भा.कृ.अनु.प.–अखिल भारतीय समन्वित आलू अनुसंधान परियोजना

ICAR-All India Coordinated Research Project on Potato

Annual Report
2014-15

ICAR-Central Potato Research Institute
(Indian Council of Agricultural Research)
Shimla-171 001, H.P. (India)

AICRP on Potato Annual Report 2014-15

Printed: September, 2015

No. of copies: 150

Acknowledgement

Material for this report received from 7 CPRI based, 17 SAU based and 1 voluntary centre of AICRP (Potato). The Heads of Divisions of CPRI and their colleagues assisted in compilation and interpretation of the results. Their assistance is gratefully acknowledged.

Compilation and Production: NK Pandey and Dharminder Verma

Photographs: CPRI

Secretarial Assistance: Nirmala Chauhan and Sita Ram

Published by:

Dr Bir Pal Singh
Director
ICAR – Central Potato Research Institute
Shimla – 171 001, H.P.
Month/Year of publication: September, 2015
E-mail: aicrp_potato@hotmail.com
Website: http://cpri.ernet.in

Printed at Venus Printers and Publishers, B62/8, Naraina Industrial Area, Phase-II, New Delhi-110 028.
Mobile: 98100 53617; Email: pawannanda@gmail.com

PREFACE

All India Coordinated Research Project on Potato initiated in 1970-71 is operating through 17 State Agricultural Universities based centers, 7 CPRI based centers and 1 voluntary center.

In this 43rd Annual Report of AICRP (Potato), experiments conducted during summer/*kharif* 2014 in hills/plateau and *rabi* 2014-15 in the plains have been reported. There were 14 experiments in Crop Improvement, 12 in Crop Production and 16 in Crop Protection at various locations. Efforts have been made to collect, consolidate, analyze and compile data collected in these experiments in this report. The significant achievements during the year in Crop Improvement are the pooled analysis of the performance of advanced hybrids which showed that two of them are promising. The environment of the potato growing season across the country has been categorized and thematic maps developed & this would help better targeting of genotypes to their target domains. Studies have been initiated to determine the base temperature of already released as well as advanced hybrids so that their thermal unit requirement can be worked out.

Under Crop Production detailed studies on the applied–yield, uptake–yield as well as applied–update relations have been carried out which would enable in developing precision recommendations. Experiments on omission plot technique have been carried out and these would help to develop target yield equations. Since P nutrition is a serious problem in the hills, P use efficient cultivars viz K Swarna and K Neelima have been identified. Studied on water and nutrient economy through irrigation scheduling and its combination with mulching has been studied. The crop weed competition in terms of yield & nutrients at different locations has been studied in depth. Detailed micro nutrients analysis has been carried out in collaboration with IIHR which would enable in deciding the best micronutrient combination for potato.

Under Plant Protection the salient achievements include validation of the Indoblightcast DSS, developing fungicide scheduling recommendations for Pantnagar & Shillong and a schedule for controlling early blight and recommendation for an alternative to imidacloprid for the control of sucking pests.

I would like to record my sincere thanks to Dr NK Krishna Kumar, Deputy Director General (Horticulture Sciences), ICAR, New Delhi, and Dr Janakiram, Assistant Director General (Horticulture Sciences -II), ICAR, New Delhi and Dr BP Singh, Director, CPRI for their keen interest in the programme, help and guidance. I am indebted to my colleagues Dr K Manorama, Dr SK Singh, Dr. SK Yadav, Dr SK Luthra, Dr VK Gupta for their help in compiling the results of various experiments.

I am also thankful to Dr Vinay Bhardwaj (Acting Head, Crop Improvement), Dr VK Dua, (Head, Crop Production), and Dr. M Nagesh, (Head, Crop Protection) and Dr NK Pandey (Head, Social Sciences) as well as their colleagues Dr Sanjeev Sharma and Dr Sridhar for interpreting the analyzed results and preparing write ups of their respective disciplines for this annual report. Dr Raja Shankar, Sr Scientist, AICRP Unit, CPRI, Shimla has been instrumental in compiling the information and his efforts are greatly appreciated.

Statistical analyses by Mr Dharminder Verma, Sr Technical Officer; secretarial assistances by Mrs Nirmala Chauhan, UDC; and assistance provided by Mr Sita Ram, Technician and Mr Surinder Pal, Technician in reprography are appreciated and thankfully acknowledged.

August, 2015
Shimla

PM Govindakrishnan
Project Coordinator

ABBREVIATIONS

AICRP Project	All India Coordinated Research
Av.	Average
BHN	Bhubaneshwar
BW	Bacterial wilt
BS	Black Scurf
CD	Critical difference
CHN	Chhindwara
CPRIC	Central Potato Research Institute Campus
CPRS	Central Potato Research Station
CS	Common Scab
CV	Coefficient of variation
cv.	Cultivar
DAP	Days after planting
DES	Deesa
DHL	Dholi
DWD	Dharwad
EB	Early blight
FZB	Faizabad
g or gm	Gram
GWL	Gwalior
ha	Hectare
HIS	Hisar
HSN	Hassan
HYB	Hybrid
IPM	Integrated pest management
JAL	Jalandhar
JRH	Jorhat
K	Potassium
Kg	kilogram
KAL	Kalyani
KAN	Kanpur
KBD	Kufri Badshah
KCM	Kufri Chandramukhi
KFI	Kufri
Kg	Kilogram
KTT	Kota
LB	Late blight
LR	*Leaf roll*
MDP	Modipuram
MM	*Mild mosaic*
N	Nitrogen
OC	Organic carbon
OOT	Ootacamund
P	Phosphorus
PALCD	Potato apical leaf curl diseases
PAS	Pasighat
PAT	Patna
PLRV	*Potato leafroll virus*
PNT	Pantnagar
PTM	Potato tuber moth
PTR	*Purple top roll*
PUN	Pune
q	Quintal
RBD	Randomized block design
RDF	Recommended dose of fertilizers
Rs	Rupees
RPR	Raipur
SEd	Standard error of difference
SHI	Shillong
SM	*Severe mosaic*
SN	*Stem necrosis*
SPT	Split plot
SRI	Srinagar
SW	*Sclerotium wilt*
t	tonne

TABLE OF CONTENTS

Executive Summary

Potato is the fourth most important food crop in the world and is also the most consumed food crop which is grown in several ecosystems. The potato is grown in hills as well as plains and plateau in the country. The plains presently account for more about 85% of the potato acreage as against the hills and plateaus which together accounting for about 15% of the total acreage under the crop. For, exploiting the growing environment, there is need for testing of genotypes at multilocations in the hills, plateau and plains across the country and then recommend the best variety and superior technology to its most adapted domain. Hence, The All India Coordinated Research Project on Potato (AICRP on Potato) was established in 1971 with the primary mandate of conducting multilocation trials across the country. Presently the AICRP on Potato is functioning at 25 locations representing a diversity of potato growing environments. The hybrids developed at the Central Potato Research Institute are tested at multilocations through the AICRP network for evaluating their yield potential, stability, disease reaction etc. and based on their performance at the different centres, their target domains are determined. Different experiments were designed and executed on germplasm characterisation, varietal evaluation at different centres, precise nutrient and water management, weed management, disease and insect pest spread, dynamics and its control. The salient findings for the year 2014-15 are described below.

CROP IMPROVEMENT

Environmental characterization of potato growing regions in India: Multilocational trials are the forte of AICRPs. It is essential to study the yield potential, adaptability and stability of genotypes in different environments and accordingly determine their target domains. The AICRP (Potato) Centres are representative of target environments where potato is grown in different parts of India. Thus hybrids performing well at the centres would imply that they would also perform well at the target environments which they represent. Analysis of the climatic variables of the potato growing season (growing period of 90 days) of AICRP (Potato) centres was carried out which showed high diversity with respect to mean maximum temperature and minimum temperature. The study showed that at Pantnagar, Srinagar and Jalandhar the mean temperature of the growing season is expected to be quite low, hence the crop could experience low temperature stress at these centres. The optimum temperatures of 18-20 °C would be prevalent at Kanpur, Shillong, Shimla, Patna, Hissar, Dholi, Chhindwara, Kota and Modipuram while mild stress i.e. mean temperature of 20-22 °C is expected at Gwalior, Kalyani, Jorhat and Raipur and high stress i.e. mean temperature of >22 °C is expected at Bhubaneshwar, Pune, Deesa and Dharwad. Hence, these centres are target locations for evaluating genotypic performance against heat stress as well for optimum conditions

Base temperature for different potato genotypes: Study to prepare a database of base temperature of varieties released by CPRI, was initiated. The study revealed that at 3^0C none of the varieties sprouted up to the duration of the experiment (60 days). The base temperature of Kufri Badshah, Kufri Lauvkar and Kufri Swarna is 4^0C while that of Kufri Shailja, Kufri Muthu, Kufri Himsona, Kufri Chipsona 2, Kufri Satluj, Kufri Bahar, Kufri Surya and Kufri Chandramukhi is 5^0C. All

the other varieties sprouted at 7^{0}C within the duration of the experiment.

Development of Growing Degree Days (GDD) and P day map of potato growing regions in India: The meteorological data of potato growing period was used to calculate the Growing Degree Days with a base temperature of 4 ^{0}C and P days using 7, 21 and 30 ^{0}C as the cardinal temperatures. The GDD calculated for different locations were then interpolated and then classified into different categories. The study showed that in the north western plains 1200 to 1400 heat units are accumulated during the potato growing season subject to a maximum of 120 days while in the central Indo Gangetic plains the accumulated heat units are 1600 to 1800. In the Eastern plains especially Bihar and West Bengal it is about 1800 to 2000 heat units. In the plateau areas of Maharashtra and Karnataka also about 1600 to 1800 heat units are accumulated. Based on this information and on the heat units required by different varieties to attain maturity and the corresponding days to reach maturity it would be possible to target the varieties to different environment.

Apart from GDD, information on the P days accumulated during the season is also important. P days refer to the effective temperature during the growing season and it takes into consideration the non linear effect of temperature on the response of the crop. The study showed that in the north western Indo Gangetic plains only 600 -700 P days are available while in the other parts of the Indo Gangetic plains viz central and eastern Indo Gangetic plains, about 800 to 1000 P days is available. In the plateau areas also the Pdays available is only 600 -700. This shows that the effective temperatures are less in the north west Indo Gangetic plains as well as in the plateau. This information would help in better targeting of genotypes to environment.

Heat stress index of Potato: Screening for stress tolerance under field conditions is often carried out by exposing test genotypes to high temperature by manipulating sowing date or growing them in ''hot spots''. Quantification of heat stress is required for effective screening of heat tolerance under field environments. At present there is no reliable method to quantify heat stress for potato, hence, this study was undertaken. The calculation of Heat Stress Index (HSI) from historical yield trials at different locations and years showed that HSI is high at early planting and decreased as the planting is delayed at all the locations. Yield decreased linearly due to heat stress but the slope of the decrease was different in different years and at different locations.

Evaluation of germplasm: Two hundred & eighty seven germplasm accessions including 186 CP Nos., 98 advanced hybrids and 2 potato varieties were evaluated against potato apical leaf curl virus disease (PALCVD) at Hisar. CP 1458 and HIS 98-55 along with control Kufri Bahar were found highly resistant as in the previous year. Ninety-five germplasm accessions were evaluated in replicated trials at Hassan (Karnataka) under *kharif* season for adaptability. Three highest yielding accessions were viz., CP2068, CP2003 and CP2008 and these yielded 23.08 t/ha, 19.42 t/ha and 18.04 t/ha total yield respectively. All these three accessions were resistant to late blight disease.

Trial with table potato hybrids: Five advanced hybrids viz., MS/7-645, MS/6-1947, PS/06-88, PS/5-75 and PS/6-24 along with the controls were evaluated at 75 and 90 days durations at North, Central and Eastern plains during rabi season. None of the hybrids could out yield the controls Kufri Khyati or Kufri Pukraj at all the dates of harvest i.e. 75 and 90 days after planting. However, hybrid MS/6-1947 was at par with the controls in the Eastern plains.

Trial with processing hybrids: Two processing hybrids viz. MP/01-916 and MP/4-816 were evaluated against Atlantic, Kufri Chipsona-1 and Kufri Chipsona-3 the common controls at many locations across the country. The results showed that the effect of locations, genotypes and location x genotype interaction were significant. Considering the mean total yield in the northern plains, MP/04-816 significantly out yielded the check varieties.

Trial with French fries: One promising hybrid, MP/4-578 was evaluated against two controls viz., Kufri Chipsona-1 and Kufri Frysona at 90 &105 days at 11 centres. As regards marketable yield, Kufri Chipsona 1 and MP/4-578 were statistically at par at Deesa while at Modipuram MP/4-578 significantly out yielded Kufri Chipsona 1. However, the overall processing grade mean yield of the hybrid was found significantly higher over K.Chipsona-1

On-farm trial for heat tolerance: The heat tolerant hybrid, CP-4054 was evaluated against control varieties at 75 and 90 days crop duration. The hybrid CP-4054 registered significantly greater over all mean total yield and marketable yield as compared to the overall genotypic mean across years.

Varietal evaluation for production of baby/ salad potatoes (speciality potato): Potato cultivars K Khyati, K.Pukhraj and K.Pushkar were tested at three locations Bhubaneswar, Chhindwara and Raipur for assessing their potential to produce baby potato at 60, 75 and 90 days crop duration. The results showed that as the duration increases there is corresponding increase in total yield at all the three durations and all the cultivars. All the varieties produced higher proportion of baby potatoes but there were location to location differences.

Trial with speciality potato hybrids (red skinned hybrids): Studies conducted to evaluate the performance of red skinned hybrids showed MS/08-1565 to be promising as compared to the checks K Sindhuri and K Lalit.

KHARIF SEASON TRIAL

On farm trial with hybrids having combined resistance to late blight and cyst nematode: Two hybrids namely OS/01-516 and OS/01-497 with four controls, Kufri Neelima, Kufri Girdhari, Kufri Himalini and Kufri Swarna were evaluated at 120 days crop duration at seven locations. Hybrid OS/01-516 and OS/01-497 performed better than the controls. Both the hybrids showed better resistance to cyst nematode in comparison to Kufri Neelima and Kufri Swarna.

Varietal evaluation for production of baby/ salad potatoes (speciality potato): Eight varieties viz., Kufri Himsona, Kufri Khyati, Kufri Pukhraj, Kufri Pushkar, Kufri Lauvkar, Kurfi Ashoka, Kufri Jyoti and Kufri Surya were evaluated at 60 days crop duration at Dharwad and at 75 and 90 days crop durations at Pune centres of AICRP during *Kharif* season. At Dharwad, Kufri Khyati, and Kufri Surya gave high yields along with high proportion of baby potatoes while at Pune the yields were high but proportion of baby potatoes was low. Kufri Himsona produced >77% tubers of less than 50 gm tuber weight (baby tubers).

CROP PRODUCTION

Nitrogen requirement of newly released potato cultivars: The response to N by newly released hybrids and thus derive their N requirement was studied for variety Kufri Surya during the year. The results showed that the response to N application in the different years is polynomial but the coefficients are different. This indicates that for the same yield level the N application required is different in different years and in different locations.

Therefore, N recommendations based on the N applied-yield relation are not very reliable. To further analyse the reasons for the same and to develop a reliable method for determining the N requirement, the N uptake-yield relation was also studied and this showed that this relation is linear and also very stable across locations and seasons. **The slope of the uptake - yield curve was 0.2708 tons tubers on fresh weight basis per kg N uptake.** To determine the relation between N applied and that taken up, the uptake at different levels of N were plotted and the results showed that the N applied-uptake relationship was also polynomial indicating that the variation in the N response is due to differences is N applied - Uptake relationship.

Validation of DSS for N (Advisory System for Nitrogen Management in Potato (ASNMP): A DSS called Advisory System for Nitrogen Management in Potato (ASNMP) has been developed for precise recommendation of the N dose to be applied. During the year under report, the data required for calibrating and validating the ASNMP were generated through different experiments and different components of the DSS were tested.

Site specific N,P,K requirement of Potato: Studies were conducted as per omission plot technique and various efficiencies indices were calculated for using in target yield equation.

P use efficient varieties: Studies on P use efficient varieties were conducted at Ooty, which showed that **Kufri Swarna and Kufri Neelima are highly efficient in utilization of P and their economic optimum dose of P in the Niligiri hills is 85 and 87 Kg P_2O_5/ha.**

Water management in potato under low water availability conditions: The water use efficiency of potato is quite low and frequent irrigation reduces the nutrient use efficiency. Therefore studies to minimize the irrigation showed that **irrigation at 20mm CPE is the best for potato at Dholi conditions and its combination with mulching is desirable to reinforce the beneficial effect**

Weed management in potato: Studies were conducted at Dholi, Faizabad, Jorhat, Kalyani, Kota, Pantnagar, Raipur, Shillong centres to determine the competition due to weeds in terms of yield loss, nutrient loss as well as efficiency. The results showed that potato productivity was significantly reduced by weeds. Chemical weed control through Metribuzin both as pre emergence and as post emergence spray were equally effective and were comparable to weed free and hand weeding treatments. The average yield loss due to weeds was about 35%. This study showed that **application of Metribuzin @ 0.75 kg/ha either as pre emergence or as post emergence at 10 % plant emergence were comparable to manual hand weeding to control the weeds in the potato crop.**

Evaluation of potato - transplanted onion sequence: Potato onion sequence is an important sequence since both are important crops and have similar problems. This sequence is especially suited for the eastern plains. The success of the sequence depends upon the proper adjustment of the planting and harvesting schedule. Therefore studies were initiated at Faizabad and Patna to determine the proper planting and harvesting schedule for potato and onion following potato. The results showed that the potato and onion yields were affected significantly by both planting and harvesting dates. While optimum time of planting and harvesting at 90 days after planting is best for high yield of potato early planting and harvest is advantageous for onion.

Drip fertigation for potato: An experiment was initiated at Hissar to study the N savings due

drip fertigation. The treatments comprised of different proportion of recommended N dose (%) applied according to standard practice which served as the control. The results showed that tuber yield was significantly higher when 60 and 80 % of the recommended N dose was applied through fertigation.

CROP PROTECTION

Monitoring of late blight and A2 mating type of *Phytophthora infestans* : Monitoring for late blight appearance and its progress was undertaken in 10 locations during *rabi*, summer and *kharif* seasons. There was no late blight incidence at Jorhat in the first date of planting and in Kota. At Faizabad, Pantnagar and Shillong the disease was <5% at 7 days after disease appearance and increased gradually. The disease incidence was higher at 7 days after disease appearance at Patna in the first two dates of planting and Srinagar in all the dates of planting. However, at 7 days after disease appearance the disease incidence was highest at Kalyani which indicates that the rate of growth of the disease was fastest at Kalyani perhaps due to the favourable temperatures and high humidity. The study of samples of the pathogen showed that A2 mating type has completely replaced A1 mating type in the hills.

Scheduling of fungicide application for the management of Late Blight: Forecasting the time of disease appearance is very critical in late blight management so that prophylactic control measures can be adopted timely. Under the AICRP (Potato), the date of appearance of late blight is being monitored at those centres where it is a severe problem and this was related to weather factors to develop a generic model INDOBLIGHTCAST. This model was further validated during the year and the results showed that the difference between model predicted date of late blight appearance and actual date of appearance was less than 15 days at all the centres thus validating the model. Evaluation of different fungicide schedules revealed that **Prophylactic spray (just at the time of canopy closure) with mancozeb followed by Fenamidone+mancozeb (Secure/ Sectin 50% WG) @ 0.3% and one more spray with mancozeb) and Prophylactic spray (just at the time of canopy closure) with mancozeb followed by dimethomorph + Mancozeb @ 0.3% followed by mancozeb are the best for the control of late blight at Pantnagar.**

At Shillong, Prophylactic spray (just at the time of canopy closure) with mancozeb followed by Fenamidone+mancozeb (Secure/ Sectin 50% WG) @ 0.3% and one more spray with mancozeb) and Prophylactic spray (just at the time of canopy closure) with mancozeb followed by dimethomorph + Mancozeb @ 0.3% followed by mancozeb were found to be the best for the control of late blight.

Management of early blight: Studies on scheduling of fungicide for control of early blight showed **first spray of mancozeb 75WP (0.25%), second spray of hexaconazole 5EC (0.05%) and third spray of mancozeb 75WP (0.25%) at 10 days interval) and First spray of chlorothalonil 75WP (0.25%), second spray of hexaconazole 5EC (0.05%) and third spray of chlorothalonil 75WP (0.25%) at 10 days interval) treatments were best for effective control of early blight.**

Surveillance of important potato pests in pest capture plots: Aphid infestation was reported from most of the centres, Whitefly from Bhubaneswar, Dholi, Hisar, Kanpur, Kota, Pasighat, and Raipur. Thrips infestation was recorded in Kota. Infestation of *Heliothis* was recorded in Pasighat. Potato tuber moth damage was recorded in Hassan. Tuber damage due to soil borne insects like cut worms were reported from Deesa, Kanpur, Ooty, Patna, Pasighat and Srinagar while white

grubs damage was observed in Dholi, Ooty, Pasighat, Shillong and Srinagar. Mole cricket in Jorhat, Kalyani and Pasighat, and red ants in Jorhat and Pasighat were also recorded.

Monitoring of Aphids, *Myzus Persicae* and *Aphis Gossypii* in unsprayed potato crop: The aphids are the vectors of important potato viruses mainly PVY and PLRV responsible for seed degeneration and lower yields. In this context, aphids population was monitored on unsprayed potato crop at 19 AICRP centers, Bhubaneswar, Chhindwara, Deesa, Dholi, Faizabad, Hassan, Hisar, Jorhat, Kalyani, Kanpur, Kota, Modipuram, Ooty, Pasighat, Patna, Pune, Raipur, Shillong and Srinagar across the country. Both *M. persicae* and *A. gossypii*, were found in all the centres except Shillong and Srinagar where the latter was not found. *M. persicae* population buildup was higher in all the locations as compared to *A. gossypii*. In Ooty, aphid population were not present on potato crop planted in May. The aphid transmitted virus incidence was also recorded at Deesa, Hassan, Jorhat, Kanpur and Pune. The population trend of weekly aphid population averaged over the years was calculated for these locations. The results showed that the trend was polynomial. The threshold aphid number per hundred compound leaves was crossed in the third week of January at Faizabad and Kota, first week of January at Kanpur and Hisar and fourth week of December at Patna.

Management of sucking pest: Studies showed that the insecticide schedule viz., thiacloprid @48g a.i./ha + yellow sticky trap at the time of aphid appearance or thiacloprid @48g a.i./ha at the time of aphid appearance + Yellow trap, second spray with thiamethoxam 25WG @125g a.i./ha after 15 days were found very effective and can be adopted as a good alternative to imidacloprid for the management of sucking pests at Raipur.

CROP IMPROVEMENT

Environmental characterization of AICRP (Potato) centres

Multilocational trials (MLT) are the forte of AICRPs. MLT is essential to study the yield potential, adaptability and stability of genotypes in different environments and accordingly determine their target domains. The AICRP (Potato) centres are representatives of environments where potato is grown in different parts of India. Thus hybrids performing well at the centres would imply that they would also perform well at the target environments which they represent. Under the AICRP (Potato), the genotypes are tested at 25 centres. Analysis of the climatic variables of the potato growing season (growing period of 90 days) of these AICRP (Potato) centres was carried out which showed high diversity with respect to mean maximum temperature and minimum temperature. Based on the optimum temperature for photosynthesis, the AICRP centres can therefore be classified into different classes according to mean temperature of the growing season of 90 days (Table 1.1).

The table shows that at Pantnagar, Srinagar and Jalandhar the mean temperature of the growing season is expected to be quite low, hence the crop could experience low temperature stress at these centres. The optimum temperatures of 18-20 °C would be prevalent at Kanpur, Shillong, Shimla, Patna, Hissar, Dholi, Chhindwara, Kota and Modipuram while mild stress i.e. mean temperature of 20-22 °C is expected at Gwalior, Kalyani, Jorhat and Raipur and high stress i.e. mean temperature of >22 °C is expected at Bhubaneshwar, Pune, Deesa and Dharwad. Hence, these centres are target locations for evaluating genotypic performance against heat stress. The mean temperatures of these locations are also reflected in the corresponding thermal time accumulation at these centres. The different AICRP (Potato) centres thus provide an opportunity for testing of genotypes at diverse environments to assess the yield potential and stability of the genotypes.

Plant growth and development depends on temperature. The occurrence of different growth stages (called developmental stage) of the crop is a function of temperature and it is necessary to know the thermal time requirement to reach different development stages. Thermal time is calculated by different methods and one of the most common method is the average minus base temperature method. The base temperature is defined as the minimum temperature at which growth starts. Different base temperatures are used for different phenological stages but mostly

Table 1.1: Classification of AICRP (Potato) centres according to temperature

Group	Temp. range (°C)	Location	*Accumulated GDD (°Cd)	Stress level
1	<18	Pantnagar, Srinagar, Jalandhar	<1600	Low temperature stress
2	18-20	Kanpur, Shillong, Shimla, Patna, Hissar, Dholi, Chhindwara, Kota, Modipuram	1600-1800	Stress free
3	20-22	Gwalior, Kalyani, Jorhat Raipur	1800-2000	Mild stress
4	>22	Bhubaneshwar, Pune, Deesa, Dharwad	>2000	High stress

*with non crop specific base temperature of 0 ^{0}C

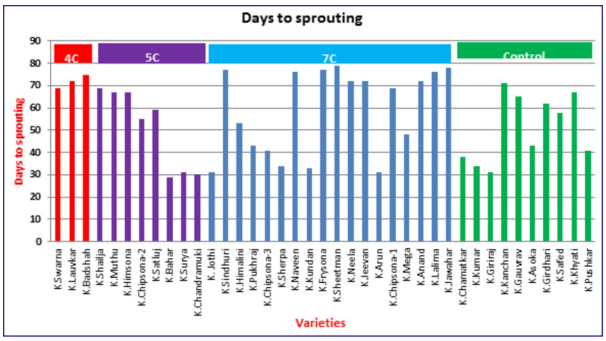


Fig 1.1 Base temperature for different potato genotypes

a single base temperature is used. To prepare a database of base temperature of varieties released by CPRI, a preliminary experiment was started in which tubers of 39 varieties were procured from the September harvested crop at CPRS, Kufri and kept at different temperatures in a BOD incubator in Ist week of December. Observations on sprouting, weight loss etc were recorded periodically. The results (Fig 1.1) showed that at 3^{0}C none of the varieties sprouted up to the duration of the experiment (60 days). At 4^{0}C Kufri Badshah, Kufri Lauvkar and Kufri Swarna sprouted while at 5^{0}C Kufri Shailja, Kufri Muthu, Kufri Himsona, Kufri Chipsona 2, Kufri Satluj, Kufri Bahar, Kufri Surya and Kufri Chandramukhi sprouted. All the other varieties sprouted at 7^{0}C within the duration of the experiment.

For better targeting of genotypes to different environments, weather database was created for important locations in India using MARKSIM weather generator in a spreadsheet. Algorithms were used for screening the database for delineating the potato growing period. The algorithm adopted was maximum temperature < 35^{0}C and minimum temperature < 21^{0}C and >2^{0}C at least three weeks after the maximum temperature condition is satisfied. Among the many suitable thermal windows delineated through the algorithm, the longest growing period was selected as the most appropriate growing season for each location. The meteorological data of the delineated growing period was used to calculate the

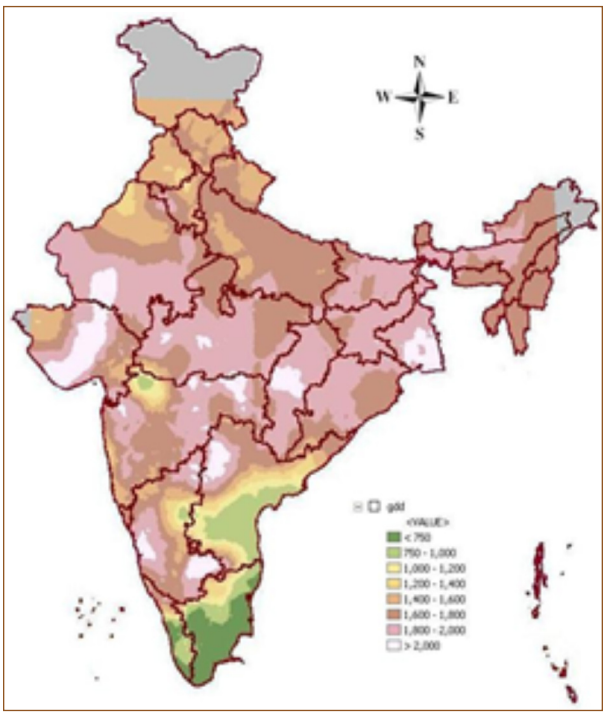


Fig 1.2 Available heat units during potato growing season in India

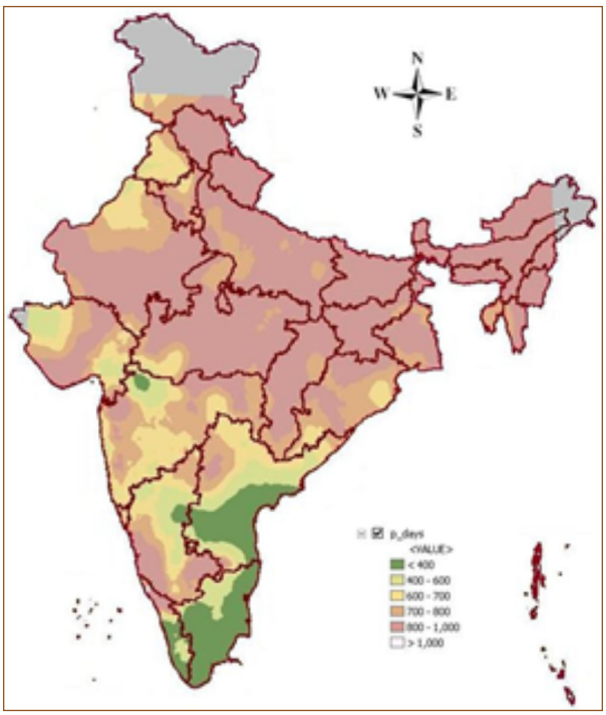


Fig 1.3 Available P days during potato growing season in India

Growing Degree Days with a base temperature of 4 ^{0}C and P days using 7, 21 and 30 ^{0}C as the cardinal temperatures. The GDD calculated for different locations were then interpolated and classified into different categories and are presented in Fig 1.2.

The results show that in the northwestern plains 1200 to 1400 heat units are accumulated during the potato growing season subject to a maximum of 120 days while in the central Indo Gangetic plains the accumulated heat units are 1600 to 1800. In the Eastern plains especially Bihar and West Bengal it is about 1800 to 2000 heat units. In the plateau areas of Maharashtra and Karnataka also about 1600 to 1800 heat units are accumulated. Based on this information and also on the heat units required by different varieties to attain maturity and the corresponding days to reach maturity it would be possible to target the varieties to different environment.

Apart from GDD, information on the P days accumulated during the season is also important. P days refer to the effective temperature during the growing season and it takes into consideration the non linear effect of temperature on the response of the crop. It has been widely used to study the response to temperature of many growth processes. The calculation of P days during the available growing period of potato at many locations in the country and its interpolation and classification into different categories shows that (Fig 1.3) in the north western Indo Gangetic plains only 600–700 P days are available while in the other parts of the Indo Gangetic plains viz. Central and eastern Indo Gangetic plains, about 800 to 1000 P days is available. In the plateau areas also the P days available is only 600–700. This shows that the effective temperatures are less in the north west Indo Gangetic plains as well as in the plateau. These information would help in better targeting of genotypes to environment.

Screening for stress tolerance under field conditions is often carried out by exposing test genotypes to high temperature by manipulating sowing date or growing them in ''hot spots''.

