaCl_2$ One time	5.86 *b*	2.06	6.0	6.07 *c*
$CaCl_2$ two times	5.71 *b*	1.96	6.29	6.07 *c*
Control	6.21 *b*	2.00	6.14	6.21 *c*
F-test	*	NS	NS	**
LSD	1.054	-	-	0.891
CV (%)	15.7	10.3	17.1	12.7

Color (1-9 scale): 1-6 none accepted, 7 accepted rather, 8 accepted & 9 accepted completely. Crispness (1-3 scales: 1 too crisp, 2 not crispy enough and 3 Ideal . Taste (1-9 scales): 1-3 poor, 4-5 moderate, 6-7 good, and 8-9 = V. good. Overall acceptability (1-9 scales): 1–3 poor, 4-5 moderate, 6-7 good, 8-9 V. good.
NS = No significantly different, * significant at 0.05 and **, *** highly significant at 0.01 & <0.001 levels, respectively. Same small letters are not significantly different by DMRT at 0.05 levels

3.1.4 Sustainability Studies for Pre-Basic and Basic Seed Production of Potato under *in vitro* and *in vivo* Conditions

Since the establishment of tissue culture laboratory and the glasshouse in 1989, NPRP has been producing certain amount of PBS annually (NPRP, 2007/08). 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 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 the 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 there is a 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.

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

This study was conducted to evaluate the performance of *in vitro* plantlets cultured under different incubation conditions for plant development under laboratory and PBS production under screenhouse conditions. The nine different incubation conditions used for the development of *in vitro* plantlets were: (i) one week in standard growth room (SGR) and three weeks in natural light condition (NLC), (ii) two weeks in SGC and two weeks in NLC, (vi) three weeks in SGC and one week in NLC, and (vii) four weeks in NLC (Table 4.1). Ten single nodal explants were used per jar (400 ml) in MS solid medium at five replications on potato cvs. Cardinal and Kufri Jyoti at CRD design.

The experiment was conducted in a complete randomized design (CRD) under *in vitro* condition at NPRP. 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.

Result indicated that sub-culture incubation for four weeks under natural light condition (NLC) gave significantly the lowest plant height, nodal number and branching and were better from the three weeks standard growth condition (SGC) plus one week natural light condition. However, two weeks SGR plus two weeks in natural light condition (NLC) also showed good performance on most of the evaluated parameters (Table 4.1). Similar types of performance were observed in both of the evaluated cultivars. From this study it can predict that natural night can utilize for production of the *in vitro* plantlets.

Table 4.1: Performance of *in vitro* plantlets of potato cvs. Cardinal and Kufri Jyoti grown under different incubation conditions

Incubation condition	Plant establish (%)	Plant ht. (cm)	Node/ plant (No.)	Branch/ plant (No.)
Cardinal				
1 week in SGC and 3 weeks in NLC	96.7	6.3	6.1	1.0
2 weeks in SGC and 2 weeks in NLC	96.7	7.5	6.6	1.8
3 weeks in SGC and 1 week in NLC	96.7	7.7	7.9	1.5
4 weeks in NLC	90.0	6.1	5.9	0.8
Kufri Jyoti				
1 week in SGC and 3 weeks in NLC	93.3	6.4	5.9	1.6
2 weeks in SGC and 2 weeks in NLC	100	7.3	7.1	1.9
3 weeks in SGC and 1 week in NLC	96.7	6.6	7.8	1.8
4 weeks in NLC	85.0	5.9	5.2	1.0

SGC = standard growth condition, NLC = natural light condition

3.1.4.2 Effect of incubation conditions 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). In the studies microtuber production, number and fresh weight of microtuber were recorded from each treatment.

Result indicated that among the evaluated four conditions, transferred to darkness after one week in light produced the highest number and fresh weight of microtuber in Desiree and also in Kufri Jyoti, but the largest microtuber was

produced in transferred to darkness after two weeks in light in Desiree and transferred to darkness after two weeks condition produced the largest size of tuber in Kufri Jyoti. The lowest yield and number of MT were produced from the continue incubation in standard light condition (Table 4.2). This result is also in agreement the finding of previous work that transferred to dark after 60 days of sub-culture produced the highest number and weight of microtuber.

Table 4.2: Effect of culture conditions on number and yield of microtuber (MT) under different four incubation conditions*

Incubation condition	Desiree			Kufri Jyoti		
	Microtuber/ Container		Fresh wt. /microtuber (mg)	Microtuber/ container		Fresh wt. /microtuber (mg)
	No.	Fresh wt. (g)		No.	Fresh wt. (g)	
Desiree						
Transfer to darkness immediately	9.7	5.4	556	8.3	5.1	614
Transfer to darkness after 1 wk in light	10.2	5.8	569	8.5	5.3	624
Transfer to darkness after 2 wks in light	8.8	5.7	647	8.4	5.6	666
Continuous incubation in standard light	8.3	4.1	494	6.8	4.4	647

* Ten plantlets per container and ten bottles/replication and repeated three times in each variety.

3.1.4.3 Comparative study of hydroponic and soil based medium for efficient production of PBS under glasshouse conditions

This experiment was designed to know the performance of hydroponic cultivation system in potato for minituber production. Before planting, the *in vitro* plantlets were rooted in the sterilized sand medium for 3 weeks under glasshouse condition on plastic tray. Three varieties were planted in the bed, i.e. Kufri Jyoti, Khumal Rato-2 and IPY-8. One day before planting, nutrient medium was formulated and mixed in the over head tank and circulated in the planting bench and underground tank and again in the overhead tank using electric pump. The plants were planted on 2068/9/28 and harvested on 206/1/21. From the experiment number of plant established, plant height, number of main stem, tuber/plant and yield of PBS were recorded.

The experiment was just started from this year (2068/69), so all the facilities were not completely established in the glasshouse; however, planting was done in the basic facility. The plant establishment and plant height of the planted plants were good, but tuber formation was not satisfactory in hydroponic compared to the soil based medium (Table 4.3). The experiment needs to continue two more years with some improvement in the basic system.

Table 4.3: Comparative study of hydroponic and soil based medium for minituber production under glasshouse conditions

Treatment	Plant establish (%)	Plant ht. (cm)	Minituber/ plant (No.)	Minituber yield/ Plant (g)
Kufri Jyoti				
Soil medium	92.6	59.0	4.1	4.1
Soilless medium	87.5	52.5	0.6	1.0
Khumal Rato-2				
Soil medium	94.6	70.0	4.0	3.1
Soilless medium	78.5	55.0	0.3	0.8
IPY-8				
Soil medium	94.6	72.5	3.8	4.3
Soilless medium	87.5	47.5	0.5	0.8

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

Under this activity three activities were designed and conducted at farmers field conditions at Hemja, Kaski District of Nepal. Hemja is one of the most famous places for potato production in western development region of Nepal. Previously, potato variety: MS 42.3 was only one potato being cultivated under whole Hemja area, but at present farmers show interest on other different varieties. MS-42.3 has more disadvantages rather than advantage, so NPRP likes to introduce better alternative varieties at that areas. Three different sizes of PBS (viz. >5g, >1-5g, and 0.5-1g) each of potato variety Cardinal and Desire under the first activity were evaluated under RCBD with two replications, while, the performance of basic seed-1 of Kufri Jyoti and Janakdev were evaluated against those of farmers seed of respective varieties under the second activity following RCBD with three replications. A one day training program on potato seed production was organized at the farmers' field of Hemja. From the 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.

The yield from the different sizes of Cardinal and Desire PBS was non-significant, while vegetative traits such as plant height, stem number and tuber number all found significantly different. The results revealed that Cardinal PBS size of >5g performed the best as regard to higher number of main stem (4.2/plant), number of tuber (25.8 /plant) and corresponding higher tuber yield (8.28 q/Ropani) as compared to those of smaller PBS sizes of the same variety and those of Desire as well. Similarly, the best performance was reported at PBS size of >5g with tuber yield of 5.5 q/ropani compared to those of PBS size

of >1-5 g (1.6 q/ropnai) and size of 0.5-1 g (1.97 q/ropani) in Desire variety (Table 4.4).

Table 4.4: Performance of different size of PBS for basic seed production at Hemja, Kaski during winter season, 2011/12

Treatment	Plant height (cm)	No of main stem/Plant	No of tuber/ Plant	Yield (q/ropani)
Cardinal >5g	40.90	4.2	25.8	8.28
Cardinal >1-5g	37.00	3.9	16.9	3.52
Cardinal 0.5g	16.75	1.5	12.0	1.85
Desire >5g	31.70	2.7	10.0	5.50
Desire >1-5g	27.10	2.1	09.8	1.60
Desire 0.5g	13.90	1.7	05.7	1.97
Mean	27.79	2.68	13.38	3.74
P-value	***	**	***	ns
LSD	4.107	1.26	3.8	4.37
CV %	5.7	18.4	11.1	45.5

3.1.4.5 Demonstrate performance of basic seed-1 and farmer's seed for potato production in farmers' field

The performance of both basic seed and farmer's seed of Janakdev yielded higher than others; however, it was insignificantly different. On the contrary, vegetative attributes, such as plant height, number of stem and tuber were found significantly different as higher number of stem and tuber was recorded at MS-42.3, an unregistered variety, which is popular at the location (Table 4.5). In conclusion, similar performance of basic seed and farmer's seed indicates of less importance of basic seed, so that some improvements on the basic seed production need to be done.

Table 4.5: Performance of basic seed-1 of Kufri Jyoti and Janakdev in comparison with the farmer's seed at Hemja during winter, 2011/12

Treatment	Plant height (cm)	No of main stem/Plant	No of tuber/Plant	Yield (q/ropani)
Kufri Jyoti	27.60	3.8	9.2	8.98
Janakdev	51.33	4.0	7.8	9.22
M.S.42-3	40.60	6.6	11.1	8.11
Janakdev Farmer's seed	56.40	4.1	7.2	9.97
Mean	43.98	4.6	8.87	9.07
P-value	***	**	***	ns
LSD	3.54	1.27	1.197	4.018
CV %	4.0	13.7	6.8	22.2

3.1.5 Potato Diseases

3.1.5.1 Late blight

3.1.5.1.1 Initial evaluation of potato genotypes

A total of forty five potato genotypes introduced from International Potato Center as CIP accessions and developed by National Potato Research Programme as PRP accessions were evaluated with high emphasis particular on late blight resistance along with higher tuber yield comparing with the performance of released and recommended cultivars Janakdev, Kufri Jyoti, Cardinal and Desiree.

Genotypes were planted in autumn season, most conducive weather for late blight disease development at Hattiban Farm Khumaltar, Lalitpur. Plot size was 0.6 x 2.5 m (1.5 m^2) and replicated twice. Single row of susceptible cultivar (Desiree) was planted in between the blocks and all sides of the experiment to enhance the disease pressure. Fertilizer was applied as basal dose i.e. 100:100:60 kg N, P_2O_5 and K_2O respectively. Planting spacing was given 60 cm x 25 cm. Irrigation was given two times first at 40 and second at 60 days after planting (DAP) followed by weeding and earthing up. No fungicide was sprayed throughout the crop period. Late blight severity was recorded as foliage damage (%) for 5 times starting from 40 up to 70 DAP.

Out of 48 potato genotypes, eleven, i.e. PRP 226265.1, PRP 226267.11, CIP 395017.242, PRP 266265.15, PRP 146267.8, CIP 395112.32, PRP 056267.1, PRP 146267.11, PRP 146267.6, CIP 393617.229, and CIP 391058.175 were found highly resistant to late blight ranging from 0-95 AUDPC along with the highest tuber yield ranging from 31 to 20 t/ha. However, few other genotypes PRP 286265.22, PRP 226267.4, CIP 393083.2, PRP 226267.1, and PRP 056267.9 were also found highly resistant to late blight with moderate level of yielding capacity (Table 5.1).

3.1.5.1.2 Multi-location evaluation of genotypes

Experiments were conducted in three locations at Khumaltar (Mid hills), Chitwan (Terai) and Nigale (High hill) to identify late blight resistant and high yielding potato genotypes.

The experiment was set in RCBD with 3 replications. Twenty-five genotypes were screened against late blight disease. In the experiment, Kufri Jyoti and Janakdev were used as the check. The plot size was maintained at 0.6 m x 2.5 m and the tubers were planted at 25 cm apart. Fertilizer was applied at the rate of 100:100:60 N, P_2O_5 and K_2O kg/ha. Cultural practices were carried out as per

Table 5.1: Initial evaluation of potato genotypes for resistant to late blight and yielding capacity under Khumaltar conditions, 2011/12

Genotypes	AUDPC	Tuber no./ plot	Tuber yield (kg/plot)	Tuber yield (t/ha)
PRP 146267.3	14	48	2.07	13.80
PRP 146267.6	80	74	3.19	21.27
PRP 146267.7	125	103	3.64	24.27
PRP 146267.8	80	105	3.65	24.33
PRP 146267.11	85	62	3.25	21.67
PRP 056267.1	40	87	3.31	22.07
PRP 056267.2	40	113	2.96	19.73
PRP 056267.6	40	90	3.45	23.00
PRP 056267.9	7	130	3.42	22.80
L-235.4	792	40	1.32	8.80
PRP 056267.29	311	83	1.98	13.20
PRP 226267.1	1	51	2.88	19.20
PRP 226267.6	915	66	1.36	9.07
PRP 226267.3	72	126	2.22	14.80
PRP 226267.4	0	109	2.19	14.60
PRP 226267.8	12	58	2.18	14.53
PRP 226267.10	53	103	2.98	19.87
PRP 226267.11	95	152	4.01	26.73
PRP 226265.1	0	134	4.66	31.07
Kufri Jyoti	2709	42	0.83	5.53
PRP 266265.4	16	77	2.85	19.00
PRP 266265.15	8	98	3.70	24.67
PRP 276365.12	40	76	2.89	19.27
PRP 266365.6	40	65	2.58	17.20
PRP 286265.22	0	71	2.88	19.20
PRP 26267.1	2800	39	1.04	6.93
CIP 390478.9	3020	53	1.11	7.40
CIP 391058.175	0	126	3.01	20.07
CIP 389746.2	2480	63	2.03	13.53
CIP 392740.4	3340	40	0.53	3.53
CIP 392820.1	3260	34	0.36	2.40
CIP 393073.179	340	59	2.75	18.33
CIP 393083.2	0	2	0.05	0.33
CIP 303382.44	1760	108	2.38	15.87
CIP 393536.13	2750	27	0.34	2.27
CIP 393617.229	53	90	3.18	21.20
CIP 394611.112	1060	86	2.59	17.27
Janakdev	726	50	2.11	14.07
CIP 394613.139	1627	58	1.48	9.87
CIP 395017.229	105	105	4.04	26.93
CIP 395017.242	40	101	3.81	25.40
CIP 395112.32	20	66	3.59	23.93
CIP 397060.19	1670	53	1.34	8.93
CIP 39*9004.19	792	35	0.61	4.07
CIP 399067.22	217	98	2.04	13.60
CIP 399079.22	1102	58	0.92	6.13
CIP 399078.11	117	72	2.1	14.00
CIP 399090.116	1235	59	1.49	9.93
CV	56.67	25.93	16.42	
F test	**	**	**	
LSD(0.05)	809.7	39.5	0.77	

requirement. Fungicides were not sprayed throughout the crop period in all the locations. Late blight severity was estimated in percent foliage damage at 7-10 days intervals starting from the date of symptoms appearance. Percent foliage damage data were computed in area under disease progress curve (AUDPC). In Khumaltar and Chitwan crop was harvested at 100 DAP and in Nigale at 150 DAP.

LBr-40 showed an average minimum AUDPC value (13.58) followed by CIP 384321.15 (24.8), and PRP 266264.01 (36.4), PRP 25861.1 (109.5). However, other 10 genotypes also showed significantly resistant to late blight as compared to Kufri Jyoti (1979) and Janakdev (753) (Table 5.2).

Table 5.2: Disease severity (AUDPC) of late blight on potato genotypes under three agro climatic conditions, 2011/12

Genotypes	AUDPC at			Mean (AUDPC)
	Khumaltar	Chitwan	Nigale	
PRP 35861.2	171.00	111.00	440.00	240.67
PRP 85861.12	125.67	91.25	218.33	145.08
PRP 25861.10	85.00	287.50	871.67	414.72
PRP 225861.2	142.33	138.00	235.00	171.78
LBr-40	0.00	5.75	35.00	13.58
PRP 85861.8	65.33	259.75	81.67	135.58
L-235.4	1051.33	795.00	706.67	851.00
PRP 276264.01	0.00	305.25	35.00	113.42
PRP 266264.01	0.00	69.25	40.00	36.42
$BSUPO_3$	23.67	84.25	481.67	196.53
Kufri Jyoti (Check)	2123.67	2530.25	1283.33	1979.08
CIP 384321.15	0.00	1.25	73.33	24.86
PRP 25861.1	0.00	55.25	273.33	109.53
CIP 388580.6	1591.00	1893.00	381.67	1288.56
CIP 394050.110	1164.67	1661.50	513.33	1113.17
CIP 393385.39	34.00	58.75	595.00	229.25
PRP 266264.15	0.00	74.50	380.00	151.50
Janakdev (Check)	1059.00	635.25	565.00	753.08
CIP 393280.57	106.33	294.25	420.00	273.53
PRP 25861.11	48.00	71.50	295.00	138.17
PRP 85861.11	0.00	127.75	331.67	153.14
CIP 393077.54	881.33	623.25	410.00	638.19
CIP 392657.8	26.67	143.25	155.00	108.31
CIP 385499.11	982.00	876.75	806.67	888.47
CIP 389746.2	686.67	804.25	671.67	720.86
CV %	16.31	20.11	17.42	
F test	**	**	**	
LSD (0.05)	111.10	136.00	117.80	

Regarding with the tuber yield across the locations, clones PRP 266264.01, PRP 266264.15, LBr 40, and PRP 25861.1 yielded ranging 4.1 - 4.78 kg/plot. Genotypes L-235.4, PRP 276264.01 and CIP 389746.2 performed better in

Nigale (2450 m asl) than Khumaltar and Chitwan conditions (Table 5.3). Overall performance of genotypes in Chitwan was poorer than Khumaltar and Nigale.