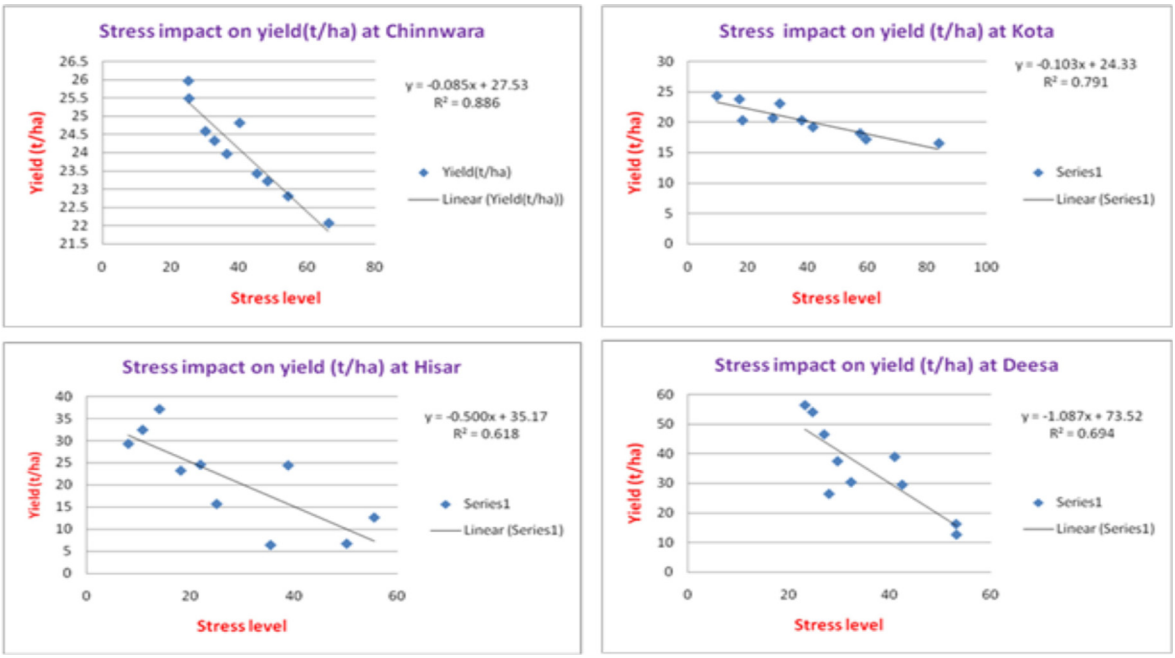


Fig 1.4 Yield response to heat stress at different locations

Quantification of heat stress is required for effective screening for heat tolerance under field conditions. At present there is no reliable method to quantify heat stress for potato, hence, this study was undertaken. The heat stress intensity index (HSI) for potato was developed based on the framework reported in literature. However, in view of the characteristics of the potato crop, the methodology was modified to include the effect of maximum and minimum temperatures separately. The heat stress was computed for the complete duration of the crop and not for any particular phenological stage. The daily heat stress due to high maximum and minimum temperatures were calculated separately and summed over the total duration.

The calculation of HSI of historical yield trials at different locations and years showed that HSI is high at early planting and decreased as the planting is delayed at all the locations (Fig 1.4). Yield decreased linearly due to heat stress but the slope of the decrease was different at different locations. The figure shows that at Chhindwara the slope of yield decrease with increase in heat stress was -0.0859x while at Kota, Hisar and Deesa it was 0.1039x, -0.5007x and -1.0871x respectively. This indicates that the decrease in yield was high at Deesa, followed by Hisar and Kota and was least at Chhindwara. Further studies to develop a common scale applicable across locations and seasons is being undertaken.

EVALUATION OF GERMPLASM

Evaluation against potato apical leaf curl disease

Two hundred & eighty seven germplasm accessions including 186 CP Nos., 98 advanced hybrids and 2 potato varieties were evaluated against Potato Apical Leaf Curl Virus disease (PALCVD) at Hisar. CP 1458 and HIS 98-55 along with control Kufri Bahar were found highly resistant as in the previous year. Seventeen germplasm accessions, twelve hybrids along with Kufri Chipsona-4 were found moderately resistant to PALCVD.

Evaluation for adaptability in *kharif* season

Ninety-five germplasm accessions were evaluated in replicated trials at Hassan (Karnataka) under *kharif* season for adaptability. Three highest yielding accessions were viz., CP2068, CP2003 and CP2008 and these yielded 23.08 t/ha, 19.42 t/ha and 18.04 t/ha total yield respectively. All these three accessions were resistant to late blight disease.

REGION SPECIFIC BREEDING PROGRAMMES AT SAU BASED CENTERS

In the early generations, many hybrids were evaluated at Hisar. Hybrid TPS (2773) of five crosses were sown, 126 seedlings were transplanted and one hundred genotypes were selected. Besides, 16 advanced hybrids were also evaluated for Late blight resistance at CPRS, Kufri along with three control varieties. Out of these, three hybrids, viz., HIS/12-57, HIS/12-201 and HIS/12-226 were found to be highly resistant, three hybrids,. viz., HIS/12-3, HIS/12-232 and HIS/12-235-1 were resistant, and two hybrids viz., HIS/12-383 and HIS/12-404 were moderately resistant.

F_1: Seeds (2773) of five crosses were sown in November, 2014 and 126 seedlings were planted in January, 2015. One hundred genotypes were selected on the basis of virus disease incidence, tuber shape, size and colour for planting in the next season.

F_1C_2: Out of 14 genotypes/clones (F_1C_1) selected during 2013-14 based on plant vigour, tuber shape, size, colour and disease

incidence, 6 genotypes were planted on 27.10.2014 and remaining were rejected due to rotting, sprouting and poor color during cold storage. Four genotypes out of 6 of 6 crosses were selected based on plant vigour, tuber shape, size, colour and disease incidence.

F_1C_3: Out of fifteen promising genotypes/clones *viz*., HIS/-12-3, HIS/-12-17, HIS/-12-32, HIS/-12-57, HIS/-12-70, HIS/-12-104, HIS/-12-104-1, HIS/-12-163, HIS/-12-201, HIS/-12-226, HIS/-12-235, HIS/-12-235-1, HIS/-12-383, HIS/-12-356 and HIS/-12-404 were tested for late blight resistance at Kufri (Shimla) and eight genotypes reported resistant to late blight disease were planted for further observations and multiplication for next year evaluation.

F_1C_4: Out of six promising genotypes which were found resistant to PALCD and late blight disease, two genotypes/hybrids were planted in initial evaluation trial and rest were planted for further observations and multiplication.

F_1C_5: Out of four promising genotypes/hybrids *viz*., HIS/10-120-14, HIS/10-152-10, HIS/10-253-11 and HIS/10-454-14, two hybrids were put in initial yield trial and two were planted for multiplication for next year evaluation.

Twelve tubers of each of eleven promising genotypes viz., HIS/10-120-14, HIS/10-253-11, HIS/10-452-14, HIS/11-65-12, HIS/13-8, HIS/13-13-4, HIS/11-93-11, HIS/13-76, HIS/13-87, HIS/13-89 and HIS/13-96 were sent for testing for late blight resistance at CPRS, Kufri (Shimla).

SRINAGAR

a) Six crosses were made at Kufri during 2013-14 and 840 genotypes from these six crosses were evaluated at Srinagar and 50 genotypes were selected.

b) In the early generations, F_1C_2: 1 genotype was planted and it was selected; F_1C_3: 1 genotype was planted and it was selected; F_1C_4: 1 genotype was planted and it was selected

RABI SEASON TRIALS

INITIAL YIELD TRIAL ON NEWLY DEVELOPED HYBRIDS (Ist year)

At Hisar, in advance generation trial, one promising hybrid HIS/11-14-9 along with controls Kufri Pukhraj, Kufri Khyati, Kufri Bahar and Kufri Pushkar was evaluated at 60, 75 and 90 days crop durations while three promising hybrids HIS/11-143-9, HIS/10-152-10 and HIS/10-454-14 along with the same controls were evaluated at 90 days crop duration only. For total tuber yield the best control variety was Kufri Bahar at 60 days and Kufri Pushkar at 75 days and 90 days crop durations. None of the hybrids could statistically outyield the best control varieties for tuber yield. Hybrid, HIS/11-143-9 produced significantly higher dry matter content than the best control at 75 and 90 days, while hybrid, HIS/10-152-10 could produce significantly high dry matter content than the best control at 90 days crop only.

ON FARM TRIAL WITH EARLY AND MEDIUM MATURING HYBRIDS

The performance of two hybrids J/100-152 and MS/5-1543 were evaluated at Bhubaneshwar, Chhindwara, Deesa, Dholi, Faizabad, Hisar, Jalandhar, Jorhat, Kalyani, Kanpur, Modipuram, Patna, Pantnagar amd Raipur. The results showed that there was no significant difference between the hybrids and the control varieties at all the dates of harvesting (Table 1.2a). However, perusal of the location wise yield data showed that the hybrid performed well at central and

eastern plains but not in the western plains. Therefore, pooled analysis was carried out of the data of the centres located in the central and eastern Indo Gangetic plains as given in table 1.2b. The results showed that the hybrid MS/5-1543 yields significantly higher over Kufri Pukhraj but not higher than Kufri Khyati as regards total yield. More or less similar trend is observed in the case of marketable yield.

Table 1.2a: Plant emergence (%), total and marketable tuber yield (t/ha) & Dry matter (%) in 60 and 75 days crop

Centres : **BHN, CHN, DES, DHL, FZB, HIS, JAL, JRH, KAL, KAN, MDP, PAT, PNT, RPR**
At 60 Days : All centers except Pantnagar
In 75 & 90 Days : All Above centers
Dry Matter : All Above centers except Dessa, Kalyani and Pantnagar

Hybrid/ variety	Total yield (t/ha)	Marketable yield (t/ha)	Total yield (t/ha)	Marketable yield (t/ha)	Total yield (t/ha)	Mkt yield (t/ha)	Dry matter (%)
	60 days		75 days		90 days		
J/100-152	17.66	14.16	25.43	21.97	30.81	27.37	17.40
MS/5-1543	18.12	14.72	26.41	23.43	32.37	29.19	17.10
K Khyati	18.06	14.41	26.22	23.48	33.70	30.05	17.60
K Pukhraj	17.20	13.82	26.59	23.57	32.76	29.32	17.62
SEd	0.87	0.83	1.20	1.25	1.54	1.50	0.43
CD (0.05)	1.76	1.68	2.42	2.52	3.12	3.04	0.89
CV (%)	12.48	14.80	12.11	14.28	12.58	13.72	5.84

Table 1.2b: Plant emergence (%), total and marketable tuber yield (t/ha) & Dry matter (%) in 60 and 75 days crop

Centres : **BHN, DHL, FZB, HIS, KAL, MDP, PAT**
At 60 days : All centers except Pantnagar
In 75 & 90 Days : All Above centers
Dry Matter : All Above centers except Kalyani

Hybrid/ variety	Total yield (t/ha)	Marketable yield (t/ha)	Total yield (t/ha)	Marketable yield (t/ha)	Total yield (t/ha)	Marketable yield (t/ha)	Dry matter (%)
	60 days		75 days		90 days		
J/100-152	16.45	13.40	25.69	20.57	29.51	25.37	17.54
MS/5-1543	17.83	14.89	27.58	23.59	34.17	30.42	17.14
K Khyati	16.57	13.51	25.60	22.21	32.38	27.58	17.57
K Pukhraj	14.56	11.92	24.26	20.36	29.90	25.86	17.68
SEd	1.11	1.10	1.12	1.30	1.19	1.12	0.60
CD (0.05)	2.33	2.31	2.36	2.72	2.50	2.36	1.28
CV (%)	12.66	15.30	8.15	11.18	7.08	7.69	5.95

TRIAL WITH TABLE POTATO HYBRIDS

Northern Plains: Three advanced hybrids viz., J/2-14, MS/7-645 and MS/6-1947 along with the controls were evaluated at 75 and 90 days durations at 3 AICRP centres in the Northern plains during rabi season. None of the hybrids could out yield the controls Kufri Khyati or Kufri Pukraj at all the dates of harvest i.e. 75 and 90 days after planting.

Table 1.3: Evaluation of Advanced hybrids for table purposes at 75 days after planting

Hybrids/ Locations	HIS	JAL	MDP	Mean
Total yield (t/ha)				
J/2-14	20.85	34.31	32.70	29.29
MS/7-645	26.34	38.29	32.54	32.39
MS/6-1947	26.03	40.65	38.01	34.90
K Bahar	19.58	38.33	31.59	29.84
K Khyati	24.28	51.90	37.20	37.79
K Pukhraj	23.67	50.56	35.36	36.53
K Sadabahar	25.85	37.22	24.72	29.27
Mean	23.80	41.61	33.16	32.86
CD (5%)	Location = 1.67	Varieties= 2.55	Location X Varieties= 4.42	
Marketable yield (t/ha)				
J/2-14	19.76	33.52	26.40	26.56
MS/7-645	23.97	36.76	25.56	28.76
MS/6-1947	23.50	39.35	32.67	31.84
K Bahar	18.48	36.72	28.22	27.80
K Khyati	23.09	50.70	33.89	35.89
K Pukhraj	22.20	48.94	29.30	33.48
K Sadabahar	23.99	35.93	21.73	27.22
Mean	22.14	40.27	28.25	30.22
CD (5%)	Location = 1.72	Varieties= 2.63	Location X Varieties= 4.56	
Dry matter content (%)				
J/2-14	15.42	15.37	11.14	13.97
MS/7-645	12.38	14.23	11.08	12.56
MS/6-1947	13.30	12.23	10.21	11.91
K Bahar	15.30	15.33	14.57	15.07
K Khyati	13.88	14.27	10.32	12.82
K Pukhraj	12.92	14.47	11.67	13.02
K Sadabahar	15.75	14.90	13.11	14.58
Mean	14.14	14.40	11.73	13.42
CD (5%)	Location = 0.25	Varieties= 0.39	Location X Varieties= 0.67	

Table 1.4: Evaluation of Advanced hybrids for table purposes at 90 days after planting

Hybrids/ Locations	HIS	JAL	MDP	Mean
Total yield (t/ha)				
J/2-14	31.72	41.35	47.54	40.20
MS/7-645	37.18	49.77	51.89	46.28
MS/6-1947	40.96	46.99	53.96	47.30
K Bahar	25.58	47.88	40.52	37.99
K Khyati	34.03	61.35	46.97	47.45
K Pukhraj	31.63	60.14	50.57	47.45
K Sadabahar	33.76	50.05	37.32	40.38
Mean	33.55	51.08	46.97	43.86
CD (5%)	Location = 1.26	Varieties= 1.93	Location X Varieties= 3.34	
Marketable yield (t/ha)				
J/2-14	31.72	40.05	40.63	37.47
MS/7-645	37.18	48.43	43.66	43.09
MS/6-1947	40.96	45.79	48.21	44.99
K Bahar	25.58	45.70	35.97	35.75
K Khyati	34.03	59.50	42.12	45.22
K Pukhraj	31.63	59.03	46.12	45.59
K Sadabahar	33.76	48.38	33.56	38.57
Mean	33.55	49.55	41.47	41.52
CD (5%)	Location = 1.28	Varieties= 1.95	Location X Varieties= 3.38	
Dry matter content (%)				
J/2-14	17.58	15.63	13.86	15.69
MS/7-645	16.05	15.47	14.33	15.28
MS/6-1947	13.08	13.07	12.63	12.93
K Bahar	17.41	16.70	15.07	16.39
K Khyati	15.78	14.83	13.70	14.77
K Pukhraj	14.36	16.17	14.71	15.08
K Sadabahar	20.82	16.27	12.70	16.60
Mean	16.44	15.45	13.86	15.25
CD (5%)	Location = 0.32	Varieties= 0.49	Location X Varieties= 0.85	

Eastern plains: Five advanced hybrids viz., MS/7-645, MS/6-1947, PS/06-88, PS/5-75 and PS/6-24 along with the controls were evaluated at 75 (Table 1.5) and 90 days (Table 1.6) durations at 5 AICRP centres in the Eastern plains during rabi season. None of the hybrids could out yield the controls Kufri Khyati or Kufri Pukraj at all the dates of harvest i.e. 75 and 90 days after planting. However, hybrid MS/6-1947 was at par with the controls.

Table 1.5: Evaluation of Advanced hybrids for table purposes at 75 days after planting

Hybrids/ Locations	BHN	FZB	JRH	KAN	PAT	Mean
Total yield (t/ha)						
MS/7-645	21.62	22.00	13.40	29.45	22.91	21.88
PS/06-88	17.05	27.68	10.21	26.21	21.71	20.57
MS/6-1947	25.65	26.01	14.55	25.76	25.68	23.53
PS/5-75	20.00	23.50	10.76	23.06	14.27	18.32
PS/6-24	16.96	22.60	7.67	24.21	15.17	17.32
K Ashoka	21.32	27.34	12.99	29.54	21.15	22.47
K Khyati	22.73	25.34	12.36	31.90	23.53	23.17
K Lalima	23.29	25.51	12.57	27.50	14.97	20.77
K Pukhraj	21.85	25.34	13.89	32.32	22.64	23.21
K Lalit	21.85	27.01	10.52	27.69	16.89	20.79
Mean	21.23	25.23	11.89	27.76	19.89	21.20
CD (5%)	Location = 1.08		Varieties= 1.52		Location X Varieties= 3.41	
Marketable yield (t/ha)						
MS/7-645	20.61	19.47	9.51	22.73	18.82	18.23
PS/06-88	16.39	24.34	6.42	18.75	17.62	16.71
MS/6-1947	24.54	22.90	10.70	18.89	21.86	19.78
PS/5-75	18.72	20.57	6.95	16.81	10.40	14.69
PS/6-24	16.36	20.00	5.80	18.11	9.74	14.00
K Ashoka	20.07	24.10	9.10	26.44	17.87	19.52
K Khyati	21.76	22.33	8.33	23.43	18.22	18.82
K Lalima	22.46	22.53	9.38	22.82	12.26	17.89
K Pukhraj	20.33	22.33	9.72	24.17	18.51	19.01
K Lalit	20.60	23.77	6.60	23.29	14.20	17.69
Mean	20.18	22.23	8.25	21.54	15.95	17.63
CD (5%)	Location = 1.02		Varieties= 1.44		Location X Varieties= 3.23	
Dry matter content (%)						
MS/7-645	15.00	17.26	17.92	15.67	17.86	16.74
PS/06-88	15.45	17.20	13.07	16.58	18.74	16.21
MS/6-1947	16.15	17.15	18.09	16.28	17.82	17.10
PS/5-75	17.04	17.05	14.81	12.86	18.30	16.01
PS/6-24	18.65	17.30	10.83	14.67	18.03	15.90
K Ashoka	16.30	17.20	16.86	15.58	18.18	16.82
K Khyati	16.70	17.25	14.31	15.86	17.61	16.35
K Lalima	16.33	17.55	15.48	14.19	17.83	16.28
K Pukhraj	16.03	17.25	17.81	15.67	17.66	16.88
K Lalit	16.45	16.70	14.72	16.58	18.53	16.60
Mean	16.41	17.19	15.39	15.39	18.06	16.49
CD (5%)	Location = 0.30		Varieties= 0.42		Location X Varieties= 0.94	

Table 1.6: Evaluation of Advanced hybrids for table purposes at 90 days after planting

Hybrids/Locations	BHN	FZB	JRH	KAN	PAT	Mean
Total yield (t/ha)						
MS/7-645	19.91	26.04	12.43	36.48	26.30	24.23
PS/06-88	17.04	32.68	7.71	28.88	24.74	22.21
MS/6-1947	25.51	30.84	12.50	32.62	33.19	26.93
PS/5-75	19.59	27.68	9.38	30.53	17.81	21.00
PS/6-24	21.16	26.71	5.63	31.20	17.58	20.45
K Ashoka	19.63	31.44	11.47	29.54	23.30	23.08
K Khyati	24.35	29.18	8.54	40.42	27.93	26.08
K Lalima	23.43	30.58	10.07	35.88	21.58	24.31
K Pukhraj	20.97	30.51	11.81	40.51	26.16	25.99
K Lalit	21.99	32.51	9.58	34.96	23.53	24.51
Mean	21.36	29.82	9.91	34.10	24.21	23.88
CD (5%)	Location = 1.18		Varieties= 1.67		Location X Varieties= 3.73	
Marketable yield (t/ha)						
MS/7-645	18.24	24.17	19.97	29.45	22.54	22.87
PS/06-88	16.34	30.34	17.50	26.21	20.11	22.10
MS/6-1947	24.73	28.78	22.43	25.76	30.18	26.38
PS/5-75	18.61	25.71	19.24	23.06	12.79	19.88
PS/6-24	20.19	24.80	16.84	24.21	13.32	19.87
K Ashoka	19.49	29.34	19.38	21.67	20.89	22.15
K Khyati	23.24	27.18	19.65	31.90	24.70	25.34
K Lalima	22.32	28.34	20.84	27.50	17.52	23.30
K Pukhraj	19.77	28.34	22.36	32.32	18.62	24.28
K Lalit	21.21	30.34	18.23	27.69	21.96	23.89
Mean	20.41	27.74	19.64	26.98	20.26	23.01
CD (5%)	Location = 1.12		Varieties= 1.59		Location X Varieties= 3.55	
Dry matter content (%)						
MS/7-645	15.98	18.35	11.81	17.60	19.77	16.70
PS/06-88	16.55	18.30	9.58	18.34	19.59	16.47
MS/6-1947	17.20	18.25	14.31	17.93	18.46	17.23
PS/5-75	17.08	18.15	10.97	15.20	19.69	16.22
PS/6-24	18.85	18.40	8.96	16.17	23.94	17.26
K Ashoka	16.30	18.30	11.39	18.28	19.22	16.70
K Khyati	17.25	18.20	11.95	15.92	18.55	16.37
K Lalima	16.40	18.65	12.50	15.23	18.84	16.32
K Pukhraj	16.10	18.35	14.24	16.67	15.96	16.26
K Lalit	16.40	18.30	10.24	17.58	17.99	16.10
Mean	16.81	18.33	11.60	16.89	19.20	16.56
CD (5%)	Location = 0.62		Varieties= 0.88		Location X Varieties= 1.96	

Central plains: Three advanced hybrids viz., MS/7-645, MS/6-1947, and J/2-14 along with the controls were evaluated at 75 (Table 1.7) and 90 days (Table 1.8) durations at 2 AICRP centres in the Central plains during rabi season. Hybrid MS/6-1947 significantly out yielded the controls Kufri Khyati and Kufri Pukraj at both the dates of harvest i.e. 75 days after planting. Similar trend was observed with regard to marketable yield.

Table 1.7: Evaluation of Advanced hybrids for table purposes at 75 and 90 days after planting

Hybrids/Locations	Total yield (t/ha)			Marketable yield (t/ha)			Dry matter (%)		
	At 75 days								
	CHN	DES	Mean	CHN	DES	Mean	CHN	DES	Mean
J/2-14	28.54	38.90	33.72	25.65	35.83	30.74	18.70	15.78	17.24
MS/7-645	29.20	51.11	40.16	26.27	48.39	37.33	18.90	14.96	16.93
MS/6-1947	36.00	51.47	43.74	32.43	48.91	40.67	19.00	14.65	16.82
K Bahar	26.63	39.17	32.90	23.96	36.33	30.15	16.80	15.44	16.12
K Khyati	26.73	54.25	40.49	24.04	51.86	37.95	17.20	14.44	15.82
K Laukar	30.35	34.57	32.46	26.61	30.78	28.70	17.90	15.34	16.62
K Pukhraj	31.60	44.75	38.17	28.44	41.18	34.81	18.40	15.51	16.95
K Garima	26.02	44.46	35.24	24.41	40.99	32.70	18.20	17.16	17.68
Mean	29.39	44.83	37.11	26.48	41.78	34.13	18.14	15.41	16.77
CD Location	1.59			1.43			0.11		
CD Variety	3.18			2.86			0.22		
CD Location x Variety	4.50			4.05			0.31		
	At 90 days								
J/2-14	34.28	43.92	39.10	30.78	40.77	35.78	19.20	16.94	18.07
MS/7-645	35.03	53.19	44.11	31.53	50.29	40.91	19.40	17.88	18.64
MS/6-1947	43.25	55.69	49.47	38.92	54.05	46.49	19.50	15.48	17.49
K Bahar	31.96	42.75	37.36	28.76	41.32	35.04	18.70	16.50	17.60
K Khyati	32.07	59.52	45.80	28.86	58.00	43.44	18.80	16.19	17.50
K Laukar	36.44	39.95	38.20	32.72	36.69	34.71	19.20	16.74	17.97
K Pukhraj	37.94	59.38	48.66	34.14	56.94	45.54	18.70	16.26	17.48
K Garima	32.56	48.15	40.36	29.31	45.88	37.59	18.90	18.18	18.54
Mean	35.44	50.32	42.88	31.88	47.99	39.94	19.05	16.77	17.91
CD Location	1.87			1.94			0.16		
CD Variety	3.75			3.89			0.31		
CD Location x Variety	5.30			5.50			0.44		
CV %	8.68			9.66			1.73		

Eastern plains (with hybrid J/2-14): Six advanced hybrids viz., MS/7-645, MS/6-1947, PS/06-88, PS/5-75 PS/6-24 and J2-14 along with the controls were evaluated at 75 (Table 1.8) and 90 days (Table 1.9) durations at 4 AICRP centres in the Eastern plains during rabi season. None of the hybrids could out yield the controls Kufri Khyati or Kufri Pukraj at all the dates of harvest i.e. 75 and 90 days after planting. However, hybrid MS/6-1947 was at par with the controls.

Table 1.8: Evaluation of Advanced hybrids for table purposes at 75 days after planting

Hybrids/Locations	FZB	JRH	KAN	PAT	Mean
Total yield (t/ha)					
J/2-14	24.50	12.29	27.41	17.49	20.42
MS/7-645	22.00	13.40	29.45	22.91	21.94
PS/06-88	27.68	10.21	26.21	21.71	21.45
MS/6-1947	26.01	14.55	25.76	25.68	23.00
PS/5-75	23.50	10.76	23.06	14.27	17.90
PS/6-24	22.60	7.67	24.21	15.17	17.41
K Ashoka	27.34	12.99	29.54	21.15	22.76
K Khyati	25.34	12.36	31.90	23.53	23.28
K Lalima	25.51	12.57	27.50	14.97	20.14
K Pukhraj	25.34	13.89	32.32	22.64	23.55
K Lalit	27.01	10.52	27.69	16.89	20.53
Mean	25.17	11.93	27.73	19.67	
CD (5%)	Location = 0.87	Varieties= 1.44		Location X Varieties= 2.87	
Marketable yield (t/ha)					
J/2-14	21.67	8.40	20.19	14.07	16.08
MS/7-645	19.47	9.51	22.73	18.82	17.63
PS/06-88	24.34	6.42	18.75	17.62	16.78
MS/6-1947	22.90	10.70	18.89	21.86	18.59
PS/5-75	20.57	6.95	16.81	10.40	13.68
PS/6-24	20.00	5.80	18.11	9.74	13.41
K Ashoka	24.10	9.10	26.44	17.87	19.38
K Khyati	22.33	8.33	23.43	18.22	18.08
K Lalima	22.53	9.38	22.82	12.26	16.75
K Pukhraj	22.33	9.72	24.17	18.51	18.68
K Lalit	23.77	6.60	23.29	14.20	16.96
Mean	22.18	8.27	21.42	15.78	
CD (5%)	Location = 0.83	Varieties= 1.38		Location X Varieties= 2.77	
Dry matter (%)					
J/2-14	16.95	16.56	14.19	18.38	16.52
MS/7-645	17.26	17.92	15.67	17.86	17.18
PS/06-88	17.20	13.07	16.58	18.74	16.40
MS/6-1947	17.15	18.09	16.28	17.82	17.34
PS/5-75	17.05	14.81	12.86	18.30	15.76
PS/6-24	17.30	10.83	14.67	18.03	15.21
K Ashoka	17.20	16.86	15.58	18.18	16.95
K Khyati	17.25	14.31	15.86	17.61	16.26
K Lalima	17.55	15.48	14.19	17.83	16.26
K Pukhraj	17.25	17.81	15.67	17.66	17.10
K Lalit	16.70	14.72	16.58	18.53	16.63
Mean	17.17	15.50	15.29	18.09	
CD (5%)	Location = 0.30	Varieties= 0.50		Location X Varieties= 0.99	

Table 1.9: Evaluation of Advanced hybrids for table purposes at 90 days after planting

Hybrids/Locations	FZB	JRH	KAN	PAT	Mean
Total yield (t/ha)					
J/2-14	28.84	11.11	33.98	22.34	24.07
MS/7-645	26.04	12.43	36.48	26.30	25.32
PS/06-88	32.68	7.71	28.88	24.74	23.50
MS/6-1947	30.84	12.50	32.62	33.19	27.29
PS/5-75	27.68	9.38	30.53	17.81	21.35
PS/6-24	26.71	5.63	31.20	17.58	20.28
K Ashoka	31.44	11.47	29.54	23.30	23.94
K Khyati	29.18	8.54	40.42	27.93	26.52
K Lalima	30.58	10.07	35.88	21.58	24.53
K Pukhraj	30.51	11.81	40.51	26.16	27.25
K Lalit	32.51	9.58	34.96	23.53	25.15
Mean	29.73	10.02	34.09	24.04	
CD (5%)	Location =1.05	Varieties= 1.75		Location X Varieties= 3.49	
Marketable yield (t/ha)					
J/2-14	26.84	20.14	27.41	18.22	23.15
MS/7-645	24.17	19.97	29.45	22.54	24.03
PS/06-88	30.34	17.50	26.21	20.11	23.54
MS/6-1947	28.78	22.43	25.76	30.18	26.79
PS/5-75	25.71	19.24	23.06	12.79	20.20
PS/6-24	24.80	16.84	24.21	13.32	19.80
K Ashoka	29.34	19.38	21.67	20.89	22.82
K Khyati	27.18	19.65	31.90	24.70	25.86
K Lalima	28.34	20.84	27.50	17.52	23.55
K Pukhraj	28.34	22.36	32.32	18.62	25.41
K Lalit	30.34	18.23	27.69	21.96	24.56
Mean	27.65	19.69	27.02	20.08	
CD (5%)	Location =0.99	Varieties= 1.64		Location X Varieties= 3.28	
Dry matter content (%)					
J/2-14	18.00	11.95	16.25	22.62	17.20
MS/7-645	18.35	11.81	17.60	19.77	16.88
PS/06-88	18.30	9.58	18.34	19.59	16.45
MS/6-1947	18.25	14.31	17.93	18.46	17.24
PS/5-75	18.15	10.97	15.20	19.69	16.00
PS/6-24	18.40	8.96	16.17	23.94	16.87
K Ashoka	18.30	11.39	18.28	19.22	16.80
K Khyati	18.20	11.95	15.92	18.55	16.15
K Lalima	18.65	12.50	15.23	18.84	16.30
K Pukhraj	18.35	14.24	16.67	15.96	16.30
K Lalit	18.30	10.24	17.58	17.99	16.03
Mean	18.30	11.63	16.83	19.51	
CD (5%)	Location =0.69	Varieties= NS		Location X Varieties= 2.28	

TRIAL WITH PROCESSING HYBRIDS

Two processing hybrids viz. MP/01-916 and MP/4-816 were evaluated against Atlantic, Kufri Chipsona 1 and Kufri Chipsona 3 the common controls at many locations across the country. The results showed that the effect of locations, genotypes and location x genotype interaction were significant. Considering the total yield in the northern plains, MP/04-816 significantly out yielded the check variety Atlantic at all the locations except Jalandhar (Table 1.10). At Modipuram the total yield was significantly higher than both Atlantic and K.Chipsona-1. The processing grade yield of MP/04-816 was significantly higher at Modipuram and Hisar over Atlantic. None of the hybrids exhibited significant yield over checks at Jalandhar. None of the hybrid registered significantly higher dry matter content at any of the locations against any checks.

In the eastern plains at 75 days after planting (Table 1.11) significantly greater totals yield of both hybrids was observed at Jorhat as compared to all the checks. The hybrid MP/04-816 out yielded significantly the check Atlantic and K Chipsona-3 as regards overall mean of the locations of Eastern plains. The hybrid MP/01-916 also out yielded these two checks at Jorhat and Bhubaneswar. As regards marketable yield, the hybrid MP/04-816 out yielded Atlantic at all the locations. The dry matter content in MP/01-916 the check Atlantic was similar. At 90 days after planting, (Table 1.12) in the case of total yield, MP/04-816 out yielded all the check varieties in the northern plains at 90 days after planting. The hybrid out yielded significantly the checks at Jorhat and Dholi however they could out yield significantly Chipsona-1 at Faizabad and Bhubaneswar. With regard to the marketable yield, MP/04-816 significantly out yielded Atlantic at all the locations of Eastern plains. The overall mean dry matter content was found at par in MP/04-816 as compared to the checks.