Table 5.3: Performance of potato genotypes to tuber production under three agro-climatic condition, 2011/12

Genotypes	Tuber yield (kg/plot) at			Mean
	Khumaltar	Chitwan	Nigale	
PRP 35861.2	2.14	2.30	3.93	2.79
PRP-85861.12	3.06	3.33	1.27	2.55
PRP 25861.10	3.98	3.54	1.60	3.04
PRP 225861.2	3.57	2.80	5.23	3.86
LBr-40	3.33	4.80	4.28	4.13
PRP 85861.8	3.99	3.32	4.96	4.09
L-235.4	1.48	0.49	5.63	2.53
PRP 276264.01	3.83	2.77	5.46	4.02
PRP 266264.01	5.51	3.94	4.90	4.78
$BSUPO_3$	3.13	2.23	3.83	3.06
Kufri Jyoti (Check)	2.11	0.65	2.70	1.82
CIP 384321.15	3.95	3.20	1.90	3.02
NPRP 25861.1	3.81	3.50	4.93	4.08
CIP 388580.6	1.46	0.70	3.90	2.02
CIP 394050.110	2.18	0.93	3.77	2.29
CIP 393385.39	2.74	3.70	3.43	3.29
PRP 266264.15	4.59	3.95	5.02	4.52
Janakdev (Check)	2.99	1.20	2.90	2.36
CIP 393280.57	2.58	2.63	2.50	2.57
PRP 25861.11	3.11	2.93	3.07	3.03
PRP 85861.11	4.00	3.80	2.30	3.37
CIP 393077.54	2.68	1.65	3.30	2.54
CIP 392657.8	2.17	1.81	1.68	1.89
CIP 385499.11	3.08	2.96	3.23	3.09
CIP 389746.2	2.26	1.50	5.67	3.14
CV%	16.41	18.65	22.57	
F test	**	**	**	
LSD(0.05)	0.84	0.68	1.35	

3.1.5.1.3 Rational application of fungicides

Field experiment were conducted at Hattiban Farm in 2068/69 to find out the rational application of fungicide for obtaining highest tuber yield by managing late blight disease on two promising potato genotypes L-235.4 and CIP 389746.2.

Promising genotypes were compared with two genotypes Kufri Jyoti (susceptible) and Janakdev (moderate level of resistance) as one factor and four

level of spray frequency 0, 2, 4, and 6 sprays at an intervals of no spray, 18, 9 and 6 days respectively. Sectin (Fenamidon 10% + mancozeb 50%) @ 1.2 kg/800 lit water/ha was used in each spray. Late blight severity was recorded in percent foliage damage at 7 days intervals starting from 40 days after planting (DAP) to 68 DAP.

Plot size was 2.5 m x 2.4 m (6 m^2) with planting geometry of 25 x 60 cm. Crop was grown following NPRP's recommended package of practices. Two irrigations were given at 35 and 55 days after planting.

Genotype L-235.4 showed resistant character similar to Janakdev, whereas CIP 389746.2 was found resistant as compared to both genotypes L-235.4 and Janakdev (Table 5.4).

Table 5.4: Effects of host resistance and frequency of fungicide sprays on disease severity % at different stages and AUDPC under Khumaltar Conditions, 2011/12

	40 DAP	47 DAP	54 DAP	61 DAP	68 DAP	AUDPC
Genotypes						
Kufri Jyoti (V1)	1.4	13.8	28.1	39.3	49.8	747.2 a
Janakdev (V2)	0.5	1.0	4.6	12.5	17.1	188.3 c
L 235.4 (V3)	0.5	1.2	3.9	11.4	18.3	181.4 c
CIP 389746.2 (V4)	0.5	1.7	6.9	13.3	23.8	239 b
F-Test	<.001	<.001	<.001	<.001	<.001	<.001
LSD (0.05)	0.2325	1.175	1.639	2.629	2.131	31.32
Spray frequency						
No spray (S0)	0.833	9.79	28.83	45.42	61.67	807.2 a
Two sprays (S2)	0.625	3.58	7.00	18	28	300.3 b
Four sprays (S4)	0.708	2.33	4.87	8.92	13.08	161.2 c
Six sprays (S6)	0.792	1.96	2.79	4.25	6.17	87.4 d
F-Test	0.287	<.001	<.001	<.001	<.001	<.001
LSD (0.05)	0.2325	1.175	1.639	2.629	2.131	31.32
Interaction (Genotype X Spray frequency)						
V1S0	1.667	33.33	73.33	91.67	98.33	1738.7 a
V1S2	0.833	11.00	18.33	35.00	55.00	645.7 b
V1S4	1.333	6.33	14.00	21.67	33.33	415.7 e
V1S6	1.667	4.33	6.67	9.00	12.33	189 g
V2S0	0.500	1.33	13.33	33.33	43.33	489.3 d
V2S2	0.500	1.00	2.00	9.33	13.33	134.7 h
V2S4	0.500	0.83	1.67	5.00	7.00	78.7 i
V2S6	0.500	1.00	1.33	2.33	4.67	50.7 ij
V3S0	0.500	1.17	8.67	26.67	46.67	420.7e
V3S2	0.667	1.33	2.67	10.33	13.67	150.7 h
V3S4	0.500	1.17	2.17	5.00	7.00	84.7 i
V3S6	0.500	1.00	2.17	3.67	5.67	69.7 ij
V4S0	0.667	3.33	20.00	30.00	58.33	580 c
V4S2	0.500	1.00	5.00	17.33	30.00	270 f
V4S4	0.500	1.00	1.67	4.00	5.00	65.7 ij
V4S6	0.500	1.50	1.00	2.00	2	40.3 j
F value	0.125	<.001	<.001	<.001	<.001	<.001
LSD (0.05)	0.465	2.351	3.278	5.257	4.262	62.65
CV%	37.7	31.9	18.1	16.5	9.4	11.1

Kufri Jyoti and Janakdev showed significant positive effect on disease control as per increasing number of frequency. There were no significant differences of AUDPC on promising genotypes in four and six times sprayed plots. Results indicated that these genotypes require only 4 sprays for ate blight management under Khumaltar field conditions (Table 5.4).

Table 5.5: Effects of host resistance and frequency of fungicide sprays on tuber yield of potato genotypes under Khumaltar Conditions, 2011/12

	Under size		Seed size		Over size		Total yield	
Treatments	No.	Yield (kg)	No.	Yield (kg)	No.	Yield (kg)	No.	Yield (kg)
Genotypes								
Kufri Jyoti (V1)	118.2	1.798	149.1	5.963	42.6	3.3	309.9	11.06 c
Janakdev (V2)	88.4	1.356	132.1	5.28	56.9	4.25	277.4	10.88 c
L 235.4 (V3)	76.7	1.178	173.9	7.01	52.6	3.85	303.2	12.04 b
CIP 389746.2(V4)	35.4	0.533	140.9	5.694	110.6	9.14	286.9	15.36 a
F-Test	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
LSD (0.05)	9.27	0.1467	9.5	0.4068	7.46	0.731	15.57	0.72
Spray frequency								
No spray (S0)	80.9	1.215	142.8	5.698	26	1.95	250	8.87 d
Two sprays (S2)	80.2	1.232	151	6.04	58	4.62	289.4	11.89 c
Four sprays (S4)	70.7	1.112	149.8	6.058	78	6.18	298.9	13.35 b
Six sprays (S6)	87	1.307	152.3	6.151	100	7.78	339.1	15.24 a
F-Test	0.011	0.078	0.197	0.138	<.001	<.001	<.001	<.001
LSD (0.05)	9.27	0.1467	9.5	0.4068	7.46	0.731	15.57	0.72
Interaction (Genotype X Spray frequency)								
V1S0	122.3	1.137	136	5.44	4	0.32	262.7	7.59 g
V1S2	118.3	1.777	148.7	5.947	28	2.09	295.0	9.81 f
V1S4	107	1.697	148.3	5.933	47	3.81	302.7	11.43 de
V1S6	125.3	1.883	163.3	6.533	91	6.98	379.3	15.39 b
V2S0	96	1.443	148.3	5.66	22	2.01	266.3	9.12 f
V2S2	103.3	1.663	124.3	4.973	52	3.66	280.0	10.3 ef
V2S4	75.7	1.137	141.7	5.925	67	4.67	284.0	11.73 de
V2S6	78.7	1.18	114	5	87	6.65	279.3	12.39 cd
V3S0	88	1.32	132.3	5.507	6	0.42	226.7	7.25 g
V3S2	65.3	0.983	186	7.44	47	3.75	298.7	12.17 cd
V3S4	67.3	1.12	188.3	7.533	67	4.92	322.3	13.57 c
V3S6	86	1.29	189	7.56	90	6.3	365.0	15.15 b
V4S0	17.3	0.26	154.7	6.187	72	5.06	244.3	11.51 de
V4S2	33.7	0.507	145	5.8	105	8.98	284.0	15.28 b
V4S4	32.7	0.493	121	4.84	133	11.32	286.7	16.65 ab
V4S6	58	0.873	143	5.95	132	11.18	332.7	18.01 a
F value	1	0.001	<.001	<.001	0.013	0.022	<.001	<.001
LSD (0.05)	18.55	0.293	19	0.8136	14.92	1.462	31.14	1.44
CV%	14	14.5	7.6	8.1	13.6	17.1	6.3	7

Under size= <20 g; Seed size= 20-40g over size= >50 g

Figures followed by same letter are not statistically different.

Clone CIP 389746.2 produced highest tuber yield (15.36 t/ha) followed by L-235.4 (12.04 t/ha), but yielding capacity of these genotypes was significantly different. Tuber yield of Kufri Jyoti and Janakdev was found at par. There was no significant differences between the yields of four and six times sprayed plots of genotypes CIP 389746.2. L-235.4 produced the highest tuber yield at six

times sprayed. In case of susceptible genotypes spray frequencies had shown significant increment on tuber yield as the spray frequency increases. Among the genotypes tested, there was significant variation in number of under size and over size tubers. Under size tubers were highest in Kufri Jyoti and lowest in CIP-389746.2 and vice versa in over size tubers (Table 5.5). Interaction between potato genotypes and the number of spray frequencies was found significant.

3.1.5.1.4 Participatory evaluation of late blight resistant potato genotypes

Farmers' participatory multi-location field experiments were conducted in 2011/12 with the objectives of evaluating late blight disease (*Phytophthora infestans* (Mont) de Barry) resistant and high yielding potato genotypes.

Twenty-five promising potato genotypes which have been selected through the series of experiments since 2006, were tested in farmers fields of Dhikure (Nuwakot), Parwanipur (Bara), Belachapi (Dhanusa), Sonpur (Dang) and Kimugaun (Dailekh) involving two to four farmers in each location. A farmer's field trial (FFT) set per farmer, composed of 6-8 genotypes, were planted in the plot size ranging 3 to 6 m^2 during the respective potato planting season. Potato cultivars Desiree and Kufri Sindhuri in Bara, Lalgulab in Dhanusa, MS-42.3 and Cardinal in Nuwakot and Tharu Local in Dang were used as check to compare with test genotypes. Fungicide against any disease was not sprayed throughout the crop period. Late blight severity as foliage damage % was recorded at 70-75 days after planting. Crop was harvested at 90-110 days after planting depending on the location and farmers decision.

Genotype PRP 266264.01 produced highest tuber yield 46.67 t/ha followed by PRP 266264.15 (41.67 t/ha) in Dang, LBr-40 (37.17 t/ha) and CIP 384321.15 (31.83 t/ha) in Nuwakot, PRP 266264.15 (17.9 t/ha) in Dhanusa, PRP 25861.1 (26.37 t/ha) and PRP 266264.01 (22.66 t/ha) in Parwanipur, $BSUPO_3$ (47.05 t/ha), and PRP 266264.01 (44.33 t/ha) in Dailekh. Tuber yields of these genotypes were significantly highest as compared to the yields of respective local check ranging 2.8 to 13.33 t/ha.

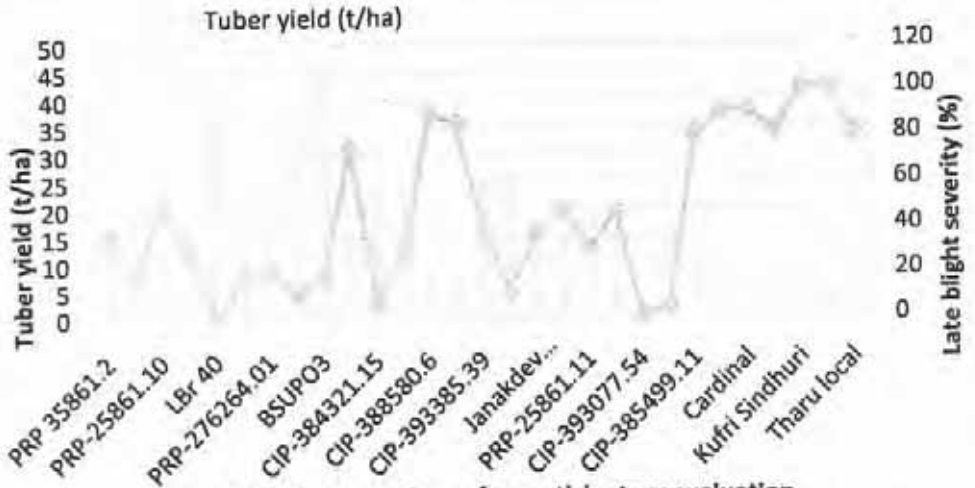


Fig. 5.1 Potato genotypes for participatory evaluation

3.1.5.2 Wart

3.1.5.2.1 Screening under laboratory conditions

Wart (*Synchytrium endobioticum*) is the disease of temperate zone above 2000 m a s l. Preliminary experimental results obtained at Khumaltar revealed that disease development can be observed if sporangia inoculated at 3 x 10^3 /ml and incubated at 15°-18° C and relative humidity 80-90% for 70-90 days. This technique seems to be effective in screening potato genotypes against wart under controlled conditions at Khumaltar.

3.1.5.2.2 Screening under pot culture high hill conditions

An experiment was conducted to screen potato clones against wart during spring season of 2068 at Nigale, Sindupalchowk in complete block design with three replications.

Experiment was carried out in pot culture method. The experimental pots were filled with wart infected soil collected from wart infected areas. In addition pots were inoculated with *Synchitrium endobioticum* suspension, 10 ml with the sporangial concentration of $3x10^3$ sporangia/ml in each pot and then tubers were planted. Irrigations were given as and when required. Disease incidence on tuber was recorded at harvest.

Of 25 potato genotypes tested 12 genotypes, PRP 35861.2, PRP 225861.2, L 235.4, PRP 276264.01, PRP 266264.01, $BSUPO_3$, CIP 384321.15, PRP 25861.1, CIP 393280.57, PRP 25861.11, PRP 85861.11, CIP 385499.11 showed resistance to wart as compared to local cultivar 'Rosita'. Wart incidence was highest in Rosita (74.8%). Released varieties Kufri Jyoti and Janakdev

were found still resistant to wart infection (Table 5.6). This screening method was found better than the naturally infested sick plot in farmer's field.

Table 5.6: Performance of potato genotypes to wart susceptibility under pot culture at Nigale conditions, 2011/12

Genotypes	Total tuber (No.)	Infected tuber (No.)	Wart Incidence (%)
PRP 35861.2	7.67	0.00	0.00
PRP 85861.12	5.33	1.33	24.53
PRP 25861.10	7.67	2.33	30.53
PRP 225861.2	4.00	0.00	0.00
LBr-40	7.00	2.00	28.97
PRP 85861.8	5.33	2.33	41.67
L-235.4	8.33	0.00	0.00
PRP 276264.01	5.67	0.00	0.00
PRP 266264.01	4.67	0.00	0.00
$BSUPO_3$	9.00	0.00	0.00
Kufri Jyoti (Check)	6.33	0.00	0.00
CIP 384321.15	5.00	0.00	0.00
PRP 25861.1	5.67	0.00	0.00
CIP 394050.110	9.00	1.67	19.97
CIP 393385.39	5.33	2.67	47.77
PRP 266264.15	6.00	2.00	37.77
Janakdev (Check)	3.33	0.00	0.00
CIP 393280.57	9.67	0.00	0.00
PRP 25861.11	3.00	0.00	0.00
PRP 85861.11	11.33	0.00	0.00
CIP 393077.54	4.67	1.67	40.00
CIP 392657.8	6.33	4.33	67.23
CIP 385499.11	3.67	0.00	0.00
CIP 389746.2	5.67	1.33	24.47
Rosita	6.67	5.00	74.83
CV%	37.02	67.53	52.35
F test	**	**	**
LSD(0.05)	3.8	1.18	15.05

3.1.5.3 Powdery scab disease management

In 2068, an experiment was conducted during normal potato growing season at Sharadanagar, Chitwan to identify suitable treatment for the management of powdery scab disease.

Experiment was set in randomized complete block design with three replications. There were six treatments including healthy and infected check. Chemical treatments were; Uthane M 45 (8%), Antracol (4%), Boric acid (3%) and Bleaching powder (8%). Each fungicide suspension was made by dissolving in water sufficient to dip the planting tubers. Potato tubers were dipped in suspension for 30 minutes before planting and shade dried. The remaining suspension was applied in the furrows of respective plots opened for planting.

The result revealed that seed treatment with bleaching powder 8% concentration showed highest disease control (78.2%) followed by planting apparently healthy tubers (72.8%) and treatments were at par. Results clearly indicated that seed treatment with any one of bleaching powder or Boric acid or Mancozeb (Uthane M 45) could be an effective alternative option for powdery scab management under field condition (Table 5.7). If soils are severely infested with the powdery scab (*Spongospora subterranea*) even after planting of symptomless healthy tubers, there would be possibility of getting disease incidence up to 28 percent. Regarding with the treatment effects on tuber yield, no significant differences observed.

Table 5.7: Efficacy of fungicide and healthy tubers on Powdery scab incidence and impact on tuber yield

Treatments	Disease Incidence (%)	Disease control (%)	Tuber yield (kg/plot)
Uthane M 45 (8%)	18.7	68.4	12.50
Antracol (4%)	26.1	55.8	11.83
Boric acid (3%)	18.2	69.2	12.57
Bleaching powder (8%)	12.9	78.2	12.20
Healthy (Check)	16.1	72.8	12.90
Infected (Check)	59.1	0.0	11.50
CV %	10.8		5.9
F test	**		NS
LSD 0.05	4.932		

3.1.6 Screening of Advanced Potato Clones against Moisture Stress at National Potato Research Program, Khumaltar, Lalitpur and Regional Agricultural Research Station Parwanipur, Bara

Potato is well adapted in different climates, but when there are even slight deviations, it can be adversely affected than other warm season crops. Thus, potato may be among the crops most-affected by climate warming. In the hills of Nepal, normal season crop mostly faces heat and drought stresses of summer immediately after the emergence throughout the crop season. Similarly, in the plains crop faces heat stresses at the early stage of the emergence and drought at later stage. Potatoes grown in rice-based cropping system in the valleys and plains, as a succeeding crop to the rice, utilize residual moisture from the fields for the emergence, but as the plants reach to the tuberization stage, the scarcity of irrigation and unavailability of soil moisture also hampers this crop. Some of the major potato growing areas are rain-shadow where crop gets more suffered from drought every year and farmers do not obtain expected yield from the crop. Potato tuber itself consists of 80% water and plant is herbaceous in nature. Due to this nature, all the developmental stages of potato plant are susceptible to moisture stress, which makes potato plant a highly sensitive crop to the stress which brings many physiological and bio-chemical changes in plants and in the tubers as well.