In the central plains (Table 1.13) at 60 days after planting it was observed that significantly higher total yield of MP/04-816 hybrids at Chhindwara as compared to the checks Atlantic and K.Chipsona-1. However both the hybrid out yielded K.Chipsona-1 and K. Chipsona-3 at Raipur. The marketable yield trend indicated that both hybrids out yield significantly the checks Atlantic and K.Chipsona-1 at Chindwara and against K Chipsona-1 and 3 at Raipur. Comparatively the performance of hybrid MP/01-916 was found better for total as well as marketable yield in Central plains. At 75 days after planting it was observed that the total yield of MP/01-916 (mean over the locations) was non significant over Atlantic and K Chipsona-1. At 90 days after plating, both hybrid yielded significantly higher as compared to the check Atlantic at Chhindwara and Deesa. At Kota, both hybrids out yielded significantly K Chipsona-3. The overall mean marketable yield at 90 days after planting was both in MP/04-816. The overall mean dry matter content in both hybrids were comparable to the checks.

Northern Plains

Table 1.10: Evaluation of Advanced hybrids for processing purposes at 90 days after planting

Varieties/ Locations	MP/01-916	MP/4-816	Atlantic	K Chip-1	K Chip-3	Mean
	Total yield (t/ha)					
Hisar	32.90	45.09	23.70	43.31	33.29	35.66
Jalandhar	28.78	30.94	37.50	35.44	32.25	32.98
Modipuram	28.21	34.95	29.23	29.07	33.30	30.95

Mean	29.96	36.99	30.14	35.94	32.95	33.20
CD (5%)	Location= 1.46		Varieties= 1.88		Location x Varieties= 3.26	
	Processing grade yield (t/ha)					
Hisar	29.22	32.56	21.44	32.23	26.63	28.42
Jalandhar	24.03	26.58	33.72	31.58	25.36	28.25
Modipuram	23.41	28.18	24.13	20.84	25.81	24.47
Mean	25.55	29.11	26.43	28.22	25.94	27.05
CD (5%)	Location= 1.34		Varieties= 1.73		Location x Varieties= 3.00	
	Dry matter (%)					
Hisar	18.58	18.61	20.02	17.62	17.80	18.52
Jalandhar	20.03	19.90	20.00	19.33	19.08	19.66
Modipuram	19.30	19.25	20.01	18.47	18.44	19.10
CD (5%)	Location= 0.47		Varieties= 0.74		Location x Varieties= 1.05	

Eastern Plains

Table 1.11: Evaluation of Advanced hybrids for processing purposes at 75 days after planting

Varieties/ Locations	MP/01-916	MP/4-816	Atlantic	K chip-1	K chip-3	Mean
Total yield (t/ha)						
Bhubaneswar	17.50	21.32	14.17	23.89	14.24	18.22
Faizabad	23.35	24.55	22.17	25.51	22.70	23.66
Jorhat	13.94	14.94	8.87	12.13	10.74	12.12
Mean	18.26	20.27	15.07	20.51	15.89	18.00
CD (5%)	Location= 0.64		Varieties= 0.83		Location x Varieties= 1.44	
Marketable yield (t/ha)						
Bhubaneswar	9.37	10.98	8.19	13.40	6.32	9.65
Faizabad	17.52	18.42	16.64	19.14	17.03	17.75
Jorhat	10.55	11.42	5.72	8.94	7.50	8.83
Mean	12.48	13.60	10.18	13.83	10.28	12.08
CD (5%)	Location= 0.64		Varieties= 0.82		Location x Varieties= 1.43	
Dry Matter Content (%)						
Bhubaneswar	20.43	19.65	20.08	20.80	20.97	20.39
Faizabad	18.04	18.17	17.73	18.08	17.98	18.00
Jorhat	20.00	18.00	17.80	17.70	19.25	18.55
Mean	19.49	18.61	18.54	18.86	19.40	18.98
CD (5%)	Location= 0.18		Varieties= 0.23		Location x Varieties= 0.39	

Table 1.12: Evaluation of Advanced hybrids for processing purposes at 90 days after planting

Varieties/ Locations	MP/01-916	MP/4-816	Atlantic	K Chipsona-1	K Chipsona-3	Mean
Total yield (t/ha)						
Bhubaneswar	20.98	23.82	18.06	26.25	23.26	22.47
Faizabad	25.36	27.43	23.77	28.66	24.73	25.99
Jorhat	13.98	14.60	11.57	12.51	12.29	12.99
Dholi	18.75	23.89	15.55	11.11	11.53	16.16
Mean	19.77	22.44	17.24	19.63	17.95	19.41
CD (5%)	Location= 0.92		Varieties= 1.03		Location x Varieties= 2.06	
Marketable yield (t/ha)						
Bhubaneswar	16.11	17.57	14.31	20.76	18.96	17.54
Faizabad	21.80	23.59	20.45	24.93	21.15	22.38
Jorhat	9.83	10.22	7.72	8.44	8.22	8.89
Dholi	16.39	21.53	14.31	10.41	10.00	14.53
Mean	16.03	18.23	14.20	16.14	14.58	15.84
CD (5%)	Location= 0.98		Varieties= 1.10		Location x Varieties= 2.20	
Dry Matter Content (%)						
Bhubaneswar	20.72	19.70	20.12	20.85	21.47	20.57
Faizabad	20.85	20.58	20.15	20.48	20.33	20.48
Jorhat	20.00	18.55	18.15	16.90	17.70	18.26
Dholi	24.25	20.50	20.88	21.50	20.75	21.58
Mean	21.45	19.83	19.82	19.93	20.06	20.22
CD (5%)	Location= 0.27		Varieties= 0.30		Location x Varieties= 0.61	

Central plains

Table 1.13: Evaluation of Advanced hybrids for processing purposes at 60, 75 & 90 days after planting

Varieties/ Location	MP/01-916	MP/4-816	Atlantic	K Chipsona-1	K Chipsona-3	Mean
Total yield (t/ha) at 60 days						
Chhindwara	21.84	21.11	17.55	17.56	20.91	19.80
Raipur	25.86	19.98	18.75	13.98	16.58	19.03
Mean	23.85	20.55	18.15	15.77	18.75	19.41
CD (5%)	Location= 1.21		Varieties= 1.91		Location x Varieties= 2.70	
Marketable yield (t/ha) at 60 days						
Chhindwara	12.01	11.61	9.65	9.66	11.47	10.88
Raipur	15.02	10.72	13.46	6.86	4.59	10.13
Mean	13.52	11.16	11.56	8.26	8.03	10.51
CD (5%)	Location= 0.81		Varieties= 1.28		Location x Varieties= 1.82	
Total yield (t/ha) at 75 days						
Chhindwara	29.53	27.09	24.15	34.53	30.41	29.15

Raipur	26.58	23.69	25.80	19.85	20.76	23.33
Mean	28.06	25.39	24.98	27.19	25.59	26.24
CD (5%)	Location= 1.36		Varieties= 2.15		Location x Varieties= 3.04	
Marketable yield (t/ha) at 75 days						
Chhindwara	19.19	17.55	15.54	23.94	19.76	19.20
Raipur	15.76	12.31	14.60	9.00	9.56	12.25
Mean	17.48	14.93	15.07	16.47	14.66	15.72
CD (5%)	Location= 0.91		Varieties= 1.44		Location x Varieties= 2.04	
Total yield (t/ha) at 90 days						
Chhindwara	40.00	37.54	29.05	41.81	36.50	36.98
Raipur	27.76	31.77	31.11	26.60	32.47	29.94
Deesa	50.61	39.69	23.18	46.87	38.03	39.68
Kota	23.72	23.67	21.44	23.61	19.83	22.45
Mean	35.52	33.17	26.20	34.72	31.71	32.26
CD (5%)	Location= 1.25		Varieties= 1.40		Location x Varieties= 2.80	
Marketable yield (t/ha) at 90 days						
Chhindwara	29.99	26.27	20.07	28.17	24.85	25.87
Raipur	16.77	21.08	21.81	12.09	17.88	17.93
Deesa	43.05	30.03	20.65	40.21	31.43	33.07
Kota	22.61	22.22	20.03	20.69	18.53	20.82
Mean	28.11	24.90	20.64	25.29	23.17	24.42
CD (5%)	Location= 1.06		Varieties= 1.19		Location x Varieties= 2.37	
Dry matter content (%)						
Chhindwara	18.90	19.10	19.00	18.80	19.00	18.96
Raipur	20.68	20.19	20.57	20.99	20.85	20.66
Deesa	21.46	20.96	19.04	21.55	20.97	20.80
Kota	25.63	22.00	20.70	21.15	22.15	22.33
Mean	21.67	20.56	19.83	20.62	20.74	20.68
CD (5%)	Location= 0.22		Varieties= 0.24		Location x Varieties= 0.48	

TRIAL WITH FRENCH FRIES

One promising hybrid, MP/4-578 was evaluated against two controls viz., Kufri Chipsona-1 and Kufri Frysona at 90 days at 11 centres viz Bhubaneshwar, Chhindwara, Deesa, Dholi, Faizabad, Hisar, Jalandhar, Modipuram, Pantnagar Patna, and Raipur during Rabi season. The results showed that the effect of locations, genotypes and their interaction were significant. Perusal of the table (Table 1.1) shows that with respect to total yield at 90 days after planting, Kufri Chipsona 1 gave significantly higher yield than hybrid MP/4-578 at Bhubaneshwar, Deesa, Patna and Raipur and at par yields at Chhindwara, Faizabad, Jalandhar Modipuram and Pantnagar. Kufri Frysona was inferior to both these genotypes at all the locations. The hybrid out yielded significantly over K Chipsona-1 and K Chipsona-3 at Hisar.

In the case of processing grade yield, Kufri Chipsona 1 gave significantly higher yield

at Bhubaneshwar, Patna and Raipur while at Chhindwara, Deesa, Faizabad, Jalandhar, Modipuram and Pantnagar the yields of MP/4-578 and Kufri Chipsona 1 were at par. The hybrid MP/4-578 yielded significantly higher as compared to K chipsoan-1 at Hisar and Dholi.

At 105 days after planting it was evaluated at Deesa and Modipuram and results showed that Kufri Chipsona 1 was significantly better yielder at Deesa while MP/4-578 was better at Modipuram as regards total yield. As regards marketable yield, Kufri Chipsona 1 and MP/4-578 were statistically at par at Deesa while at Modipuram MP/4-578 significantly out yielded Kufri Chipsona 1. However, the overall processing grade mean yield of the hybrid was found significantly higher over K.Chipsona-1

Table 1.14: Evaluation of Advanced hybrids for processing purposes (French Fries) at 90 days after planting

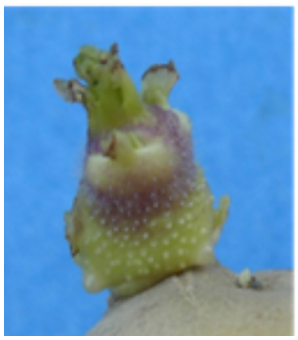
Locations /Varieties	MS/4-578	K Chipsona-1	K Frysona	Mean
Total yield (t/ha)				
Bhubaneswar	22.43	26.25	20.28	22.99
Chhindwara	43.71	42.20	42.50	42.80
Deesa	39.65	46.86	36.75	41.09
Dholi	18.61	13.33	12.92	14.95
Faizabad	27.68	29.51	26.89	28.03
Hisar	30.12	25.10	26.00	27.07
Jalandhar	35.83	38.97	34.72	36.51
Modipuram	34.43	33.68	33.58	33.90
Pantnagar	30.25	31.04	29.97	30.42
Patna	12.26	19.68	17.30	16.41
Raipur	23.31	26.95	19.92	23.40
Mean	28.93	30.33	27.35	28.87
CD (5%)	Location= 1.98	Varieties= 1.03	Location x Varieties= 3.43	
Processing grade yield (t/ha)				
Bhubaneswar	17.15	20.76	14.24	17.38
Chhindwara	30.59	28.69	29.58	29.62
Deesa	32.89	32.82	25.59	30.43
Dholi	17.36	11.81	11.66	13.61
Faizabad	23.53	24.49	22.85	23.62
Hisar	23.98	16.30	21.47	20.58
Jalandhar	22.00	23.89	21.17	22.35
Modipuram	27.47	24.90	24.51	25.63
Pantnagar	26.01	27.23	25.87	26.37
Patna	9.81	15.71	12.02	12.51
Raipur	15.77	19.91	12.06	15.91
Mean	22.41	22.41	20.09	21.64
CD (5%)	Location= 1.94	Varieties= 1.01	Location x Varieties= 3.37	

Table 1.15: Evaluation of Advanced hybrids for processing purposes (French Fries) at 105 days after planting

Varieties/location	MS/4-578	K Chipsona-1	K Frysona	Mean
Total yield (t/ha)				
Deesa	43.64	52.12	45.88	47.21
Modipuram	42.53	36.42	40.90	39.95
Mean	43.09	44.27	43.39	43.58
CD (5%)	Location= 1.36	Varieties= 1.01	Location x Varieties= 2.35	
Processing grade yield (t/ha)				
Deesa	38.95	39.09	36.66	38.23
Modipuram	37.24	30.06	35.04	34.12
Mean	38.10	34.58	35.85	36.17
CD (5%)	Location= 1.38	Varieties= 1.69	Location x Varieties= 2.39	

ON-FARM TRIAL FOR HEAT TOLERANCE

One heat tolerant hybrid, CP-4054 was evaluated with control varieties viz., Kufri Surya, Kufri Khyati, Kufri Pukhraj, Kufri Badshah. Kufri Lauvkar, Kufri Bahar and kufri Jyoti at 75 and 90 days crop duration at 6 centres, viz. Chhindwara, Deesa, Hisar, Kalyani, Modipuram and Pune during rabi season in the plains. The trials were conducted for 60 days crop duration at Chhindwara and Modipuram, while at Kalyani and Pune the trials was conducted for 90 days crop duration. The results showed that the overall mean of the hyrbrid showed significantly better over the check K Surya for total yield (Table 1.17). However the hybrid CP-4054 exhibited significantly higher yield over K Lauvkar and K Chipsona-3 for both traits at Deesa (Table 1.18). The hybrid CP-4054 registered significantly greater over all mean total yield and marketable yield as compared the overall genotypic mean across years. At Karnal (Table 1.19), CP-4054 registered significantly higher total and marketable yield against K Surya. At Kalyani (Table 1.20) hybrid CP-4054 recorded significantly higher total and marketable yield over K Surya.



At Pune (Table 1.21), the hybrid CP-4054 did not significantly outyield Kufri Surya. However, all the hybrids out yielded K. Chipsona-3 for both the traits total and marketable yield.

Table 1.17: Evaluation of advanced hybrids for Heat tolerance on farm trials (pooled over two years)

Year/ Hybrids	Total yield (t/ha)			Marketable yield (t/ha)			Dry Matter (%)		
	CP-4054	K Surya	Mean	CP-4054	K Surya	Mean	CP-4054	K Surya	Mean
2013-14	42.17	30.44	36.31	42.90	31.95	37.42	18.03	17.37	17.70
2014-15	42.98	30.89	36.93	45.30	33.51	39.40	18.32	18.44	18.38
Mean	42.58	30.66	36.62	44.10	32.73	38.41	18.18	17.91	18.04
CD (5%)	Year=10.85 Varieties=10.85 Year x Varieities=15.35			Year=10.06 Varieties=10.06 Year x Varieities=14.23			Year=1.88 Varieties=1.88 Year x Varieities=2.66		

Table 1.18: Evaluation of advanced hybrids for Heat tolerance replicated trials at Deesa (pooled over two years)

Year/Hybrids	Total yield (t/ha)			Marketable yield (t/ha)		
	2011-12	2012-13	Mean	2011-12	2012-13	Mean
CP-4054	41.35	42.02	41.68	40.79	41.55	41.17
CP-4184	38.70	39.83	39.27	37.37	37.43	37.40
CP-4197	31.65	33.56	32.60	30.95	32.69	31.82
CP-4206	34.81	30.03	32.42	33.25	29.20	31.23
K. Badshah	43.26	31.42	37.34	41.68	29.84	35.76
K. Chipsona-3	27.50	32.07	29.78	26.37	29.92	28.15
K. Lauvkar	19.89	22.09	20.99	18.90	21.29	20.09
K. Pushkar	49.24	35.61	42.42	47.43	33.87	40.65
CP-4054	42.79	33.71	38.25	41.79	33.13	37.46
CP-4184	36.58	33.37	34.97	35.39	32.10	33.75
CP-4197	Year=1.42 Varieties=3.01 Year x Varieities=4.26			Year=1.40 Varieties=2.97 Year x Varieities=4.20		

Table 1.19: Evaluation of Advanced hybrids for Heat tolerance replicated trials at Karnal (pooled over two years)

Varieties/Year	Total yield (t/ha)			Marketable yield (t/ha)		
	2011-12	2012-13	Mean	2011-12	2012-13	Mean
CP-4054	33.74	48.56	41.15	33.21	47.88	40.54
CP-4184	28.93	35.62	32.27	28.05	34.22	31.14
CP-4197	30.38	32.79	31.59	29.72	31.98	30.85
CP-4206	25.41	43.69	34.55	24.28	43.12	33.70
K. Badshah	23.81	30.49	27.15	22.53	29.68	26.10
K. Bahar	17.10	22.77	19.93	16.46	21.97	19.22
K. Surya	28.08	36.25	32.17	27.46	35.01	31.24
Mean	26.78	35.74	31.26	25.96	34.84	30.40
CD (5%)	Year=1.70 Varieties=3.17 Year x Varieities=4.49			Year=1.65 Varieties=3.09 Year x Varieities=4.37		

Table 1.20: Evaluation of Advanced hybrids for Heat tolerance replicated trials at Kalyani (pooled over two years)

Varieties/Year	Total yield (t/ha)			Marketable yield (t/ha)		
	2011-12	2012-13	Mean	2011-12	2012-13	Mean
CP-4054	61.73	51.07	56.40	51.80	48.48	50.14
CP-4184	61.30	47.00	54.15	49.35	38.96	44.16
CP-4197	62.58	54.43	58.50	55.78	47.36	51.57
CP-4206	62.95	46.81	54.88	52.88	37.36	45.12
K. Badshah	61.05	42.29	51.67	53.25	33.71	43.48
K. Jyoti	51.65	41.30	46.48	44.10	35.78	39.94
K. Pushkar	66.88	51.23	59.06	52.88	38.67	45.77
K. Surya	57.87	42.45	50.17	50.58	38.48	44.53
Mean	60.75	47.08	53.91	51.32	39.85	45.59
CD (5%)	Year=2.32 Varieties=4.67 Year x Varieties=6.56			Year=2.04 Varieties=4.07 Year x Varieties=5.96		

Table 1.21: Evaluation of Advanced hybrids for Heat tolerance replicated trials at Pune (pooled over two years)

Varieties/Year	Total yield (t/ha)			Marketable yield (t/ha)		
	2011-12	2012-13	Mean	2011-12	2012-13	Mean
CP-4054	10.87	34.38	22.63	9.63	32.81	21.22
CP-4184	11.05	30.72	20.89	9.94	28.44	19.19
CP-4197	22.79	41.45	32.12	21.57	40.43	31.00
CP-4206	21.27	31.83	26.55	18.96	31.09	25.02
K. Chipsona-3	7.16	19.16	13.16	6.03	17.24	11.63
K. Jyoti	18.50	37.32	27.91	17.40	35.69	26.55
K. Lauvkar	14.40	16.18	15.29	14.33	15.68	15.00
K. Surya	17.98	34.06	26.02	17.07	33.22	25.14
Mean	15.50	30.64	23.07	14.37	29.32	21.85
CD (5%)	Year=1.12 Varieties=2.23 Year x Varieties=3.16			Year=1.12 Varieties=2.23 Year x Varieties=3.16		

EVALUATION OF TPS POPULATION (2nd year)

One TPS population, PT/08-109 with control 92-PT-27 was evaluated at Patna for 75 and 90 days crop durations. Seedling survival (%) was at par to the control at 75 days duration (80%) and higher at 90 days crop duration. The gradewise and total tuber yields of TPS population PT/08-109 was higher than the control at both durations. Tuber uniformity, plant vigor and dry matter content of the TPS population were at par with the control. No disease appeared in both population and control variety.

VARIETAL EVALUATION TRIAL TO IDENTIFY TOP THREE PROMISING VARIETIES OF THE REGION (2ND YEARS TRIALS)

NORTHERN PLAINS

Varietal evaluation trial was conducted with K Jyoti, K Bahar, K Gauvrav, K Pushkar, K Khyati and K Pukhraj for ifdentifying three promising varieties for different regions. The results show that there was a wide variation in the performance of varieties over locations. For Northern plains (Table 1.22), the varieties K Khyati, K Pukhraj and K Bahar were promising as they produced higher total yield per ha at 60 days. K Khyati and K Pukhraj were non significant between themselves while K Bahar yielded quite low.

At 75 days, K Pushkar, K Khyati and K Pukhraj recorded to be the promising varieties of this region. K. Pushkar (Hisar, Jalandar), K Khyati (Hisar, Jalandhar) and K Pukhraj (Jalandhar) recorded significantly greater yield in specific locations against their overall regional mean values. The similar trend was observed for marketable yield too.

At 90 days, K Khyati, K Pukhraj and K Pushkar were found to be the promising varieties of this region. K. Pushkar, K Khyati and K Pukhraj recorded significantly greater yield at Jalandhar and Hisar locations against their overall regional mean values. The similar trend was observed for marketable yield too. K Khyati, K Pukhraj and K Pushkar recorded significantly higher marketable yield at Jalandhar and Hisar. K Jyoti, K Bahar and K. Pukhraj registrered comparatively higher values for dry matter.

Table 1.22: Evaluation of varieties to identify top three promising varieties (northern plains)

Varities/ Location	K Jyoti	K Bahar	K Gaurav	K Pushkar	K Khyati	K Pukhraj	Mean
	Total yield (t/ha) at 60 days						
Hisar	14.99	21.30	22.19	22.96	23.69	17.07	20.37
Jalandhar	17.08	21.53	20.05	23.47	24.12	23.24	21.58
Modipuram	16.19	20.30	13.24	16.18	17.16	22.09	17.53
Pantnagar	20.97	20.37	18.89	19.17	26.62	26.67	22.12
Mean	17.31	20.88	18.59	20.44	22.90	22.27	20.40
CD (5%)	Year=1.12		Varieties=1.38			Year x Varieties=2.75	
Marketable yield (t/ha) at 60 days							
Hisar	13.15	16.40	19.36	20.30	21.33	15.00	17.59
Jalandhar	16.39	20.70	19.12	22.83	23.61	22.18	20.80
Modipuram	11.17	15.06	8.00	10.08	14.95	16.36	12.60
Pantnagar	17.55	17.41	16.30	16.16	24.03	23.94	19.23
Mean	14.56	17.39	15.69	17.34	20.98	19.37	17.56
CD (5%)	Year=1.124		Varieties=1.39			Year x Varieties=2.78	

Dry matter content (%) at 60 days							
Hisar	13.17	12.05	13.10	12.39	12.17	12.82	12.62
Jalandhar	14.95	14.70	14.10	12.90	14.25	13.55	14.08
Modipuram	11.92	12.37	11.58	10.42	10.94	11.06	11.38
Mean	13.35	13.04	12.93	11.90	12.45	12.48	12.69
CD (5%)	Year=0.41		Varieties=0.59		Year x Varieties=1.02		
Total yield (t/ha) at 75 days							
Hisar	30.09	29.62	38.11	39.31	38.62	29.34	34.18
Jalandhar	32.41	30.88	35.14	40.37	39.22	37.23	35.88
Modipuram	26.96	25.29	23.69	28.82	26.06	28.47	26.55
Pantnagar	28.20	27.41	25.00	29.54	31.39	32.82	29.06
Mean	29.41	28.30	30.49	34.51	33.82	31.97	31.42
CD (5%)	Year=1.72		Varieties=2.11		Year x Varieties=4.22		
Marketable yield (t/ha) at 75 days							
Hisar	27.73	27.08	34.62	35.06	33.82	26.90	30.87
Jalandhar	31.02	29.40	33.66	37.92	38.29	35.42	34.29
Modipuram	22.67	21.68	18.16	23.38	23.01	23.62	22.09
Pantnagar	24.45	24.45	21.85	25.37	29.08	30.05	25.87
Mean	26.47	25.65	27.07	30.43	31.05	29.00	28.28
CD (5%)	Year=1.60		Varieties=1.97		Year x Varieties=3.93		
Dry matter content (%) at 75 days							
Hisar	15.60	13.94	13.16	11.80	14.78	14.41	13.95
Jalandhar	16.05	15.90	14.40	14.60	15.15	14.10	15.03
Modipuram	12.42	13.21	11.91	10.86	10.99	13.06	12.07
Mean	14.69	14.35	13.16	12.42	13.64	13.86	13.69
CD (5%)	Year=0.49		Varieties=0.69		Year x Varieties=1.20		
Total yield (t/ha) at 90 days							
Hisar	35.80	41.76	48.24	48.59	54.25	44.68	45.55
Jalandhar	44.22	40.98	50.10	51.72	51.76	50.56	48.22
Modipuram	33.27	35.40	32.81	38.40	36.48	40.98	36.22
Pantnagar	31.60	31.81	29.21	32.59	36.35	35.61	32.86
Mean	36.22	37.49	40.09	42.83	44.71	42.96	40.71
CD (5%)	Year=1.95		Varieties=2.38		Year x Varieties=4.77		
Marketable yield (t/ha) at 90 days							
Hisar	32.71	39.76	43.35	44.52	49.86	42.83	42.17
Jalandhar	40.70	38.57	48.20	49.49	49.91	49.49	46.06
Modipuram	30.53	31.26	28.64	33.91	33.60	36.15	32.35
Pantnagar	28.52	28.99	26.62	29.03	33.43	32.36	29.83
Mean	33.12	34.65	36.70	39.24	41.70	40.21	37.60
CD (5%)	Year=1.75		Varieties=2.16		Year x Varieties=4.32		

Dry matter content (%) at 90 days							
Hisar	14.17	14.80	16.03	14.40	13.98	14.89	14.71
Jalandhar	16.95	16.40	15.00	15.30	16.65	14.65	15.82
Modipuram	15.93	14.97	13.00	14.30	13.63	15.47	14.55
Mean	15.69	15.39	14.68	14.67	14.75	15.00	15.03
CD (5%)	Year=0.33		Varieties=0.47		Year x Varieties=0.82		

EASTERN PLAINS

Varietal evaluation trial was conducted having K Jyoti, K Himalini, K Gauvrav, K Lalima, K Khyati, K Pukhraj and K Ashoka for identifying three promising varieties for different regions. The results show that there was a wide variation in the performance of varieties over locations. For eastern plains (Table 1.23), the varieties K Khyati, K Pukhraj and K Himalini have been identified as promising as they produced higher total yield per ha at 60 days. K Khyati, K Pukhraj and K Himalini had significantly greater yield at Pasighat as compared to other locations.

For marketable yield, K Khyati, K Gauvrav and K Pukhraj were found to be promising varieties. All the varieties had significantly greater yield at Pasighat over their respective regional yields.

At 75 days, K Khyati, K Himalini and K Pukhraj were found to be the promising varieties of this region. All the varieties had significantly greater yield at Pasighat over their respective regional yields. Similar trend was observed for marketable yield at 75 days too.

At 90 days, K Khyati, K Pukhraj and K Pushkar were found to be the promising varieties of this region. K Khyati had significantly greater yield at Pasighat, Kalyani and Faizabad over their regional mean value. Similarly, K Pukhraj had significant greater total yield at Kanpur, Pasighat and Faizabad. K Pushkar recorded significantly greater yield at Pasighat against their overall regional mean values. Similar trend was observed for marketable yield too. K Khyati, Pukhraj and K Pushkar recorded significantly higher marketable yield at Jalandhar and Hisar. None of the varieties recorded significant higher dry matter content over the regional mean values. K Jyoti, K Bahar and K. Pukhraj registered comparatively higher values for dry matter.