Despite three decades long vigorous official attempts of National Potato Research Programme in various fields of potato research, the area focusing on moisture stress has not received due attention in Nepal, however, several attempts on finding high yielding and disease resistant varieties has resulted several potato varieties available to be commercially cultivated for the country. Cultivar, NPI-106, one of the widely cultivated varieties in the hills, has been observed with moderate moisture stress tolerating trait in dry hills. Some of the mulching trials conducted in the past have demonstrated very positive effect on moisture retention, but not been focused to relate with potato varieties and moisture stress tolerance in planned way. In some of the potato growing countries of the world including India, variety improvement work against this stress is gaining momentum from some years back and as a result, some of the hybrids and cultivars are reported as with satisfactory results. International Potato Center (CIP) has listed some germplasm with moisture stress resistance in its germplasm list, but not a single cultivar has been observed gaining popularity so far in this area (CIP, 1992). In other hand technologies and varieties developed under different conditions, such as in CIP Peru or Central Potato Research Institute (CPRI) India may or may not be suitable for Nepalese conditions.

Varieties must not only be well adapted to local growing conditions but also suit the changing environment. Therefore, selecting suitable varieties becomes an essential first step in any of the successful production systems in any of the potato growing countries of the world. Luckily, about a dozen of improved varieties and some of the local land races are potentially available to potato

growers through the continuous efforts of NPRP but none of them had been tested against moisture stress so far. Therefore, aiming to cope with moisture stress through variety selection a project was undertaken at Hattiban Research Farm Khumaltar, Lalitpur and Regional Agricultural Research Station Parwanipur, Bara, representing mid-hills and terai conditions of Nepal.

Another set of the trial was planted at Regional Agricultural Research Station (RARS) Parwanipur, Bara, central region Terai of Nepal. It is one of the largest areas for potato production in the country but yields are comparatively lower. Lack of irrigation is one of the major contributing factors for lower productivity and the potato varieties cultivated are not drought tolerant. By selecting drought tolerant suitable potato varieties, more areas could be brought under potato cultivation and secure potato yields in this region and other part of terai as well. Therefore, the main objective of the trial was identifying high yielding potato varieties with moisture stress tolerance.

Total of 33 advanced potato clones available at National Potato Research Programme (NPRP) Khumaltar were assessed at Hattiban Research Farm Khumaltar in the years 2008/09 and 2009/10. The treatments applied were completely rain-fed, mulching and irrigated conditions. Rice straw was used as the mulching material. All other cultural practices were followed as per the NPRP recommendations. To help tuber emergence, first irrigation was provided immediately after planting to all the treatments after then only irrigated plot was irrigated when needed and in other two treatments irrigation was completely stopped. In the plots, 12 tubers were planted per row in rod-row design with 60 x 25 row to row and plant to plant spacing. Fertilizer was applied at the rate of 100:100:60 kg NPK and 20 tons FYM per hectare. Observations taken in the trial were; plant growth parameters (% plant emergence, plant height, plant uniformity, plant vigor and number of main stems per plant) and tuber yield and its attributes (number of plants harvested, number and weight fraction of the tubers in three grades, total number and weight of tubers per plot, yield tons per hectare and color, shapes and eye depth of the tubers at harvest.

Another set of trial was planted with 43 clones at RARS, Parwanipur, Bara. Field was laid out as in Khumaltar. Tubers were planted on furrows by maintaining row to row 60 cm and plant to plant 25 cm in three growing conditions; rainfed (under plastic and without under plastic), mulching and irrigation. In all the plots, first irrigation was done just after planting to facilitate the emergence. But later on no any irrigation was done except in irrigation plot. In mulching plot, paddy straw was sprayed over the ridge as mulch. Chemical fertilizers and compost were applied on furrow at the rate of 100:100:60 kg NPK and 15 ton farm yard manure, respectively. All the cultivation practices were done as per NPRP recommendation.

At Khumaltar, in the completely rainfed condition, LBr-40, CIP 391061.73, BR 63-65 and BSU PO_3 were highest emerging clones, however, none of the clones were 100% emerged even at 45 days after planting (Table 6.1) which could be due to the moisture stress at emergence stage of the tubers. Single irrigation

provided immediately after planting seems not sufficient to boost emergence in potato if soil is dry at planting. Probably due to the second irrigation in the irrigated treatment, majority of the clones had 100% emergence ranging from 71 to 100%, whereas in mulching treatment, clones CIP 394007.55, CIP 393574.71B, LBr-40 and NPl-106 were the best performing clones in emergence. The average plant emergence was highest (94%) in irrigation treatment followed by mulching (90%) and lowest in rainfed treatment (77%). Percent ground cover of the assessed clones was highest (75%) in clone CIP 393574.72B and lowest (20%) in Ca x 27/40 in rainfed treatment, whereas in irrigated conditions, highest (99%) ground cover was observed in the clone CIP 393385.39 followed by CIP 392242.25 (85%). Clone CIP 393574.72B had the highest percentage ground cover (83%). However, the percent ground cover of irrigated treatment was higher than the rainfed and mulching treatments.

Table 6.1: Treatment effects on vegetative characteristics of different clones at NPRP Khumaltar, 2067/68 and 2068/69

Clones	Emergence (%)			Ground cover (%)			Plant height (cm)			Plant vigor (1-5 scale)			Stem plant (No.)		
	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
CIP378711.7	71	100	84	43	58	53	8.4	36.6	28.5	3	4	3	2.2	2.0	2.3
CIP389660.9	88	100	75	60	65	55	21.4	24.6	23.0	3	5	2	4.5	4.5	3.7
CIP391011.47	84	100	96	38	45	48	11.9	16.9	16.2	3	4	3	2.8	3.8	2.9
CIP391058.35	63	75	96	30	55	53	22.7	26.0	27.3	3	3	3	3.2	3.2	2.6
CIP 391061.73	96	100	96	45	53	48	19.5	24.0	21.8	3	4	4	3.0	2.8	2.4
CIP 391598.75	75	100	92	63	73	53	22.9	24.9	23.8	4	4	3	3.7	3.1	2.6
CIP 392242.25	88	91	91	63	85	60	27.0	30.2	23.6	4	5	3	3.2	3.4	3.1
CIP 392243.17	84	100	96	60	63	43	18.3	23.5	20.1	4	4	3	2.6	2.8	2.5
CIP 392244.3	88	92	88	68	78	53	27.4	31.6	28.8	5	4	4	4.0	4.2	3.6
CIP 393385.39	88	100	92	73	88	73	23.8	27.8	23.2	5	5	4	4.7	4.3	3.6
CIP394003.161	84	96	100	58	65	63	29.6	27.8	29.3	5	5	4	3.0	3.2	2.6
CIP 394007.55	75	100	96	45	68	60	22.4	31.5	25.6	4	5	4	2.9	3.5	2.5
CIP 394051.4	88	100	100	38	53	53	17.7	24.4	22.9	3	4	4	3.8	4.2	3.5
CIP 393574.72	92	96	92	75	78	83	20.4	21.9	24.4	5	5	4	3.9	4.4	2.7
BR 63-65	96	100	92	63	68	55	20.7	24.6	22.3	5	5	4	3.1	3.1	3.4
BSU PO3	96	100	88	58	70	58	31.2	30.1	29.8	5	4	3	3.7	3.9	2.6
BW3	88	88	79	58	38	40	21.2	19.8	16.5	2	4	2	3.2	2.5	2.5
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
CaxLBr40.6	50	100	92	20	48	38	20.3	24.5	29.8	5	3	2	2.2	2.8	2.9
Dc x LBr40.10	59	100	84	28	70	58	20.5	24.3	22.3	2	4	4	2.4	1.9	2.8
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
K. Ashoka	59	84	84	28	50	48	16.8	30.3	28.1	2	2	3	2.0	2.4	2.6
K. Kanchan	79	96	92	50	75	73	23.3	22.1	24.5	4	5	6	3.0	2.5	2.9
K. Sutlez	75	100	83	21	68	43	29.3	29.3	25.6	2	2	2	2.5	3.4	2.6
K. Chipsona2	59	96	83	30	65	43	17.5	26.9	29.4	2	4	3	2.6	2.5	3.1
K. Seto 1	63	100	92	39	75	45	20.7	32.1	31.6	2	3	3	3.7	4.7	2.8
L 235-4	75	96	96	35	78	63	18.1	27.2	21.1	4	5	3	2.1	2.5	2.1
LBr 40	96	96	100	60	78	78	18.2	25.9	25.3	3	5	4	3.2	3.8	3.2
MS 35.9	58	75	92	38	48	63	18.6	22.9	23.8	32	3	3	2.6	2.8	2.3
NPl 106	75	88	100	30	58	55	19.4	23.6	21.8	3	4	3	3.7	4.3	3.0
Primicia	71	71	96	28	33	65	21.4	25.1	24.8	2	2	3	3.2	2.8	2.3
Desiree (ch)	75	75	84	45	48	50	25.0	26.9	16.5	3	3	3	3.2	3.6	2.8
K. Jyoti (ch)	67	96	84	25	65	60	18.4	27.1	23.1	3	4	3	2.3	2.4	2.2
Mean	**77**	**94**	**90**	**44**	**63**	**56**	**21.0**	**26.1**	**24.3**	**4**	**4**	**3**	**3.0**	**3.2**	**2.8**

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

Average number of main stems was counted highest (4.7) in the clone CIP 393385.39 in rainfed treatment followed by CIP 389660.9 (4.5). Khumal Seto-1 had the highest number of main stems in irrigated conditions. Interestingly the average number of main stems was counted lower with mulched treatment

scoring highest (3.6) in the clones CIP 392244.3 and CIP 393385.39. Average number of followed by rainfed (3.0) and mulched, respectively.

Average plant vigor did not differ between irrigated and rainfed conditions, but slightly differed with mulching. Except one of the Indian clones Kufri Kanchan, none of the tested clones were superior in plant vigor, however, majority of the tested clones tested in irrigated treatment and some of the clones in rainfed conditions were scored 5 in 1-5 scales in plant vigor.

In tuber yield and its attributes at Khumaltar, highest number of tubers per plot in 1.5 m^2 plot size were harvested in the clone CIP 391598.75 (157) followed by NPI-106 (146) in rainfed, whereas in irrigated plots, clone L-235-4 was the highest tuber producing clone (194) (Table 6.2). In rainfed treatment, total tuber weight per plot was obtained highest (3.9 kg) from the clone CIP 391598.75 followed by NPI-106 (3.1), CIP 391011.47 (3.0 kg) and CIP 392242.25 (2.9 kg), respectively. In irrigated plot (T2), clone CIP 391011.47 produced highest (4.7 kg) tuber yield. Clones CIP 391011.47, CIP 378711.7 and Ca x LBr-4.06 were found superior to Kufri Jyoti. Almost all of the tested clones were superior to Desiree one of the check varieties in the trial. CIP 391011.47 and LBr-40 were highest yielding clones (Table 6.2) in mulching treatment. Clone CIP 391598.75 was found highest tuber yielder (25.7 t/ha) among all the clones tested in the trial in rainfed conditions followed by NPI 106 (22.6 t/ha) and CIP 391011.47 (20.7 t/ha), CIP 391058.35 (20.5 t/ha), respectively. In irrigated conditions, CIP 391011.47 produced highest yield (31.2 t/ha) and Kufri Kanchan produced lowest (9.7 t/ha).

Kufri Jyoti, one of the check varieties also gave satisfactory yield (24.7 t/ha). In mulching treatment, clone CIP 391011.47 was found highest yielder (26.9 t/ha) followed by LBr-40 (26.0 t/ha). The average yields of all the clones tested were highest (17.7 t/ha) in irrigated treatment followed by mulching (16.6 t/ha) and lowest 14.3 t/ha) by rainfed treatment. The average yield of all 3 different treatments was highest (26.3 t/ha) in the clone CIP 391011.47 followed by CIP 391598.75 (24.5 t/ha), LBr-40 (22.8 t/ha), Ca x LBr-40.6 (22.6 t/ha) and NPI-106 (21.8 t/ha), respectively, whereas check varieties Desiree gave 16.0 and Kufri Jyoti 20.6 t/ha respectively in the trial.

In completely rain-fed conditions, clones CIP 394003.161, CIP 392243.17, CIP 391058.35, CIP 392242.25, Khumal Seto-1, CIP 378711.7, Ca x 27/40-7, CIP 396011.47, Primicia, CIP 391598.75, LBr-40, L-235.4, CIP 394007.55, Kufri Chipsona-2, NPI-106 and Ca x LBr-40.6 were found performing comparatively better than the check variety Kufri Jyoti. In the irrigated treatment, clones CIP 391011.47, Ca x LBr-40.6, CIP 378711.7 and LBr-40 were superior to Kufri Jyoti (Table 6.2). In the mulching treatment, clone LBr-40 performed the best followed by 394003.161, Ca x LBr-40.6, CIP 391011.47, Kufri Jyoti, CIP 392250.56, Primicia, CIP 391598.75, CIP 392236.6, Khumal Seto-1, CIP 389746.2, 27/40, Des x LBr 43.18, CIP 800947 and 391058.35 respectively. Some of the clones like CIP 391598.75, NPI-106 CIP 39242.25 and CIP 391011.47, CIP 394003.161 and LBr-40 were found the best performing in all

of the three conditions. The highest yield in irrigated treatment was obtained 31.2 t/ha whereas in rainfed conditions it was 23.5 t/ha and in mulching treatment, highest yield was 26.9 t/ha indicating that the contribution of moisture in tuber yield increment is highly significant.

Table 6.2: Treatment effects on yield characteristics of different clones at NPRP Khumaltar, 2067/68 and 2068/69

Clones	Total tuber/plot						Adjusted yield (t/ha)			
	Number			Wt. kg						
	T1*	T2	T3	T1	T2	T3	T1	T2	T3	Mean
CIP 391598.75	157	98	122	3.9	3.8	3.4	25.7	23.5	24.2	24.5
NPI 106	146	136	115	3.1	3.6	3.1	22.6	22.9	19.8	21.8
CIP 391011.47	99	149	104	3.0	4.7	3.9	20.7	31.2	26.9	26.3
CIP 392242.25	110	136	101	2.9	2.6	3.1	20.5	16.2	20.7	19.1
CIP 391058.35	94	103	147	1.9	1.9	3.2	19.8	13.7	20.4	18.0
CIP 394003.161	105	111	83	2.9	3.0	2.8	19.0	18.1	18.9	18.7
CIP 392243.17	73	110	83	2.0	2.6	2.5	17.4	15.9	15.8	16.4
Primicia	91	89	95	2.7	2.9	3.1	17.4	18.1	20.5	18.7
CIP 378711.7	64	109	98	2.1	4.4	2.1	17.3	26.4	12.9	18.9
LBr 40	72	87	144	2.6	4.1	3.9	17.2	25.1	26.0	22.8
L 235-4	139	194	161	2.4	3.5	2.2	17.1	22.3	14.4	17.9
Ca x 27/40.7	57	64	63	1.9	1.9	1.8	16.3	14.3	13.2	14.6
K. Seto 1	79	96	122	1.7	2.8	3.4	16.0	20.0	21.3	19.1
CIP 394007.55	54	77	103	1.6	2.2	1.8	15.5	13.1	13.1	13.9
K. Chipsona2	116	63	102	1.9	1.6	2.5	15.5	12.9	16.2	14.9
CaxLBr40.6	74	127	44	2.2	4.6	3.6	15.4	28.7	23.7	22.6
CIP 393385.39	84	139	135	1.8	2.9	3.1	13.8	17.5	20.7	17.3
CIP 389660.9	85	98	41	1.9	3.1	1.9	13.7	19.3	12.6	15.2
Des x LBr40.10	77	82	85	1.9	3.0	1.6	13.4	20.2	10.1	14.6
MS 35.9	134	119	91	1.9	2.5	1.4	13.2	15.3	9.9	12.8
Des x LBr 44.8	73	76	108	1.7	2.5	2.0	10.9	14.9	12.9	12.9
K. Sutlez	63	59	41	1.6	1.6	1.1	10.9	10.2	7.8	9.6
CIP 394051.4	32	89	44	1.2	2.9	1.8	10.4	18.8	12.1	13.8
K. Ashoka	69	93	63	1.5	2.6	2.0	10.4	16.1	12.4	13.0
BSU PO3	56	93	108	1.4	2.3	3.2	10.0	14.3	21.2	15.2
CIP 393574.72B	34	63	33	1.4	1.6	1.1	9.4	10.8	8.7	9.6
CIP 391061.73	38	60	91	1.2	1.9	2.3	8.6	13.2	16.9	12.9
BW3	58	41	63	1.1	1.7	1.9	7.9	10.7	12.3	10.3
CIP 392244.3	41	79	96	1.0	2.5	1.9	7.4	15.9	15.4	12.9
BR 63-65	62	118	85	1.0	2.2	2.2	7.1	13.6	15.9	12.2
K. Kanchan	38	67	63	0.5	1.5	100	3.4	9.7	6.7	6.6
Desiree (ch)	65	61	3	1.5	1.9	2.9	12.7	15.2	20.0	16.0
K. Jyoti (ch)	74	114	108	2.2	3.9	3.7	14.3	24.7	22.9	20.6
Mean	**79.2**	**97.0**	**89.2**	**1.9**	**2.8**	**2.5**	**14.3**	**17.7**	**16.6**	16.2

* T1: Rainfed, T2: Irrigated, T3: Mulched

Based on all the performance, some of best clones will be assessed next year in replicated way at Hattiban Research Farm Khumaltar, in Potato Physiology lab at NPRP Khumaltar, Lalitpur and in major collaborating research stations of NARC.

At Parwanipur, 14 clones showed excellent plant uniformity under plastic condition. Clones 393663.8, PRP 35861.13, 387115.8LB, 397077.16, 391598.75, 392242.25, and 388676.1 had attained the highest ground coverage. Nine clones were found resistant to late blight. Thirteen clones were most vigorous (10) followed by 16 clones (9). Six clones; 393280.64, 393663.8, PRP 35861.13, L 235.4, 397077.16, and 394034.65 were found resistant to drought. Clones 396011.47, 388746.1, 386612.5 and BSU PO_3 produced highest yield (Table 6.3).