Table 1.23: Evaluation of varieties to identify top three promising varieties (eastern plains)

Varieties/ Location	Kufri Jyoti	Kufri Himalini	Kufri Gaurav	Kufri Pushkar	Kufri Lalima	Kufri Khyati	Kufri Pukhraj	Kufri Ashoka	Mean
Total yield (t/ha) at 60 days									
BHN	16.67	18.44	17.59	17.98	16.59	20.91	18.52	19.29	18.25
JRH	22.67	21.55	23.21	22.16	21.59	24.53	22.80	22.66	22.65
KAN	24.59	22.44	19.37	20.18	19.00	20.89	20.63	17.33	20.55
PAS,	37.77	37.40	37.77	36.66	36.66	38.88	38.15	34.07	37.17
PAT	17.84	17.03	14.53	19.08	15.55	16.91	19.67	18.39	17.37
Mean	23.91	23.37	22.49	23.21	21.88	24.43	23.95	22.35	23.20
CD (5%)	Location= 1.14			Varieties= 1.45			Location x varieties=3.25		

Marketable yield (t/ha) at 60 days									
BHN	16.13	17.83	16.98	17.13	15.98	19.83	17.44	18.52	17.48
JRH	14.44	13.33	14.83	13.89	13.33	16.17	14.44	14.44	14.36
KAN	18.85	16.48	13.65	14.48	13.54	15.50	15.42	11.85	14.97
PAS,	36.85	36.66	37.04	35.92	35.92	37.77	37.03	33.33	36.32
PAT	13.79	12.98	10.94	14.54	12.52	13.41	15.74	14.43	13.54
Mean	20.01	19.46	18.69	19.19	18.26	20.54	20.01	18.51	19.33
CD (5%)	Location= 1.12			Varieties= 1.42			Location x varieties=3.18		
Dry matter content (%) at 60 days									
BHN	16.65	15.97	16.47	16.25	16.90	16.55	15.45	15.75	16.25
JRH	18.40	18.45	18.90	18.10	18.70	18.15	18.20	17.25	18.27
PAS	20.17	19.57	20.49	21.36	21.57	19.53	18.77	20.17	20.20
PAT	19.29	19.81	17.03	17.95	17.70	19.82	18.33	18.79	18.59
Mean	18.63	18.45	18.22	18.42	18.72	18.51	17.69	17.99	18.33
CD (5%)	Location= 0.67			Varieties= 0.96			Location x varieties=1.92		
Total yield (t/ha) at 75 days									
BHN	20.91	23.15	21.91	26.24	20.22	25.62	21.76	23.54	22.92
FZB	26.51	25.01	24.70	24.91	25.31	30.61	29.21	27.11	26.67
JRH	22.27	23.06	23.71	23.95	24.55	26.15	23.68	22.76	23.77
KAL	22.46	27.59	21.11	17.78	24.26	25.60	19.54	23.19	22.69
KAN	27.18	26.92	23.44	23.40	22.59	24.74	23.59	20.22	24.01
PAS	39.25	39.63	39.62	38.52	38.14	40.37	39.26	40.75	39.44
PAT	22.39	24.42	18.28	25.14	18.34	23.70	26.18	22.91	22.67
Mean	25.85	27.11	24.68	25.70	24.77	28.11	26.17	25.78	26.02
CD (5%)	Location= 1.27			Varieties= 1.36			Location x varieties=3.61		
Marketable yield (t/ha) at 75 days									
BHN	19.52	22.07	21.30	25.16	19.22	24.23	20.53	22.61	21.83
FZB	23.37	22.03	21.77	21.87	22.33	26.91	25.71	23.83	23.48
JRH	13.42	14.05	14.67	14.72	15.39	16.44	14.67	13.72	14.63
KAL	21.44	26.95	20.61	13.79	23.24	24.72	17.69	22.32	21.34
KAN	24.59	22.44	19.37	20.18	19.00	20.89	20.63	17.33	20.55
PAS	35.92	37.03	36.66	37.03	37.03	38.51	37.03	37.50	37.09
PAT	17.77	19.75	13.49	20.16	13.94	18.59	21.55	18.36	17.95
Mean	22.29	23.48	21.12	21.84	21.45	24.33	22.54	22.24	22.41
CD (5%)	Location= 1.21			Varieties= 1.29			Location x varieties=3.42		
Dry matter content (%) at 75 days									
BHN	17.15	16.85	17.73	16.90	17.63	17.08	15.75	16.10	16.90
FZB	17.80	17.53	17.43	17.83	17.37	17.57	17.77	17.73	17.63
JRH	20.25	18.70	17.30	19.70	19.30	17.70	18.95	20.00	18.99
KAN	16.69	17.63	17.70	16.90	17.53	16.28	16.36	18.52	17.20
PAS	20.00	19.57	20.49	21.36	21.57	19.53	18.77	19.18	20.06

PAT	19.89	19.07	17.47	18.11	17.20	19.57	18.93	18.29	18.57
Mean	18.63	18.23	18.02	18.47	18.43	17.95	17.75	18.30	18.22
CD (5%)	Location= 0.48			Varieties= 0.56			Location x varieties=1.37		
Total yield (t/ha) at 90 days									
BHN	22.22	23.84	22.22	27.09	21.07	25.77	20.76	23.38	23.30
DHL	15.00	11.66	11.29	24.07	21.29	20.37	13.33	12.41	16.18
FZB	30.51	28.81	28.41	28.71	29.11	35.21	33.61	30.11	30.56
JRH	23.08	23.44	23.38	23.31	23.46	23.28	23.48	23.63	23.38
KAL	30.97	38.61	28.48	31.21	35.42	38.43	32.59	29.31	33.13
KAN	30.89	31.37	28.26	28.22	26.30	36.22	42.55	30.07	31.73
PAS	39.26	41.85	39.63	38.52	38.14	40.37	38.89	43.06	39.96
PAT	28.10	28.70	21.50	30.16	26.13	32.07	32.66	27.60	28.37
Mean	27.50	28.54	25.40	28.91	27.62	31.46	29.73	27.45	28.33
CD (5%)	Location= 1.28			Varieties= 1.28			Location x varieties=3.64		
Marketable yield (t/ha) at 90 days									
BHN	21.38	22.92	21.53	26.08	20.22	24.38	19.99	22.61	22.39
DHL	13.52	10.55	9.44	22.41	19.63	17.04	11.85	11.29	14.47
FZB	27.68	26.21	25.84	26.14	26.48	32.08	30.61	27.41	27.81
JRH	12.97	13.33	13.17	13.36	13.22	13.49	13.54	13.25	13.29
KAL	30.60	36.95	27.87	28.34	34.59	36.44	31.44	27.45	31.71
KAN	26.82	25.81	22.33	21.92	21.48	28.07	26.92	24.67	24.75
PAS	38.61	41.38	38.79	37.96	37.59	39.81	41.70	41.21	39.63
PAT	22.86	23.27	15.88	24.31	20.43	26.72	26.82	22.32	22.83
Mean	24.30	25.05	21.86	25.07	24.20	27.25	25.36	23.78	24.61
CD (5%)	Location= 1.33			Varieties= 1.33			Location x varieties=3.77		
Dry matter content (%) at 90 days									
BHN	17.90	17.35	17.85	17.60	17.95	17.65	16.15	17.65	17.51
DHL	20.50	20.33	19.33	21.00	20.83	19.33	17.67	20.50	19.94
FZB	19.37	19.13	18.93	19.40	18.87	19.10	19.40	18.37	19.07
JRH	19.40	18.50	17.35	17.65	17.65	18.20	19.00	17.45	18.15
KAN	17.69	17.63	17.70	18.23	17.53	16.95	17.02	18.85	17.70
PAS	18.97	19.17	19.67	19.92	19.03	20.67	18.72	20.27	19.55
PAT	18.21	18.74	18.57	19.20	19.10	19.21	19.14	19.42	18.95
Mean	18.86	18.69	18.49	19.00	18.71	18.73	18.16	18.93	18.70
CD (5%)	Location= 0.29			Varieties= 0.31			Location x varieties=0.84		

CENTRAL PLAINS

In an experiment K Jyoti, K Bahar, K Badshah, K Pushkar, K Surya, K Khyati, K Pukhraj and K Laukar were evaluated for identifying three promising varieties for central plains. The results (Table 1.24) show that there was a wide variation in the performance of varieties over locations. At 60 days, the varieties K Pushkar, K Lauvkar and K Pukhraj were found promising varieties for higher total yield.

The similar trend was observed for marketable yield per ha also. K Badshah, K Pushkar, K Lauvkar had a significantly higher marketable yield at Raipur location over their regional mean values. The dry matter content indicated that K Surya, K Jyoti and K Khyati were promising varities at 60 days category. K Badshah, K Khyati, K Pukhraj and K Laukar also had similiar dry matter content at Raipur location.

At 75 days, K Pukhraj, K Badshah and K Bahar were higher yielding varieties of this region. For marketable yield, K Pukhraj, K Lauvkar and K Badshah were promising in this region.

As regards dry matter content, K Surya, K Lauvkar and K Pukhraj had recorded greater values.

At 90 days, K Pukhraj, K Pushkar and K Khyati, were found to be promising varieties of this region due to greater total yield per ha. For marketable yield, K Pushkar, K Khyati and K Pukhraj recorded higher values. K Surya, K Badshah and K Jyoti recorded higher dry matter content in this region.

Table 1.24: Evaluation of varieties to identify top three promising varieties (central plains)

Varieities/ Location	Kufri Jyoti	Kufri Bahar	Kufri Badshah	Kufri Pushkar	Kufri Surya	Kufri Khyati	Kufri Pukhraj	Kufri Laukar	Mean
Total yield (t/ha) at 60 days									
CHN	21.62	18.07	21.25	21.58	22.55	21.28	22.56	23.84	21.59
GWL	12.12	10.46	14.45	15.63	13.12	14.24	15.56	12.44	13.50
RPR	17.92	23.59	24.89	25.17	19.80	22.66	23.39	25.29	22.84
Mean	17.22	17.37	20.19	20.79	18.49	19.39	20.50	20.52	19.31
CD (5%)	Location= 1.88			Varieties= 3.08			Location x varieties=5.34		
Marketable yield (t/ha) at 60 days									
CHN	16.50	13.51	15.90	16.13	14.56	15.90	16.87	17.85	15.90
GWL	10.42	8.76	11.17	12.48	10.99	13.32	13.11	10.63	11.36
RPR	16.35	21.96	24.47	23.33	18.19	21.17	21.89	23.78	21.39
Mean	14.43	14.74	17.18	17.31	14.58	16.80	17.29	17.42	16.22
CD (5%)	Location= 1.98			Varieties= 3.24			Location x varieties=5.61		
Dry matter content (%) at 60 days									
CHN	17.25	14.30	13.50	16.90	18.50	17.10	16.50	15.00	16.13
GWL	15.60	15.52	15.52	15.31	15.86	14.16	14.60	16.29	15.36
RPR	19.92	18.76	20.49	17.94	19.97	20.47	20.25	20.12	19.74
Mean	17.59	16.20	16.50	16.72	18.11	17.24	17.12	17.14	17.08
CD (5%)	Location= 0.99			Varieties= 1.62			Location x varieties=2.81		
Total yield (t/ha) at 75 days									
CHN	26.85	25.77	26.52	24.18	26.02	26.85	27.17	26.99	26.30
GWL	20.14	22.85	24.06	24.42	18.20	18.80	28.25	18.33	21.88
RPR	18.27	26.49	25.72	26.32	28.65	24.50	24.97	28.82	25.47
Mean	21.75	25.04	25.43	24.97	24.29	23.38	26.8	24.72	24.55
CD (5%)	Location= 1.06			Varieties= 1.74			Location x varieties=3.02		

Marketable yield (t/ha) at 75 days									
CHN	22.78	21.84	22.52	20.48	22.10	22.80	23.03	25.10	22.58
GWL	18.29	19.13	21.72	21.18	16.17	17.48	25.41	17.15	19.57
RPR	16.04	26.08	24.02	23.16	27.01	24.24	29.06	27.54	24.64
Mean	19.04	22.35	22.75	21.61	21.76	21.51	25.84	23.26	22.26
CD (5%)	Location= 1.07			Varieties= 1.75			Location x varieties=3.03		
Dry matter content (%) at 75 days									
CHN	17.60	16.70	15.30	17.50	19.10	17.60	17.10	16.25	17.14
GWL	16.06	15.60	15.76	15.53	16.26	14.69	15.24	16.57	15.71
RPR	20.09	19.42	20.60	19.38	20.35	20.52	20.46	20.13	20.12
Mean	17.92	17.24	17.22	17.47	18.57	17.60	17.60	17.65	17.66
CD (5%)	Location= 0.93			Varieties= 1.52			Location x varieties=2.64		
Total yield (t/ha) at 90 days									
CHN	31.88	28.98	31.32	32.56	29.52	30.55	31.32	27.27	30.43
GWL	24.88	23.74	28.12	34.59	26.03	27.92	35.00	22.22	27.81
RPR	18.42	28.51	26.35	26.83	38.61	26.25	30.87	29.08	28.12
DES	34.69	37.02	59.88	55.00	48.19	58.15	59.13	37.18	48.65
KTT	30.86	32.47	27.11	28.86	29.58	30.42	22.44	24.03	28.22
Mean	28.15	30.14	34.56	35.57	34.39	34.66	35.75	27.96	32.65
CD (5%)	Location= 1.41			Varieties= 1.79			Location x varieties=4.00		
Marketable yield (t/ha) at 90 days									
CHN	28.62	26.01	28.17	29.25	26.55	27.45	28.18	26.58	27.60
GWL	21.94	21.00	24.45	30.09	22.96	25.54	31.42	20.46	24.73
RPR	16.57	24.76	23.15	25.02	31.67	22.81	23.41	26.98	24.30
DES	32.24	35.46	57.93	51.46	47.05	56.20	56.06	34.43	46.35
KTT	28.69	29.64	24.63	26.50	28.14	29.25	20.89	22.19	26.24
Mean	25.61	27.37	31.67	32.47	31.27	32.25	31.99	26.13	29.85
CD (5%)	Location= 1.32			Varieties= 1.67			Location x varieties=3.74		
Dry matter content (%) at 90 days									
CHN	18.10	18.20	17.80	18.50	19.50	18.70	17.50	16.70	18.12
GWL	16.95	15.97	16.79	15.78	17.70	15.57	15.65	16.68	16.39
RPR	20.54	19.92	20.99	20.33	20.45	20.98	20.61	20.72	20.57
DES	17.70	17.01	18.21	17.89	20.13	17.49	16.34	18.29	17.88
KTT	22.42	22.45	22.20	21.15	23.10	19.25	19.35	16.30	20.78
Mean	19.14	18.71	19.20	18.73	20.18	18.40	17.89	17.74	18.75
CD (5%)	Location= 0.67			Varieties= 0.85			Location x varieties=1.90		

VARIETAL EVALUATION FOR PRODUCTION OF BABY/SALAD POTATOES (SPECIALITY POTATO)

Potato cultivar K Khyati, K.Pukhraj and K.Pushkar were tested at three locations Bhubaneswar, Chhindwara and Raipur for assessing its potential to produce small sized baby potato at 60, 75 and 90 days crop duration. The results (Table 1.25) showed that as the duration increases the total yield increases correspondingly at all the three durations and all the cultivars.The overall yield mean of the varieties were similar.

As regards the proportion of baby potatoes (<50g) Kufri Pukhraj was the best variety for both total and marketable tuber yields at Bhubaneswar (60 days) and Chhindwara (60, 90 days) and also for marketable tuber yield (75 days) and total tuber yield (90 days) at Raipur. Kufri Khyati was the best variety for total and marketable tuber yield at Bhubaneswar (90 days) and for marketable tuber yield at Raipur (75 and 90 days). Kufri Ashoka and Kufri Badshah were the best varieties for total and marketable tuber yield at Bhubaneswar and Chhindwara (75 days). Kufri Lauvkar was the best variety for total tuber yield at Raipur (60 and 75 days).

Kufri Himsona produced >61% tubers of less than 50 gm tuber weight (baby tubers) during both 60 & 90 days crop durations at Bhubaneshwar, while at Chhindwara Kufri Himsona produced 89.5%, 82.8% & 71.8% baby tubers during 60, 75 &90 days crop durations, respectively.

As regards, dry matter content Kufri Jyoti at Bhubanaswar, Kufri Himsona at Chhindwara and Kufri Khyati at Raipur were found better than other varieties.

Table 1.25: Evaluation of varieties for production of baby/salad potatoes

Location/ Varieties	K Khyati	K Pukhraj	K Pushkar	Mean
Total yield (t/ha) at 60 days				
BHN	16.22	17.47	15.33	16.34
CHN	17.04	18.32	16.93	17.43
RPR	13.29	13.78	15.22	14.10
Mean	15.52	16.52	15.83	15.96
CD (5%)	Location= 1.23	Varieties= 1.23	Location x varieties=2.14	
Total yield (t/ha) at 75 days				
BHN	20.49	20.22	19.28	20.00
CHN	23.92	23.23	22.84	23.33
RPR	22.78	21.22	21.01	21.67
Mean	22.39	21.56	21.04	21.67
CD (5%)	Location= 1.28	Varieties= 1.28	Location x varieties=2.21	
Total yield (t/ha) at 90 days				
BHN	19.76	19.50	19.75	19.67
CHN	28.18	29.78	29.31	29.09
RPR	26.78	27.66	24.07	26.17
Mean	24.91	25.65	24.38	24.98
CD (5%)	Location= 1.81	Varieties= 1.81	Location x varieties=3.15	

STANDARDIZATION OF TPS TECHNOLOGY

a) For seedling tuber production

Two methods of seedling tuber production viz., brick bed method and normal nursery method were compared using D-150 and 92-PT-27 varieties at Gwalior and Patna. At both the locations the yield per unit area was higher under the brick bed method.

b) Ware potato production using seedling tubers

Trial was conducted only at Patna. The results showed that D-150 performed better for plant emergence (%), total and marketable tuber yield, tuber uniformity and organoleptic test under both brick bed method and nursery bed method but seedling vigor of 92-PT-27 was higher in both the methods. For most of the traits the ware potato tubers produced by brick method were better than the other method.

TRIAL WITH SPECIALITY POTATO HYBRIDS (RED SKINNED HYBRIDS)

Studies were conducted at Jalandhar, Modipuram, Patna and Kalyani to evaluate the performance of a high yielding red skinned hybrid MP/08-1565 against Kufri Lalima, Kufri Sindhuri and Kufri Lalit. The results (Table 1.26) shows that the overall mean total yield of MS/08-1565 was found significantly higher over K. Sindhuri and at par with Kufri Lalima and Kufri lalit at 75 days after planting. The overall mean marketable yield of MS/08-1565 was found significantly higher over K. Sinduri at 75 days. At none of the location, the hybrid registered significantly higher dry matter content over checks, while K Lalima recorded comparatively higher dry matter content across locations. Similar trend was observed at 90 days after planting as regards overall mean total yield and marketable yield.

Table 1.26: Evaluation of hybrids to identify high yielding red skinned hybrid

Varieties/ Location	MS/08-1565	Kufri Lalima	Kufri Sindhuri	Kufri Lalit	Mean
Total yield (t/ha) at 75 days					
JAL	34.08	34.54	30.23	36.16	33.75
MDP	31.73	29.07	25.95	27.61	28.59
PAT	26.77	26.29	23.40	24.60	25.27
KAL	26.94	26.39	24.54	23.10	25.24
Mean	29.88	29.07	26.03	27.87	28.21
CD (5%)	Location= 1.64	Varieties= 1.64		Location x varieties=3.29	
Marketable yield (t/ha) at 75 days					
JAL	31.99	33.20	27.73	35.14	32.02
MDP	26.48	25.05	21.48	24.66	24.42
PAT	23.60	21.90	18.93	21.57	21.50
KAL	26.35	25.23	22.82	22.83	24.31
Mean	27.10	26.34	22.74	26.05	25.56
CD (5%)	Location= 1.67	Varieties= 1.67		Location x varieties=3.34	
Dry matter content (75 days)					
JAL	15.47	18.77	15.23	14.70	16.04

MDP	12.13	13.25	13.30	12.16	12.71
PAT	22.39	21.18	21.89	20.04	21.37
Mean	16.66	17.73	16.81	15.63	16.71
CD (5%)	Location= 0.63	Varieties= 0.73		Location x varieties=1.27	
Total yield (t/ha) at 90 days					
JAL	48.85	52.13	40.10	48.34	47.35
MDP	41.69	39.48	39.96	38.88	40.00
PAT	31.98	31.45	27.94	29.36	30.18
KAL	33.06	32.32	30.56	27.55	30.87
Mean	38.89	38.84	34.64	36.03	37.10
CD (5%)	Location= 2.13	Varieties= 2.13		Location x varieties=4.26	
Marketable yield (t/ha) at 90 days					
JAL	47.23	50.65	37.97	47.55	45.85
MDP	36.44	32.91	33.31	34.16	34.21
PAT	28.16	26.18	22.56	25.71	25.66
KAL	32.41	31.58	28.80	27.18	29.99
Mean	36.06	35.33	30.66	33.65	33.93
CD (5%)	Location= 2.14	Varieties= 2.14		Location x varieties=4.29	
Dry matter content (90 days)					
JAL	16.17	18.27	16.47	15.53	16.61
MDP	16.22	15.42	18.94	13.78	16.09
PAT	23.05	23.43	24.24	21.82	23.13
Mean	18.48	19.04	19.88	17.04	18.61
CD (5%)	Location= 0.70	Varieties= 0.81		Location x varieties=1.41	

TRIALS IN KHARIF/HILLS SEASON

ON FARM TRIAL WITH EARLY AND MEDIUM MATURING HYBRIDS

One hybrid, J/100-152 with five controls, Kufri Jyoti, Kufri Pukhraj, Kufri Surya, Kufri Laukar and Kufri Pushkar was evaluated in on farm trials at Dharwad at 60 days and Pune at 60 and 75 days crop duration. Late blight, leaf spot and viral diseases incidence was low at both locations. For total and marketable tuber yields, Kufri Pukhraj and Kufri Surya were the best control at Dharwad and Pune respectively. The hybrid could not yield better than the best control.

TRIAL WITH NEW MEDIUM MATURING HYBRID

Five Hybrids viz., MS/5-1543, MS/6-819, MS/7-645, MS/6-1947 and 2004-P-5 with three controls, Kufri Jyoti, Kufri Lauvkar and Kufri Pushkar were evaluated at 75 and 90 days crop duration at Hassan and at 60 and 75 days crop duration at Pune. All hybrids and controls were susceptible to late blight (100% incidence) at Hassan. Leaf spot diseases incidence was higher at Pune. Kufri Lauvkar was the best control at both Hassan and Pune. For total and marketable tuber yields, the hybrids MS/7-645 and MS/6-1947 significantly outyielded the control at Pune centre. The senescence was about 73-77 % at Pune at 90 days crop duration in all hybrids and controls.

TRIAL WITH NEW RED SKINNED HYBRIDS

One hybrid, 2003-P-2 with Kufri Lalima as control was evaluated at Srinagar at 125 crop duration. Performance of the hybrid was not better than the control. Late blight disease incidence was at par in both hybrid (28.26%. and control (21.65%). The foliage senescence was 55.56 and 62.31% in control and hybrid, respectively at 125 days crop duration.

TRIAL WITH NEW LATE BLIGHT AND VIRUS RESISTANT HYBRIDS

Three hybrids namely SM/92-338, LBY-17 and LBY-15 with four controls, Kufri Jyoti, Kufri Pushkar, Kufri Shailja and Kufri Himalini were evaluated at 60 days crop duration at Dharwad and at 75 & 90 days crop durations at Hassan. Hybrid, LBY-15 was resistant to late blight, while all other hybrids and controls were susceptible (80-100% incidence). Viral diseases incidence was 31-49% at Hassan. For total and marketable tuber yields, the best control was K. Himalini at Dharwad and Hassan, for both crop durations. At Hassan the two hybrids, LBY-17 and LBY-15 yielded statistically at par with the best control.

TRIAL WITH PROCESSING HYBRIDS

Four hybrids viz., CP-4184, CP-4206, MP/01-916 and MP/04-578 with five controls viz. Kufri Chipsona-1, Kufri Chipsona-3, Kufri Frysona, Kufri Surya and Atlantic were evaluated at 60 days crop duration at Dharwad and at 75 and 90 days duration at Pune. Two more hybrids, viz., MP/02-516 and MP/04-816 were evaluated at 90 days crop duration at Hassan. Two hybrids, viz., C-3 and C-4 were also evaluated at Srinagar at 125 days crop duration. For total and processing grade yields, the hybrids CP-4184 and CP-4206 significantly out yielded the best control, Atlantic at 75 and 90 days crop durations at Pune centre. Two hybrids, MP/01-916 and FC-4 significantly out yielded the best control, Kufri Chipsona-3 at 125 days crop duration at Srinagar centre for total tuber yield only

TRIALS WITH ANDIGENA HYBRIDS DURING SPRING AND KHARIF SEASON

Two hybrids namely A/97-29 and A/98-98 with three controls, Kufri Jyoti, Kufri Lauvkar and Kufri Pushkar were evaluated at 75 and 90 days crop duration at Hassan during *kharif* season. Plant emergence was normal. Late blight disease incidence was 100%.

For total and marketable tuber yields the best control was Kufri Pushkar. None of the hybrids performed better than the controls.

TRIAL FOR HEAT TOLERANCE

One CIP clone, CP 4054 with two controls, Kufri Jyoti and Kufri Surya was evaluated at 60 days crop duration at Dharwad. No disease was observed. For total and marketable tuber yields, CIP clone, CP 4054 was at par to the best control, Kufri Surya.

EVALUATION TRIAL WITH TPS POPULATIONS

One TPS population viz., PT/08-109 with two controls 92-PT-27 and D-150 was evaluated at Shillong for seedling tuber let crop at 120 days crop duration. Seedling survival and vigor was at par with control. As regards total yield and tuber shape, TPS population PT/08-109 was at par with controls. The crop was also free of any disease.

ON FARM TRIAL WITH HYBRIDS HAVING COMBINED RESISTANCE TO LATE BLIGHT AND CYST NEMATODE

Two hybrids namely OS/01-516 and OS/01-497 with four controls, Kufri Neelima, Kufri Girdhari, Kufri Himalini and Kufri Swarna were evaluated at 120 days crop duration at seven locations [I-Thummanatty, II-Ajjur, III-Kallakorai, IV, V &VI-Muthorai (spring, summer and autumn) and VII-Wellington] in Ooty. For total and marketable tuber yields, Kufri Himalini was the best control at locations I, II, III & IV and K. Neelima at locations V &VI. Hybrid OS/01-516 and OS/01-497 performed better than the controls at location VII and were found at par with Kufri Girdhari regarding late blight disease resistance. Both the hybrids showed better resistance to cyst nematode in comparison to Kufri Neelima and Kufri Swarna. The total weight loss in hybrid OS/01-497 was at par to the controls after 90 days of storage at ambient temperature.

VARIETAL EVALUATION TRIAL TO IDENTIFY TOP THREE PROMISING VARIETIES OF THE REGION (2ND YEARS TRIALS)

To identify the top three promising potato varieties of the region, sixteen potato varieties viz. Kufri Jyoti, Kufri Himalini, Kufri Pushkar, Kufri Khyati, Kufri Pukhraj, Kufri Ashoka, Kufri Gaurav, Kufri Garima, Kufri Bahar, Kufri Badshah, Kufri Lauvkar, Kufri Shailja, Kufri Kanchan, Kufri Girdhari, Kufri Megha and Kufri Surya were evaluated through front line demonstration at 5 AICRP centres viz., Dharwad, Hassan, Pune, Ranichuri, Shillong and Srinagar. The varieties were evaluated at 60 days crop duration at Dharwad and Hassan; at 60, 75 and 90 days crop duration at Pune; at 60, 75, 90 and 110 days crop durations at Ranichuri; at 90 and 120 days crop durations at Shillong and at 125 days crop duration at Srinagar.

The best performing variety at Dharwad was Kufri Jyoti followed by Kufri Gaurav and Kufri Khyati, while at Hassan the best performing variety was Kufri Himalini followed by Kufri Badshah and Kufri Pushkar. At Pune centre Kufri Surya was the best performing variety followed by Kufri Laukar and Kufri Pukhraj during all three crop durations. At Ranichuri Kufri Himalini was found to be the best cultivar in the view of early bulking and total tuber yield. However, Kufri Kanchan and Kufri Shailaja also had equal potential of tuber yield in mid hill conditions of Uttarakhand. At Shillong the top 2 performing varieties were Kufri Girdhari followed by Kufri Himalini at both crop durations, while Kufri Megha at 90 days and Kufri Jyoti (sprayed) at 120 days crop durations were the 3rd best performing varieties. At Srinagar, Kufri Jyoti (sprayed), Kufri Himalini and Kufri Girdhari were the top three performing varieties. Late blight incidence was 80-100% at Hassan centre and 8 to 28 % at Pune centre.

VARIETAL EVALUATION FOR PRODUCTION OF BABY/ SALAD POTATOES (SPECIALITY POTATO)

Eight varieties viz., Kufri Himsona, Kufri Khyati, Kufri Pukhraj, Kufri Pushkar, Kufri Lauvkar, Kurfi Ashoka, Kufri Jyoti and Kufri Surya were evaluated at 60 days crop duration at Dharwad and at 75 and 90 days crop durations at Pune centres of AICRP during *Kharif* season.

At Dharwad, Kufri Khyati, and Kufri Surya gave high yields along with high proportion of baby potatoes while at Pune the yields were high but proportion of baby potatoes was low.

Kufri Himsona produced >77% tubers of less than 50 gm tuber weight (baby tubers) during both 60 days crop durations at Dharwad

STANDARDIZATION OF TPS TECHNOLOGY

A) For seedling tuber production:

Two methods of seedling tuber production viz., brick bed method and normal nursery method were compared for plant emergence, seedling vigor, total tuber yield and tuber uniformity using D-150 and control, 92-PT-27 during 90 days duration at Shillong. The results showed that brick method of seedling tuber production was considerably better than the normal nursery method for all characters.

b) Ware potato production using seedling tubers

Two TPS populations, 92-PT-27 and D-150 were grown with two controls, K. Girdhari and K. Himalini and evaluated at 120 days duration at Shillong.

The results showed that the control varieties performed significantly better with respect to plant emergence, plant vigour, total and marketable tuber yield and tuber uniformity.

CROP PRODUCTION

PRECISION NUTRIENT MANAGEMENT

Nutrient recommendations are made on the basis of crop response to applied nutrients estimated through field trials. Statistical models are commonly used to describe the crop response to fertilization. Normally the response of yield to nutrient application is polynomial which indicates that yield increases with nutrient application up to a maximum and then decreases. The optimum nutrient values are estimated through field trials which are time consuming and costly. Moreover, the response to fertilizer is governed by many factors e.g. varieties, season, soil texture, irrigation method, soil fertility status, management practices etc. Thus, the average nutrient optimum across the years and/or sites etc may lead to under or over fertilization. Therefore, more precise approaches are required to develop site specific nutrient recommendations due to the limitation of extrapolating the results of yield response models.

NITROGEN REQUIREMENT OF NEWLY RELEASED POTATO CULTIVARS

A trial was conducted to study the response of newly released hybrids to N and thus derive their N requirement. The treatments consisted of 5 Nitrogen levels viz N_0: 0, N_1: 75 kg N/ha, N_2: 150 kg N/ha, N_3: 225 kg N/ha and N_4: 300 kg N/ha. Detailed analysis of the N applied – yield, N uptake – yield and N applied – N uptake relations were carried out for two locations viz Chindwara (Fig 2.1).and Faizabad (Fig 2.2).for variety Kufri Surya during the year. The results showed that the response to N application in the different years is polynomial but the coefficients are different.

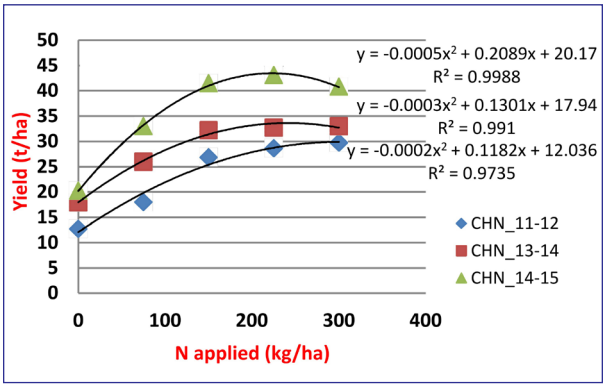


Fig. 2.1. Response to N application at Chindwara

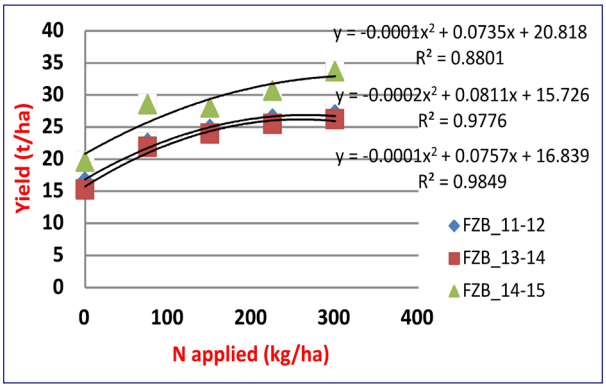


Fig. 2.2. Response to N application at Faizabad

This indicates that for the same yield level, the N application required is different in different years and also in different locations. This is because the response to N application is a function of many factors and hence it varies with locations and years. Therefore, N recommendations based on the N applied-yield relation are not very reliable. To further analyse the reasons for the same and to develop a reliable method for determining the N requirement, the N uptake-yield relation was also studied and this showed that this relation is linear and also very stable across locations and seasons (Fig 2.3).

The slope of the uptake - yield curve was 0.2708 tons tubers (fresh weight basis)/ kg N uptake. To determine the relation between N applied

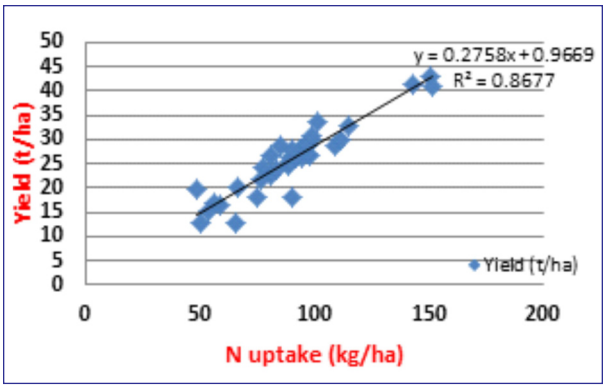


Fig. 2.3. Response to N uptake in K.Surya

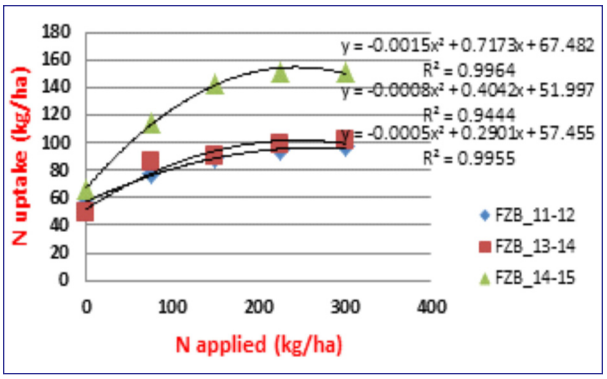


Fig.2.4. Response to N application to N uptake at Chhinwara

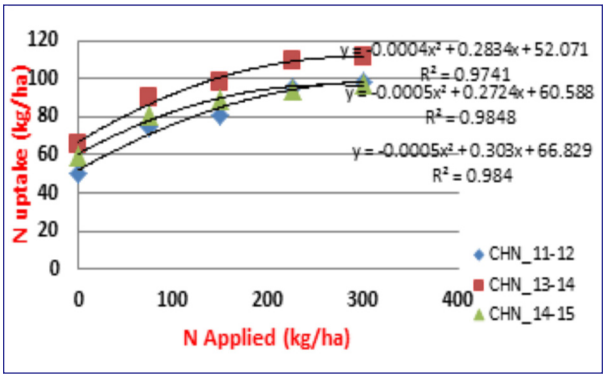


Fig. 2.5. Response to N application to N uptake at Faizabad

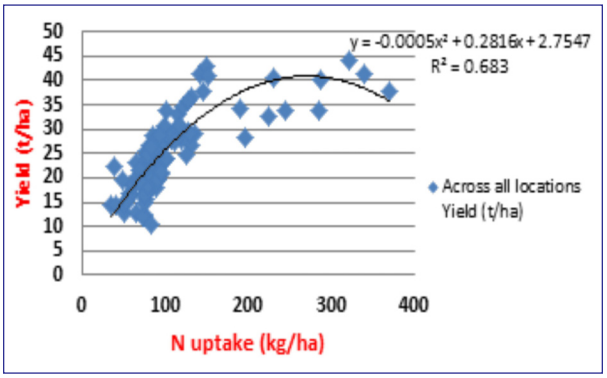


Fig. 2.6. Yield (t/ha) response to N uptake across AICRP locations and varieties Faizabad

and that taken up, the uptake at different levels of N were plotted and the results showed that the N applied-uptake relationship was also polynomial (Fig 2.4 and 2.5). Perusal of the figures shows that in control where no N was applied the uptake was between 55-65 kg N/ha and that the rate of N application required per unit N uptake increases to a maximum uptake and thereafter further increase in N uptake is marginal even at high N application. This indicates that the efficiency of Kufri Surya to utilize soil available N does not vary much between locations and years but most of the variation is in the uptake of applied N.

N uptake –yield relationship was also derived for other varieties and locations and the pooled response was found to be polynomial (Fig 2.6). Perusal of the figure shows that two distinct segments can be delineated in this curve. The first is a linear one extending upto 30 t/ha. The other is from 30 t/ha and beyond, in which the points are widely scattered. Thus, the uptake – yield relation for yields upto 30 t/ha is linear as per equation $y = 0.2708x + 1.5555$ ($R^2 = 0.9267$) and polynomial for the complete range of yields as per equation $y = -0.0005x^2 + 0.2816x + 2.7547$ ($R^2 = 0.683$).

Advisory System for Nitrogen Management in Potato

A DSS called Advisory System for Nitrogen Management in Potato (ASNMP) has been developed for precise recommendation of the N dose to be applied. This tool requires information on the crop duration, target yield, harvest index, dry matter content in tubers, seasonal

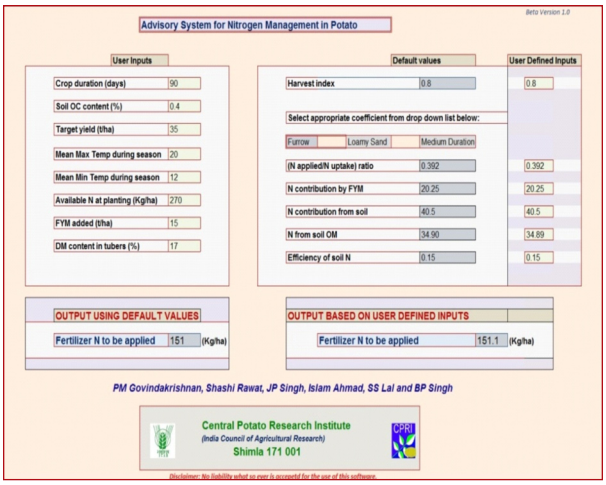


Fig. 2.7. Screen shot of ASNMP DSS

temperature, soil test values, quantity of FYM added, the soil texture, irrigation method etc. The DSS computes the N requirement of the crop, the contribution of N from soil, FYM, as well as the efficiency of applied N and then arrives at the situation specific recommendations. The tool also has option for the user to input his estimate of the N contribution by any of the components (Fig 2.7). During the year under report, the data required for calibrating and validating the ASNMP were generated through different experiments and different components of the DSS are being tested.

DEVELOP SITE SPECIFIC NPK REQUIREMENTS

Another method to derive site specific nutrient requirement is the omission plot technique. This method involves three steps viz establishing an attainable yield target, effectively use the existing nutrients and finally applying fertilizer to minimize the deficit between crop needs and indigenous supply. The target yield can be easily obtained from the farmers based on their experience and the nutrient requirement for their target yield can be calculated based on the requirement per ton of yield reported in literature. The soil nutrient supplying capacity can be calculated from field trials as per omission plot technique. In this technique, four treatments are laid out in a field with the following treatments:

1. Full fertilization: NPK applied
2. N omission (–N): No N applied, PK applied
3. P omission (–P): No P applied, NK applied
4. K omission (–K): No K applied, NP applied

In full fertilization treatment, sufficient N, P, and K are applied and good crop management are adopted so that yield is not limited by an insufficient supply of nutrients hence the yield in these plots can be used as an estimate of attainable yield target. Nutrient-limited yields are determined from plots in which the nutrient of interest is not added. The N-limited yield is determined in an N omission plot receiving no N fertilizer but sufficient P and K to ensure that they do not limit yield. Similarly the P and K-limited yields are determined. The difference in yields between the fully fertilized plot and the N omission plot gives the deficit between the crop demand for N and indigenous supply of N, to be met by fertilizers. Similarly the deficit for P and K are also determined. The experiments as per omission plot technique were conducted during the year and detailed analysis of the results of Srinagar and Faizabad carried out. All experiments followed a standardized experimental protocol and the treatments are listed below.

T1 50% RDF of NPK

T2 100% RDF of NPK

T3 150% RDF of NPK

T4 Without N fertilizer (PK)

T5 Without P (NK)

T6 Without K (NP)

T7 Without NPK (Absolute control)

Initial soil samples for the determination of general soil properties in the 0-15 cm depth were collected from each field before planting of the experiment. From these samples; organic carbon (Walkley and Black, 1947), available P (Olsen et al., 1954), exchangeable K (Thomas, 1982), and soil pH (1:2 soil: water ratio) have been analyzed. Soil chemical characteristics of the experimental fields are presented in Table 2.1.

Table 2.1: Initial soil fertility status of the experimental plots

Character/ Location	pH	OC*	Av N	Av P	Av K
Srinagar	7.10	1.47	125	49	248
Faizabad	7. 95	0.37	130	15.85	261.0

Nutrient uptake in tuber and haulms was calculated by multiplying tuber and haulm dry weight yields by their respective N, P and K concentrations and total uptake (TNU, TPU and TKU) calculated. N (NHI), P (PHI) and K (KHI) harvest indices were calculated as the ratios NTU/TNU, PTU/TPU and KTU/TKU, respectively, and expressed as percentages. Tuber yields, total nutrient uptake, internal efficiency, agronomic efficiency and tuber yield at maximum dilution were subjected to analysis of variance (ANOVA).

Estimation of recovery fraction of applied nutrients: Recovery fraction of applied nutrient (Nre(x)) is the ratio between nutrient uptake from applied fertilizer and the rate of fertilizer application. It is calculated as:

Nre(x) = (TU(xf) – TU(x0))/ Fr(x)

Where,

TU(xf) : average total nutrient uptake (kg ha-1) from treatments receiving a dose Fr(x)

TU(x0) : average total nutrient uptake (kg ha-1) from the control (zero fertilizer) treatments

Fr(x): Rate of fertilizer application (kg ha-1)

(x) : nutrient under consideration (N, P or K)

Tuber yield at maximum dilution: Tuber yield at maximum dilution of a nutrient occur when that nutrient is the only limiting factor and growth doesn't respond to application of other nutrients. Tuber yield per unit nutrient (x) uptake at maximum dilution of that nutrient (Y(x)D, kg kg-1 (x)) was calculated as:

Y(x)D = TY(x)D/TU(x)d

Where,

TY(x) D: Tuber yield (kg/ha) from treatments receiving no nutrient (x) (and the maximum rates of the other two nutrients)

TU(x)d : total nutrient uptake in plant DM (kg/ ha) from treatments receiving no nutrient (x) (and the maximum rates of the other two nutrients).

Internal nutrient use and agronomic efficiencies

Internal nutrient use efficiencies (INue, kg tube/ kg nutrient) were calculated as:

INue = TY/ TU

where,

TY : tuber yield (kg/ha)

TU : total nutrient uptake (kg/ha) in plant DM at maturity

Agronomic efficiency (AE, kg tuber/kg applied fertilizer) was calculated as:

AE = (TY(xr) –TY(c))/R(xr)

where,

TY(xr): tuber yield (kg/ha) of treatment receiving fertilizer nutrient x at rate r

TY(c): tuber yield (kg/ha) of the control treatment R(xr) : rate of fertilizer (x) application (kg/ha)

The initial soil analysis indicated large variation in soil fertility characteristics and between the two potato production sites (Table 2.1). For example, organic carbon values—an index used to determine available N was low (0.37) at Faizabad and high (1.47) at Srinagar.

Tuber yield and actual uptake of N, P and K

Average potato tuber yields in nutrient omission plots increased in the order 0-N (6.3 t) , 0-P (4.24 t) and 0-K (3.77 t) (Table 2.2). At the present soil fertility levels, P and K supplies are seemingly less limiting factors for potato production. Plant N accumulation in the 0-N plot, also known as INS, ranged from 59.18 to 65.76 kg/ha (Table 2.3), IPS ranged from 17.35 to 19.68 kg/ha (Table 2.4), and IKS ranged from 96.09 to 122.75 kg/ ha (Table 2.5). This field-to-field variability includes spatial variability due to omission plots, climatic and crop management factors, and the errors associated with plant sampling and chemical analysis. However, no consistent difference was observed among the two year of experimentation for indigenous N, P, and K supplies and also year-wise no significant differences in tuber yield were observed.

Table 2.2: Tuber yield (t/ha) in nutrient omission plots at different sites during 2012-13 to 2014-15

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	31.90	34.80	36.10	31.80	31.20	31.30	27.60	32.10
Faizabad	21.40	27.10	29.40	17.60	22.30	23.10	14.80	22.20
Mean B	26.60	31.00	32.80	24.70	26.70	27.20	21.20	
CD (5 %)	Location = 1.10		Treatment = 2.10		Location x Treatment = 3.00			

Table 2.3: Total nitrogen uptake by potato at different

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	69.20	89.90	95.20	59.20	75.20	73.80	45.70	72.60
Faizabad	87.60	103.70	110.20	65.80	83.80	83.60	52.20	83.80
Mean B	78.40	96.80	102.70	62.50	79.50	78.70	49.00	
CD (5 %)	Location = 4.80		Treatment = 9.10		Location x Treatment = NS			

Table 2.4: Total Phosphorous uptake by potato at different sites

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	23.74	27.47	29.02	21.91	19.68	22.41	16.04	22.90
Faizabad	20.66	26.25	29.21	17.13	17.35	18.54	11.10	20.03
Mean B	22.20	26.86	29.11	19.52	18.52	20.47	13.57	
CD (5 %)	Location = 2.24		Treatment = 4.18		Location x Treatment = NS			

Table 2.5: Total Potassium uptake by potato at different sites

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	130.20	142.10	145.50	115.20	124.10	122.70	90.50	124.30
Faizabad	93.50	118.80	123.20	78.70	96.10	96.10	62.70	95.60
Mean B	111.80	130.40	134.30	96.90	110.10	109.40	76.60	
CD (5 %)	Location = 20.50		Treatment = NS		Location x Treatment = NS			

Recovery fraction: The N-recovery fraction (Table 2.6) varied between 0.22 at Srinagar and 0.30 at Faizabad. The recovery fraction of P (Table 2.7) was between 0.09 at Srinagar and 0.20 at Faizabad. The recovery fraction of K (Table 2.8) was between 0.41 at Faizabad and 0.45 at Srinagar. Therefore, for Potato maximum recovery fractions of 0.30, 0.20 and 0.45 can be used for N, P and K, respectively. Recovery fraction of applied nutrients decreased with increasing dose of nutrients.

Table 2.6: Recovery fraction of applied Nitrogen in potato at different sites

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	0.29	0.28	0.21	0.00	0.19	0.18	0.00	0.16
Faizabad	0.48	0.35	0.26	0.00	0.21	0.21	0.00	0.21
Mean B	0.38	0.31	0.23	0.00	0.20	0.19	0.00	
CD (5 %)	Location = 0.02		Treatment = 0.04		Location x Treatment = 0.05			

Table 2.7: Recovery fraction of applied Phosphorous in potato at different sites

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	0.16	0.11	0.09	0.06	0.00	0.06	0.00	0.07
Faizabad	0.32	0.26	0.20	0.10	0.00	0.13	0.00	0.14
Mean B	0.24	0.18	0.14	0.08	0.00	0.09	0.00	
CD (5 %)	Location = 0.03		Treatment = 0.06		Location x Treatment = 0.08			

Table 2.8: Recovery fraction of applied Potassium in potato at different sites

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	0.80	0.52	0.37	0.25	0.34	0.00	0.00	0.32
Faizabad	0.62	0.56	0.40	0.16	0.34	0.00	0.00	0.30
Mean B	0.71	0.54	0.39	0.21	0.34	0.00	0.00	
CD (5 %)	Location = NS		Treatment = 0.19		Location x Treatment = NS			

Internal efficiency, agronomic efficiency and grain yield at maximum dilution

Internal efficiency: Average internal nitrogen use efficiency (Table 2.9) was higher in the Srinagar (459.31) than in Faizabad (266.68). Average internal phosphorus use efficiency (Table 2.10) was highest at Srinagar (1445) and lowest at Faizabad (1139). Average internal potassium use efficiency (Table 2.11) was higher at Srinagar (261.75) than at Faizabad (252.81).

Table 2.9: Internal use efficiency of nitrogen in potato at different sites

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	461.13	387.72	379.82	537.40	417.62	425.12	606.39	459.31
Faizabad	244.55	261.52	266.39	267.63	265.75	277.39	283.52	266.68
Mean B	352.84	324.62	323.10	402.51	341.68	351.25	444.95	
CD (5 %)	Location = 20.67		Treatment = 38.67		Location x Treatment = 54.69			

Note: bold figures are values used for tuber yield at maximum dilution

Table 2.10: Internal use efficiency of Phosphorous in potato at different sites

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	1381.3	1271.4	1246.4	1474.7	1597.5	1420.5	1722.9	1445
Faizabad	1038.8	1032.9	1005.1	1034.3	1285.2	1248	1333.5	1139.7
Mean B	1210.1	1152.2	1125.8	1254.5	1441.3	1334.2	1528.2	
CD (5 %)	Location = 127.1		Treatment = 237.7		Location x Treatment = NS			

Note: bold figures are values used for tuber yield at maximum dilution

Table 2.11: Internal use efficiency of potassium in potato at different sites

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	246.87	247.01	248.52	276.75	251.61	255.24	306.26	261.75
Faizabad	245.80	248.01	258.68	240.06	253.91	265.89	257.30	252.81
Mean B	246.34	247.51	253.60	258.41	252.76	260.56	281.78	
CD (5 %)	Location = NS		Treatment = NS		Location x Treatment = NS			

Note: bold figures are values used for tuber yield at maximum dilution

Agronomic efficiency: Average agronomic nitrogen efficiency (Table 2.12) was higher at Faizabad (48.55) and lower at Srinagar (25.67). Average phosphorous agronomic efficiency (Table 2.13) was highest at Faizabad (110.21) and lower at Srinagar (41.86). Average agronomic potassium efficiency (Table 2.14) was higher at Faizabad (64.92) and lower at Srinagar (41.72). Agronomic efficiency nutrients decreased with increasing dose of nutrients.

Table 2.12: Agronomic efficiency of applied nitrogen at different sites in potato

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	53.13	45.25	35.57	0.00	22.57	23.16	0.00	25.67
Faizabad	88.14	82.00	64.73	0.00	49.67	55.30	0.00	48.55
Mean B	70.63	63.63	50.15	0.00	36.12	39.23	0.00	
CD (5 %)	Location = 4.50		Treatment = 8.41		Location x Treatment = 11.90			

All fertilizer use efficiencies for each site are average of two years

Table 2.13: Agronomic efficiency of applied Phosphorous at different sites in potato

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	85.0	72.4	56.9	41.7	0.0	37.1	0.0	41.9
Faizabad	220.3	205.0	161.8	46.1	0.0	138.3	0.0	110.2
Mean B	152.7	138.7	109.4	43.9	0.0	87.7	0.0	
CD (5 %)	Location = 12.13		Treatment = 22.69		Location x Treatment = 32.09			

Table 2.14: Agronomic efficiency of applied Potassium at different sites in potato

	T1	T2	T3	T4	T5	T6	T7	Mean A
Srinagar	85.0	72.4	56.9	41.7	36.1	0.0	0.0	41.7
Faizabad	132.2	123.0	97.1	27.7	74.5	0.0	0.0	64.9
Mean B	108.6	97.7	77.0	34.7	55.3	0.0	0.0	
CD (5 %)	Location = 11.17		Treatment = 20.89		Location x Treatment = 29.54			

Thus coefficients used to quantify indigenous soil nutrient supply and parameterization of nutrient requirements of potato have been worked out for two contrasting situations and these would be used to develop target yield equations.

Phosphorus use efficient potato cultivars for Nilgiris

Phosphorus use efficiency is generally very low (<30%) in potato. However, cultivated soils contain good reserves of P but its availability to the plants is restricted because of transformations to other relatively insoluble forms by the reaction of Al, Fe, Ca, K, and Mg present in soil with fertilizer P, hence, the need to improve P use efficiency. Differences in efficiency of nutrient use among potato varieties grown in the plains have been reported.

In low pH soils of Nilgiris region of Tamil Nadu, the fixation of phosphorus is very high due to the abundance of Fe and Al compounds. Hence there is need to identify P efficient varieties which can produce higher yields per unit of nutrient applied or absorbed. Field experiment was therefore, conducted at Central Potato Research Station, Muthorai, The Nilgiris, Tamil Nadu under the AICRP (Potato) to determine P use efficient varieties for the Nilgiri hills. The treatments included six potato cultivars under four levels of P (0, 50, 100 and 150 Kg P_2O_5 per hectare) application. The six cultivars tested were Kufri Swarna, K. Jyoti, K. Neelima, K. Girdhari, K. Giriraj and K. Himalini. The total biomass of the plants were recorded at 90 days and the tuber yield at 120 days after planting. Harvest index was calculated in all the varieties at different P levels. P uptake was estimated in different plant parts at 90 days after planting by drawing samples from five plants in each plot. Phosphorus content in tubers was estimated at harvest. The pooled data of three years was used to fit quadratic models for yield for all the six cultivars and the P efficient variety as compared to the standard variety (K.Jyoti) determined as per standard statistical techniques.

The agronomic use efficiency which is a measure of how much economic biomass is produced per unit of nutrient supplied (soil supply + fertilizer applied) was also calculated as below

Agronomic use efficiency (AUE)

$$AUE = \frac{Y}{S+F}$$

Where Y is tuber yield in a particular treatment (kg/ ha), S is soil available nutrient (kg/ ha) and F is quantity of fertilizer nutrient applied (kg/ ha)

Growth parameters: Plant height, number of shoots per plant and leaf number was significantly affected by P application in potato varieties. The two varieties K Swarna and K Neelima performed better in terms of plant height, number of shoots and leaf number than rest of the varieties. Efficiency of the above two varieties in utilization of P from the initial stage itself was observed based on the plant growth parameters (Table 2.15).

Table 2.15: Growth parameters and yield components of potato varieties

Potato varieties	Plant height (cm)	No. of shoots	No. of leaves	Yield / net plot (kg)	Tuber number / net plot	P content in tubers
K. Jyoti	22.76	2.58	17.69	4.49	62	0.2868
K. Swarna	33.53	3.05	23.12	6.64	65	0.2988
K. Girdhari	24.97	2.87	18.31	4.83	65	0.2955
K. Himalini	22.73	2.41	15.20	3.58	68	0.2965

K. Giriraj	18.01	2.26	14.43	2.78	42	0.2977
K. Neelima	31.19	2.69	23.03	6.79	80	0.2913
LSD	2.711	0.311	2.356	0.607	7	0.0046
P0	20.31	2.26	15.31	3.59	50	0.2755
P50	24.99	2.64	18.43	4.59	61	0.2932
P100	25.15	2.58	18.59	4.72	60	0.2993
P150	24.21	2.40	17.75	4.37	58	0.3052
LSD	2.050	0.235	1.781	0.462	5	0.0035

Yield parameters: The yield response of all the varieties to P application followed a polynomial trend. With increase in P dose the yield increased up to a maxima and then it decreased (Table 2.16).

Table 2.16: Yield at economic optimum, P_{Max}, no P and dry root bio mass of potato cultivars

Varieties	Equation	Economic Optimum (kg/ha)	Yield at Economic optimum P (t/ha)	Yield at Maximum P of std variety (t/ha)	Yield at no P (t/ha)	Root dry weight (g/plant)
K. Jyoti	$y = -0.0005x^2 + 0.135x + 17.895$ $R^2 = 0.8935$	132	27.4	27.0	17.9	1.72
K. Swarna	$y = -0.0005x^2 + 0.0884x + 31.14$ $R^2 = 0.7459$	85	35.0	40.2	31.1	3.07
K. Girdhari	$y = -0.0017x^2 + 0.3028x + 17.418$ $R^2 = 0.8539$	88	30.9	26.5	17.4	2.61
K. Himalini	$y = -0.0008x^2 + 0.1622x + 13.926$ $R^2 = 0.6822$	99	22.1	23.0	13.9	2.52
K. Giriraj	$y = -0.0007x^2 + 0.0987x + 12.834$ $R^2 = 0.4901$	68	16.3	21.9	12.8	1.98
K. Neelima	$y = -0.0006x^2 + 0.1072x + 32.968$ $R^2 = 0.9475$	87	37.7	42.1	32.9	3.14

(Econ opt= Economic optimum, Yd = Yield)
P opt (kg/ha) =- (cp-b) /2c
Cp: cost of P fertilizer per kg/ Price of potatoes per tone = (37.5/12000) = 0.003125

There were differences in the intercept as well as the response. The intercept ranged from 12.8 t/ha in the case of Kufri Giriraj to 32.9 t/ha in the case of Kufri Swarna. This indicates that Kufri Swarna is very efficient in utilizing soil P. This is also apparent from the root dry weights which was 3.14 g/plant in Kufri Neelima and 3.07 in Kufri Swarna the two varieties with high uptake in control as against 1.72 g/plant in Kufri Swarna a low efficient variety. The economic optima also varied in the different varieties. Kufri Jyoti had the highest value at 132 K P_2O_5/ha while the minimum was in the case of Kufri Giriraj (68 kg P_2O_5/ha). The economic optima of K.Neelima and K.Swarna were 85 and 87 kg P_2O_5/ha.

Agronomic Use Efficiency (AUE): The two varieties K Neelima (228) and K Swarna (222) also had higher Agronomic Use Efficiency

(Kg tuber dry matter/kg nutrient applied) as compared to other varieties while the varieties K Girdhari (162), K Jyoti (150) and K Himalini (120) which showed moderate values for AUE. The least AUE values were recorded in K Giriraj (93) (Table 2.17).

Table 2.17: P concentration, P uptake, DMP and AUE of potato cultivars

Varieties and P doses	Plant P conc (%)	Stem Dry matter (t/ha)	AUE	P uptake in stems (kg/ha)	Tuber Dry matter (t/ha)
K. Jyoti	0.14	1.44	150.13	2.02	4.65
K. Swarna	0.10	2.21	222.98	2.21	6.91
K. Girdhari	0.13	1.56	162.13	2.02	5.03
K. Himalini	0.14	1.12	120.39	1.57	3.73
K. Giriraj	0.10	0.90	93.42	0.90	2.90
K. Neelima	0.12	2.33	228.06	2.80	7.07
P0	0.12	1.16	120.77	1.39	3.74
P50	0.13	1.53	154.19	1.99	4.78
P100	0.13	1.57	158.71	2.05	4.92
P150	0.14	1.50	146.84	2.10	4.55

The results thus show that Kufri Swarna and Kufri Neelima are highly efficient in utilization of P and their economic optimum dose of P in the Niligiri hills is 85 and 87 Kg P_2O_5/ha.

WATER MANAGEMENT IN POTATO UNDER LOW WATER AVAILABILITY CONDITIONS

Potato is an irrigated crop in the Indogangetic plains of India. About 8-10 irrigations are required during the crop season. Since potato is a shallow rooted crop, the frequent irrigations, especially the first few irrigations, leach out the nutrients and are also very less efficient. Therefore, there is need to find ways and means to reduce the irrigation requirements especially when furrow irrigation is practiced and a minimum of 5 cm of water has to be applied irrespective of the requirement due to operational constraints. Mulching is one of the simplest techniques to reduce evaporation and thus the water requirement. Therefore, studies on the irrigation requirement under mulching with paddy straw were studied at Dholi. The treatments consisted of irrigation at different CPE levels with and without mulching. The treatment details are given in below.

Irrigation schedule **Mulching**

I_1: Irrigation at 20 mm CPE **M1**: No mulch

I_2: Irrigations at 25 mm CPE

I_3: Irrigations at 30 mm CPE **X** **M2**: Mulching with paddy straw or any other locally available organic mulch material @ 5 t/ha

I_4: Irrigations at 35 mm CPE

I_5: Irrigation at 40 mm CPE

I_6: Irrigations at stolon formation, tuber initiation and tuber development stages.

The irrigation at different CPE levels affected the number of irrigations as well as the irrigation schedule (Table 2.18). The numbers of irrigations were only 3 in the case of I6 while in the others it was 6 irrigations.

Table 2.18: Irrigation schedule under treatements

Treatments	Number of irrigations applied at different DAP					
	I	II	III	IV	V	VI
I_1M_1	8	23	40	54	66	78
I_2M_1	8	23	40	54	66	78
I_3M_1	8	23	40	58	66	78
I_4M_1	8	23	40	63	73	78
I_5M_1	8	23	40	66	73	83
I_6M_1	0	23	40	68	-	-
I_1M_2	8	23	40	54	70	78
I_2M_2	8	23	40	63	70	78
I_3M_2	8	23	40	63	73	83
I_4M_2	8	23	40	68	76	83
I_5M_2	8	23	40	73	76	83
I_6M_2	8	23	40	73	-	-

Irrigation and mulching significantly affected the yield, however, the interaction of irrigation and mulching was non significant (Table). As regards the main effects, mulching increased the yield over un-mulched treatments while in the case of irrigation, the yield was lowest in I_6 (Irrigations at stolon formation, tuber initiation and tuber development stages) which was at par with I_5(Irrigation at 40 mm CPE). Irrigation at 20 mm CPE (I_1) gave significantly higher yield than other treatments followed by I_3. I_2 and I_4 which were non significant between themselves (Table 2.19).

The study thus shows that irrigation at 20mm CPE is the best for potato at Dholi conditions and its combination with mulching is desirable to reinforce the beneficial effect.

Table 2.19: Effect of mulching and Irrigation on tuber yield (t/ha)

Factors	I1	I2	I3	I4	I5	I6	Mean for M
M1	21.19	18.80	19.49	17.19	15.89	15.55	18.02
M2	26.14	24.48	25.06	22.27	20.96	18.71	22.94
Mean for I	23.66	21.64	22.28	19.73	18.42	17.13	
C.D. (5 %)	Year = 1.18		Mulching = 0.96			Year x Mulching = N.S.	
C.D. (5 %)	Irrigation = 1.66 Year x Irrigation = N.S. Mulching x Irrigation = N.S. = Year x Mulching x Irrigation = N.S.						

WEED MANAGEMENT IN POTATO

Field experiments were conducted as per treatments given below at various locations to study the crop weed competition and determine efficient weed control strategy to be followed.

Treatment details

T1 Weedy check

T2 Weed free

T3 Hand weeding at 30 days and weed free upto maturity

T4 Hand weeding at 40 days and weed free upto maturity

T5 Hand weeding at 50 days and weed free upto maturity

T6 Herbicides (Metribuzin @ 0.75 kg/ha) pre-emergence

T7 Herbicides (Metribuzin @ 0.75 kg/ha) as post emergence at 10% of plant emergence

The experiment conducted at Dholi, Faizabad, Jorhat, Kalyani, Kota, Pantnagar, Raipur, Shillong centres was compiled during the year and the competition due to weeds in terms of yield loss, nutrient loss as well as efficiency were calculated. The results showed that potato productivity was significantly reduced by weeds. The increase in productivity in weed free treatment over weedy check across locations was 9.4 t/ha (Table 2.20). Delay in weeding decreased the yield though the difference in yield between the different hand weeding treatments was non significant. Chemical weed control through Metribuzin, both as pre emergence and as post emergence spray, were equally effective and were comparable to weed free and hand weeding treatments. The average yield loss due to weeds was about 35%.

Table 2.20: Effect of weed management practices on productivity (t/ha) of potato (Pooled over years)

Treatment	Location									Mean
	DHL	FZB	JRH	KAL	KAN	KTT	PNT	RPR	SHL	
T1	18.7	18.9	16	27.8	24.6	17.5	19.5	16.1	10	18.1
T2	30.8	26.8	20.9	32	34.7	33.2	29.4	29.5	20.6	27.5
T3	29.1	24	18.1	30.5	32.5	29.2	25.8	20.4	17.7	24.6
T4	25.8	23.2	17.6	29	31.3	23.3	24.6	18.6	16.7	23.1
T5	24.1	22.5	17.5	28.7	29.9	19.7	23.9	18	16.1	22.4
T6	25.8	25.6	17.9	28.2	31.8	28.5	25.5	26	19.6	25.2
T7	26	25.6	19.2	30.3	30.6	28.2	27.7	22.8	18.8	25.4
SEm±	0.3	0.8	0.5	1.3	0.5	0.8	1.8	2	0.4	0.9
CD (0.05)	0.9	2.2	1.5	4.1	1.4	2.4	5.7	6.2	1.1	2.7
CV (%)	1.9	6.3	4.5	7.7	2.6	6.4	12.6	16	4.2	7.3

Table 2.21: Effect of weed management practices on Nitrogen uptake (kg/ha) by weeds (Pooled over years)

Treatment	Location						Mean
	DES	DHL	FZB	JRH	KAN	SHL	
T1	7.5	6.8	5.6	24.5	15.1	55.9	19.2
T2	2.3	1.5	0.0	29.0	3.5	0.0	6.1

T3	2.3	1.5	1.4	28.2	3.9	0.0	6.2
T4	3.1	2.3	2.5	30.1	6.8	7.7	8.8
T5	3.1	2.3	4.0	23.1	10.8	7.7	8.5
T6	3.1	2.3	1.5	17.6	2.6	7.7	5.8
T7	3.1	2.3	1.8	21.6	2.9	7.7	6.6
SEm±	0.1	0.1	0.2	4.9	0.3	0.7	1.0
CD (0.05)	0.2	0.2	0.5	14.6	0.8	2.2	3.1
CV (%)	4.2	5.8	14.3	39.4	8.4	11.8	14.0

The Shillong centre of AICRP recorded the highest uptake of nitrogen by weeds among the AICRP centre. Similarly, the highest uptake of nitrogen took place under weedy check treatment followed by hand weeding at 40 DAP and weed free upto maturity. Application of metribuzin recorded the maximum reduction in nitrogen uptake by weeds than other treatments (Table 2.21).

The Shillong centre of AICRP recorded the highest uptake of phosphorus by weeds among other AICRP centre (Table 2.22). Similarly, the highest uptake of phosphorus took place under weedy check treatment followed by hand weeding at 40/50 DAP and weed free upto maturity. Application of metribuzin recorded the maximum reduction in phosphorus uptake by weeds than other treatments.

The Shillong centre of AICRP recorded the highest uptake of potassium by weeds among other AICRP centres (Table 2.23). Similarly all the centres, recorded the highest uptake of potassium under weedy check treatment followed by hand weeding at 50 DAP and weed free upto maturity. Application of metribuzin recorded the maximum reduction in potassium uptake by weeds than other treatments..