In open condition, nine clones showed excellent plant uniformity. Clones 393663.8, 392243.17, 394004.161 and 388676.1 had attained highest ground coverage. The highest number of stems per plant (4.6) was counted in 392242.25 followed by LBR 44 and 395192.1 (4.2). Clones $BSUPO_3$, 389660.9, and LBr-40 were found resistant to late blight. Clones 393280.64, 386612.5, 391004.18, 397077.16, 393077.159 and 389746.2 were found resistant to drought followed by $BSUPO_3$, L-235.4 and D x 27/40-8. LBr-40, 395192.1, 388676.1, 396011.47 and 397077.16 produced highest yield (Table 6.4).

The highest number of stems per plant (5.4) was counted in LBR 40 followed by LBr-44 (5.2). Clones 396011.47, 388764.26LB, 395192.1, 391598.75, 393663.8, 393280.64 and 391004.18 produced highest tuber yield (Table 6.5).

In irrigated condition, the highest number of stems per plant (5.2) was counted in LBR 44 followed by LBR 40 (5.0) and 392244.3 (4.6) respectively. For the yields, 388676.1, 389660.9, 386612.5, 393663.8, and D x LBR 40-10 produced highest yield (Table 6.6).

This study compared the responses of different advanced potato cultivars for their tolerance against moisture stresses. Completely rain-fed, rice-straw mulching and frequently irrigated conditions were considered as the moisture treatments in the trial. Based on the preliminary results, the best performing clones will be further assessed in multi-locational varietal trials of NPRP in the future.

Table 6.3: Response of potato varieties in rain-fed condition under plastic in Parwanipur on vegetative parameter

Treatment No.	Varieties	Plant uniformity	Plant vigor	Drought susceptibility	LB	Ground Cover %	Adj. Yield (t/ha)	Tuber grading (% wt)		
								US	SS	OS
Under plastic										
1	BR 63.65	9	8	4	2	80	21.83	14.5	30.5	55.0
2	Baronesa	10	9	5	2	80	15.50	9.7	23.6	66.7
3	393280.64	9	9	1	1	90	14.00	9.5	25	65.5
4	MS 35.9	8	8	4	2	90	15.83	34.7	54.7	10.5
5	DxLBR 40-10	8	9	6	2	75	22.33	5.2	17.2	77.6
6	378711.7	8	8	6	3	85	21.83	8.4	22.9	68.7
7	393663.8	9	10	2	3	100	19.50	7.7	44.4	47.9
8	Andinita	8	7	5	2	65	24.17	62.1	15.2	22.7
9	K.Giriraj	9	8	8	3	75	13.33	12.5	42.5	45
10	NPI-106	9	10	4	3	95	19.00	17.5	40.3	42.1
11	K.Laxmi	8	9	5	3	85	17.00	16.7	73.5	9.8
12	LBR 44	10	10	3	2	95	9.17	20	45.4	34.5
13	386612.5	9	8	5	2	85	28.17	4.7	28.4	66.9
14	BSU PO3	8	8	6	1	75	28.17	7.7	39.0	53.2
15	PRP 35861.13	9	10	1	2	100	18.33	6.4	52.7	40.9
16	389660.9	10	9	4	1	95	6.833	14.6	61.0	24.4
17	L 235.4	10	9	1	1	85	16.67	14	76	10
18	DxLBR 40-6	9	8	4	2	70	16.83	7.9	16.8	75.2
19	388576.1D	10	10	5	3	85	24.83	6.7	42.3	51.0
20	392244.3	9	9	5	1	90	26.67	4.4	43.1	52.5
21	K.Ashoka	8	6	5	3	65	8.00	6.2	93.7	0
22	K.Badsah	8	8	6	3	80	20.00	10	7.5	82.5
23	387115.8LB	9	10	5	3	100	24.00	0	11.8	88.2
24	391004.18	9	9	4	1	85	26.17	15.3	48.4	36.3
25	397077.16	10	10	1	1	100	27.50	3.1	17.6	79.4
26	393077.159	8	8	6	2	75	21.67	6.1	22.3	71.5
27	392243.17	8	8	5	2	70	20.67	10.5	20.2	69.3
28	388764.26LB	10	9	5	1	85	21.17	16.5	34.6	48.8
29	Dx27/40-8	9	7	5	3	70	8.00	8.3	22.9	68.7
30	394004.161	9	9	6	4	75	22.67	8.1	39.0	52.9
31	395192.1	10	9	4	2	95	28.00	4.2	19.0	76.8
32	Desiree	10	9	5	3	85	27.17	6.1	26.4	67.5
33	394034.65	10	9	2	2	75	23.50	9.2	34.0	56.7
34	Cax27/40-7	9	10	6	3	85	20.17	7.4	22.3	70.2
35	391598.75	9	10	5	3	100	26.33	14.5	34.8	50.6
36	396011.47	10	10	5	2	85	34.50	14.0	33.8	52.2
37	392242.25	9	10	5	2	100	16.50	13.1	31.3	55.5
38	388676.1	10	10	4	2	100	32.67	2.0	35.2	62.7
39	392256.48	9	9	5	2	95	16.42	5.6	60.9	33.5
40	389746.2	10	10	3	2	100	16.33	3.1	32.6	64.3
41	CaxLBR 40-6	9	9	7	3	75	19.00	5.3	22.8	71.9
42	K.Sindhuri	8	7	4	2	85	17.17	8.7	46.6	44.7
43	LBR 40	10	9	5	1	85	27.00	1.8	31.5	66.7

Table 6.4: Response of potato varieties in rain-fed condition in Parwanipur on vegetative parameter

Treat No.	Varieties	Plant uniformity	Plant vigor	Drought susceptibility	LB	Ground Cover (%)	Adj. Yield (t/ha)	Tuber grading (% wt)		
								US	SS	OS
Rainfed										
1	BR 63.65	9	9	6	2	85	21.25	5.5	60.4	34.1
2	Baronesa	9	9	6	5	80	17.25	9.7	47.8	42.5
3	393280.64	9	9	1	2	75	19.25	9.9	37.2	52.8
4	MS 35.9	9	8	5	2	70	14.67	16.5	63.6	19.9
5	D x LBR 40-10	8	9	5	2	80	19.67	14.0	43.6	42.4
6	378711.7	9	10	6	3	90	21.58	9.3	36.7	54.0
7	393663.8	10	10	4	3	100	27.5	1.2	18.2	80.6
8	Andinita	8	8	4	4	80	11.83	7.0	30.3	62.7
9	K.Giriraj	9	8	8	6	70	9.083	3.7	45.9	50.4
10	NPI-106	9	8	4	5	85	19.08	6.1	52.0	41.9
11	K.Laxmi	8	7	6	6	70	15.67	10.6	85.1	4.2
12	LBr 44	9	8	5	3	65	7.667	10.9	58.7	30.4
13	386612.5	10	9	1	3	90	23.83	2.1	18.5	79.3
14	BSU PO_3	9	8	2	1	70	18.33	4.0	26.8	69.1
15	PRP 35861.13	9	7	3	2	65	15.33	0.3	24.4	75.5
16	389660.9	9	9	4	1	65	21.17	3.1	16.1	80.7
17	L-235.4	9	9	2	2	75	18.33	5.9	22.7	71.3
18	D x LBR 40-6	8	9	5	2	80	19.25	4.8	32.5	62.8
19	388576.1D	9	8	5	3	75	17.33	7.7	22.1	70.2
20	392244.3	9	9	5	3	85	20.17	11.1	15.7	73.1
21	K.Ashoka	7	8	6	3	65	14.08	2.4	26.6	71.0
22	K.Badsah	9	10	5	3	95	17.17	8.2	35.9	55.8
23	387115.8LB	8	9	4	3	80	22.17	9.0	27.1	63.9
24	391004.18	9	10	1	3	95	18.92	3.5	22.9	73.6
25	397077.16	10	10	1	2	80	24.58	4.1	16.3	79.7
26	393077.159	9	10	1	2	95	22.67	1.8	19.5	78.7
27	392243.17	9	10	4	3	100	23.17	8.6	54.7	36.7
28	388764.261.B	10	9	3	4	75	17.67	10.8	57.1	32.1
29	D x 27/40-8	10	10	2	3	85	14.25	16.4	28.6	55.0
30	394004.161	9	10	5	4	100	23.25	3.6	14.3	82.1
31	395192.1	10	9	5	5	100	31.5	5.5	21.9	72.5
32	Desiree	10	9	5	3	90	20	3.3	17.1	79.6
33	394034.65	8	8	5	2	80	18.08	11.5	36.9	51.6
34	Ca x 27/40-7	9	9	5	5	85	22.33	9.3	27.2	63.4
35	391598.75	10	9	5	6	95	24.42	14.3	37.9	47.8
36	396011.47	9	10	4	5	95	26.33	2.5	25.9	71.5
37	392242.25	9	10	4	6	90	12.17	12.3	52.7	34.9
38	388676.1	9	10	6	6	100	28.58	2.6	21.3	76.1
39	392256.48	9	9	5	5	95	21.17	6.3	24.8	68.9
40	389746.2	10	9	1	2	70	21.5	7.7	26.0	66.3
41	Ca x LBR 40-6	7	7	5	3	65	9.583	13.0	50.4	36.5
42	K.Sindhuri	9	8	5	3	70	13.92	26.3	41.9	31.7
43	LBr 40	9	9	5	1	70	32.42	6.7	3.3	90.0

Table 6.5: Response of potato varieties in mulching condition in Parwanipur on vegetative parameter

Treat no.	Varieties	Plant uniformity	Plant vigor	Drought susceptibility	LB	Ground Cover %	Adj. Yield t/ha	Tuber grading (% wt)		
								US	SS	OS
Mulching										
1	BR 63.65	9	9	2	3	90	24.50	5.1	54.8	40.1
2	Baroness	9	10	3	3	100	23.25	7.2	44.1	48.7
3	393280.64	8	10	1	2	95	28.08	12.5	32.1	55.5
4	MS 35.9	9	8	4	3	75	22.92	10.5	58.2	31.3
5	DxLBR 40-10	9	9	4	3	80	15.50	5.4	43.0	51.6
6	378711.7	9	9	4	5	85	29.00	6.6	35.9	57.5
7	393663.8	8	9	4	7	95	28.17	12.4	33.4	54.1
8	Andinita	9	8	4	7	85	18.83	12.3	61.9	25.7
9	K.Giriraj	9	8	5	7	80	12.92	6.4	34.2	59.3
10	NPI-106	9	9	4	7	75	14.50	9.2	41.9	48.8
11	K.Laxmi	10	9	4	6	85	16.25	12.8	71.8	15.4
12	LBR 44	9	10	4	6	80	9.42	32.7	67.2	0
13	386612.5	10	10	3	4	95	24.00	6.9	57.3	35.8
14	BSU PO3	10	8	4	3	80	21.75	9.6	40.6	49.8
15	PRP 35861.13	10	10	2	4	95	17.25	11.1	53.1	35.7
16	389660.9	9	10	1	5	95	20.17	9.5	47.5	43.0
17	L 235.4	9	9	2	8	80	17.42	25.8	40.7	33.5
18	DxLBR 40-6	10	8	4	8	70	18.58	11.2	36.3	52.5
19	388576.1D	9	9	5	8	90	17.92	7.0	51.2	41.9
20	392244.3	9	9	4	8	95	19.33	12.9	50.4	36.6
21	K.Ashoka	9	8	5	8	70	11.08	8.3	69.2	22.6
22	K.Badsah	9	10	5	5	100	21.17	7.1	55.1	37.8
23	387115.8LB	9	10	4	4	100	27.00	1.5	30.9	67.6
24	391004.18	10	9	4	4	95	27.67	6.0	48.8	45.2
25	397077.16	9	10	2	4	85	19.67	16.9	29.7	53.4
26	393077.159	9	8	5	3	80	25.58	4.6	18.9	76.5
27	392243.17	10	10	6	4	95	26.08	23.9	61.3	14.7
28	388764.26LB	9	9	3	5	90	30.08	12.5	57.6	29.9
29	Dx27/40-8	10	9	3	5	95	17.25	22.7	46.4	30.9
30	394004.161	10	10	4	6	100	24.33	4.1	29.1	66.8
31	395192.1	10	10	3	6	100	29.67	2.2	30.3	67.4
32	Desiree	8	9	5	5	90	14.50	11.4	71.8	16.7
33	394034.65	8	8	4	4	80	14.67	14.2	43.2	42.6
34	Cnx27/40-7	9	8	4	5	70	17.00	13.2	51.5	35.3
35	391598.75	9	9	6	9	95	28.50	13.1	51.7	35.1
36	396011.47	9	10	5	7	100	34.83	15.1	37.1	47.8
37	392242.25	9	10	4	8	100	16.50	8.6	52.0	39.4
38	388676.1	9	10	3	6	100	24.25	2.7	44.0	53.3
39	392256.48	10	10	2	4	100	22.67	4.8	57.0	38.2
40	389746.2	7	10	2	3	100	14.83	14.0	42.7	43.3
41	CnxLBR 40-6	8	7	6	2	70	13.42	13.0	34.2	52.8
42	K.Sindhuri	10	8	5	2	75	25.75	14.2	63.1	22.6
43	LBR 40		8	3	1	80	18.33	11.4	36.4	52.3

Table 6.6: Response of potato varieties in irrigation condition in Parwanipur on vegetative parameter

Treat No.	Varieties	Plant uniformity	Plant vigor	Stems No.	LB	Ground Cover %	Adj. Yield t/ha	Tuber grading (% wt)		
								US	SS	OS
Irrigated										
1	BR 63.65	9	9	2.2	6	80	28.75	5.8	65.2	29.0
2	Baronesa	9	7	4	8	60	18.75	17.8	46.7	35.5
3	393280.64	9	8	3	3	65	27.5	9.1	45.4	45.4
4	MS 35.9	9	8	1.4	3	75	26.17	4.4	54.1	41.4
5	DxLBR 40-10	9	7	2.4	2	60	31.67	2.6	42.1	55.3
6	378711.7	10	9	3.8	7	75	27.92	3.0	61.2	35.8
7	393663.8	10	10	3.2	5	90	30.42	6.8	56.1	37.0
8	Andinita	9	8	5.2	8	80	17.5	11.9	50.0	38.1
9	K.Giriraj	8	7	2.6	7	80	14.83	14.0	46.6	39.3
10	NPI-106	9	8	3.2	6	60	21.5	11.6	53.5	34.9
11	K.Laxmi	8	7	2.6	5	55	17.33	13.5	86.5	0
12	LBR 44	9	7	5.2	4	55	15.33	27.7	53.3	19.0
13	386612.5	10	10	2.8	5	85	32.25	3.1	33.6	63.3
14	BSU PO3	9	8	3.6	3	65	21.25	15.7	52.9	31.4
15	PRP 35861.13	10	10	2.8	4	75	24.92	4.7	55.2	40.1
16	389660.9	9	9	3.4	4	95	33.33	8.7	26.2	65
17	L 235.4	10	9	2.8	6	80	19.42	15.0	77.2	7.7
18	DxLBR 40-6	7	8	1.8	7	50	18.33	18.2	56.8	25
19	388576.1D	9	9	2	7	55	23.42	5.7	48.0	46.3
20	392244.3	9	8	4.6	6	70	19.25	13.0	59.3	27.7
21	K.Ashoka	8	6	2.2	7	50	5.833	20	80	0
22	K.Badsah	9	9	3.8	8	55	22.17	17.3	67.7	15.0
23	387115.8LB	9	9	2.6	3	70	23	7.2	38.4	54.3
24	391004.18	9	10	2.2	8	90	16.67	15	67.5	17.5
25	397077.16	10	10	3.4	6	90	26	10.2	38.5	51.3
26	393077.159	9	8	3.6	2	80	28.33	8.8	52.9	38.2
27	392243.17	9	8	1.8	6	75	18.75	22.2	51.1	26.7
28	388764.26LB	9	8	2.4	8	70	16	23.9	62.5	13.5
29	Dx27/40-8	9	7	2.2	6	65	21.33	16.8	64.4	18.7
30	394004.161	10	10	3.6	7	85	25.42	4.9	59.0	36.1
31	395192.1	9	9	3.8	6	95	25.92	1.9	51.4	46.6
32	Desiree	9	10	3.2	6	85	25.5	8.5	49.0	42.5
33	394034.65	8	7	2.2	5	55	19.33	6.0	36.2	57.7
34	Cax27/40-7	8	7	2.6	6	70	15.33	10.9	45.6	43.5
35	391598.75	9	8	2	7	80	14.33	11.6	62.8	25.6
36	396011.47	9	10	4	5	100	25.58	5.2	66.8	28.0
37	392242.25	9	9	4	7	85	21.33	6.2	72.3	21.5
38	388676.1	9	9	3.6	6	80	35.67	3.3	37.4	59.3
39	392256.48	8	9	2.2	4	80	21.33	3.9	49.2	46.9
40	389746.2	8	8	4	3	70	24.25	8.9	27.5	63.6
41	CaxLBR 40-6	8	8	2	3	80	27.92	3.0	58.2	38.8
42	K.Sindhuri	9	8	4	6	75	19.5	6.4	85.0	8.5
43	LBR 40	9	7	5	2	70	15.25	7.6	57.4	35.0

2.3.7 Bio-fertilizer Studies on Potato

Potato is an economically important vegetable as well as food crop of Nepal. It is a short season crop and fits well in rice-based cropping system of hills and terai of Nepal. It is considered as heavy nutrient feeder crop and therefore, the balanced amount of nutrient is a must for the successful potato production. The single source of fertilizer is not capable to supply the required amount of nutrients and therefore, integrated use of all sources of plant nutrients is necessary to supply the balanced dose of nutrition to the potato. Integrated Nutrient Management (INM) involving the combination of organic manure and fertilizer is an essential tool for the balanced fertilization and sustainability of crop production on long term basis. The application of organic manures in conjunction with fertilizers improves physical, chemical, and biological properties of the soil besides improving fertilizer use efficiency and crop yield. Researches carried out so far in potato crops in Nepal are focused on chemical fertilizers and organic manures but the study of the bio-fertilizers on potato has not received much priority so far.