Weed index is the reduction in crop yield due to presence of weeds in comparison with weed-free check, which is an ideal parameter to judge the effectiveness of herbicide or weed

Table 2.22: Effect of weed management practices on Phosphorus uptake (kg/ha) by weeds (Pooled over years)

Treatment	Locations						Mean
	DES	DHL	FZB	JRH	KAN	SHL	
T1	2.6	1.8	1.1	6.3	4.5	13.3	4.9
T2	1.6	0.8	0.0	7.4	0.5	0.0	1.7
T3	1.7	0.9	0.3	7.0	0.8	0.0	1.8
T4	1.8	1.0	0.5	7.6	1.0	1.5	2.2
T5	1.8	1.1	0.8	5.8	1.3	2.1	2.2
T6	1.8	1.0	0.3	4.3	0.7	1.7	1.6
T7	1.8	1.0	0.4	4.9	0.6	1.7	1.7
SEm±	0.0	0.0	0.0	1.1	0.1	0.2	0.2
CD (0.05)	0.1	0.1	0.1	3.2	0.2	0.6	0.7
CV (%)	1.8	6.1	14.2	34.7	8.1	12.9	13.0

Table 2.23: Effect of weed management practices on potassium uptake (kg/ha) by weed (Pooled over years)

Treatment	Location						Mean
	DES	DHL	FZB	JRH	KAN	SHL	
T1	8.1	7.3	11.0	10.0	13.0	50.7	16.7
T2	2.3	1.5	0.0	11.2	3.8	0.0	3.1
T3	3.1	2.3	2.7	11.3	3.2	0.8	3.9
T4	3.9	3.1	4.9	12.4	5.3	6.0	5.9
T5	3.9	3.1	7.8	10.1	8.8	8.1	7.0
T6	3.9	3.1	3.1	7.9	2.1	7.1	4.5
T7	3.9	3.1	3.7	8.9	1.9	7.9	4.9
SEm±	0.1	0.1	0.3	1.9	0.3	1.1	0.6
CD (0.05)	0.3	0.3	1.0	5.7	1.0	3.3	1.9
CV (%)	4.1	5.3	14.4	37.2	11.6	19.3	15.3

management practices. The minimum loss (13.4 %) in crop yield due to presence of weed was found at Kalyani while maximum (53.5%) at Dharwad among all AICRP centres. The weed index (all AICRP centres) was found to be in the range of 7.4–35.0%. The maximum reduction in crop yield due to presence of weed was 35.0 per cent under weedy check followed by T5 (Hand weeding at 50 days and weed free upto maturity) compared to weed free treatment.

The uptake of N, P and K by the weeds was 19.2, 4.9 Kg and 16.7 kg/ha respectively across all locations. The uptake by the potato crop increased by 54.1, 12.4 and 53.2 kg/ha N, P and K due to weed free conditions. The weed control efficiency was highest (95.5%) in weed free treatment followed by weeding at 30 days after planting. Weed control efficiency was only 32.4% under weeding at 50 days after planting treatment while in the case of chemical weed control treatments it was around 65%.

Thus, application of Metribuzin @ 0.75 kg/ha either as pre emergence or as post emergence at 10 % plant emergence were comparable to manual hand weeding to control the weeds in the potato crop.

ROLE OF BORON IN REDUCING TUBER CRACKING IN PROCESSING VARIETY KUFRI CHIPSONA-3

K Chipsona-3 is a variety with good processing quality but the main defect in it is that it has high proportion of cracked tubers. Boron is associated with cracking and hence experiments were conducted to study the effect of Boron in reducing cracking in K. Chipsona-3. An experiment was therefore conducted at Bhubaneshwar, Chindwara, Deesa, Kalyani, Kota and Raipur. The experiment involved different levels of boron in combination with recommended dose of fertilizers as per details below.

T1: RDF of NPK only

T2: RDF of NPK + 2.0 kg B/ha as soil application

T3: RDF of NPK + 0.1% boric acid as foliar application at 40 DAP

T4: RDF of NPK + 0.1% boric acid as foliar application in two equal splits at 40 and 60 DAP

T5: RDF of NPK + 0.1% boric acid as foliar application in three times at 40, 50 and 60 DAP.

The results showed that minimum cracking was in T5 (RDF of NPK + 0.1% boric acid as foliar application in three times at 40, 50 and 60 DAP) at Bhubaneshwar, Chindwara and Raipur while at Kota the differences in yield of cracked tubers were non significant except in T3 (RDF of NPK + 0.1% boric acid as foliar application at 40 DAP) which had significantly lower cracked tubers than T2 (RDF of NPK + 2.0 kg B/ha as soil application). There was no significant difference in cracked tubers among the treatments at Deesa (Table 2.24).

Detailed chemical analysis of leaf, tuber and soil were made and the general conclusions are as below.

Leaf: The results indicated that, highest concentration of Nitrogen was noticed inT4 (4.75%). Phosphorous concentration also showed wide variation, ranging from 0.31 to 0.56. However the mean value was nearly 0.46%. The variation in Potassium concentration was not as large as that of nitrogen which varied from 4.77 to 5.84%.

The Ca concentration was generally on the higher range varying from 3.35 to 3.59% and differences among different treatments were very narrow. Similar was the case with that of Mg which ranged from 0.54 to 0.57%.

Among micronutrients, Fe concentration was generally high, whereas Zn concentration was in optimum range in almost all the samples and differences due to treatments effects was very marginal.

Tuber: No substantial difference in Cu concentration was noticed among different treatments.

The analysis of tubers indicated that the Zn concentration showed maximum variation ranging from 5.40 to 39.50 ppm. Among major nutrients the variation was not significant due to Boron application at different levels.

Soil: The variation in soil properties due to application of Boron in reducing tuber cracking revealed that the pH was not affected greatly due to different treatments. Similar was the case with EC. The available Nitrogen showed marginal differences due to different treatments, whereas available P concentration in soil increased by 2 fold in T_5 treatment. The K concentration was also highest in T_5 treatment. The Ca concentration was generally high irrespective of the treatments. Whereas available Mg was in optimum range in almost all the samples tested.

Among the micronutrients, available Zn concentration varied from 1.06 ppm in T5 to 1.64

Table 2.24: Effect of Boron on cracked tuber yield (t/ha) at different AICRP locations

Treatments	Locations				
	BHB	CHN	DES	KTT	RPR
T1	6.57	0.36	0.47	2.19	1.99
T2	6.84	0.12	0.35	2.96	1.70
T3	6.00	0.17	0.49	1.76	1.56
T4	6.60	0.07	0.42	2.32	1.20
T5	5.92	0.05	0.40	2.11	1.28
SEd	0.28	0.06	0.15	0.47	0.28
CD (0.05)	0.61	0.13	NS	1.03	0.60
CV%	6.19	54.84	49.28	29.48	25.31

ppm in T_3 treatments. Available Fe concentration varied narrowly from 12 to 22 ppm.

RESPONSE OF POTATO TO ZINC APPLICATION

Micronutrients are becoming deficient in potato growing regions due to the high use of P and that as DAP. Therefore Zn deficiency has been noticed in general in potato crop. To study the response to Zn application in potato field experiments were conducted at different centres with the following treatments

T1: RDF of NPK

T2: RDF of NPK + 1.5kg Zn/ha

T3: RDF of NPK + 3.0 kg Zn/ha

T4: RDF of NPK + 4.5 kg Zn/ha

T5: RDF of NPK + 6.0 kg Zn/ha

The results showed that the response varied from location to location. By and large the response was quadratic at Bhubaneswar, Jorhat, Raipur, Hissar, Modipuram, Pantnagar, Chindwara and Deesa, Almost linearly increasing at Kanpur Kota and Faizabad and decreasing at Patna. While no definite trend was noticed at Dholi, Kalyani and (Figs 2.8 to 2.11).

Detailed chemical analysis of leaf, tuber and soil were made and the general conclusions are as below.

Leaf: Nitrogen concentration was generally high and difference due to treatment effect was noticeable. The highest Nitrogen concentration of 4.26% was recorded in T_2 treatment. The Phosphorous concentration showed only marginal difference because of different treatments.

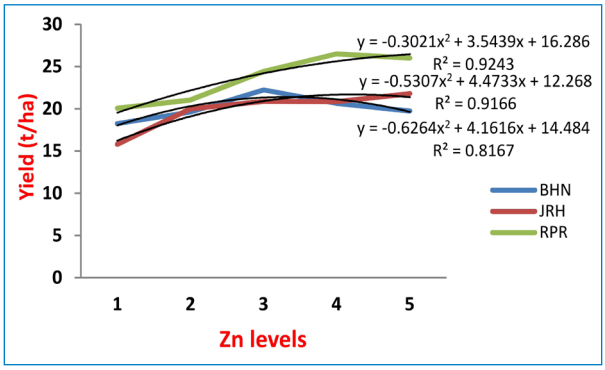


Fig.2.8. Zn influence on tuber yield of potato in the Eastern Plains

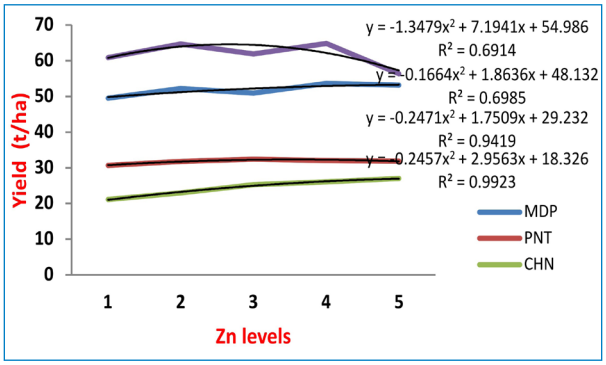


Fig.2.9. Zn influence on tuber yield of potato in the Central & Western Plains

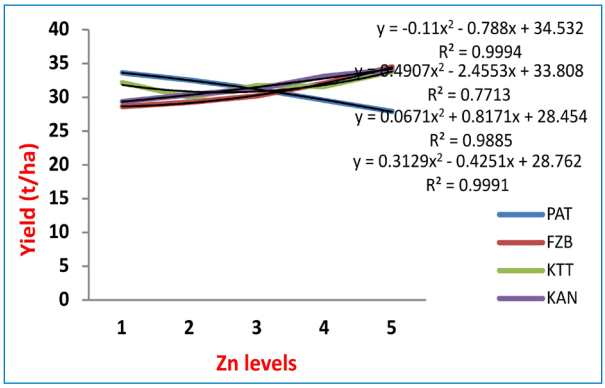


Fig.2.10. Zn influence on tuber yield of potato at Alluvial soil

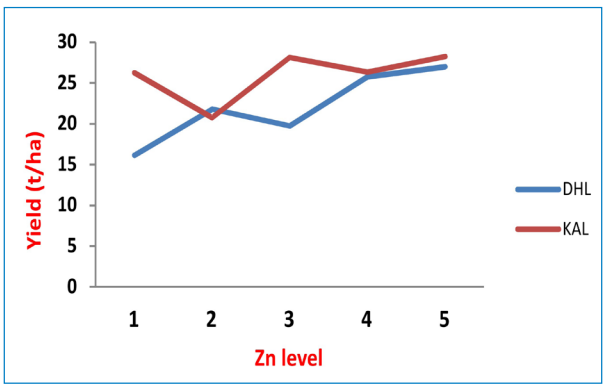


Fig.2.11. Zn influence on tuber yield of potato at Dholi & Kalyani

The potassium concentration was generally high and while treatment effect was very marginal. The Ca concentration was highest in T_5 treatment. The lowest Mg concentration of 0.49% was recorded in T_1 treatment and increased up to 0.71% due to application of 6kg Zn/ha. The variations in Zn concentration was noticed due to imposition of treatments, however there was no specific trend with increasing levels of Zn application, Zn application also influenced the concentration of other micronutrients like Fe and Mn.

Tuber: The monitoring of concentration of different nutrients in potato tuber due to Zn application revealed that Zn level in tuber varied from 19.95 to 31.00 ppm with the highest being in T_3 treatments.

Soil: The pH was near neutral in reaction and Ec was within safe range in almost all the places and irrespective of treatments. The available Nitrogen varied from 86 to 126 ppm. Highest available Nitrogen was noticed in T1. The available Phosphorous was generally high in almost all the samples while the differences due to treatments was noticeable with highest available P in T_2 treatment. Among the major nutrients K concentration showed least fluctuation due to treatments. The Ca concentration was very high irrespective of treatments, whereas Mg concentration was in optimum range in almost all the treatments. Among the micronutrients, the application of Zn made only marginal difference In DTPA extractable Zn status of soil with the highest Zn of 2.33 ppm being noticed in T_2 treatment. The available Fe also got affected only marginally due to imposition of Zn treatments in potato.

EVALUATION OF POTATO - TRANS-PLANTED ONION SEQUENCE

Potato onion sequence is an important sequence since both are important crops and have similar problems. This sequence is especially suited for the eastern plains. The success of the sequence depends upon the proper adjustment of the

Table 2.25: Yield of potato and onion component crops under different planting and harvesting dates

Treatments	Faizabad						Patna					
	Potato yield (t/ha)			Onion yield (t/ha)			Potato yield (t/ha)			Onion yield (t/ha)		
	H1	H2	Means	H1	H2	Means	H1	H2	Means	H1	H2	Means
D1	24.19	26.85	25.52	32.96	30.82	31.89	25.91	28.46	27.18	19.64	20.27	19.96
D2	27.32	29.66	28.49	32.05	29.50	30.77	27.34	31.62	29.48	20.83	18.05	19.44
D3	23.70	26.17	24.94	30.57	26.69	28.63	25.26	29.24	27.25	15.67	13.15	14.41
Means	25.07	27.56	26.31	31.86	29.00	30.43	26.17	29.77	27.97	18.71	17.16	17.94
SE (D)	0.44			0.58			1.23			0.65		
SE (H)	0.36			0.47			1.01			0.53		
SE (DH)	0.63			0.82			1.74			0.92		
CD D (5%)	0.94			1.23			2.63			1.39		
CD H (5%)	0.77			1.01			2.14			1.13		
CD DH (5%)	1.33			1.75			3.72			1.96		
CV (%)	3.36			3.81			8.81			7.27		

planting and harvesting schedule. Therefore studies were initiated at Faizabad and Patna to determine the proper planting and harvesting schedule for potato and onion following potato. The treatments comprised of three dates of planting viz optimum, 10 days before and 10 days after optimum and 2 harvesting dates viz 80 and 90 days after planting.

The results (Tables 2.25) shows that the potato and onion yields were affected significantly by both planting and harvesting dates. While optimum time of planting and harvesting at 90 days after planting is best for high yield of potato early planting and harvest is advantageous for onion.

EFFECT OF DRIP FERTIGATION ON GROWTH AND YIELD OF POTATO.

An experiment was initiated at Hisar to study the N savings due drip fertigation. The treatments comprised of different proportion of recommended N dose (%) applied according to standard practice which served as the control. The results (Table 2.26) showed that tuber yield was significantly higher when 60 and 80 % of the recommended N dose was applied through fertigation. At higher N dose through fertighation, the yields, though higher than in the standard practice, but were lower than when 60 and 80% were applied through fertigation.

DEVLOPMENT OF POTATO BASED ORGANIC FARMING SYSTEM

The experiment was conducted at Faizabad, and Pasighat with the objective to optimize the yield under organic potato production system through the use of crop residues in conjunction with microbial cultures. The treatment details are as below:

T1: Absolute control

T2: Coventional technology

T3: Cropresiduebased:compositingofavailable cheaper crop/weed residues (like NADEP method) + Crop residue incorporation (Main crop/catch/green manuring/bio-fumigation crop) + biofertilizer (*Azotobacter* and Phosphobacteria) + microbial culture to decompose crop residues

Table 2.26: Tuber yield in different grades under different N doses through fertigation

Treatments	Grade-wise yield (t/ha)				
	0-25g	25-50g	50-75g	>75g	Total
T1-60% N	3.61	4.65	8.39	17.20	33.84
T2-80% N	2.82	5.56	7.16	15.62	31.15
T3- 100% N	2.81	6.18	6.94	12.42	28.35
T4- 120% N	2.95	4.10	7.54	13.85	28.43
T5 - 140% N	2.84	4.79	7.96	11.42	27.01
T6 RDF N as basal dose in Furrow irrigation	2.14	5.03	5.93	9.49	22.59
SEd	0.18	0.23	0.36	0.61	0.77
CD(0.05)	0.39	0.49	0.77	1.30	1.65
CV%	9.05	6.42	6.95	6.47	3.83

T4: T3 + FYM @ 25 t/ha

T5: T3 + Vermicompost 7.5 t/ha

The results showed that T2 (Coventional technology) gave significantly higher yield as compared to the organic treatments. However, T4 (Crop residue based: compositing of available cheaper crop/weed residues (like NADEP method) + Crop residue incorporation (Main crop/catch/green manuring/bio-fumigation crop) + biofertilizer (*Azotobacter* and Phosphobacteria) + microbial culture to decompose crop residues + FYM @ 25 t/ha and T5 (Coventional technology) gave significantly higher yield as compared to the organic treatments. However, T4 (Crop residue based: compositing of available cheaper crop/weed residues (like NADEP method) + Crop residue incorporation (Main crop/catch/green manuring/bio-fumigation crop) + biofertilizer (*Azotobacter* and Phosphobacteria) + microbial culture to decompose crop residues + Vermicompost 7.5 t/ha) gave reasonably high yield and seems to be promising at both Faizabad (Table 2.27) and Pasighat (Table 2.28).

Table 2.27: Plant emergence (%), morphological traits and grade-wise tuber yield (t/ha) at Faizabad

Treatments	Emergence (%)	Plant height (cm)	No. of shoots/ plant	Marketable yield (t/ha)	Non -marketable yield (t/ha)	Total yield (t/ha)
T1	94.22	32.60	3.00	10.91	3.60	14.51
T2	95.32	55.50	6.60	30.03	2.59	32.62
T3	92.50	35.42	4.50	14.62	3.19	17.81
T4	95.32	46.75	5.21	19.77	3.75	23.53
T5	93.91	51.47	6.05	22.21	2.99	25.21
SEd	0.98	1.93	0.28	0.85	0.16	0.99
CD(0.05	2.15	4.21	0.61	1.85	0.34	2.16
CV %	1.48	6.17	7.78	6.17	6.87	6.15

Table 2.28: Plant emergence (%), morphological traits and grade-wise tuber yield (t/ha) at Pasighat

Treatments	Emergence (%)	Plant height (cm)	No. of shoots/ plant	Marketable yield (t/a)	Non-marketable yield (t/a)	Total yield (t/ha)
T1	83.50	32.94	3.50	10.11	0.10	10.21
T2	80.00	31.87	4.75	31.71	0.12	31.83
T3	79.50	36.49	5.25	15.88	0.16	16.04
T4	79.75	37.73	3.25	17.22	0.09	17.31
T5	79.50	38.21	6.25	17.35	0.15	17.50
SEd	2.90	2.86	1.10	1.43	0.12	1.47
CD (0.05)	6.33	6.24	2.40	3.11	0.25	3.19
CV %	5.10	11.43	33.91	10.93	133.13	11.16

CROP PROTECTION

MONITORING OF LATE BLIGHT AND A2 MATING TYPE OF *PHYTOPHTHORA INFESTANS* IN STANDING CROP AND TUBERS AT HARVEST AND AFTER COLD STORAGE

Monitoring for late blight appearance and its progress was undertaken in 10 locations during *rabi*, summer and *kharif* seasons. During *rabi* 2014, late blight monitoring was undertaken in 8 locations, i.e. Faizabad, Jorhat, Kalyani, Kanpur, Kota, Patna, Pantnagar, and Passighat. The experiment involved planting the crop of a susceptible variety viz Kufri Chandramukhi, Kufri Jyoti or Kufri Bahar on three dates and harvested them accordingly on three dates.

Table 3.1: Late blight appearance date and incidence at different days after appearance

Centre	Date of 1st appearance of LB	Incidence (%) at days				
		7	14	21	28	At harvest
Faizabad	D1: 04.01.15	<5	5-10	20-30	>70	5-10
	D2: 06.01.15	<5	5-10	20-30	>70	<5
	D3: 06.01.15	<5	5-10	20-30	>70	<5
Jorhat	Disease did not appear					
	D2:09.02.15	<5	0			
	D3:09.02.15	5-10	10-20	Crop Harvested	0	
Kalyani	D1: 24.1.15	20-30	40-50	60-70	>70	-
	D2: 25.1.15	20-30	40-50	60-70	>70	-
	D3:28.1.15	30-40	60-70	>75	-	-
Kanpur	D1: 28.11.14	<5	<5	5-10	10-20	5-10
	D2: 05.12.14	<5	<5	5-10	10-20	5-10
	D3: 04.12.14	<5	<5	5-10	10-20	<5
Kota	Disease did not appear					
Pantnagar	D1: 08.12.14	<5	10-20	40-50	60-70	Nil
	D2: 16.12.14	<5	5-10	30-40	70.0	Nil
	D3: 24.12.14	<5	5-10	30-40	>70	Nil
Patna	D1: 24.12.14	5-10	20-30	>70	>70	<5
	D2: 03.01.15	10-20	30-40	>70	>70	<5
	D3: 13.01.15	5-10	20-30	60-70	>70	<5
Pasighat	D1:26.12.14	5-10	10-20	10-20	10-20	5-10
	D2:08.01.15	5-10	10-20	10-20	10-20	10-20
	D3:14.01.15	26.0	20-30	30-40	30-40	10-20
Shillong	D1: 02.06.14	<5	20-30	>70	>70	5-10
	D2: 02.06.14	<5	5-10	60-70	>70	<5
	D3: 02.06.14	<5	5-10	60-70	>70	<5
Sringar	D1:08.06.14	5-10	10-20	20-30	30-40	<5
	D2:01.07.14	10-20	10-20	30-40	30-40	5-10
	D3:20.07.14	10-20	20-30	30-40	40-50	5-10

The results show that there was no late blight incidence at Jorhat in the first date of planting and in Kota (Table 3.1). At Faizabad, Pantnagar and Shillong the disease was <5% at 7 days after disease appearance and increased gradually. The disease incidence was higher at 7 days after disease appearance at Patna in the first two dates of planting and Srinagar in all the dates of planting. However, at 7 days after disease appearance the disease incidence was highest at Kalyani which indicates that the rate of growth of the disease was fastest at Kalyani perhaps due to the favourable temperatures and high humidity. Tuber infection was not reported at Jorhat and Pantangar, it was very less at Faizabad, Patna and Shillong while at the other centres it was about 5-10%. From the analysis of the pathogen collected in the plains (Punjab, West Bengal, Bihar, MP, UP) and the hills it is apparent that A_2 mating type has completely replaced A_1 mating type in the plains.

SURVEILLANCE OF IMPORTANT POTATO PESTS IN THE REGION (PEST CAPTURE PLOTS)

The pests and diseases occurring in potato crop were recorded at different AICRP centres in pest capture plots raised for this purpose (Table 3.2). The pests and diseases observed at the different centres are given in (Table 3.2). Perusal of the table shows that Late blight was very serious at Ooty, Patna, Shillong Faizabad, Hassan and moderate at Pantnagar, Raipur, Kalyani, Srinagar. The interesting observation is that late blight was reported from Raipur which is not prone to late blight has also recorded this time.

Early blight was recorded at all the centres except Dholi, Hassan, Kota, Patna and Raipur. Higher incidence was recorded from Bhubaneswar, Chhindwara, Deesa, Faizabad, Jorhat, Kanpur, Ooty, and Srinagar.

Table 3.2: Pests and diseases observed in pest capture plots at different centres.

Location	Diseases					
	LB	EB	Leaf spot	Mosaics	CS	BS
Bhubaneswar	NR	2-14	0-3	0-2	0.5-1.0	NR
Chhindwara	NR	13-24	5-8	2-7	0.3-0.4	0.6-1.3
Deesa	NR	7-12	NR	2-6	2-30	1-22
Dholi	10-63	NR	NR	0-5	NR	2-5
Faizabad	20-90	0-35	0-13	4-15	12-29	30-40
Hassan	80-100	NR	NR	20-56	NR	NR
Hisar	NR	0-2	NR	NR	NR	14.5-57.5
Jorhat	0-6	4-14	NR	0-7	7.2-12.6	NR
Kalyani	53-86	0-5	0-4	0-4	1.6-5.8	NR
Kanpur	5-7.5	6-12	2-3	3-5	1.5-2.4	1.5-3.3
Kota	NR	NR	NR	NR	NR	25-37
Ooty	1-100	2-70	NR	NR	0-3.2	NR
Patna	82-95	NR	8-44	0-1	0-3	0-1
Pasighat	10-13	4-8	3-5	3-4	3-6	NR
Pantnagar	20-80	0-5	NR	0-10	NR	0-20
Raipur	58-78	NR	NR	28-40	4-8	NR
Shillong	15-100	2-8	2-3	NR	NR	NR
Srinagar	22-39	15-25	NR	6-15	NR	NR

Comparatively lower incidence was recorded from Hisar, Kalyani, Pasighat, Pantnagar, and Shillong. At some centres both early blight and late blight have been reported which indicates different weather profile at different phases of the crop.

Incidence of *Phoma* leaf spot was most severe at Patna followed by Faizabad. Chhindwara also had a high degree of leaf spots. The centres had very low incidence of leaf spots.

Except Hisar, Kota, Ooty and Shillong all centres have reported one or the other forms of mosaics in the pest capture plots. Hassan and Raipur have reported the highest incidence.

Common scab have been observed only at Bhubaneswar, Chhindwara, Deesa, Faizabad, Jorhat, Kalyani, Kanpur, Ooty, Patna, Pasighat and Raipur centres with the incidence being very high at Faizabad, Jorhat and Raipur centres. The incidence of black scurf was also high at Faizabad, Hisar,Kota and Pantnagar.

Aphid infestation was reported from most of the centres, Whitefly from Bhubaneswar, Dholi, Hisar, Kanpur, Kota, Pasighat, and Raipur. Thrips infestation was recorded in Kota. Infestation of *Heliothis* was recorded in Pasighat. Potato tuber moth damage was recorded in Hassan. Tuber damage due to soil borne insects like cut worms were reported from Deesa, Kanpur, Ooty, Patna, Pasighat and Srinagar while white grubs damage was observed in Dholi, Ooty, Pasighat, Shillong and Srinagar. Mole cricket in Jorhat, Kalyani and Pasighat, and red ants in Jorhat and Pasighat were also recorded.

MANAGEMENT OF LATE BLIGHT

Late blight forecasting and management

Forecasting the time of disease appearance is very critical in late blight management so that prophylactic control measures can be adopted timely. Under the AICRP (Potato), the date of appearance of late blight is being monitored at those centres where it is a severe problem and this was related to weather factors to develop a generic model INDOBLIGHTCAST. The model requires daily minimum & maximum temperature and minimum & maximum relative humidity from meteorological observatory as inputs. The model computes the Physiological days (P-days) and the night time relative humidity and both P days and night time relative humidity are accumulated over the previous 7 days. Test of various permutations and combinations of accumulated P-days and accumulated relative humidity showed that the thumb rule "if the accumulated P-days over 7 days exceeds 52.5 and accumulated RH over the same period exceed 525 for 7 consecutive days, then late blight would appear within the next 15 days" gave reliable forecasts across agro-ecologies. **This model was tested during the year under report at Dholi, Faizabad, Kalyani, Pantnagar and Ooty centres. The results shows that the difference between model predicted date of late blight appearance and actual date of appearance was less than 15 days at all the centres thus validating the model.**

This model was also built as a DSS framework. The framework consists of two modules one for data entry and the other for the general users to see the late blight forecast. The data entry module consists of a database to "Add data" (to enter data),"Load data"(for viewing already entered data), "Edit data" (to change entered data values) and "Delete data" (to remove data) on daily basis (Fig 3.1). The other module is for checking the late blight appearance status. This consists of a window with drop down menu to select location which would lead to another window with a calendar, a run model button and a 2 x 15 dimensional array for display of disease severity status

(Fig 3.1). The user can select a date in the calendar and click on the "Run model" button which would then display the status of late blight for fifteen days prior to the selected date in the 2 x 15 dimensional array. The first row displays the date while the second row displays the disease severity values and the late blight status in colour code. The colour code consists of three colours; Green colour (for disease severity values up to 4) indicates that late blight is not likely to appear soon; yellow colour (for disease severity values between 4-6) indicates that late blight would appear very soon; and red colour (for disease

Fig 3.1: Screen shots of Indoblightcast home page and forecast display page

severity values above 6) indicates that the weather conditions have become suitable for late blight and it can appear any time within fifteen days.

The start of spray at yellow colour is advised because in the case of late blight prophylactic control is advised and some time is required for completing the spray operation in the field especially in large farms. The display of the status of late blight of the previous 15 days enables to decide whether to spray or not because if late blight appearance had been predicted earlier and preventive sprays had been given, then it would help to decide whether the spray is to be repeated or not. Thus, the structure of the DSS enables its use not only to forecast late blight appearance but also decide on the need based application of fungicides.

SCHEDULING OF FUNGICIDE APPLICATION FOR THE MANAGEMENT OF LATE BLIGHT

The late blight pathogen has the ability to quickly a dapt to fungicidal formulations and host genotypes. It is, therefore, essential to find out effective fungicidal formulation for its management in a continuous basis. With this in mind, an experiment was conducted to find out suitable spray schedule for effective management of late blight. The experiment was conducted at 5 locations, i.e. Hassan, Pantnagar, Patna, Shillong and Srinagar in RBD with 6 treatments and 3 replications as per treatment details below.

T1 Prophylactic spray (just at the time of canopy closure) with mancozeb @ 0.2% followed by two more sprays at weekly intervals.

T2 Prophylactic spray (just at the time of canopy closure) with mancozeb followed by three more sprays at weekly intervals.

T3 Prophylactic spray (just at the time of canopy closure) with mancozeb followed by cymoxanil + mancozeb @ 0.3% and one more spray with mancozeb.

T4 Prophylactic spray (just at the time of canopy closure) with mancozeb followed by Fenamidone + mancozeb (Secure/Sectin 50% WG) @ 0.3% and one more spray with mancozeb.

T5 Prophylactic spray (just at the time of canopy closure) with mancozeb followed by dimethomorph 0.2% + Mancozeb @ 0.3% followed by mancozeb.

T6 Control.

Table 3.3: AUDPC of late blight incidence at different centres and varieties

Treatment	Hassan (K Jyoti)	Pantnagar (K Bahar)	Pantnagar (K Sutlej)	Patna (K Ashoka)	Patna (K Jyoti)	Shillong (K Jyoti)
T1	2226.11	724.50	586.25	1172.54	1297.31	1489.85
T2	2001.30	540.75	451.50	1262.24	1308.97	1465.38
T3	1846.15	470.75	404.25	633.54	777.00	946.19
T4	1666.04	319.38	367.50	1040.66	851.69	928.66
T5	1867.25	246.75	220.50	1126.97	945.00	862.23
T6	2685.45	1974.00	1707.13	1985.66	2214.38	2677.54

The results showed that the disease progressed almost linearly in all the treatments. All the treatments reduced the disease intensity as seen by the AUDPC values (Table 3.3). The highest value was in control which had a value ranging from 2685.45 at Hassan to 1707.1 in V2 at Pantnagar. Here, the lowest value was in T4 (Prophylactic spray (just at the time of canopy closure) with mancozeb followed by Fenamidone+mancozeb (Secure/ Sectin 50% WG) @ 0.3% and one more spray with mancozeb). The disease intensity was lesser at Pantnagar and Patna as seen by the AUDPC values in control which were 1974, 1707.13, 1985.66 and 2214.38 in V1 and V2 at Pantnagar and Patna respectively. However the best treatment was different at both the locations. At Pantnagar the lowest AUDPC values (246.75 and 220.5 in V1 and V2 respectively) were in T5 (Prophylactic spray (just at the time of canopy closure) with mancozeb followed by dimethomorph + Mancozeb @ 0.3% followed by mancozeb) while at Patna it was (633.535 and 777 in V1 and V2 respectively) in T3 (Prophylactic spray (just at the time of canopy closure) with mancozeb followed by cymoxanil+mancozeb @ 0.3% and one more spray with mancozeb). At Shillong in the eastern hills, late blight severely affected the V1 variety but there was hardly any effect on V2. Therefore, AUDPC values were computed for V1 only which showed that here also, T5 (Prophylactic spray (just at the time of canopy closure) with mancozeb followed by dimethomorph + Mancozeb @ 0.3% followed by mancozeb) was the best as seen by the AUDPC values (862.23), however, T3 (Prophylactic spray (just at the time of canopy closure) with mancozeb followed by cymoxanil+mancozeb @ 0.3% and one more spray with mancozeb) and T4 (Prophylactic spray (just at the time of canopy closure) with mancozeb followed by Fenamidone+mancozeb (Secure/Sectin 50% WG) @ 0.3% and one more spray with mancozeb) were also equally effective in decreasing the AUDPC.