The treatments consisted bio-fertilizers namely Agrolive, Poshan, Poshan Liquid, Agrolive Liquid, Chelazin, Agrizyme, and Agri182 which are included in the experiment along with recommended NPK fertilizer (100:100:60 kg/ha) and farmyard manure (20 t/ha). Nine treatments consisting T_1 (Agrolive + NPK +FYM), T_2 (Poshan+NPK+FYM), T_3 (Poshan liquid+NPK+FYM), T4 (Agrolive liquid+NPK+FYM), T_5 (Chelozin+NPK+FYM), T_6 (Agrizyme + NPK+FYM), T_7 (Agri182+NPK+FYM), T_8 (Recom. NPK+FYM) and T_9 (Control) were planted at Hattiban Research Farm, Khumaltar in randomized complete block design (RCBD) with three replications.

The effects of different bio-fertilizers on potato are given in Table 7.1. The highest (100%) plant emergence was recorded at T_1 (Arolive+NPK+FYM) followed by the T_2 (Poshan+NPK+FYM), T_8 (recommended NPK+FYM) and T_9 (control) treatment. Ground cover was highest (50%) in T_1 (Agrolive+NPK+FYM) and T_5 (Chelozin+NPK+FYM) plot. Plant vigor was ranged from three to four in the treatment applied. However, the highest (5) plant uniformity was observed in the treatment of Agrolive+NPK+FYM and Chelozin+NPK+FYM applied plot. The plant height was highest (76.5) in T_6 (Agrizyme+NPK+FYM) followed the plot of Agrolive+NPK+FYM (76). The number of main stem per plant was not much varied among the treatments applied.

The highest (73) number of undersize tuber was obtained in NPK+FYM applied plot whereas the highest weight (8%) was obtained at control plot followed by T_8 (NPK+FYM) (7%) treatment. The highest number of seed size tuber was

produced in the treatment of Agrolive+NPK+FYM (106) and Poshan+NPK+FYM (106) applied plot but the lowest (73) was in control plot. Likewise, the highest (42%) seed weight was produced in T_1 (Agrolive+NPK+FYM) followed by T8 (NPK+FYM) (40%). Application of agrolive liquid+NPK+FYM produced the highest number (71) and weight (64%) of oversize potato tuber. Total number of tuber per plot was highest (230) in Poshan+NPK+FYM and NPK+FYM, whereas the tuber weight per plot was highest (13.4 kg) in Poshan+NPK+FYM treated plot. The application of Poshan+NPK+FYM imparted the highest (30.9 t/ha) yield but the lowest (14.9 t/ha) yield was in control plot.

Table 7.1: Effect of different bio-fertilizers on the growth and tuber yield in potato cv. 'Janak Dev' at Hattiban Research Farm, Khumaltar, 2068/69

Treatments	Ground cover (%)	Plant vigor (1-5)	Plant unif. (1-5)	Pl. ht. (cm)	Stem/ plant (no.)	Tuber size distribution (No. and % Wt.)						Total tuber /plot		Adj. yield (t/ha)
						US		SS		OS				
						No.	Wt.	No.	Wt	No	Wt	No	Wt.kg	
T1	50	4	5	76.0	3.7	55	5	106	42	51	53	212	11.9	27.5
T2	48	4	4	65.1	3.7	57	4	106	38	66	57	230	13.4	30.9
T3	45	4	4	75.1	3.4	36	3	81	33	69	64	186	11.8	27.2
T4	48	4	4	72.0	2.9	51	4	84	32	71	64	206	12.4	28.7
T5	50	5	5	73.7	3.7	53	4	91	36	65	60	210	11.6	26.9
T6	43	4	4	76.5	3.3	55	5	97	38	54	57	206	12.0	26.9
T7	48	4	3	64.9	3.7	57	5	95	35	64	60	215	12.4	28.8
T8	43	3	3	68.9	3.8	73	7	102	40	55	53	230	11.6	26.8
T9	35	3	3	35.5	3.1	45	8	73	52	25	40	144	6.4	14.9
F-test														**
LSD (0.05)														4.3
CV (%)														9.4

Treatments: T1 Agrolive +NPK+FYM, T2 Poshan +NPK+FYM, T3 Poshan liquid +NPK+FYM, T4 Agrolive liquid +NPK + FYM, T5 Chelozin+NPK+FYM, T6 Agrizyme + NPK+FYM, T7 Agri182+NPK+FYM, T8 Recom. NPK+FYM, T9 Control

Recommended dose of NPK =100:100:60 Kg/ha, FYM- 20 t/ha Control- without NPK, FYM and Biofertilizers. **- highly significant.

3.2 Sweet Potato

3.2.1 Sweetpotato Variety Improvement

3.2.1.1 Germplasm collection, maintenance and evaluation

Germplasm collection, maintenance and evaluation are major research activities of NPRP. International Potato Centre (CIP), Lima, Peru is one of the major germplasm sources. Till date 21 exotic clones received from CIP and four local collections are been maintained under *in vitro* and field conditions (Table 8.1). Collection and maintenance of local as well as exotic germplasm of sweet potato will be continued for several years in the programme.

Table 8.1: List of *in vitro* and *in vivo* sweet potato germplasm maintained in NPRP, 2011/12

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

In the case of sweet potato evaluation, NPRP is trying to follows similar varietal evaluation scheme as followed in potato evaluation scheme. Collected germplasm are multiplied in *In vitro* and/or screen house conditions, followed by 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 (CFFT) 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.

3.2.1.2 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 2068/69, one set of IET materials was planted at RARS Tarahara, one set at ARS (Hort.) Pokhara and one set at RARS, Nepalgunj as the representative sites.

Materials and Methods

Total of 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. Trials were laid out in RCBD with two replications. The 5.4 m^2 sized plots were fertilized @ 40:40:50 kg NPK together with 10 tons of compost per hectare as basal dose. Planting was done at 60 x 30 cm row to row and plant to plant spacing.

Observations taken were:

- Incidence of pest and diseases (scale 1-5)
- Plant type (spreading, compact, semi compact, elliptical, semi-elliptical, broad teeth, semi-circular, lanceolate),
- Vine growth rate (fast, slow and 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 RARS, Tarahara, plant stand was good and the ground cover ranged from 10-90% (Table 8.2). Regarding the tuber yield, CIP 440112 produced the highest yield (16.85 t/ha) followed by CIP 440012 (15.74 t/ha). The top five

promising lines were CIPs 440112, 440012, 440014, 440020 and 440328 with the average yield ranging from 12.1 to 16.9 t/ha.

At ARS (Hort.), Pokhara, better plant performances were observed in most of the CIP clones in most of the evaluated parameters (Table 8.3). The highest yield was observed in the clone CIP 440021 (44.18 t/ha) followed by CIP 440015 (36.93) and CIP 440185 (33.98 t/ha) (Table 8.4). Other promising clones were CIPs 400039 (31.57 t/ha) and 441624 (27.62 t/ha).

At RARS, Nepalgunj all clones performed better mainly in ground cover, plant uniformity and vine growth (Table 8.5). 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, CIP 400039 produced the highest yield (17.22 t/ha) followed by CIP 440328 (12.41 t/ha) and 440015 (12.22 t/ha) (Table 8.6). Most of the CIP clones were produced attractive size, shape and also very good in raw eating. All sweet potato CIP clones were found to be light orange to red in skin color and light orange to orange in flesh color.

Based on the performance of the tested clones on IET of this year and last year, elite clones will be selected for coordinated varietal trials (CVTs) to be conducted next year.

Table 8.2: Plant and yield characteristics of sweet potato clones under Initial Evaluation Trial (IET) at RARS Tarahara, 2011/12

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	Yield (t/ha)
400039	1	25	1	Spreading	1	Pigmented	Thin	Medium	Round	0.75
400917	1	25	1	Spreading	1	Pigmented	Thin	Short	Serrated	4.45
440001	1	20	1	Spreading	1	Pigmented	Thin	Medium	Pointed	8.15
440007	3	75	3	Spreading	3	Yes	Medium	Medium	Round	7.69
440008	1	15	1	Spreading	1	Yes	Thin	Short	Round	3.80
440012	1	20	2	Spreading	2	No	Medium	Short	Pointed	15.74
440014	1	10	1	Spreading	1	Yes	Thin	Short	Round	13.52
440015	2	30	2	Spreading	2	Yes	Thin	Medium	Highly serrated	11.12
440020	4	80	3	Semi-spreading	3	Yes	Medium	Short	Pointed	12.97
440021	3	60	3	Spreading	3	Yes	Medium	Short	Round	6.21
440047	2	40	2	Spreading	2	Yes	Thin	Short	Serrated and pointed	5.10
440099	4	90	4	Spreading	3	Yes	Thin	Short	Pointed	10.47
440112	2	30	2	Semi-spreading	3	Pigmented	Thick	Short	Round	16.85
440135	4	85	4	Semi-spreading	4	purple	Medium	Medium	Round & pointed	6.49
440185	3	80	4	Spreading	3	Yes	Medium	Medium	Round	5.19
440267	3	75	3	Spreading	3	Yes	Medium	Short	Round & oval	4.45
440287	2	50	2	Spreading	2	Pigmented	Thin	Medium	Oval & pointed	7.04
440328	3	60	3	Spreading	3	Pigmented	Thin	Long	Serrated	12.13
440513	3	60	4	Spreading	3	Green	Medium	Medium	Round	7.50
441538	1	20	2	Spreading	1	Pigmented	Thin	Medium	Serrated	5.19
441624	3	40	3	Spreading	3	Pigmented	Medium	Short	Round & pointed	9.72
Dhankuta-1	3	75	4	Spreading	3	Light pigmented	Medium	Medium	Serrated	4.08
Dhankuta-2	3	70	3	Spreading	4	Light purple	Medium	Medium	Serrated	4.07
Sunsari-1	3	80	4	Spreading	4	Green	Medium	Medium	Serrated	3.43
Japanese Red	3	60	4	Spreading	4	Purple	Thick	Medium	Round	7.32

Note: 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 8.3: Plant and foliar characteristics of sweet potato clones under Initial Evaluation Trial (IET) at ARS (Hort.) Pokhara, 2011/12

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	2	60	2	Determinate	2	Light purple	Medium	Short	Round	No
400917	4	80	4	Indeterminate	4	Light purple	Medium	Long	Serrated	No
440001	3	60	3	Indeterminate	3	Purple	Medium	Long	Triangular	Pink
440007	4	80	4	Semi-determinate	4	Light purple	Medium	Medium	Round	Pink
440008	5	95	4	Indeterminate	4	Purple	Medium	Long	Triangular	Pink
440012	4	90	4	Determinate	3	Green	Medium	Short	Triangular	Pink
440014	3	80	3	Indeterminate	3	Light purple	Medium	Long	Triangular	No
440015	5	95	4	Semi-determinate	4	Dark purple	Medium	Short	Serrated	Pink
440020	4	90	4	Determinate	4	Light purple	Thick	Short	Triangular	Pink
440021	5	95	4	Indeterminate	4	Light purple	Medium	Short	Triangular	Pink
440047	5	90	4	Indeterminate	5	Green	Thin	Short	Serrated	Pink
440099	4	80	4	Indeterminate	4	Purple	Thin	Short	Triangular	Pink
440112	4	90	4	Semi-determinate	4	Purple	Thick	Short	Round	Pink
440135	4	80	3	Semi-determinate	3	Red	Thick	Short	Round	No
440185	5	95	4	Indeterminate	4	Reddish purple	Medium	Medium	Triangular	No
440267	5	95	5	Semi-determinate	4	Purple	Medium	Medium	Round	No
440287	4	80	4	Indeterminate	4	Light purple	Thin	Long	Triangular	No
440328	5	95	5	Determinate	4	Green	Thick	Short	Triangular	No
440513	5	90	5	Indeterminate	4	Green	Thick	Medium	Round	Pink
441538	4	90	4	Indeterminate	5	Light purple	Medium	Long	Serrated	No
441624	5	90	4	Semi-determinate	4	Light purple	Thick	Short	Round	Pink
Dhankuta-1	5	95	5	Indeterminate	5	Green	Thick	Short	Serrated	No
Dhankuta-2	5	90	4	Indeterminate	4	Green	Thick	Short	Serrated	No
Sunsari-1	5	95	5	Indeterminate	5	Green	Thick	Medium	Serrated	No
Japanese Red	5	95	5	Indeterminate	5	Dark purple	Thick	Short	Round	No

Note: 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 8.4: Yield and tuber characteristics of sweet potato clones under Initial Evaluation Trial (IET) at ARS (Hort.) Pokhara, 2011/12

Clones	Tuber character			Flesh color	Tuber uniformity	Tuber yield Wt./pt (gm)	Remarks (Raw taste)
	Skin color	Shape	Size				
400039	Red	Oval	Large to medium	Orange	3	31.57	Medium sweet, crispy
400917	Yellow	Long	Medium	Orange	4	18.82	Medium sweet, hard
440001	Red	Round to oval	Large	Orange	4	19.06	Sweet, hard
440007	Orange	Oval	Large	Orange	4	24.76	Sweet, hard
440008	Red	Long to oval	Medium	Orange	3	20.14	Medium sweet, hard
440012	Red	Round	Medium to large	Orange	4	27.46	Little sweet, crispy
440014	Red	Long	Large	Orange	3	19.05	Sweet, crispy
440015	Yellow	Oval	Medium	Orange	4	36.93	Medium sweet, hard
440020	Orange	Long	Large	Orange	3	16.62	Sweet
440021	Dark red	Round	Large	Orange	5	44.18	Sweet, crispy
440047	Red	Oval	Medium	Orange	3	17.42	Medium sweet, hard
440099	Dark orange	Round to oval	Large	Orange	4	13.74	Sweet, crispy
440112	Orange	Medium long	Medium	Orange	3	19.09	Medium sweet, hard
440135	Light red	Long to oval	Small	Orange	3	21.18	Sweet, crispy
440185	Orange	Long to oval	Large	Orange	3	33.98	Medium sweet, hard
440267	Dark red	Long	Large	Orange	4	20.05	Sweet, crispy
440287	Red	Round	Small	Orange	3	8.04	Sweet, crispy
440328	Orange	Round to long	Large	Orange	4	23.88	Medium sweet, crispy
440513	Dark red	Long	Small	Orange	5	8.49	Sweet, crispy
441538	Dark red	Long	Medium	Orange	3	12.59	Medium sweet, crispy
441624	Orange	Long	Large	Orange	4	27.62	Sweet, crispy
Dhankuta 1	Red	Long	Large	White	3	9.95	Sweet, hard
Dhankuta 2	Red	Long to oval	Medium	White	3	9.39	Little sweet, hard
Sunsari 1	Dark red	Long	Small	White	4	11.33	Little sweet, hard
Japanese red	Dark red	Round to long	Large	Light yellow	3	15.12	Little sweet, hard

Note: 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= very poor, 5= very good)

Table 8.5: Plant and foliar characteristics of sweet potato clones under Initial Evaluation Trial (IET) at RARS, Nepalgunj, 2011/12

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	3	50	3	Spreading	3	Green	Medium	Medium	Medium	-
400917	4	90	4	Spreading	4	Green purple	Thin	Medium	Serrated	-
440001	2	50	2	Spreading	2	Red	Thin	Medium	Serrated	White purple
440007	4	80	4	Spreading	4	Light purple	Thick	Long	Medium	White purple
440008	4	80	4	Spreading	4	Light purple	Thick	Long	Round	White purple
440012	2	40	2	Spreading	2	Green	Medium	Short	Broad	White purple
440014	2	20	2	Spreading	2		Thin	Short	Serrated	White purple
440015	3	70	3	Spreading	3	Red	Thin	Medium	Serrated	White purple
440020	3	50	3	Spreading	3	Green	Thin	Short	Serrated	White purple
440021	4	80	4	Spreading	4	Light purple	Thick	Long	Small	White purple
440047	4	80	4	Semi spreading	4	Green	Thin	Medium	Serrated	White purple
440099	4	85	4	Spreading	4	Red	Medium	Long	Serrated	White purple
440112	4	75	4	Semi spreading	4	Red	Thick	Long	Broad	White purple
440135	4	90	4	Semi spreading	4	Red	Thin	Long	Broad	-
440185	3	70	3	Spreading	3	Red	Thin	Short	Broad	White purple
440267	4	70	4	Spreading	4	Red	Medium	Medium	Broad	White purple
440287	3	65	3	Spreading	3	Purple	Thin	Long	Oval pointed	-
440328	4	80	4	Spreading	4	Green	Medium	Long	Broad	White purple
440513	4	90	4	Semi spreading	4	Green	Thick	Long	Broad	-
441538	3	50	3	Semi spreading	3	Green purple	Thin	Medium	Serrated	White purple
441624	4	80	3	Spreading	3	Green	Medium	Short	Broad	White purple
Dhankuta-1	4	90	4	Spreading	4	Green	Thick	Long	Serrated	-
Dhankuta-2	5	95	5	Spreading	4	Green	Medium	Medium	Serrated	White purple
Sunsari-1	5	95	5	Spreading	5	Green	Medium	Medium	Serrated	-
Japanese Red	4	90	4	Semi spreading	4	Dark red	Thick	Medium	Broad	-

Note: 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 8.6: Yield and tuber characteristics of sweet potato clones under Initial Evaluation Trial (IET) at RARS, Nepalgunj, 2011/12

Clones	Tuber character			Flesh color	Tuber uniformity	Adj. yield t/ha	Remarks (Raw taste)
	Skin color	Shape	Size				
400039	Light red	Round to long	Large	Light orange	3	17.2	3
400917	Light orange	Medium long	Medium	Light orange	4	8.3	3
440001	Red	Medium round	Small	Light yellow	4	4.8	3
440007	Light orange	Medium long	Small	Light orange	3	5.9	4
440008	Light red	Medium long	Medium	Orange	3	6.5	4
440012	Red	Round	Medium to large	Light orange	4	8.4	3
440014	Red	Round	Medium	Light orange	4	3.7	4
440015	Light orange	Medium long	Medium	Orange	4	12.2	4
440020	Light orange	Round to long	Medium to large	Light orange	3	8.5	4
440021	Red	Medium long	Medium	Light orange	4	6.6	4
440047	Red	Narrow long	Small	Light orange	3	4.6	4
440099	Red	Narrow long	Medium to large	Orange	2	7.0	3
440112	Light orange	Long	Medium	Light orange	3	6.5	3
440135	Light orange	Long	Medium to small	Light orange	3	11.4	3
440185	Light red	Long	Medium to large	Dark orange	3	10.7	5
440267	Red	Long & some round	Medium	Light orange	4	11.4	4
440287	Red	Medium long	Medium	Light orange	4	5.4	3
440328	Light red	Oval long	Medium to large	Orange	4	12.4	4
440513	Red	Medium long	Medium	Orange	3	9.7	4
441538	Red	Medium long	Medium to small	Light orange	3	3.0	3
441624	Light orange	Long	Medium	Orange	3	9.5	3
Dhankuta 1	Red	Narrow long	Small	White	3	4.4	2
Dhankuta 2	Red purple	Long	Small to medium	White	2	3.4	2
Sunsari 1	Red	Narrow long	Medium	White	3	2.5	2
Japanese red	Red	Long	Medium	Light orange	4	4.4	3

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= very poor, 5= very good); Raw taste (1-5): 1=poor; 5=best

4. PRODUCTION

4.1 Pre-Basic Seed Potato Production

4.1.1 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 2011/12 (2068/69).