Pooled analysis of the yield over years was carried out for Pantnagar and Shillong centres and results showed that the differences in AUDPC were reflected in yield in the different treatments. At Pantnagar (Table 3.4) the main effect of year, variety and location were significant. The interaction of variety and treatment was also significant. Perusal of the table shows that all the treatments increased the yield significantly over control as regards main effects. However, perusal of the interactions

Table 3.4: Tuber yield in different late blight control treatments at Pantnagar

Factors	T1	T2	T3	T4	T5	T6	Mean for Varieties
K Bahar	39.99	40.29	40.76	43.44	45.08	27.90	39.58
K Sutlej	23.17	25.38	24.95	24.77	24.21	19.89	23.73
Mean for Treatment	31.58	32.84	32.85	34.10	34.65	23.89	
C.D. (5 %)	Year = 1.71			Varieties = 1.39		Varieties x Year = N.S.	
C.D. (5 %)	Treatment = 2.41		Year x Treatment = 4.18			Varieties x Treatment = 3.41	
	Year x Varieties x Treatment = N.S.						

shows that in the case of Kufri Bahar all the treatments increased the yield significantly over control but the differences between T1, T2 and T3 were non significant. T4 and T5 were inturn non significant between themselves. In the case of Kufri Sutlej, T2, T3, T4 and T5 increased the yield significantly over control but were no significant between themselves. **Thus, treatments T4 (T4 Prophylactic spray (just at the time of canopy closure) with mancozeb followed by Fenamidone+mancozeb (Secure/ Sectin 50% WG) @ 0.3% and one more spray with mancozeb) and T5 (Prophylactic spray (just at the time of canopy closure) with mancozeb followed by dimethomorph + Mancozeb @ 0.3% followed by mancozeb) are the best for the control of late blight at Pantnagar.**

In the case of Shillong (Table 3.5) also the mean effect of varieties and treatments were significant. The interaction of varieties and treatment was also significant. Perusal of the interactions shows that treatments T1 and T2 significantly increased the yield over control but were non significant between themselves. Treatments T3, T4 and T5 increased the yield significantly even over treatments T1 and T2 but were non significant between themselves. In the case of Kufri Girdhari also all the treatments significantly increased the yield over control but the best control was in treatments T4 and T5 which were non significant between themselves. **Thus, treatments T4 (Prophylactic spray (just at the time of canopy closure) with mancozeb followed by Fenamidone+mancozeb (Secure/ Sectin 50% WG) @ 0.3% and one more spray with mancozeb) and T5 (Prophylactic spray (just at the time of canopy closure) with mancozeb followed by dimethomorph + Mancozeb @ 0.3% followed by mancozeb) are the best for the control of late blight at Shillong.**

At Srinagar, late blight appeared after 75 days in Kufri Badshah and 78 days in Kufri Jyoti. Minimum incidence of late blight (8.60%) was recorded in T5 followed by T4 and T11 on first date of observation. On second and third dates of observation, same trend was observed. On last date of observation i.e. 28 days after appearance, minimum incidence of late blight (17.9%) was recorded on Kufri Jyoti in the treatment where prophylactic spray of mancozeb followed by dimethomorph+mancozeb and one more spray of mancozeb (T5) was given. The next best treatment was prophylactic spray of

Table 3.5: Tuber yield in different late blight control treatments at Shillong

Factors	T1	T2	T3	T4	T5	T6	Mean for Varieties
K. Jyoti	30.20	30.79	34.11	34.88	35.51	22.35	31.31
K. Giridhari	34.86	34.99	35.67	36.28	37.10	34.23	35.52
Mean for Treatment	32.53	32.89	34.89	35.58	36.31	28.29	
C.D. (5 %)	Year = 1.26			Varieties = 1.03		Varieties x Year = N.S.	
C.D. (5 %)	Treatment = 1.78 Year x Varieties x Treatment = N.S.		Year x Treatment = N.S.			Varieties x Treatment = 2.51	

mancozeb followed by fenamidone+mancozeb and mancozeb spray on Kufri Jyoti (T4). Maximum yield (37.75t/ha) was recorded in T5 followed by T11 (35.12t/ha) and T4 (35.22t/ha) treatment.

STUDIES ON RATE OF DEGENERATION

Degeneration of seed health is the primary limiting factor for production of certified seed potato in a particular area. It also decides how frequently seed replacement is required for ware potato production. Rate of degeneration was studied at four locations, i.e. Deesa, Kalyani, Pune, and Raipur. The experiment involved planting seed of previous generation and recording incidences of mild mosaic, severe mosaic and PLRV were recorded after 50, 65 and 80 days of planting. Yield data was also recorded on harvest. Incidences of mild mosaic, severe mosaic as well as PLRV were lower in crops raised from fresh breeder seed. Incidence of mild mosaic and severe mosaic was 6.0 and 5.0%, respectively at Deesa, 1.18 and 0.87%, respectively, whereas no incidence of mild and severe mosaic was observed at Kalyani. PLRV incidence was 13 and 0.46% at Deesa and Raipur, respectively and nil at Kalyani.

EVALUATION OF VARIETIES FOR RESISTANCE AGAINST POTATO APICAL LEAF CURL VIRUS

Apical leaf curl virus is spread by white flies. It is likely to become the major threat to potato seed production in future under the climate change scenario due to the warming of the potato growing season. Varietal differences as well declining trend in the population of whiteflies during the season have been observed. Therefore, studies to monitor the population of whiteflies on different varieties have been conducted since a few years. During

the year under report the study was conducted at Hisar, Deesa and Kota which are known to be hot spots for PALCV disease. The studies at Hisar showed that the population was high at the time of emergence and early growth and decreased progressively as the season advances. Varietal differences in the initial population and rate of decline have been observed with Kufri Khyati having the highest population followed by Kufri Pukhraj. Kufri Bahar had the lowest population of white flies. At Deesa, none of the varieties was found free from the disease. However, minimum incidence (5.27%) of apical leaf curl disease was recorded in Kufri Badshah followed by Kufri Anand (7.90%), Kufri Pushkar (8.78%) and Kufri Himsona (8.82%). On the other hand, highest incidence (29.86%) was recorded in Kufri Jyoti. At Kota, ten varieties were evaluated out of which Kufri Chipsona-4, Kufri Garima, Kufri Pukhraj, and Kufri Sadaahar remained disease free. The trends in the white fly population were reflected in the PALCV disease incidence. Correlation between PALCV disease incidence and White fly population was worked out over varieties and years for Deesa and Hisar. The results showed that the correlation coefficient was 0.77 which was highly significant.

Analysis of Leaf samples from Pantnagar, Dholi, Kota, Modipuram, Hisar, Pune and

Bhubaneshwar showed mixed infection of viruses. PALCV and PVX were also observed in the samples from the various centres except that of Dholi. PVY was found only in Pantnagar and Modipuram samples

EVALUATION OF VARIETIES FOR RESISTANCE AGAINST STEM NECROSIS DISEASE

Stem necrosis is caused by a virus groundnut bud necrosis virus which is transmitted by thrips. Therefore, monitoring of thrips population and its management is very important for controlling this disease. Varietal differences in the host preference of thrips has been reported hence, information on the population build up in different varieties of potato needs to be studied. Studies on monitoring the thrips population on different potato varieties were therefore conducted at Chhindwara, Deesa and Kota centres. The studies (Table 3.6) showed that at Chhindwara, there was no significant difference in per cent

Table 3.6: Incidence (%) of stem necrosis in different varieties at different centres at harvest

Location					
Chhindwara		Deesa		Kota	
Genotype	Incidence (%)	Genotype	Incidence (%)	Genotype	Incidence (%)
K Surya	7.60	K Badshah	2.63	K Gaurav	5.33
K Chipsona-3	8.04	K Pukhraj	3.49	K Chipsona-4	2.00
K Khyati	6.97	K Khyati	3.53	K Garima	3.67
K Pukhraj	7.16	K Laukar	4.41	K Pukhraj	35.33
K Bahar	8.78	K Surya	5.31	K Bahar	63.67
K Jyoti	8.46	K Jyoti	4.36	K Pushkar	32.67
		K Chipsona-3	3.49	K Sutlej	42.33
		K Bahar	5.27	K Surya	9.00
		K Sadabahar	4.36	K Sadabahar	3.33
		K Anand	3.49	K Khyati	9.33
		K Sutlej	3.53	K Anand	11.33
		K Himsona	2.63	K Sindhuri	10.00
		K Frysona	3.51		

		K Pushkar	6.14		
SEd	0.89		1.24		1.69
CD(0.05)	1.98		2.56		3.50
CV%	13.85		37.96		10.87

incidence of stem necrosis among different varieties. The incidence ranged from 6.97 to 8.78% being minimum in Kufri Khyati and highest in Kufri Bahar. Thrips population was highest after 40 days which decreased thereafter. At Deesa, none of the varieties were found disease free. The incidence ranged from 2.63 t0 6.14% being minimum in Kufri Badshah and Kufri Himsona and highest in Kufri Pushkar. Thrips population was high after 60 days after planting.

At Kota, none of the twelve varieties evaluated were found disease free. However, minimum incidence was recorded in Kufri Chipsona 4 (2%) followed by Kufri Sadabahar & Kufri Garima (3.33 and 3.67%) while highest was recorded in Kufri Bahar (63.67%). No relationship between stem necrosis incidence and thrips population could be established since the correlation values were low.

MANAGEMENT OF EARLY BLIGHT

Early blight is a very serious fungal disease of potato. It occurs in situations where late blight does not occur due to high temperature even though humidity conditions are suitable. Six treatments as given below were evaluated for their effectiveness against early blight and pooled analysis carried out for the trials conducted at Deesa, Pune.and Raipur.

Treatment details

T1: Control

T2: Three sprays of mancozeb 75WP (0.25%) at 10 days interval*

T3: Three sprays of chlorothalonil 75WP (0.25%) at 10 days interval

T4: Three sprays of hexaconazole 5EC (0.05%) at 10 days interval

T5: First spray of mancozeb 75WP (0.25%), second spray of hexaconazole 5EC (0.05%) and third spray of mancozeb 75WP (0.25%) at 10 days interval

T6: First spray of chlorothalonil 75WP (0.25%), second spray of hexaconazole 5EC (0.05%) and third spray of chlorothalonil 75WP (0.25%) at 10 days interval

The results showed that the disease was severe at Pune with a terminal disease severity of 36.3%. All the treatments reduced disease severity significantly compared to control leading to reduction in AUDPC (fig. 3.2) and the minimum AUDPC was observed in T6 (First spray of chlorothalonil 75WP (0.25%), second spray of hexaconazole 5EC (0.05%) and third spray of chlorothalonil 75WP (0.25%) at 10 days interval).

Pooled analysis of the yield showed that location, year, treatment was significant but

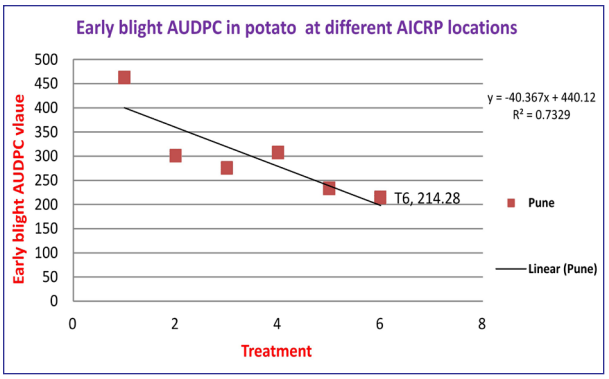


Fig 3.2 AUDPC of early blight incidence in different treatments at Pune

Table 3.7: Tuber yield as affected different fungicide treatments at different locations

Factors	T(1)	T(2)	T(3)	T(4)	T(5)	T(6)	Mean for Locations
Deesa	41.26	41.76	43.26	44.65	47.45	50.09	44.74
Pune	11.95	15.61	16.01	15.71	17.59	18.92	15.96
Raipur	18.18	19.44	20.15	20.86	22.01	21.33	20.33
Mean for Treatments	23.80	25.60	26.47	27.07	29.02	30.11	
C.D. for Location				1.11			
C.D. for Treatment				1.58			
C.D. for Location x treatment				N.S.			

the location x treatment interaction (Table 3.7) was non significant. Perusal of the mean yield under different treatments shows that it was the lowest in control and that all the treatments increased the yield significantly over control.

The yield under treatments T2 (Three sprays of mancozeb 75WP (0.25%) at 10 days interval), T3 (Three sprays of chlorothalonil 75WP (0.25%) at 10 days interval) and T4 (Three sprays of hexaconazole 5EC (0.05%) at 10 days interval) were significantly higher than control but non significant among themselves. Similarly yields under treatments T5 (First spray of mancozeb 75WP (0.25%), second spray of hexaconazole 5EC (0.05%) and third spray of mancozeb 75WP (0.25%) at 10 days interval) and T6 (First spray of chlorothalonil 75WP (0.25%), second spray of hexaconazole 5EC (0.05%) and third spray of chlorothalonil 75WP (0.25%) at 10 days interval) were significantly higher than control and also the T2, T3 and T4 group of treatments but non significant between themselves. **Thus the best control against early blight is obtained by T5 (First spray of mancozeb 75WP (0.25%), second spray of hexaconazole 5EC (0.05%) and third spray of mancozeb 75WP (0.25%) at 10 days interval) and T6 (First spray of chlorothalonil 75WP (0.25%), second spray of hexaconazole 5EC (0.05%) and third spray of chlorothalonil 75WP (0.25%) at 10 days interval) treatments.**

MANAGEMENT OF COMMON SCAB

Common scab is an important tuber borne disease in the Indo Gangetic plains. Seed treatment with boric acid is recommended for controlling this disease. In the search for safer chemicals for the control of common scab, mustard as biofumigant and pyrites due to its potential to create acidic environment were tested. The experiment was conducted at Faizabad and Kanpur with treatments as in table below.

T1: Untreated diseased tubers (Control)

T2: Tuber dip treatment with 3% boric acid for 20 minutes before storage

Table 3.8: Incidence of common scab at Faizabad and Kanpur under different treatments

Treatment	Location	
	Faizabad	Kanpur
	Incidence of diseases in tubers at harvest	Incidence of diseases in tubers at harvest
T1	56.25	14.13
T2	14.68	5.10
T3	27.43	5.89
T4	22.58	7.50
T5	17.85	6.85
T6	36.68	10.63
T7	28.20	6.98
SEd	2.53	0.44
CD(0.05)	5.32	0.93
CV%	12.30	7.65

T3: Biofumigation by incorporating one month old Indian Mustard crop (seed rate 5 kg/ha) just before the planting of potato crop

T4: T3 + compost culture to decompose Biofumigant

T5: T3 + Tuber dip treatment with 1.5% boric acid for 20 minutes before storage

T6: Pyrites @ 2.0 t/ha (soil application)

T7: T3 + Pyrites @ 2.0 t/ha

The results showed that incidence of common scab were very high at Faizabad (56.25%) while at Kanpur it was only 14.13% (Table 3.8). Further all the treatments significantly reduced common scab (CS) incidence and severity compared to control (T1) both at Faizabad and Kanpur. The CS incidence and severity was minimum (14.68 and 11.78%, respectively) in tuber dip treatment with 3% boric acid for 20 minutes before storage (T2) at Faizabad while at Kanpur tuber dip treatment with 3% boric acid for 20 minutes before storage (T2) and bio-fumigation with Indian mustard (T3) recorded minimum CS incidence (5.1 and 5.9%, respectively) and severity (5.4 and 5.9%, respectively).

ENTOMOLOGY

MONITORING OF APHIDS, *Myzus Persicae* and *Aphis Gossypii* IN UNSPRAYED POTATO CROP

The aphids are the vectors of important potato viruses mainly PVY and PLRV responsible for seed degeneration and lower yields. The dominant aphid vectors in India are *Myzus persicae* and *Aphis gossypii*. The continuous monitoring and studying vector dynamics is crucial not only to maintain the crop health status but also helps in identifying new seed production areas for healthy potato production. In this context, aphids population was monitored on unsprayed potato crop at 19 AICRP centers, Bhubaneshwar, Chindwara, Deesa, Dholi, Faizabad, Hassan, Hisar, Jorhat, Kalyani, Kanpur, Kota, Modipuram, Ooty, Pasighat, Patna, Pune, Raipur, Shillong and Srinagar across the country. The crop was planted at the optimum time of planting for the respective locations. Population was recorded on 100 compound leaves at weekly interval from the emergence of the crop till it attained the maturity. The first appearance, critical levels and peak populations of aphid varied across locations.

Both *M. persicae* and *A. gossypii*, were found in all the centres except Shillong and Srinagar where the latter was not found. *M. persicae* population buildup was higher in all the locations as compared to *A. gossypii*. In Ooty, aphid population were not present on potato crop planted in May. The aphid transmitted virus incidence was also recorded at Deesa, Hassan, Jorhat, Kanpur and Pune..

Faizabad, Kanpur, Kota, Hisar and Patna are next only to Punjab for seed producing areas and hence monitoring of aphid population dynamics of these locations is very important. The population trend of weekly aphid population averaged over the years was calculated for these locations. The results showed that the trend was polynomial. The threshold aphid number per hundred compound leaves was crossed in the third of January at Faizabad and Kota, first week of January at Kanpur and Hisar and fourth week of December at Patna (Fig 3.3).

The identification of the collected aphid samples revealed them to be Myzus *persicae*

MANAGEMENT OF VECTORS

The efficacy of newer insecticides for the management of vectors was studied at Hisar, Kalyani, Modipuram and Patna with 9 treatments as per details given below. The treatment T8 (Three foliar spray of thiacloprid 72gm a.i./ha at 7 days interval starting from aphid (*M. persicae*) appearance + Summer oil @2ml/lit of water at 7 days interval starting from at aphid (*M. persicae*) appearance) gave best control of whiteflies at Kalyani and aphids at Modipuram.

T1: Control (no pesticide applications).

T2: Foliar spray of spiromesifen @96g a.i./ha at the time of whitefly appearance + second spray with thiamethoxam 25WG @125g a.i./ha after 15 days

T3: One foliar sprays of thiacloprid 72gm a.i./ha at aphid (*M. persicae*) appearance

T4: One foliar spray of thiacloprid 72gm a.i./ha mixed with summer oil@2ml/lit at aphid (*M. persicae*) appearance

T5: Two foliar spray of thiacloprid 72gm a.i./ha at 7 days interval starting from aphid (*M. persicae*) appearance

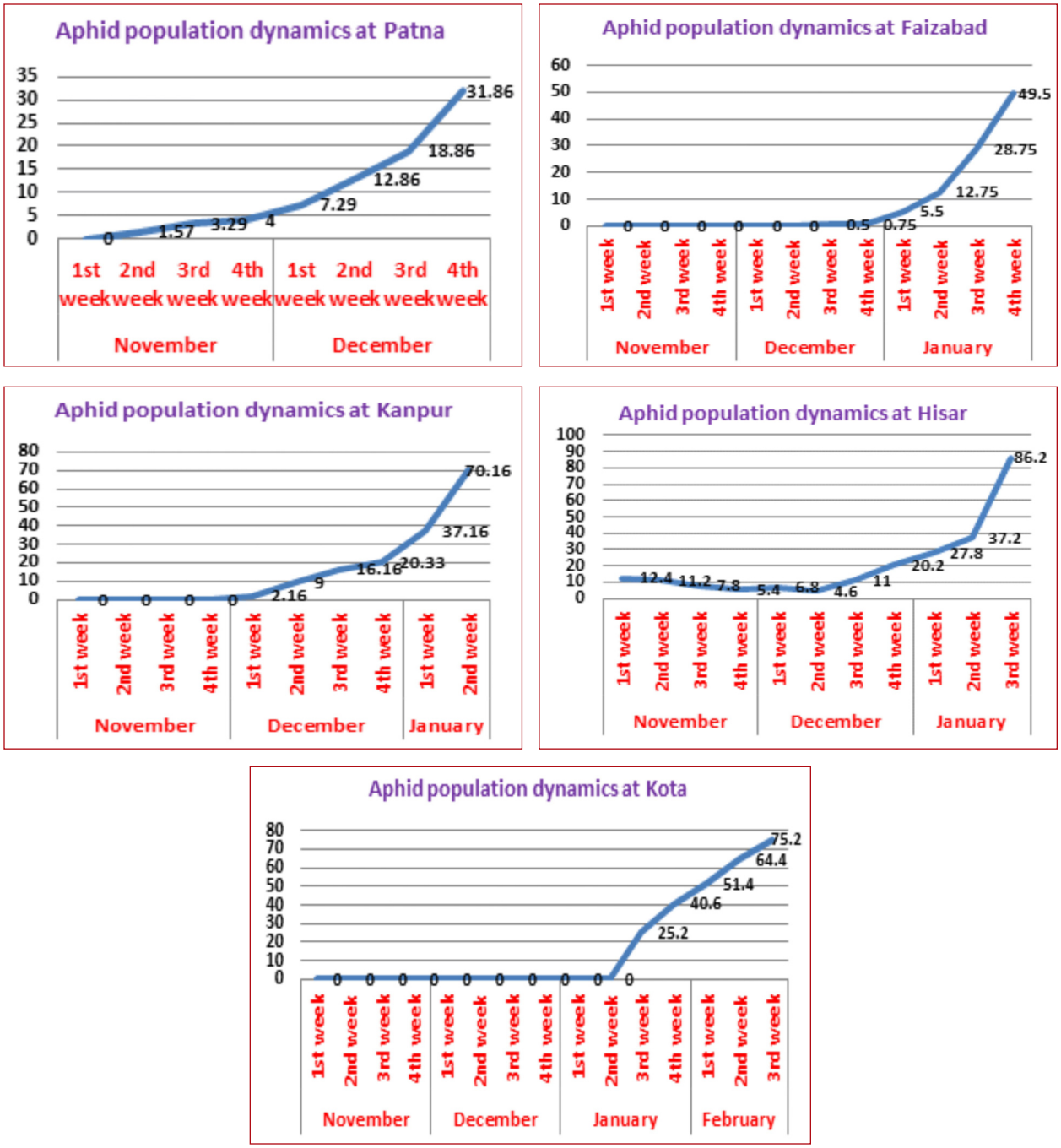


Fig 3.3 Aphid population dynamics at different AICRP (Potato) centres

T6: T5 + Summer oil @2ml/lit of water at 7 days interval starting from at aphid (*M. persicae*) appearance

T7: Three foliar spray of thiacloprid 72gm a.i./ha at 7 days interval starting from aphid (*M. persicae*) appearance

T8: T7 + Summer oil @2ml/lit of water at 7 days interval starting from at aphid (*M. persicae*) appearance

T9: Three foliar sprays of Summer oil @2ml/lit of water at 7 days interval

MANAGEMENT OF SUCKING PEST

Field experiments were conducted at Raipur during 2012-13 and 2013-14 for the control of sucking pests. The results showed that the sucking pests population was quite high and that all the treatments were found to be effective in reducing the whitefly population significantly as compared to control (Table 3.9).

The imidacloprid alone and in combination with thiamethoxam (T3 and T4) were found to highly effective in managing sucking pests but imidacloprid has got high residual effect and has been used since long and hence could cause resistance build up. However, thiacloprid @48ga.i./ha + yellow sticky trap at the time of aphid appearance (T5) and thiacloprid @48g a.i./ha at the time of aphid appearance+ Yellow trap, second spray with thiamethoxam 25WG @125g a.i./ha after 15 days (T6) were found equally effective. **Therefore, thiacloprid @48ga.i./ha + yellow sticky trap at the time of aphid appearance or thiacloprid @48g a.i./ha at the time of aphid appearance+ Yellow trap, second spray with thiamethoxam 25WG @125g a.i./ha after 15 days were found very effective and can be adopted as a good alternative to imidacloprid for the management of sucking pests at Raipur.**

Field experiment was initiated at Bhubaneshwar and Pune with 9 treatments to study the efficacy of newer insecticides for the management of sucking pests. The treatment combination involved treatment with insecticides and its combination with summer oil.

T1: Control (no pesticide applications).

T2: Foliar spray of spiromesifen @96g a.i./ha at the time of whitefly appearance + second spray with thiamethoxam 25WG @125g a.i./ha after 15 days

T3: One foliar sprays of thiacloprid 72gm a.i./ha at aphid (*M. persicae*) appearance

Table 3.9: Sucking pest population and yield under different treatments at Raipur.

Treatment	Sucking pest population (Mean)			% Reduction over control		Mean Yield (t/ha)
	Before spray	1 week	2 week	1 week	2 week	
T1. Control (no pesticide)	54.38	59.84	48.9	-	-	14.47
T2. Metasystox 25EC @300g a.i./ha as foliar spray at the time of aphid appearance and second spray after 15 days	48.02	19.24	8.2	63.58	81.01	17.2
T3. Foliar spray of Imidacloprid @40g a.i./ha at the time of aphid appearance + Yellow trap	49.6	15.135	1.5	72.27	96.63	19.07
T4. Foliar spray of Imidacloprid @40g a.i./ha at the time of aphid appearance + Yellow trap, second spray with thiamethoxam 25WG @125g a.i./ha after 15 days	52.23	15.44	2.75	73.13	94.14	19.51
T5. Foliar spray of thiacloprid @48g a.i./ha at the time of aphid appearance+ Yellow trap	56.16	16.095	1.25	73.95	97.52	18.31
T6. Foliar spray of thiacloprid @48g a.i./ha at the time of aphid appearance+ Yellow trap, second spray with thiamethoxam 25WG @125g a.i./ha after 15 days	51.48	15.34	1.925	72.92	95.84	18.92

T4: One foliar spray of thiacloprid 72gm a.i./ha mixed with summer oil@2ml/lit at aphid (*M. persicae*) appearance

T5: Two foliar spray of thiacloprid 72gm a.i./ha at 7 days interval starting from aphid (*M. persicae*) appearance

T6: T5 + Summer oil @2ml/lit of water at 7 days interval starting from at aphid (*M. persicae*) appearance

T7: Three foliar spray of thiacloprid 72gm a.i./ha at 7 days interval starting from aphid (*M. persicae*) appearance

T8: T7 + Summer oil @2ml/lit of water at 7 days interval starting from at aphid (*M. persicae*) appearance

T9: Three foliar sprays of Summer oil @2ml/lit of water at 7 days interval

The results showed that sucking pests reduced the yield significantly. The pooled analysis of the results over the locations and years showed that the effect of treatment and the interaction of treatment with location were significant. Therefore comparisons made on the basis of interaction effect showed that treatment combination T8 (Three foliar spray of thiacloprid 72gm a.i./ha at 7 days interval starting from aphid (*M. persicae*) appearance + summer oil @2ml/lit of water at 7 days interval starting from at aphid (*M. persicae*) appearance was effective against whiteflies and *jassids* at Bhubaneshwar.

AICRP (POTATO) PUBLICATIONS, EXTENSION ACTIVITIES, TRAININGS ETC. DURING 2014-15

(A) RESEARCH PAPERS

DEESA

1. Singh Narendra, MN Maheshwari and SM Chaudhari (2014). Degeneration of Potato Cultivars in North Gujarat. *Indian Phytopathology*. 67(3): 311-313.
2. Singh Narendra, MN Maheshwari, SM Chaudhari and DJ Patel (2014. Integrated management of root-knot nematode (*Meloidogyne incognita*) in potato. *Indian Phytopathology.* 67(4): 418-422.

FAIZABAD

1. Awasthi LP, SP Singh, Chaubey AN, Abhishek and Rajesh Kumar (2014). Molicular characterization of potato viruses RT-PCR and electron microscopy. *Carib J Sci Tech.* Vol 2 405-410.
2. Chaubey AN, LP Awasthi and SP Singh(2014). Impact of climate on the development of viral diseases in potato. *RR Jo AST*, 17-19.
3. Chaubey AN, Awasthi LP and Singh SP (2014). Eco-Friendly Management of Viral Diseases of Potato. Int. Res. Jour of Life Sci, 2(1):8-12.
4. Chaubey AN, LP Awasthi and SP Singh (2015). Performance of potato varieties against potato viral diseases trends in Biosciences (Communicated).

JALANDHAR

1. Kumar Raj, GS Kang and SP Trehan (2014). Kufri Gaurav : A nutrient efficient medium maturing potato variety for north Indian plains. *Potato Journal* 41(2): 137-144.
2. Trehan SP, R Kumar and BP Singh (2014). A new input efficient promising potato hybrid JX 576 - IV. Its water use efficiency in comparison to other potato cultivars. *International Journal of Agricultural and Statistical Sciences* 10 (1): 171-174.

KALYANI

1. Banerjee H, A Konar, A Chakraborty and AM Puste (2014). Impact of calcium nutrition on growth, yield and quality of potato (*Solanum tuberosum*). *SAARC Journal of Agriculture* 12(1): 127-138.
2. Chakraborty A, H Banerjee, and S Dey (2014). Bio-efficacy of Eugin 5EC against late blight and Antirot 10 DP against soil and tuber borne diseases of potato in West Bengal. *Journal of Mycopathological Research* 52(1): 93-96.
3. Mozumder M, H Banerjee, K Ray, and T Paul (2014). Evaluation of potato (*Solanum tuberosum*) cultivars for productivity, N requirement and eco-friendly indices under different nitrogen levels. *Indian Journal of Agronomy* 59(2): 327-335.

MODIPURAM

1. Gupta, Vijai Kishor, Satish Kumar Luthra and Bir Pal Singh (2014). Storage behaviour and cooking quality of Indian potato varieties. J Food Sci Technol DOI 10.1007/s13197-014-1608-z.
2. Pande PC, SK Luthra, BP Singh, VK Gupta and Sanjay Rawal (2014). Kufri Garima-a new high yielding table potato variety. Potato J 41 (2): 145-151.

3. Dalamu, Brajesh Singh, VK Gupta, Shelly Chopra, Reena Sharma and BP Singh (2014). biochemical profiling of phytonutrients for breeding nutrient rich potatoes. Potato J 41 (2): 122-129.

4. Raigond Pinky, Brajesh Singh, Vijai Kishor Gupta & Bir Pal Singh (2014). Potato flavour: profiling of umami 52 - nucleotides from Indian potato cultivars. Ind J Plant Physiol. DOI 10.1007/s40502-014-0117-4.

PANTNAGAR

1. Verma, MK and M Raghav (2014) Effect of calcium on growth, yield, quality and storage of potato (*Solanum tuberosum* L.) *I J Basic & Applied Agri. Res.*12 (2):231-234.

2. Girish Chandra, Udit Kumar and Manoj Raghav (2014) Physiological and biochemical impact of nitrogen on potato tuber. *Progressive Research.* 9(3&4): 570-573.

3. Singh, Dhirendra, JP Singh, and Aradhana Tewari, (2014) Influence of photoperiod and flowering on tuber yield of potato cultivar Kufri Pukhraj in Tarai region of Uttarakhand. Pantnagar Journal of Research. 9(2): 315-16.

RAIPUR

1. Joshi PK, PK Sharma, V Yadav and SB Rangare (2014). Identification of Suitable Potato Varieties for Chhattisgarh Plains. *Trends in Biosciences* 7(20): 3119-3121.

2. Sahu E, DA Sarnaik, PK Sharma, SB Rangare and V Yadav (2014). Influence of Varying Levels of Nitrogen on Potato Cultivars under Chhattisgarh Plains in Dorsa Soil. *Trends in Biosciences* 7(20): 3147-3150.

3. Sharma PK, PK Joshi, SK Verma, SB Rangare and V Yadav (2015). Production Potential and Completion Indices in Potato (*Solanum tuberosum* L.) + Cabbage (*Brassica oleracia var. capitata*) and Clutser Bean (*Cyamopsis tetragonalobus*). Trends in Biosciences 8 (5): 1121-1125.

4. Sharma PK, PK Joshi, SB Rangare and V Yadav (2015). Intercropping System in Chhattisgarh Plains Influence of Different Nitrogen Levels on Growth and Yield Attributes of Potato (*Solanum tuberosum* L.). Trends in Biosciences 8 (5): 1126-1127.

5. Joshi PK, PK Sharma, V Yadav and SB Rangare (2015). Evaluation of Potato Genotypes under Different Maturity Groups in Chhattisgarh. Trends in Biosciences 8 (5): 1128-1130.

(B) RESEARCH ABSTRACTS

BHUBANESHWAR

1. Biswal G, P Pradhan, SN Dash, PC Satpathy and KC Sahu (2014). Monitoring of potato pests in coastal plains of Odisha. Abstract: National Conference on Plant Physiology (NCPP-2014), November 23-25,2014, OUAT, Bhubaneswar. p-124.