Germplasm maintenance

A total of 74 potato germplasm has been maintained under i*n vitro* conditions in the laboratory (Table 9.1 and 9.2). Out of them nine cultivars had been used for PBS production purpose.

Table 9.1: List of potato germplasm introduced at NPRP's Tissue Culture Laboratory, 2068/69

S.N.	CIP Number	Clones	Received Date	Source
1.	370120	MF-II	June 6, 2012	CIP, Peru
2.	370121	TPS-7	June 6, 2012	CIP, Peru
3.	370122	TPS-67	June 6, 2012	CIP, Peru
4.	370123	TPS-13	June 6, 2012	CIP, Peru
5.	374080.5	Perricholi	June 6, 2012	CIP, Peru
6.	377957.5	Meva	June 6, 2012	CIP, Peru
7.	378711.5	Muziranzara	June 6, 2012	CIP, Peru
8.	380389.1	Canchan-INIA	June 6, 2012	CIP, Peru
9	380606.6	Enfula	June 6, 2012	CIP, Peru
10.	381379.9	Kisoro	June 6, 2012	CIP, Peru
11.	381381.13	IDIAP 92	June 6, 2012	CIP, Peru
12.	381381.9	Rukinzo	June 6, 2012	CIP, Peru
13	381406.6	Tubira	June 6, 2012	CIP, Peru
14.	384866.5	Amarilis-INIA	June 6, 2012	CIP, Peru
15.	387164.4	-	June 6, 2012	CIP, Peru
16.	387233.24	Gikungu	June 6, 2012	CIP, Peru
17.	388615.22	-	June 6, 2012	CIP, Peru
18.	388676.1	Maria Bonita-INIA	June 6, 2012	CIP, Peru
19.	389746.2	B3C0	June 6, 2012	CIP, Peru
20.	390478.9	Tacna	June 6, 2012	CIP, Peru
21.	391011.17	B3C1	June 6, 2012	CIP, Peru
22.	392657.8	B3C1	June 6, 2012	CIP, Peru
23.	392740.4	-	June 6, 2012	CIP, Peru
24.	393073.179	B3C1	June 6, 2012	CIP, Peru

S.N.	CIP Number	Clones	Received Date	Source
25.	393083.2	B3C1	June 6, 2012	CIP, Peru
26.	393248.55	B3C1	June 6, 2012	CIP, Peru
27.	393280.64	B3C1	June 6, 2012	CIP, Peru
28.	393339.242	B3C1	June 6, 2012	CIP, Peru
29	393382.44	B3C1	June 6, 2012	CIP, Peru
30	393536.13	-	June 6, 2012	CIP, Peru
31	393614.3	-	June 6, 2012	CIP, Peru
32	393617.1	-	June 6, 2012	CIP, Peru
33	394034.65	-	June 6, 2012	CIP, Peru
34	394611.112	-	June 6, 2012	CIP, Peru
35	394613.139	-	June 6, 2012	CIP, Peru
36	395017.229	B3C2	June 6, 2012	CIP, Peru
37	395017.242	B3C2	June 6, 2012	CIP, Peru
38	395112.32	B3C2	June 6, 2012	CIP, Peru
39	395193.6	-	June 6, 2012	CIP, Peru
40	395195.7		June 6, 2012	CIP, Peru
41	396018.241	B3C2	June 6, 2012	CIP, Peru
42	396287.5	-	June 6, 2012	CIP, Peru
43	397012.22	-	June 6, 2012	CIP, Peru
44	397016.7	-	June 6, 2012	CIP, Peru
45	397060.19	-	June 6, 2012	CIP, Peru
46	397073.15	-	June 6, 2012	CIP, Peru
47	397077.16	-	June 6, 2012	CIP, Peru
48	399002.38	B1C5	June 6, 2012	CIP, Peru
49	399002.52	B1C5	June 6, 2012	CIP, Peru
50	399004.19	B1C5	June 6, 2012	CIP, Peru
51	399054.16	B1C5	June 6, 2012	CIP, Peru
52	399062.115	B1C5	June 6, 2012	CIP, Peru
53	399067.22	B1C5	June 6, 2012	CIP, Peru
54	399072.11	B1C5	June 6, 2012	CIP, Peru
55	399072.21	B1C5	June 6, 2012	CIP, Peru
56	399075.7	Puca Lliclla-INIA 312	June 6, 2012	CIP, Peru
57	399078.11	B1C5	June 6, 2012	CIP, Peru
58	399079.22	B1C5	June 6, 2012	CIP, Peru
59	399092.116	B1C5	June 6, 2012	CIP, Peru
60	676008	I-1039	June 6, 2012	CIP, Peru
61	720088	Achirana-INTA	June 6, 2012	CIP, Peru
62	800048	Desiree	June 6, 2012	CIP, Peru
63	800928	MS-42.3	June 6, 2012	CIP, Peru
64	800934	MS-35.9	June 6, 2012	CIP, Peru

Table 9.2: List of potato germplasms maintained at NPRP, Tissue Culture Laboratory, 2068/69

S. N.	CIP Number	Origin	Clones	Received Date	Source
1	800258	India	Kufri Jyoti		CIP, Peru
2	-	-	Cardinal	Nov. 26, 2004	SASA, UK
3	800048	-	Desiree	Oct. 27, 2004	CIP, Peru
4	720123	-	Janak Dev	Feb. 12,1998	CIP, Peru
5	800265	India	Kufri Sindhuri	Mar. 28, 1990	CIP, Peru
6	388572.4	-	IPY-8	-	Cleaned in NPR
7	388572.1	-	Khumal Laxmi	-	Cleaned in PRP
8	676008	-	Khumal Rato-2	Feb.12,1998	CIP, Peru
9	720088	-	Khumal Seto-1	Feb.12,1998	CIP, Peru
10	-	-	L-235.4	-	CIP, Peru

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, 20±2°C temperature 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 13,430 *in vitro* plantlets of eight cultivars were supplied to the glasshouse/screenhouse in autumn season (August, 2011) and 12,310 *in vitro* plantlets of eleven cultivars in glasshouse/screenhouse for spring season (Jan., 2012) (Table 9.3).

Table 9.3: *In vitro* plantlets produced under laboratory condition for plantation in the glass/screen houses, 2068/69

Cultivars	Autumn, 2011	Spring, 2012	Total
Cardinal	4120	2050	6170
Desiree	2100	1840	3940
Janak Dev	1950	1910	3860
Kufri Jyoti	2100	1760	3860
Khumal Seto -1	2550	1580	4110
Khumal Rato -2	-	1500	1500
Khumal Laxmi	-	50	50
IPY-8	300	1010	1310
TPS 67	120	260	380
MF II	210	250	460
L-235.4	-	450	450
Total	13,430	12,310	25,740

4.1.2 Glasshouse activities for pre-basic seed production

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.

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.

Transplanting

In August 2011, a total of 13,430 plantlets of eight cultivars were transplanted in the glasshouse/screenhouse for autumn season for pre-basic seed production. Similarly, 12,310 plantlets of eleven cultivars were transplanted in the glasshouse/screenhouse for spring season pre-basic seed production. The total 25,740 *in vitro* plantlets were produced during the F.Y. 2011/12 (2068/69) (Table 9.3).

Pre-basic seed (PBS) production

PBSs were produced during two seasons, the first one during autumn 2011 and the second one during spring 2012. During autumn 2011, total of 35,733 PBS comprising eight cultivars were produced in screenhouse. The cultivars were Cardinal, Desiree, Janak Dev, Khumal Seto-1, Kufri Jyoti, Khumal Rato-2, IPY-8, TPS 67 and MF II. In spring 2012, total 22,999 pre-basic seed potatoes comprising 11 cultivars, viz. Cardinal, Desiree, Janak Dev, Khumal Seto-1, Kufri Jyoti, IPY 8, Khumal Rato, Khumal Laxmi, TPS 67, MF II and L-235.4 were produced in screenhouse only. So, altogether 58,733 pre-basic seed potatoes were produced during 2011/12 (2068/69) (Table 9.4).

4.1.3 Cold storage

PBSs were graded into four categories, viz. <0.25 g, <0.5 g, 0.5-1.0 g, 1.0-5.0 g, and >5.0 g size. After grading the PBS were packed in nylon net bags with proper leveling and then stored in Kohinoor Coldstore, Balaju.

PBS harvested in winter has 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 2012/13 (2069/70).

Table 9.4: PBS production in the glasshouse/screenhouse, 2068/69

Cultivars	Autumn 2011	Spring 2012	Total
Cardinal	12,323	1,719	14,042
Desiree	7,810	3,784	11,594
Kufri Jyoti	5,996	1,435	7,431
Janak dev	2,989	3,237	6,226
Khumal Seto-1	5,865	2,160	8,025
Khumal Laxmi	-	85	85
I.P.Y8	197	4,144	4,341
Khumal Rato-2	-	2,530	2,530
TPS 67	34	1,756	1,790
MF II	519	714	1,233
L-235.4	-	1,435	1,435
Sub total	**35,733**	**22,999**	**58,732**

About more 50 per cent of the PBS potatoes produced in autumn 2011 were larger than one gram sized. In case of spring 2012 production, only about 30 per cent tubers were larger than one gram sized (Tables 9.5 and 9.6). In the overall production of 58,732 pre-basic seed potatoes this year, about 60% were larger than one gram sized and about 19% were smaller than 0.5 g sized (Table 9.7).

Table 9.5: Pre-basic seed produced during Autumn (August – November), 2011/12 (2068/69), 1st lot (To be distributed during terai season, 2012/13 (2069/70))

Cultivars	>5 g	1-5 g	0.5-1 g	<0.5-0.25 g	<0.25 g	Total
Cardinal	8002	2258	997	631	435	12323
Desiree	4275	1665	832	650	388	7810
Janak Dev	1541	880	348	112	108	2989
Khumal Seto-1	2244	1266	1065	835	455	5865
Kufri Jyoti	3627	1119	585	468	197	5996
IPY-8	47	87	36	21	6	197
TPS 67	13	11	10	-	-	34
MF II	158	115	134	67	45	519
Grand total	20266	7419	4032	2784	1634	35,733
%	56.1	20.5	11.1	7.7	4.5	100

Table 9.6: Pre-basic seed produced during Spring (January – May), 2011/12 (2068/69), 2nd lot (To be distributed during hill season, 2012/13 (2069/70))

Cultivars	>5 g	>1-5 g	>0.5-1	<0.5-0.25 g	<0.25	Total
Cardinal	412	585	353	225	144	1,719
Desiree	292	845	1250	817	580	3,784
Janak Dev	297	903	935	637	465	3,237
Khumal Seto-1	155	625	730	266	383	2,160
Khumal Rato-2	75	550	815	620	470	2,530
Kufri Jyoti	345	421	341	237	91	1,435
IPY-8	621	1428	1005	620	470	4,144
TPS 67	160	575	380	386	355	1,756
MF II	165	330	154	-	65	714
Khumal Laxmi	-	30	20	-	35	85
L-235.4	30	340	470	370	225	1,435
Kufri Jyoti	345	421	341	237	91	1,435
Grand total	2552	6633	6453	4078	3283	22,999
%	11.1	28.8	28.1	17.7	14.3	100
Cardinal	412	585	353	225	144	1,719

Table 9.7: Overall pre-basic seed production in NPRP, 2068/69

Plant season	PBS size distribution					Total
	> 5 g	1-5 g	0.5-1 g	0.25- 0.5 g	<0.25 g	
Autumn season	20,266	7419	4032	2784	1634	35,733
Spring season	2,552	6633	6453	4078	3283	22,999
Grand total	**22,818**	**14,052**	**10,485**	**6,862**	**4,917**	**58,732**
%	38.59	23.76	17.73	11.60	8.32	100

4.1.4 Pricing and distribution of pre-basic seed

The per unit price of the pre-basic seed potatoes fixed for the fiscal year 2011/12 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 -0.50 g and Rs. 0.25 for smaller than 0.25 g sized mini tubers (Table 9.8).

Table 9.8: Pre-basic seed potato pricing of the current and past few years

PBS Grade (size)	Per unit PBS price (Rs.)						
	1996/97 2053/54	1997/98 2054/55	2003/04 2060/61	2004/05 2061/62	2009/10 2066/67	2010/11 2067/68	**20011/12 2068/69**
>5 g	-	1.25	-	-	5.00	5.50	6.00
>1 g	1.00	0.50	2.70	3.00	4.60	5.00	5.50
0.5-1 g	0.50	0.20	1.50	1.70	2.00	2.50	3.00
0.25-0.5 g	0.00	0.00	0.75	1.00	0.50	0.75	0.75
<0.25 g	-	-	0.75	1.00	-	0.25	0.25

In the Fiscal Year 2011/12, total 35,733 pre-basic seeds produced during autumn season and 22,999 PBS produced during spring season were stored in Kohinoor Cold store, Balaju Industrial Area, Kathmandu for terai season and hill season distribution, respectively. During 20011/12 all PBS produced in 2010/11 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.

4.2 Basic Seed (BS) Potato Production

Total 3,560 kg basic 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 next year (Table 9.9).

Table 9.9: Production of basic seed at Hattiban Farm, 2068/69

Variety	BS-1		BS-2		BS-3		Total		Total (kg)
	bag	kg	bag	kg	Bag	kg	bag	kg	
White									
K.Jyoti	-	45	-	10	28		28	55	
Khumal Seto-1	1	10	-	10	6	30	7	50	
NPI-106	-	-	-	-	4	-	4	-	
Red									
Cardinal	-	-	1	-	6	-	7	-	
Janakdev	1	-	-	-	9	45	10	45	
IPY 8	-	40	-	-	1	20	1	60	
Khumal Rato-2	-	-	-	-	-	25	-	25	
Desiree	-	10	-	-	8	-	8	10	
K. Laxmi		-	-	-	-	-	-	65	
Total	2	105	1	20	62	185	65	310	**3,560**

Note : 1 bag = 50 kg

Basic seed use: Hattiban plantation: 22 kg (BS1 + BS2), Others : 500 kg for miscellaneous use.

4.3 Rice Foundation Seed Production

To improve the soil health of the Hattiban Farm, rice cultivation with flooding was practiced in rotation. This year altogether two ton of rice foundation seed was produced, comprising of 1,400 kg Khumal 4 and 600 kg Khumal 11 (Table 9.10).

Table 9.10: Rice foundation seed production at Hattiban Farm, 2068/69

Variety	Foundation Seed (kg)
Khumal 4	1,400
Khumal 11	6,00
Total	2,000

5. TECHNOLOGY TRANSFER AND SERVICES

5.1 Training/Workshops

5.1.1 Training

A training course entitled "Potato Research Methodology" - Technical Officer and Scientist level was conducted by National Potato Research Programme in Khumaltar, Lalitpur during Aasadh 4-7, 2069 (June 18-21, 2012) (Annex 5.1). The objective of the training course was to communicate the knowledge of potato crop and its research methodology to the young and new researchers working in different collaborating Research Stations and Divisions under NARC. Out of the 18 invited participants, including three from the organizing institute, 17 Technical Officers/Scientists participated in the training course (Table 10.1).

Table 10.1: List of the Participants in the Potato Research Methodology Training, Aasadh 4-7, 2069

Participants	Desig-nation	Institutions	E-mail Address
Mr. Banhu Pd. Chaudhary	T-6	RARS, Tarahara	rarst@sailung.com.np
Mr. Jawahar Lal Mandal	T-6	ARS, Pakhribas	arspakh@gmail.com
Mr. Jeet Nrn. Chaudhary	T-6	RARS, Parwanipur	jnc_chaudhary@yahoo.com
Mr. Ram Pd. Mainali	T-6	Entomology Div.	mainalism.rp@gmail.com
Ms. Niru Tripathy	T-6	Pt. Pathology Div.	niru.nishan@gmail.com
Ms. Shava Shrestha	S-1	Soil Sc. Division	shovashrestha@gmail.com
Ms Sarita Gautam	T-6	Outreach Res. Div.	gtmsarita79@gmail.com
Mr. Saroj Adhikari	T-6	RARS, Lumle	sarose01@yahoo.com
Ms. Resona Simkhada	T-6	ARS, Malepatan	resona.simkhada@gmail.com
Mr. Yegya Pd. KC	T-6	RARS, Khajura	rd.khajura@narc.gov.np
Mr. Suresh Kr. Sah	T-6	ARS, Surkhet	hansysuresh@gmail.com
Mr. Basant Chalise	S-1	ARS, Dailekh	basantchalise@gmail.com
Mr. Raj Kr. Giri	S-1	ARS, Rajikot	Rk1_giri@yahoo.com
Mr. Ujjawal KS Kushwaha	T-6	ARS, Doti	kushujjwal@gmail.com
Mr. Hari Bdr. KC	T-6	NPRP, Khumaltar	prp@narc.gov.np
Mr. Krishna C. Upreti	T-6	NPRP, Khumaltar	krishna_upreti@yahoo.com
Mr. Duryodhan Chaudhary	T-6	NPRP, Khumaltar	prp@narc.gov.np

The topics covered in the training course were:

1. Potato Research in Nepal: An Overview and Future Directions
2. Variety Research Methodology in Potato
3. Source Seed Production of Potato

4. Seedling Tuber Production Technology by using TPS
5. General Management Practices of Potato Insect Pest
6. Major Diseases of Potato and their Management: Experiment and Observation Techniques
7. Potato Post Harvest Research: Storage and Processing
8. Sweet potato Variety Research Methodology
9. Breeder Seed Production and Varietal Trial (CVT) in Vegetable Crops
10. How to Make Research Papers?
11. Basic Statistics, Correlation and Regression
12. An Introduction of Statistical Package R
13. Analysis of Variance and Linear Models in R
14. Cluster Analysis (CA), Principal Components Analysis (PCA) in R
15. 'Agricolae' Add-In and Biplots Analysis in R

The pre-test and post-test conducted before and after the training among the participants revealed that there are about 73% improvement in their knowledge level (Table 10.2 and Fig. 10.1), indicating the positive efficacy of the training program.

Table 10.2: Evaluation of pre- and post-tests

Test	Minimum Mark	Maximum Mark	Average
Pre-test	16.0	76.0	42.8
Post-test	40.0	96.0	74.1
Percent Improvement	150.0	26.3	**73.1**

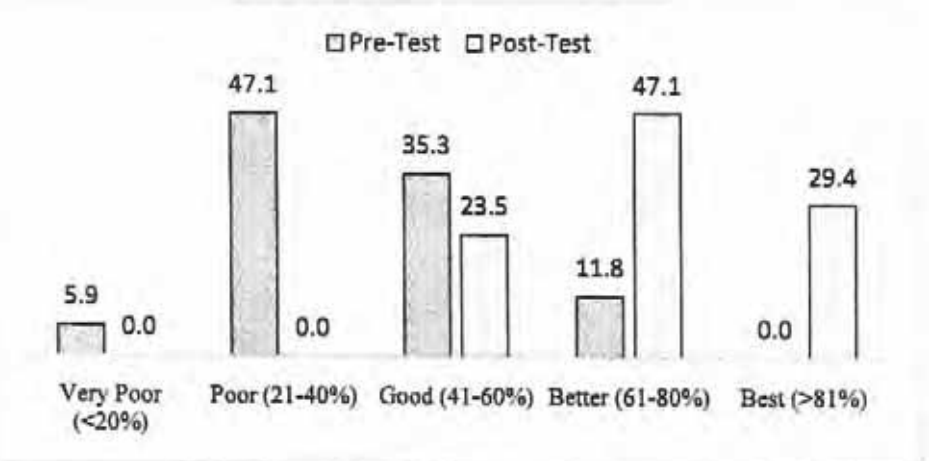


Fig. 10.1. Impact of potato research methodology training on the knowledge gained by participants.

5.1.2 Workshop

National Potato Research Program in collaboration with Horticulture Research Division had organized a Technical Working Group Workshop to move national horticultural research in focused and anticipated directions (Annex 5.1). The objectives of the workshop were:

- To prioritize the horticultural crops for research and technological support,
- To list out the problems of major horticultural commodities and prioritize them,
- To identify lead centers for responsibility sharing for horticultural commodities,
- To prepare NARC for formal seed production system maintenance for vegetable crops,

Three days long interactive workshop was organized by involving possible stakeholders. Participants were invited from relevant directorates and national programs of the Department of Agriculture, horticultural commodities associations, processing industries, disciplinary divisions of NARC and Scientists from all NARC stations working on horticultural commodities. Despite invitation, poor turnover from private sectors was recorded. To get the anticipated objectives in the planned period, an outline of the format was firstly shared with participants and finally approved by the floor.

5.2 Services

- Giving orientation classes to the students from various colleges and universities.
- Counseling on laboratory and field techniques to the national and international visitors.
- Distribution of the leaflets/booklets and folders on different areas to the visitors.

5.3 Publications

Overall 11 publications, viz. six leaflets, four booklets and one book had been published by NPRP this year (Annex 5.2).

5.4 Information through media

- Short interviews were given by concerned scientists on potato varieties and disease management through different FMs like Ujyalo Network, and a short conversation was done on "the effect of climate change on potato

crop" through Hamro Sampada monthly magazine by Dr. BB Khatri (Annex 5.3).

5.5 Visits

- Several potato farmers, researchers, extensionists and students visited NPRP laboratory and fields in this year. Their major interest was seen on value addition, disease management, tissue culture technology and variety improvement.

5.6 Fair and Exhibitions

- NPRP participated in several local level and national level agriculture fairs and displayed its specimens.

6. OTHER ACHIEVEMENTS

6.1 Training/Workshop attended

Dr. SP Dhital had participated on a short-term training entitled "Development of a new diagnostic tool using DNA barcoding to identify quarantine organisms in support of plant health" at Central Potato Research Institute, Shimla, India on Mar. 14-17, 2012 (Annex 6.1).

Likewise, Mr. BP Sharma and Dr. BB Khatri had participated in an inception workshop at Thimpu, Bhutan on July 5-8, 2012.

6.2 Paper presented/published

Overall 17 publications of the NPRP scientists had been published this year, viz. one book, 13 journals and three proceedings (Annex 6.2).

6.3 Awards (received by staff/office)

Best international paper award received by Dr. Bhim Khatri on NARC Day, 2011/12 for the publication in international journal. The award was with the amount of NRs. 5000.00 and a certificate.

6.4 Academic supervision

Dr. Bhim B. Khatri has been supervising Mr. IP Gautam, Senior Scientist, NPRP. Mr. Gautam is doing his PhD at IAAS Rampur Chitwan.

7. BUDGET AND EXPENDITURE

The approved regular annual budget for the FY 2011/12 was NRs. 22,144,000.00, out of which NRs. 22,296,000.00 was released with overall expenditure of NRs. 22,179,857.94 (Annex 7.1).

During this year, a sum of NRs. 657,177.70 was collected as revenue through source seed potato, research potato, rice seed and others (Annex 7.2). The past budget expenditures had been audited with a beruju of NRs. 691,146.00 (Annex 7.3).

8. KEY PROBLEMS

8.1 Problems Encountered

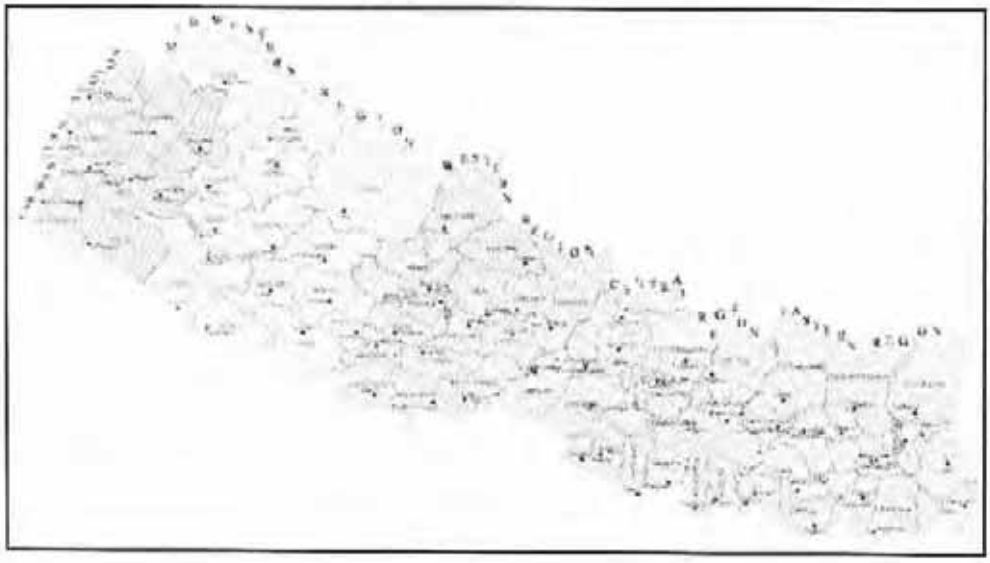
- There was heavy drought in March-April at Hattiban Farm during the tuber formation and bulking stage of potato. Existing pond also dried up. To save the crop, irrigation was given by limited water drawn from the nearby stream.
- It was very hard to manage fuel for operating generator to cope with the load shedding.
- As per the agreement, PACT was unable to supply necessary equipments for tissue culture laboratory and glasshouse, which hampered PBS production. Proposed equipments to be supplied by PACT were:
  - Water filtration plant for glasshouse
  - Renovation of incubation room for better electricity supply
  - Bio-safety laminar flow
  - Generator
- It was very hard to carry breeding activities and conduct diseases related research activities without supporting scientists/technicians
- Insufficient mid-level technical manpower for glasshouse and tissue culture laboratory for PBS production.
- Loss of *in vitro* plants in the tissue culture laboratory due to heavy bacterial and fungal contamination during repairing and construction works of the office building as well as delay in introduction of new potato germplasm have directly affected the PBS production target.
- Lack of cooling facilities in glasshouse
- Poor quality water for irrigation in glasshouse
- No cold storage facilities for storing high quality seed
- Loadshedding for longer period 80 hr/week

9. WAY FORWARD

- Variety development (high yielding and tolerant to major biotic and abiotic stresses)
- Development of varieties for processing and value addition
- Utilization of biotechnological methods for crop improvement e.g. molecular characterization, DNA finger printing, somaclonal variation.
- Varieties for high hills
- High quality nutritious varieties
- Development of late blights resistant varieties as well as management technologies for black scurf, powdery scab and wart.
- Red ant management for rainfed hill conditions
- Mechanization for planting, spraying, earthing up, harvesting and grading.
- Low cost quality seed (PBS) production
  - Natural light incubation
  - Hydroponic
  - Aeroponic
- Appropriate storage for seed and processing potato using cold and rustic storage
- Studies on adoption of released varieties and recommended technologies

Annex 1.1

Map of the Command Area



Annex 1.2

Monthly Agro-meteorological Data of the Station/Command Area

Year	Month	Temperature (°C)		Rainfall mm
		Max.	Min.	
2011	July	27.8	20.4	329
2011	August	27.9	20.3	377
2011	September	27.0	19.3	210
2011	October	26.3	13.6	17
2011	November	21.6	8.9	6
2011	December	19.0	3.6	0
2012	January	16.2	1.6	15
2012	February	20.3	3.9	37
2012	March	24.0	7.1	12
2012	April	26.8	11.8	66
2012	May	28.4	17.3	78
2012	June	30.2	19.5	139

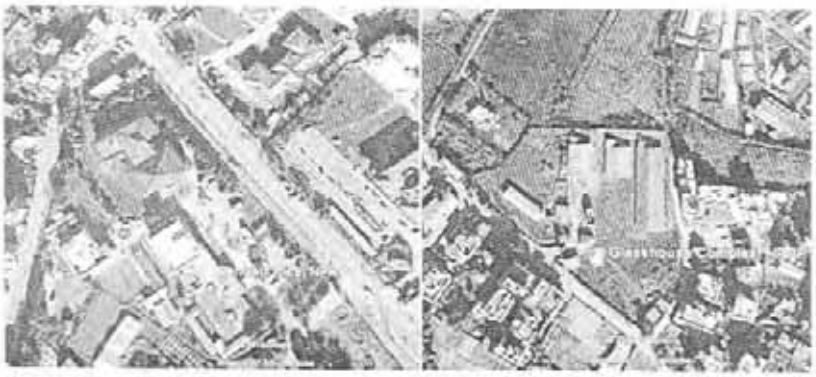
Annex 1.3

Area, Production and Productivity of Potato in Nepal, 2011/12

District	Area (ha)	Production (tonne)	Productivity (kg/ha)
E. Mountain	16,905	235,388	13,924
E. Hills	28,300	352,600	12,459
E. Terai	25,165	290,989	11,563
E. Region	70,370	878,977	12,491
C. Mountain	10,098	126,125	12,490
C. Hills	28,946	464,210	16,037
C. Terai	22,635	356,037	15,729
C. Region	61,679	946,372	15,344
W. Mountain	995	10,094	10,145
W. Hills	14,015	174,574	12,456
W. Terai	7,420	99,851	13,457
W. Region	22,430	284,519	12,685
M.W. Mountain	5,375	54,438	10,128
M.W. Hills	8,604	114,698	13,331
M.W. Terai	8,565	119,880	13,996
MW. Region	22,544	289,016	12,820
F.W. Mountain	2,471	25,947	10,501
F.W. Hills	4,280	64,721	15,122
F.W. Terai	6,476	94,750	14,631
FW. Region	13,227	185,418	14,018
NEPAL	190,250	2,584,302	13,584

Annex 2.1

Google Map of the National Potato Research Program (NPRP)



Annex 2.2

List of Laboratory Facilities

SN	Name of laboratory	Major instruments	Manpower in laboratory	Facilities
1	Tissue culture laboratory	Autoclave Laminar bench ELISA reader Hot air oven Water bath Distillation units Air conditioners	S-4 = 1 T-3 = 2 Labors on daily wage basis = 2	Major six potato viruses (PVA, PVM, PVS, PVX, PVY and PLRV) testing Potato viruses elimination Potato germplasm conservation *In vitro* potato plants production
2	Potato Pathology	BOD Incubator Seed germinator Laminar flow Oven Refrigerator Autoclave Micro digital balance Microscope Stereo microscope	S-4 = 1 T-6 = 1 Skilled technician = 1 Labor on daily wages = 1	Pathogen conservation Pathogen storage Pathogen inoculation Disease culture Microscopic observations
3	Post Harvest	Digital balance Frying pan Chip cuter machine	S-4 = 1 T-3 = 1	Chip making
4	Plant Physiology	Refrigerator Microscope Specific gravity measuring instrument	S-1 = 1 T-6 = 1	Specific gravity Microscopic observations

Annex 2.3

Human Resource in 2068/69 (2011/12)

S.N.	Name	Position	Qualification	Specialization/ Working area	Remarks
1	Mr. Buddhi Pr. Sharma	S-4	M.Sc.Ag. (Pathology)	Potato pathology	Coordinator
2	Mr. Janardan Ghimire	S-4	M.Sc.Ag. (Veg. Crops)	Weed science	Retired
3	Mr. Ishwori Pd. Gautam	S-4	M.Sc.Ag. (Hort.)	Post harvest	
4	Mr. Ram Cdr. Adhikari	S-4	M.Sc.Ag. (Hort.)	TPS technology	On study leave
5	Dr. Shambhu Prasad Dhital	S-4	Ph.D. (Hort.)	Seed potato	
6	Mr. Binesh Man Sakha	S-4	M.Sc.Ag. (Veg. Crops)	Sweet potato	
7	Dr. Bhim Bahadur Khatri	S-4	Ph. D. (Hort.)	Varietal evaluation	
8	Dr. Binod Prasad Luintel	S-1	M.Sc.Ag. (Hort.)	Varietal evaluation	On study leave
9	Mr. Ram Bharosh Nepal	T-6	SLC	Tissue culture lab.	Transferred to Biotech. Div.
10	Mr. Kalika Pd. Upadhyay	T-6	M.Sc.Ag. (Hort.)	Organic potato	On study leave
11	Mr. Amar Bdr. Pun	T-6	M.Sc.Ag. (Hort.)	Tissue culture lab.	
12	Mr. Prakash Bhattarai	T-6	B.Sc.Ag.	TPS	On study leave
13	Mr. Hari Bdr. KC	T-6	SLC	Pathology	On deputation from Ento. Div.
14	Mr. Krishna Cdr. Upreti	T-6	SLC	TPS & Sweet potato	On deputation from ARS. Pakhribas
15	Mr. Duryodhan Chaudhary	T-6	I.Sc.Ag.	Hattiban Farm	
16	Mr. Sitaram Ojha	A-6	B.A.	Administration	
17	Mrs. Sumanna Shrestha	A-5	B.Com.	Finance	
18	Mrs. Anjali Bajracharya	A-5	B.Com.	Administration	On deputation from RARS. Tarahara
19	Mr. Sanubhai Knuwar	T-5	Test Pass	Glasshouse	
20	Mrs. Bhawani Thapaliya	TH-3	I.A.	Tissue culture lab.	
21	Mr. Ramesh C. Khatiwada	TH-3	7 Class	Coldstore	
22	Mr. Yadav Kr. Shrestha	TH-3	I.A.	Hattiban	
23	Mr. Tej Prasad Ghimire	TH-3	S.L.C.	Glasshouse	
24	Mr. Pancha Maharjan	TH-3	8 Class	Driving	
25	Mrs. Sharada Thapamagar	TH-3	7 Class	Tissue culture lab.	
26	Mr. Shiva Bdr. Sapkota	AH-3	Literate	Hattiban	
27	Mr. Bidur Pokharel	AH-3	Literate	Glasshouse	
28	Mr. Shyam Bdr. Bhlon	AH-3	I.A.	Administration	

Annex 3.1

Summary Progress of NPRP Research Projects and Activities in 2068/69 (2011/12)

Project code: 40457003 Project end year: Core project

Project title: Potato variety development & improvement for different agro-ecologies of Nepal

Project leader: BB Khatri Budget for this FY: 685,000

Project activity #	Name of project/Activity	Activity leader	Major accomplishments
1	Clone multiplication	BB Khatri	This activity is continued at ARS (Hort.) Pokhara & NPRP Khumaltar.
2	Breeding of potato at NPRP Khumaltar	BP Luitel	Crossing works for high yielding & disease resistant continuously going on at Khumaltar. The old progenitors will be replaced in 2013 with the source of CIP Lima
3	Initial Evaluation Trial (IET)	BP Luitel	IETs are continued at NPRP Khumaltar, ARS (Hort.) Pokhara and ARS (Hort.) Jumla. The clones found promising for 2 years are promoted to CVTs.
4	Coordinated Varietal Trial (CVT)	BP Luitel	CVTs are continued in different locations. The clones found promising in CVTs are promoted to CFFTs
5	Coordinated Farmers Field Trial (CFFT)	BP Luitel	Most promising clones are tested in farmers' fields in various places throughout the country. Most promising and preferred two clones are proposed for releasing.

Project code: 40463001 Project end year: Core project

Project title: Study on variety improvement of potato for processing

Project leader: I.P Gautam Budget for this FY: 165,000

Activity code number	Name of activity	End year	Major progress/ achievements
1	Evaluation of potato cultivars for yield and processing qualities.	2015	Potato genotypes L-235.4, PRP 25861.1 and Khumal Seto-1 were promising for higher yield and good for chips preparation.
2	Evaluation of storability of potato in ordinary condition	2015	The genotypes K. Jyoti, Yagana and L-235 could be successfully stored in ambient room temperature for maximum period of up to 120 days with <10% weight loss.
3	Identify the effect of nitrogen and potash on storability and processing quality	2012	Different combinations of N & K_2O have no significant effect on storability of potato. However, application of 150: 60 kg N and K_2O produced higher yield and minimum sprouting.
4	Effect of chemical treatments on storability and post storage behaviours of potato in ordinary storage.	2015	Potato tubers fumigated two times with CIPC (60 ml/ lit / tons potato) before & 45 days after storage was effective for inhibition of sprouting and reduction of postharvest losses up to 120 days storage in mid hill, Khumaltar and high hills, Daman.

Project code: 40454002 Project end year: Core project

Project title: Evaluation of true potato seed (TPS) families in the nursery beds and field conditions

Project leader: I.P Gautam Budget for this FY: 250,000

Activity code number	Name of activity	End year	Major progress/ achievements
1	Evaluation of TPS families for seedling tuber production in the nursery bed	2069 /70	TPS families C96H-02.4 x C98HT-64.8, HPS 7/67 and 994013 found highest yielder in NPRP, Nepalganj and Jumla condition respectively.
2	Evaluation of F_1C_1 tuberlets of TPS for potato production	2069 /70	Kufri Jyoti, TPS F1C1 C96H 02.4 x C99HT2-32.17 and 903027 found highest yielder in NPRP, Nepalganj and Jumla condition respectively.

Project code: 40469001 Project end year: Core project

Project title: Sustainability studies for pre-basic Seed (PBS) and basic seed production

Project leader: SP Dhital Budget for this FY: 230,000

Project code #	Name of project/activity	End year	Major progress/ achievements
1	Effect of incubation conditions on microtuber production in potato (3)	2068/ 69	Microtuber can be produce efficiently in *in vitro* condition
2	Studies on the use of sugar free MS medium for *in vitro* plantlets production (3)	2068/ 69	Result not satisfactory
3	Use of natural light for the survival and development of *in vitro* plantlets for PBS production (3)	2068/ 69	Natural light can be used for *in vitro* multiplication
4	Comparative study of hydroponic and soil based medium for efficient production of PBS under glasshouse condition (3)	2070/ 71	Work is on progress
5	Demonstrate performance of different size of PBS for basic seed production (3)	2068/ 69	Seed size may influence the total tuber yield
6	Demonstrate performance of basic seed-1 and farmer's seed for potato production in farmers' field (3)	2068/ 69	Quality seed produced higher yield
7	Conduct farmers' training on production of quality seed of potato (3)	2068/ 69	27 farmers received training on seed prod^{n}

Project code: 404 67 002 Project end year: 2070/71

Project title: Studies on management of late blight, wart and powdery scab disease of potato

Project leader: BP Sharma Budget for this FY: 280,000

Project Activity #	Name of project/activity	Major progress/ achievements
1	Introduction of potato clones(in vitro plantlets) from CIP and mini tuber production	18 *in vitro* clones introduced
2	Quantification of resistance to *P. infestans* in promising potato clones in three agro ecological zones.	LB resistant clones identified
3	Studies on population dynamics of *P. infestans* A1 and A2 mating types and Metalaxyl sensitivity	Isolates collected
4	Selection of environment friendly and cost effective fungicide(s) for late blight management.	Effective fungicides identified
5	Screening of potato clones against wart (*Synchytrium endobioticum*) at Nigale.	Screening techniques developed
6	Verification of disease resistance potato clones against wart and late blight disease under farmers' field conditions.	Clones found resistant under farmers' field conditions

Project code: 40466001 Project end year: Core project

Project title: Sweetpotato variety development for food and nutrition security

Project leader: SP Dhital Budget for this FY: 215,000

Project activity	Name of project/activity	Major progress/ achievements
1	Collection of sweetpotato genotypes from different parts of the country and abroad	Altogether 27 different sweetpotato genotypes have been maintained under field conditions in NPRP, Khumaltar; RARS, Tarahara; ARS, Malepatan and RARS, Nepalgunj.
2	Clonal multiplication of elite genotypes	
3	Initial Evaluation Trial (IET)	Ten outstanding sweet potato genotype, viz. CIP 440015, CIP 440021, CIP 440012, CIP 440185, CIP 400039, CIP 440328, CIP 441624, CIP 440135, CIP 440007 and CIP 440267 had been selected for further evaluation in CVTs.

Project code: 40455002 Project end year: Core project

Project title: Pre-basic and source seed production of potato

Project leader: SP Dhital Budget for this FY: 12,70,000

Project activity	Name of project/activity	Major progress/ achievements
1	PBS production through tissue culture technology (3)	58,732 (No.)
2	Basic seed production (3)	3,560 (Kg)
3	Germplasm maintenance under *in vitro* condition (3)	Total : 74
4	Soil fertility management at NPRP, Hattiban Farm (3)	2,085 (Kg)

Annex 4.1

Production of Source Seed in FY 2068/69

SN	Commodity	Variety	Type	Unit	Target quantity	Produced quantity
1	Potato	Six varieties	Pre-basic seed (PBS)	No.	100,000	58,732
2	Potato	Six varieties	Basic seed (BS)	kg	3,000	3,560
3	Rice		Foundation	kg	1,250	
		Khumal 4		kg		1,400
		Khumal 11		kg		600

Annex 4.2

Distribution of Source Seed in FY 2068/69

SN	Commodity	Type	Quantity	Major stakeholder(s)	Distributed districts
1	Potato	PBS	91,666 (No.)	ADO and seed growers	Different ADOs
2	Potato	Foundation	3015 (kg)	ADO and seed growers	Different ADOs
3	Rice	Foundation	1200 (kg)	Local Farmers	Lalitpur

Annex 5.1

Training/Workshop/Seminar Organized in FY 2068/69 (2011/12)

SN	Name of Training/ Workshop/ Seminar	Dura-tion	Target group	Location	No. of participants
1	Potato Research Methodology Training	Jun.18-21, 2012	T-6 to S-1	Plant Pathology Division, Khumaltar	17
2	Interactive horticulture workshop	3 days	Hortic ulturist s	NARC Hall, Khumaltar	

Annex 5.2

Publications in FY 2068/69 (2011/12)

SN	Name of publications	Type *	Lan-guage	Authors	No. of copies
1.	National Potato Research Program: A Brief Introduction	Leaflet	Nepali	-	1000
2.	National Potato Research Program: A Brief Introduction	Leaflet	English	-	1000
3.	Potato Production Technology	Leaflet	Nepali	Dr. BB Khatri & BP Sharma	1000
4.	Potato Late Blight Management Technology	Leaflet	Nepali	BP Sharma	1000
5.	Organic Potato Cultivation Technology	Booklet	Nepali	IP Gautam & KP Upadhyaya	500
6.	Integrated Weed Management in Potato Crop	Booklet	Nepali	J Ghimire	500
7.	Sweetpotato Production Technology	Leaflet	Nepali	Dr. SP Dhital & KC Upreti	1000
8.	Potato Cultivation Technology from TPS	Leaflet	Nepali	RC Ghimire & KC Upreti	1000
9.	Potato Production and Post-harvest Annual Worktable	Booklet	Nepali	Dr. BB Khatri & D Chaudhary	1000
10	Disease-free Pre-Basic Seed Potato Production from Tissue Culture TEchnology	Booklet	Nepali	Dr. SP Dhital	1000
11	Annual Report 2067/68 (2010/11).	Book	English	NPRP	100

**Books, leaflet, brochure, manuals, pamphlets, audio visual etc*

Annex 5.3

Information Disseminated Through Media

S.N.	Information disseminated/Media coverage	Type*	Name/ Type of media#	Date/Time
1	Potato varieties and disease management	Interview	Ujyalo Network FM radio	
2	Effect of climate change on potato crop	Conversation	Hamro Sampada: a monthly magazine	

**news, interview, feature article, feature story, case story etc.* *#Specify print/radio/ TV etc.*

Annex 6.1

Training/Workshop/Seminar Attended by Staff in FY 2068/69 (2011/2012)

S N	Name of staff	Position	Name of workshop	Dura-tion	Place/ country	Organizer
1.	Dr. SP Dhital	Sr. Scientist	Development of a new diagnostic tool using DNA barcoding to identify quarantine organisms in support of plant health	Mar. 14-17, 2012	Shimla, India	Seventh Framework Program, EU and CPRI, Shimla
2.	Mr. BP Sharma	Co-ordinator (Sr. Scientist)	Inception workshop	July 5-8, 2012	Thimpu, Bhutan	International Potato Center (CIP)
3.	Dr. BB Khatri	Sr. Scientist	Inception workshop	July 5-8, 2012	Thimpu, Bhutan	International Potato Center (CIP)

Annex 6.2

Papers Published in FY 2068/69 (2011/12)

SN	Title of the paper	Authors	Name of proceedings, journals etc.
1	Efficacy of Fungicides against *Phytophthora infestans* in Potato under Laboratory and Field Conditions.	Sharma BP, HK Manandhar, GA Forbes, SM Shrestha and RB Thapa.	*Nepal Agric. Res. J.* (2011) 11: 26-37.
2	Maximizing productivity and improving nutrition through intercropping quality protein maize and potato.	Chapagain TR, BB Khatri, P Bhatarai, BP Luintel, G. Ortiz-Ferrara and RC Sharma	*Acta Agronomica Hungarica* (2012) 60(3):221–230.
3	On-farm evaluation of potato clones in the high hills of eastern Nepal.	Chapagain TR, BB Khatri, RK Saha and J. Mandal	Proc. of the 7th National Hort. Seminar, 12-14 June 2011, Khumaltar, Lalitpur, Nepal. (2011)
4	Microtuberization of potato (*Solanum tuberosum* L.) as influenced by supplementary nutrients, plant growth regulators, and *in vitro* culture conditions.	Dhital SP and HT Lim.	*Journal of the European Association for Potato Research* (2012). 55(2): 97-108.
5	Effects of incubation season on rapid multiplication of virus-free plantlets under *in vitro* conduction and planting season and condition on the production of pre-basic seeds of potato under *in vivo* conditions.	Dhital SP, BM Sakha and RB Nepal.	*Nepal Agric. Res. J. Nepal Agric. Res. J.* (2012) 10: 75-82.
6	Rapid multiplication of virus-free plantlets under *in vitro* condition and production of pre-basic seed of potato (*Solanum tuberosum* L.) under glasshouse condition.	Dhital SP, BM Sakha and RB Nepal.	*Journal of Plant Breeding* (2012). Institute of Agriculture and Animal Science, Rampur, Nepal. 6: 20–27.
7	Direct and efficient plant regeneration from different explants sources of potato cultivars as influenced by plant growth regulators.	Dhital SP, HT Lim and HK Manandhar.	*Nepal Journal of Science and Technology* (2012), Lalitpur, Nepal. 12:1-6.
8	Virus Elimination and Seed Production of Potato (*Solanum tuberosum* L.).	Dhital SP and Hak T. Lim.	LAP Lambert Academic Publication, Germany. (2012) ISBN: 978-3-8443-1517-2.

9	Effect of chemical treatment and storage on quality of potato chips.	Gautam IP, MD Sharma, BB Khatri, RB Thapa and K Shrestha.	*Nepalese Horticulture*. (2012)8 & 9 (1): 41-47.
10	Storability and chips quality of chemical treated potatoes under ordinary condition.	Gautam IP, MD Sharma, BB Khatri, RB Thapa and K Shrestha.	*J. of Basic and Applied Sciences* (2012). 8(2): 1-10.
11	Effect of nitrogen and potassium on yield, storability and post harvest processing qualities of potato for chips.	Gautam IP, MD Sharma, BB Khatri, RB Thapa, K Shrestha and D Chaudhary.	*Nepal Agric. Res. J.* (2011) 11: 40-51.
12	Yield and processing quality of potato in response to nitrogen and potash.	Gautam IP, MD Sharma, RB Thapa, BB Khatri, and K Shrestha.	*Nepalese Journal of Agricultural Sciences* (2012). 10:84-97.
13	Evaluation of potato genotypes for keeping quality under ambient conditions in Nepal.	Gautam, IP, BB Khatri, MD Sharma, RB Thapa, K. Shrestha and D. Chaudhari.	*Potato Journal*. (2012) 39(2):128-132.
14	Field performance of two promising potato clones in the hills and terai of Nepal.	Khatri BB, D Chaudhari, BP Sharma, BP Luitel, S Ahamad, GD Subedi, RB KC, SL Shrestha, P Karki and T Chapagain.	Proc. of the 7th National Hort. Seminar, 12-14 June 2011, Khumaltar, Lalitpur, Nepal.
15	Use of phosphonate to manage foliar potato late blight in developing countries.	Kromann P, PérezG, Taipe, A, Schulte-Geldermann E, Sharma BP, Andrade-Piedra JL, and Forbes GA.	*Plant Dis*. (2012) 96:1008-1015.
16	'Gogu Valley': A high yielding potential and raw eating potato cultivar.	Lim HT, SP Dhital, DM Khu, KH Li, SP Choi, CW Kang, TJ Kim, HS Mo, WN Hwang, WJ Lee and HS Kim.	*J. Hort. Environ. and Biotechnolo* (2012). 51(1):68-71.
17	CIP 393280.64: A promising potato cultivar for central terai.	Shrestha SL, RL Saha and BB Khatri.	Proc. of the 7th National Hort. Seminar, 12-14 June 2011, Khumaltar, Lalitpur, Nepal.

Annex 7.1

Regular Annual Budget and Expenditure Record of FY 2068/69 (2011/12)

(in NRs.)

Code	Budget Heads	Annual budget	Budget released	Expenses	Balance
40*	**Staff expenses**	**7,946,000.00**	**7,788,000.00**	**7,727,713.87**	**60,286.13**
4000	Staff Basic Salary	6,471,000.00	6,383,612.22	6,347,352.79	36,259.43
4010	Staff Allowance	0.00	0.00	0.00	0.00
4020	Staff Provident Fund	647,000.00	615,002.78	592,876.08	22,126.70
4030	Staff Medical Expenses	0.00	0.00	0.00	0.00
4040	Staff Uniform Expenses	210,000.00	195,000.00	195,000.00	0.00
4050	Staff Dasai Expenses	550,000.00	528,885.00	528,885.00	0.00
4060	Staff Overtime Expenses	0.00	0.00	0.00	0.00
4070	Staff Pension & gratuity	0.00	0.00	0.00	0.00
4080	Insurance Fund	68,000.00	65,500.00	63,600.00	1,900.00
41**	**Operational expenses**	**5,992,000.00**	**5,938,300.00**	**5,937,787.21**	**512.79**
4100	Travel Expenses	780000.00	730300.00	730218.00	82.00
4110	Vehicle Fuel & Lubricants Cost	405000.00	419200.00	419136.31	63.69
4120	Wages to Labour Cost	1655000.00	1656300.00	1656209.81	90.19
4130	Lab and Res. Supplies Cost	505000.00	493600.00	493579.43	20.57
4140	Farm Supplies Cost	917000.00	864200.00	864127.95	72.05
4150	Books, Journal & Publications	60000.00	45500.00	45434.00	66.00
4160	Training & Seminar Cost	125000.00	70900.00	70867.12	32.88
4170	Contract & Collaborative Res.	0.00	0.00	0.00	0.00
4180	Farm Management Project Cost	1545000.00	1658300.00	1658214.59	85.41
42**	**Administrative expenses**	**1,720,000.00**	**1,773,700.00**	**1,772,445.08**	**1,254.92**
4200	Rent, Utilities & Other Expenses	600,000.00	625,200.00	625,159.57	40.43
4210	Communication Expenses	75000.00	63400.00	63374.88	25.12
4220	Repairs & Maintenance Cost	905000.00	955900.00	954891.93	1008.07
4230	Station., Printing & Off. Supplies	65000.00	54200.00	54130.70	69.30
4240	Board and Panel Meeting Cost	0.00	0.00	0.00	0.00
4250	Recruitment Expenses	0.00	0.00	0.00	0.00
4260	Contingency Expenses	75000.00	75000.00	74888.00	112.00
4270	Office Furnishing Cost	0.00	0.00	0.00	0.00
4280	Other Admin. Expenditure	0.00	0.00	0.00	0.00
43**	**Capital expenses**	**6,456,000.00**	**6,796,000.00**	**6,741,941.78**	**54,058.22**
4300	Freehold Land Cost	0.00	0.00	0.00	0.00
4310	Land and Land Develop. Cost	0.00	0.00	0.00	0.00
4320	Building & Other Const^n Cost	5000000.00	5340000.00	5286158.77	53841.23
4330	Furniture & Fixture Cost	100000.00	100000.00	99995.00	5.00
4340	Machinery Tools & Equip. Cost	1000000.00	1000000.00	999992.01	7.99
4350	Vehicles Cost	156000.00	156000.00	156000.00	0.00
4360	Computer & Com. Accesso. Cost	100000.00	100000.00	99820.00	180.00
4370	Other Fixed Assets	100000.00	100000.00	99976.00	24.00
	Grand Total	**22,114,000.00**	**22,296,000.00**	**22,179,857.94**	**116,142.06**

Annex 7.2

Revenue Status of FY 2068/69 (2011/12)

(in NRs.)

S.N.	Source	Total	Remarks
A.	RESEARCH 1. Seed Potato	18,766.00	
B.	PRODUCTION 1. Pre basic potato seed (PBS) 2. Basic potato Seed 3. Rice seed 4. Ware Potato and mixed rice		
	Subtotal	527,911.70	
C.	Others 1. Last year credit 2. Admin. income 3. Others	- 96,100.00 14,400.00	
	Subtotal	110,500.00	
	Total	657,177.70	

Annex 7.3

Beruju Status of FY 2068/69 (2011/12)

(in NRs.)

Beruju	Amount	Remarks
Beruju till last year	691,146.00	
Beruju cleared this FY	0.00	
Remaining Beruju	691,146.00	
Document processed for clearance of Beruju	0.00	

Log Frame of National Potato Research Program, Khumaltar, 20011/12

NARRATIVE SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS (OVI)	MEANS OF VERIFICATION (MOV)	IMPORTANT ASSUMPTION
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 OFSP 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 its importance to address the food security climatic and edaphic factors remain congenial.

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 Soil fertility management 3.2 Studies on minimization of post harvest losses and value addition 3.3 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	**Annual Budget for FY 2068/69** Budget Heads — Rs. 4000 Staff expenses — 7,946,000 4100 Operational Expenses — 5,992,000 4200 Admin Cost — 1,720,000 4300 Capital Item cost — 6,456,000 Total Rs. — 22,114,000 **Project wise budget for 2068/69** Project # — Rs. '000 40467002 Studies on mgnt of LB, wart — 280.0 40467001 Coping with climate change — 280.0 40466001 Sweet potato variety develop. — 215.0 40463001 Variety imp. for processing — 165.0 40457003 Variety improvement — 685.0 40457002 Sustain. studies on PBS prod. — 230.0 40455002 PBS & source seed prod. — 1270.0 40454002 Evaluation of TPS — 250.0 40400001 FMP — 2,617.0 **Total Operational — 5,992.0**	Project monitoring and evaluation report	Project leader get empowered to perform their research projects effectively.
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.			

Photographs of the released potato varieties

उन्मोचित आलुका विभिन्न जातका दानाहरू

(a) Berries (b) True seeds (c) Seedling tuber production plots and (d) Seedling tubers of HPS II/67

PRP25861.1

Outstanding potato lines identified for processing