2. Biswal G, BP Mishra, SN Dash and PC Satpathy (2014). Studies on storage behavior of potato in ambient condition. Abstract: National Conference on Plant Physiology (NCPP-2014), November 23-25,2014, OUAT, Bhubaneswar. p-195.

3. Biswal G, PC Satpathy and D Ghosal (2015) Sustainable Potato Production in Odisha. Abstract: Global Social Science Conference, February 14-17, 2015, OUAT, Bhubaneswar. p-114.

FAIZABAD

1. Awasthi LP, SP Singh, AN Chaubey, Abhishek and Rajesh Kumar (2014). Molicular characterization of potato

viruses RT-PCR and electron microscopy. *Carib J Sci Tech.* Vol 2 405-410

2. Chaubey AN, LP Awasthi and SP Singh(2014). Impact of climate on the development of viral diseases in potato. *RR Jo AST*, 17-19.
3. Chaubey AN, Awasthi LP and Singh SP (2014). Eco-Friendly Management of Viral Diseases of Potato. Int. Res. Jour of Life Sci, 2(1):8-12.
4. Chaubey AN, LP Awasthi and SP Singh (2015). Performance of potato varieties against potato viral diseases trends in Biosciences (Communicated).

(C) POPULAR ARTICLES/OTHER PUBLICATIONS/ TECHNICAL BULLETINS/ BOOK CHAPTER AND EXTENSION MATERIAL

BHUBANESHWAR

1. G Biswal, B Patra and PC Satpathy (2015). Aloo phasalara rogo Poka 'O' tara pratikar, OUAT, ATIC Bulletin No.49.

DEESA

1. Singh Narendra, MN Maheshwari, CR Patel and NH Patel (2014). Batata Na Rog Jivat Nu Niyatran. Ek Prayas January (16):34-37.
2. Patel RN, MN Maheshwari and CR Patel (2014). Batata Ni Kheti Na Mahtav Na Mudda Ane Bhalamano. Krushi jivan - October (3):16-19.

FAIZABAD

1. Kumar Ajay, SP Pathak and Gireesh Chand (2014). Field Efficacy of Organic Amendmentson the Population of *Rhizoctonia solani* and Fungal Foliar diseases of potato (*Solanum tuberosum* L) *Trends in Bioscences,* vol 7(10) pp 921-924.
2. Kumar Ajay, SP Pathak, Gireesh Chand, LP Awasthi and Rahul Kumar (2015). Role of organic amendments on phenol vontent in potato tubers to manage the black scurf. *New Agriculurist,* vol 26 (1,2)pp 1-5.
3. Kumar Ajay, SP Pathak, SK Singh and Gagan Kumar (2015). Evaluation of potato genotypes against early blight of potato (*Solanum tuberosum* L) *Research in Environment and Life Sciences,* vol. 8(**3**) (Accepted).
4. Kumar Ajay, SP Pathak and SK Singh (2015). Evaluation of Foliar Applied Fungivides Against Early Blight of Potao under field conditions *Trends in Bioscences* (Accepted)
5. Abhimanyu, Ajay Kumar, SP Pathak and (2015). Cultural and morphological variability of *Alternaria solani* on different solid media. *The Bioscan,* (Communicated).
6. Abhimanyu, SP Pathak and Ajay Kumar (2015). Fungicidal Management of Major Foliar Fungal Diseases through different spray schedules of potato (*Solanum tuberosum* L). *Research in Environment and Life Sciences* (Communicated).
7. Pathak SP and SK Singh (2015). Fungicidal management of early blight through different spray schedule. *The Bioscan,* (Communicated).
8. Pathak, SP (2015) Epidemology and management of late blight. National symposium on recent advances diagnosis and Management of diseases of Field and Horticultural crops. Indian Phytopathological society (MEZ) held at NDUAT, Faizabad (28 Feb. to March 1)pp-7.
9. Chaubey AN, RS Mishra, SP Pathak and Rajat Deshwal (2015). Survey of diseases and

insects of potato in different district of eastern Uttar Pradesh National symposium on recent advances diagnosis and Management of diseases of Field and Horticultural crops. Indian Phytopathological society (MEZ) held at NDUAT, Faizabad (28 Feb. to March 1) pp-36.

10. Abhimanyu and SP Pathak (2015). Infection rates and varietal reaction against early blight disease of potato. National symposium on recent advances diagnosis and Management of diseases of Field and Horticultural crops. Indian Phytopathological society (MEZ) held at NDUAT, Faizabad (28 Feb. to March 1) pp-40.

11. Maurya Neelam, SP Pathak, Yaswant Kumar Bharti and Pintoo Kumar (2015). Different techniques for isolation of *Rhizoctonia solani* from infected potato tubers: a comparative study. National symposium on recent advances diagnosis and Management of diseases of Field and Horticultural crops. Indian Phytopathological society (MEZ) held at NDUAT, Faizabad (28 Feb. to March 1)pp-50.

12. Abhimanyu, SP Pathak, RB Singh and Ajay Kumar (2015). Evaluation of potato (*Solanum tuberosum* L) genotypes against early blight disease. National symposium on recent advances diagnosis and Management of diseases of Field and Horticultural crops. Indian Phytopathological society (MEZ) held at NDUAT, Faizabad (28 Feb. to March 1)pp-40.

HASSAN

1. Vishnuvardhana and PS Prasad (2014). Improved Production technologies in Potato (***in kannada***).

2. Prasad PS and Vishnuvardhana (2014). Plant Protection in Potato (***in kannada***).

MODIPURAM

1. बीरपाल सिंह, एस के कौशिक, वैज्ञानिक विधियों द्वारा आलू उत्पादनः आकाशणाणी, नई दिल्ली द्वारा आलू पाठ्शाला–फोन–इन–प्रोग्राम के अंतर्गत प्रसारित प्रश्नोंत्तरी का संकलन। प्रसार पुस्तिका सं. –45 (हिन्दी): पेज 107.

2. Sah Uma, KD Kokate, BP Singh, VK Gupta and SK Dubey (2014). Sustainable potato production in hilly region of India. Biotech Books, New Delhi, p 348.

(D) PARTICIPATION IN EXTENSION ACTIVITIES

BHUBANESHWAR

Sl. No.	Name of Scientist	Name of activity	Venue	Date/ Time
1	Dr PC Satpathy	Farmers training on Potato Production Technology (50 progressive farmers attended)	IMAGE Bhubaneswar	23.2.15 3.30 PM
2	Dr PC Satpathy/ D Ghosal	Monitoring of OFT / FLD	Gop/Puri Bhairipur / Cuttack	6.2.15
3		Display of exhibits on potato varieties in State Level Krishi Mahostav organized by Agril. Dept., Govt. of Odisha	Janata Maidan, Bhubanesawr	5th to 8th March, 2015

FRONT LINE DEMONSTRATION

Sl. No.	Name of the Farmer	Address	District	Planting date	Remark
1	Sri Samarendra Singh. Contact:	At/Po- Gop, Dist-Puri,	Puri	20.11.14	Monitored by Project Scientist and CPRS Scientist Dr. S.K. Singh on on 06.02.15 and 17.02.15 respectively.
2	Sri Niranjan Sahoo	At/Po- Bhairipur, Pirabazar, Block- Salepur, Dist- Cuttack	Cuttack	26.11.14	
3	Integrated Farming System	OUAT, Research Wing,Bhubaneswar-751003	Khordha	19.11.14	

DEESA

1. Dr RN Patel "Potato cultivation" was organized by ATMA, Department of Agriculture, Gujarat at Potato Research Station, Deesa on 17-18 November, 2014. The Kisan mela was attended by more than 2000 farmers.
2. Dr RN Patel "Important points for increasing production of potato" was organized by SDAU, Dantiwada at village Oldsarogi taluka Amirgarh, on 25 November, 2014, which was attended by more than 70 farmers.
3. Dr RN Patel "Potato cultivation technology" was organized by ATMA, Department of Agriculture, Gujarat in collaboration with SDAU, Dantiwada on 25 September-18 November, 2014. The Kisan Sangosthi was attended by more than 600 farmers.

FAIZABAD

1. A stall of potato was arranged in University Kisan Mela (*Rabi* and *Kharif*).

HASSAN

1. Dr Vishnuvardhana and Dr PS Prasad participated as SMS in Krishi Mela, 2014 organized by UAS, GKVK, Bangalore held at UAS, GKVK, Bangalore from 19-21 November 2014.

2. Dr Vishnuvardhana and Dr PS Prasad participated as SMS at Consultancy service and AICRP on potato stall in Bruhat Udyana Mela-2014 organized by UHS, Bagalkot from 12-15 December 2014.
3. Dr Vishnuvardhana participated in Potato Workshop organized by KVK, Hassan on Problems of Potato cultivation on 20-12-2014. Discussion with Farmers of Hassan District was carried out during the meeting.
4. Dr Vishnuvardhana participated in Supply of Potato Seed Tubers meeting organized by Lalbagh/MS Building, Bangalore on 27-01-2015. Discussion on supply of certified seed tubers to Hassan District farmers was carried out during the meeting.
5. Dr Vishnuvardhana and participated in Krishi mela organized by Shri Kshetra

Dharmasthala Rural Development Project (SKDRDP) held at Tiptur on 05-02-2015.

6. Dr Prasad PS participated in Supply of Potato Seed Tubers meeting organized by Lalbagh/MS Building, Bangalore on 13-04-2015. Discussion on supply of certified seed tubers to Hassan District farmers was carried out during the meeting.

JORHAT

1. Dr PC Bhagawati, Dr Md Z Ullah and Dr MK Saikia actively participated in the Farmers Scientists interaction programme in Kissan Mela held on 6th November, 2014 at RARS, Titabor, Jorhat.

KALYANI

1. Dr A Chakraborty and A Sarkar "Krishi Parbon" was organized by Nadia Krishi Vigyan Kendra, at Gayeshpur, Nadia during January 7-9, 2015. This programme was attended by more than 3000 farmers.

2. Dr A Chakraborty and A Sarkar "Horticulture Fair" was organized by Faculty of Horticulture, BCKV, Nadia during February 19-20, 2015. This programme was attended by more than 500 farmers.

PANTNAGAR

1. Dr M Raghav, Dr RP Singh and Dr Dhirendra Singh attended rabi and kharif kisan mela organized by GBPUA&T, Pantnagar.

2. Delivered lectures in farmers meetings organized by Directorate of Extension Education and other Govt agencies related to potato production and protection.

(E) TV/RADIO PROGRAMMES

BHUBANESHWAR

1. Dr. PC Satpathy (2014). TV talk on "Alu Sankat" on 09.08.2014 of live discussion with experts under Parikrama in DDK, Bhubaneswar.

2. Dr. PC Satpathy (2014). TV talk on "Alu chas pain Prak Prastuti" on 14.10.2014 of live programme on phone in DDK, Bhubaneswar.

3. Dr. PC Satpathy (2015). TV talk on "Alu chinta" on 13.03.2015 live discussion on phone in News 7, Bhubaneswar.

DHOLI

1. Dr RN Patel "Potato cultivation" Phone-In-Live programme at Doordarshan Kendra, Ahmedabad on 13 November, 2014.

FAIZABAD

1. Dr Amar Pal Singh (2014). Radio talk on Þbl le; dh lfCt;k e Ñf"k dk;ß-

HASSAN

1. Dr Vishnuvardhana "Production Technology of Potato "at AIR, Hassan on 19-07-2014.

2. Dr Vishnuvardhana "Management of Late blight disease in Potato" at AIR, Hassan on 21.07.2014.

JORHAT

1. Dr PC Bhagawati "Interactive discussion with farmers. Dated, 17th April, 2015 at AIR, Jorhat6.

HASSAN

1. Dr Vishnuvardhana, "Production Technology of Potato " at AIR, Hassan on 19-07-2014.

2. Dr Vishnuvardhana, "Management of Late blight disease in Potato" at AIR, Hassan on 21.07.2014.

KALYANI

1. Dr A Chakraborty and Dr H Banerjee. "Advance planning for potato cultivation" at Doordarshan Kendra, Kolkata (Sec: Krishi Darshan) on October 14, 2014.

PANTNAGAR

1. Dr RP Singh "Alu va Tamater mai Julsha Rog ke Karen va Roktham"at Jan Vani Kendra, Pantnagar on October 14, 2014.
2. Dr RP Singh "Alu ki phasal mai lagney vale rogo ki roktham" at Jan Vani Kendra, Pantnagar, November 21, 2014.

SRINAGAR

1. Dr. Fheema Mushtaq TV talk on "Potato cultivation on scientific lines.
2. Dr S.H. Khan Radio talk on storage practices in potato for avoiding wastage.

(F)TRAINING/WORKSHOP/SEMINAR ORGANISED/ATTENDED

BHUBANESHWAR

1. 32nd Group Meeting of Potato workers held at UAS, Dharwad from September 20-22, 2014 was attended by Dr PC Satpathy and Dr D Ghosal.
2. National seminar on "Post Harvest Management and Processing Potato for Increasing Food Security India" held at UAS, Dharwad (Karnataka) on 22th Sept 2014 was attended by Dr PC Satpathy and Dr D Ghosal.
3. National seminar on "Emerging Problems of Potato" held at CPRI, Shimla on 1-2 Nov., 2014 was attended by Dr PC Satpathy and Dr D Ghosal.

DEESA

1. 32nd Group Meeting of Potato workers held at UAS, Dharwad from September 20-22, 2014 was attended by Dr RN Patel and Dr. Sunil Kumar Chongtham.
2. National Conference on "Pre / Post harvest losses and value addition in vegetable" held at IIVR, Varanasi, (UP) during 12-13 July 2014 was attended by Dr Sunil Kumar Chongtham.
3. National seminar on "Post Harvest Management and Processing Potato for Increasing Food Security India" held at UAS, Dharwad (Karnataka) on 22th Sept 2014 was attended by Dr RN Patel and Dr Sunil Kumar Chongtham.

FAIZABAD

1. Participated in 32nd Group Meeting of AICRP on Potato held at Dharwad during September 20-23, 2014.

HASSAN

1. 32nd Group Meeting of Potato workers and National seminar on Post Harvest Management and Processing of potato for increasing food security in India held at UAS, Dharwad from September 20-22, 2014 was attended by Dr Vishnuvardhana and Dr PS Prasad.
2. National Seminar on **"Emerging Problems of Potato"** held at Shimla from 1-2 November 2014 was attended by Dr. Vishnuvardhana and Dr PS Prasad.
3. Summer School Training Programme on Advances in Molecular Diagnostics of Emerging Plant Diseases for Biosecurity

sponsored by ICAR from 1-21 August, 2014 was attended by Dr PS Prasad.

4. National Meet on Distant Hybridization in Horticultural Crop Improvement held at IIHR, Bangalore from 22-23rd Jan, 2015 was attended by Dr PS Prasad.

JALANDHAR

1. 32nd Group Meeting of Potato workers held at UAS, Dharwad from September 20-22, 2014 was attended by Dr Raj Kumar.

JORHAT

1. 32nd Group Meeting of Potato workers held at UAS, Dharwad from September 20-22, 2014 was attended by Dr PC Bhagawati, Dr Md. Zafar Ullah and Dr MK Saikia.

KALYANI

1. 32nd Group Meeting of Potato workers held at UAS, Dharwad from September 20-22, 2014 was attended by Dr A Chakraborty and Dr H Banerjee.
2. Summer School on "Current trends in quality potato production, processing and marketing" was attended by Dr H Banerjee at CPRI, Shimla during July 8 – 28, 2014.
3. National Seminar on "Post-harvest management and processing of potato for increasing food security in India" was attended by Dr A Chakraborty and Dr H Banerjee at UAS, Dharwad on September 22, 2014.
4. National Seminar on "Emerging problems of potato" was attended by Dr A Chakraborty at CPRI, Shimla on November 1-2, 2014.

SHILLONG

1. 32nd Group Meeting of Potato workers held at UAS, Dharwad from September 20-22, 2014 was attended by Dr T K Bag, Dr MS Gurjar and Dr SK Yadav.
2. National Seminar on Post Harvest Management and Processing of Potato for Increasing Food Security in India" at UAS, Dharwad on 22 Sept., 2014 was attended by Dr TK Bag, Dr SK Yadav and Dr MS Gurjar.

SRINAGAR

1. On day training programme organised by LAWDA on Potato cultivation on scientific lines to farmers of Fakeer Gugri cluster on 24.03.2014 was attended by Dr SH Khan as resource Person.
2. On day training programme on Vegetable and Potato cultivation for livelihood security organised by LAWDA for the farmers of Hodura cluster was attended by Dr Faheema Mushtaq on 31.03.2014 as resource Person.
3. Scientific advisory committee meeting was attended by Dr SH Khan on 17th Dec. 2014 at KVK Ganderbal District.
4. 3rd JK Science Congress was attended by Dr SH Khan and Dr FN Bhat and Dr Faheema Mushtaq on 12th- 14 May 2014 organized by Directorate of Research SKUAST-K, Shalimar.
5. National Seminar on post harvest management and processing of potato for increasing food security in India was attended by Dr SH Khan and Dr FN Bhat on 22nd Sept 2014 at UAS Dharwad.
6. 32nd AICRP (Potato) Group Meeting India was attended by Dr SH Khan and Dr FN Bhat on 20-21st Sept. 2014 at UAS Dharwad.

(G) PAPER PRESENTED IN CONFERENCE /SYMPOSIA/SEMINARS/ OTHER FORUM

BHUBESHWAR

Sl. No.	Title	Authors	Remark
1	Studies on performance and storage behavior of processing potato varieties in coastal plains of Odisha	PC Satpathy, D Ghosal, G Biswal & D Mitra	National Seminar on "PHM & processing of Potato for increasing food security", UAS Dharwad, 22nd Sept. 2014.
2	A step towards self sufficiency of potato in Odisha	PC Satpathy & SK Chadha	Poster session on National Seminar on "Emerging Problems of Potato" held at CPRI, Shimla
3	Management of Early Blight (Alternaria solani) of potato in coastal plains in Odisha	PC Satpathy, D Ghosal, G Biswal & AK Mohanty	-do-
4	Scope of growing processing potatoes in Odisha	PC Satpathy & D. Mitra	-do-
5	Monitoring of Potato pests in coastal plains of Odisha	Biswal G, P Pradhan, S.N. Dash, PC Satpathy & KC Sahu	National Conference of Plant Physiology – 2014 held at OUAT, Bhubaneswar, November 23-25, 2014

DEESA

1. Dr Sunil Kumar Chongtham attended National Conference on "Pre / Post harvest losses and value addition in vegetable" held at IIVR, Varanasi, (UP) during 12-13 July 2014 and presented a paper on " Effect of calcium application on yield and post harvest qualities of potato."
2. Shri MN Maheshwari, attended 35th Annual Conference and Symposium on "Innovative and Ecofriendly Research Approaches for Plant Disease Management" of ISMPP held at Dr. PDKV, Akola, Maharashtra from 08-10 January-2014 and presented a paper on ''Evaluation of Potato Cultivars for Resistance against Apical leaf Curl Virus."
3. Dr Narendra Singh, attended 35th Annual Conference and Symposium on "Innovative and Eco-friendly Research Approaches for Plant Disease Management" of ISMPP held at Dr. PDKV, Akola, Maharashtra from 08-10 January-2014 and presented a paper on ''Evaluation of Potato Cultivars for Resistance against Stem Necrosis Diseases."
4. Shri MN Maheshwari, attended Global conference on "Technological Challenges and Human Resources for Climate Smart Horticulture" held at Navsari Agriculture University, Navsari from 28-31 May-2014, and presented a paper on "Management of root-knot nematode (Meloidogyne incognita) in Potato field."
5. Dr RN Patel attended national seminar on "Post Harvest Management and Processing Potato for Increasing Food Security India" held at UAS, Dharwad (Karnataka) during 22th Sept 2014 and presented a paper on ''Potato scenario in Gujarat."

HASSAN

1. Dr Maheshwar, D.L., Venkatesh,J., Ramachandra Naik, K., Vishnuvardhana and Shreedhar 2014. Potato Production Scenario in Karnataka. National Seminar on Post Harvest Management and Processing of potato for increasing food security in India held on 20th to 22nd Sep 2014 at UAS, Dharwad, Karnataka.

2. Dr Maheshwar, D.L., Venkatesh,J., Ramachandra Naik, K., Vishnuvardhan and Soumya Shetty 2014. Postharvest management and Processing of Potato in Karnataka. National Seminar on Post Harvest Management and Processing of potato for increasing food security in India held on 20th to 22nd Sep 2014 at UAS, Dharwad, Karnataka.
3. Dr Vishnuvardhana, Prasad P.S. and Siddagangaih 2014. Influence of Calcium on improving yield and Post Harvest Qualities of Potato. Presented in National Seminar on "Emerging Problems of Potato" held at Shimla on 1-2 November 2014. p-160.
4. Dr Vishnuvardhana, Prasad P.S. and Siddagangaih 2014. Studies on Suitable dates of Planting of Potato under Southern Parts of Karnataka during *Kharif* Season. Presented in National Seminar on "Emerging Problems of Potato" held at Shimla on 1-2 November 2014. p-160.
5. Dr Prasad P.S., Vishnuvardhana and Siddagangaih 2014. Potato Based Cropping Systems for Southern Karnataka. Presented in National Seminar on "Emerging Problems of Potato" held at Shimla on 1-2 November 2014. p-182.
6. Dr Prasad P.S. Vishnuvardhana and Devappa V. 2014. Management of Late Blight of Potato. Presented in National Seminar on "Emerging Problems of Potato" held at Shimla on 1-2 November 2014. p-163.

KALYANI

1. Dr A Chakraborty attended National Seminar on "Emerging problems of potato" was attended by Dr A Chakraborty at CPRI, Shimla on November 1-2, 2014 and presented a paper on "Management of early blight of potato in West Bengal".
2. Dr H Banerjee attended National Seminar on "Post-harvest management and processing of potato for increasing food security in India" at UAS, Dharwad on September 22, 2014 and presented a paper on "Status of quality potato production in West Bengal: processing, storage and marketing".

MODIPURAM

1. Dr Gupta VK, SK Luthra, and BP Singh (2014) Potato processing varieties: Present status and future thrusts. National seminar on post harvest management and processing of potato for increasing food security in India. 22 Sep, 2014, UAS campus, Dharwad, Karnataka, India.
2. Dr Gupta VK (2012) presented the performance report on genetics trial conducted at CPRI campus, Modipuram in 30th Group meeting of potato workers held during 23-25 September, 2012 at OUAT, Bhubaneshwar Orrisa.
3. Dr Gupta VK (2013) presented the performance report on genetics trial conducted at CPRI campus, Modipuram in 31st Group meeting of potato workers held during 20-22 September, 2013 at CPRS, Patna, Bihar.
4. Gupta VK (2014) presented the performance report on genetics trial conducted at CPRI campus, Modipuram in 32nd Group meeting of potato workers held during 20-22 September, 2014 at UAS, Dharwad, Karnataka.
5. Dr Gupta VK, SK Luthra and BP Singh (2014) Keeping and culinary quality of indigenous potato varieties. National seminar on emerging problems of potato, November 1-2, 2014, Central potato Research Institute,

Shimla, HP, India_Abstracts: p145. Poster presentation.

6. Dr Gupta VK, SK Luthra and BP Singh (2014) Breeding potatoes for value addition: A comprehensive approach for sustainable potato production. National seminar on emerging problems of potato, November 1-2, 2014, Central potato Research Institute, Shimla, HP, India Abstracts: p159. Poster presentation.

7. Dr Gupta VK, SV Singh, Vinay Bhardwaj, SK Luthra, Ashiv Mehta, Bandana and BP Singh. 2012. MP/4-578: A promising advanced potato hybrid suitable for French Fries National Consultation on Potato Research and Development: Way Forward at Orissa University of Agricultural and Technology, Bhubneswar on September 26, 2012 Abstract page: 96-97. Poster presentation.

8. Dr S Arya, SK Luthra, VK Gupta, N Sharma, Merideth Bonierbale, MS Kadian and R. Chaturvedi (2014) Multi environment trials of potato clones as potential varieties for cereal based systems of indo gangetic plains of India. In the 19th triennial conference of the European Association of Potato Research. July 6-11, 2014.

PANTNAGAR

1. Dr Girish Chandra, Manoj Raghav and Udit Kumar attended National Symposium on "ECM" Technology for Safe, Secure and Profitable Food Production, at GBPUAT, Pantnagar during 10-11 October, 2014 and presented a paper on "Influence of nitrogen fertilizer and variety on storage behavior of potato tuber".

SHILLONG

1. Dr MS Gurjar, TK Bag, K. Suraj Singh and Sanchita Roy (2014). Production, Post harvest losses and storage of potato in Meghalaya: A current status (Poster presentation) *In* National seminar on Post Harvest Management and Processing of potato for increasing Food Security in India" UAS, Dharwad on 22 Sept., 2014. Pp. 4.

(H) STUDENT GUIDED DURING 2012-13

Name of the centre	Name of the student	Title of thesis	Degree	Name of the University
Bhubaneshwar	Miss Susama Kameswari 1VSc/13	Evaluation of Potato cultivars	M.Sc.	OUA&T, Bhubaneshwar
	Mr. Debasis Martha 5VSc/13	Response of Potato cultivar K. Ashoka as influenced by graded levels of Potassium	M.Sc.	
	Miss Aiswariya Panda 9VSc/13	Effect of zinc on tuber yield and quality of Potato	M.Sc.	
	Mrs Jyotshnarani Moharana 2VSc/PhD/12	Stability analysis in Potato during Kharif season in Odisha	Ph.D.	
Faizabad	Mr Somveer Singh	Effect of organic sources of nutrients on growth and yield of potato (*Solanum tuberosum* L.)	M.Sc. (Ag.)	NDUAT, Faizabad

	Mr Ajay Kumar	Studies on variability of *Alternaria solani* causing early blight of Potato and its managements in Eastern Uttar Pradesh.	Ph.D.	
	Mr Nitish Kumar Pandey	Extream weather conditions and its impacts on growth and development of Potato (*Solanum tuberosum* L.)	Ph.D.	
	Mr Raj Pratap Singh	Studies on Air pollutions SO_2 and suspended particulate matters (SPM) on growth and yield of potato crop (*Solanum tuberosum* L.)	Ph.D.	
Jorhat	Mr Lakhan Sarkar	Effect of organic manures and biofertilisers on growth and yield of Potato	M.Sc.	AAU, Jorhat
	Ms Roji Chutiya	Integrated nutrient management in Potato grown by TPS tuberlet and its residual effect on summer Greengram	M.Sc.	
	Mr Manas Gogoi	Thesis title: Organic management of Lateblight of Potato.	M.Sc.	
Kalyani	Kumari Lalita Rana	Development of site-specific NPK requirements for potato (*Solanum tuberosum*)	M.Sc.	BCKVV, Kalyani
Kota	Kumari Eshu Sahu	Studies on intrigued nutrient management in potato (*Solanum tuberosum* L.)	No mentioned	ARS Kota
Pantnagar	Mr Umesh Chandra Sati	Potash management in potato (*Solanum tuberosum* L.)	M.Sc.	GBPUA&T, Pantnagar
	Ms Anamika Verma	Molecular and morphological genetic divergence studies in Indian potato (*Solanum tuberosum* L.) germplasm	Ph.D.	

(I) OTHER ACTIVITIES

BHUBANESWAR

1. Dr PC Satpathy associated as one of the technical expert in potato seed source verification in Punjab, UP and WB for procurement by the Hort. Dept., Govt of Odisha.
2. Dr PC Satpathy acted as a member of the Committee to recommend suitable varieties and package of practices of Potato to Directorate of Horticulture, Govt. of Odisha.
3. Dr PC Satpathy acted as Nodal Officer by the University for planning, implementation and monitoring of potato action plan in the State.
4. Dr PC Satpathy attended various meetings/ potato action plan of the Task Force on Potato at the Directorate of Horticulture and Agriculture Dept., Govt of Odisha. On recommendation of the Committee, State Government has launched **POTATO MISSION** commencing 2015 to make Odisha self sufficient in Potato in coming 3 years.

5. Dr PC Satpathy as a member of the expert committee attended joint verification potato variety K Jyoti in farmers field of Jhinti sasan of Balianta Block, Dist-Khurdha on 13.12.2014.
6. PC Satpathy presented activities of potato on 9.4.2015 in the Breeders Group Meet held at the Directorate of Extension Education, OUAT being chaired by Hon'ble Vice-Chancellor in presence of Dean of Research cum Dean of Extension.
7. Dr Project Scientists/staff monitored Kharif potato trial at Phulbani and Koraput during 2014.

LIST OF SCIENTISTS ASSOCIATED WITH AICRP (POTATO) AS ON 31.03.2015

Name	Designation	Discipline
PROJECT HEADQUARTER (CPRI, SHIMLA)		
Dr PM Govindakrishnan	Project Coordinator	**Agronomy**
CENTRAL POTATO RESEARCH INSTITUTE BASED CENTERS		
Central Potato Research Institute, Shimla-171 001 (HP)		
Dr Vinay Bhardwaj*	Actg. Head, Div. of Crop Improvement	**Genetics and Cytogenesis**
Dr VK Dua*	Head, Division of Crop Production	**Agronomy**
Dr M Nagesh*	Head, Division of Crop Protection	**Nemotology**
Central Potato Research Institute Campus, Modipuram-250 110 (Uttar Pradesh)		
Dr SK Kaushik	Joint Director	**Plant Breeding**
Dr (Mrs.) Kamlesh Malik	Principal Scientist	**Entomology**
Dr Sanjay Rawal	Principal Scientist	**Agronomy**
Dr VK Gupta	Senior Scientist	**Plant Breeding**
Central Potato Research Station, Post Box No.4, Morar, Gwalior- 474 006 (Madhya Pradesh)		
Dr Satyajit Roy	PS & Head	
Dr SP Singh	Principal Scientist	**Agronomy**
Dr Murlidhar Sadawarti	Scientist (SS)	
Central Potato Research Station, PO Model Town, PB No.1,Jalandhar 143 001 (Punjab)		
Dr JS Minhas	PS & Head	**Physiology & Bio chemistry**
Dr Raj Kumar	Principal Scientist	**Plant Breeding**
Central Potato Research Station, PO Sahaynagar, Patna-801 506 (Bihar)		
Dr Manoj Kumar	PS & Head	**Soil Science**
Dr SK Singh	Principal Scientist	**Agronomy**
Dr Shambhu Kumar	Principal Scientist	**Plant Breeding**
Sh Rahul R Bakade	Scientist	**Pathology**
Central Potato Research Station, Shillong-793 009 (Meghalaya)		
Dr TK Bag	PS & Head	**Plant Pathology**
Dr AK Srivastava	Scientist	**Plant Breeding**
Dr MS Gurjar	Scientist	**Plant Pathology**
Dr SK Yadav	Scientist	**Agronomy**
Central Potato Research Station, PO Muthorai-643 004 (Tamil Nadu)		
Dr EP Venkatsalam	Acting Head	**Seed Technology**
Dr R Uma Maheshwari	Scientist	**Pathology**
Dr Aarti Bairwa	Scientist	**Nematology**
Central Potato Research Station, Kufri, Shimla-171 012 (HP)		
Dr Vinod Kumar	Principal Scientist & Actg. Head	**Plant Breeding**

SAU BASED CENTERS		
AICRP on Potato, Research Wing, Odisha University of Agriculture & Technology, Administrative Building, Bhubaneshwar-751 003 (Odisha)		
Dr PC Satpathy	Breeder	**Plant Breeding**
Mr Debasis Ghosal	Jr. Agronomist	**Agronomy**
Regional Agricultural Research Station, Jawaharlal Nehru Krishi Vishwavidyalya Chandangaon, Chhindwara-480 001 (Madhya Pradesh)		
Dr SN Singh	Principal Scientist	**Horticulture**
Dr DN Nandekar	Senior Scientist	**Agronomy**
Potato Research Station, Sardar Krushinagar Dantiwada Agricultural University, Deesa-385 535, Banaskantha (Gujarat)		
Dr RN Patel	Research Scientist	**Plant Breeding**
Dr Sunil Kumar Chongtham	Agronomist	**Pathology**
AICRP on Potato, Division of Horticulture, MARS, University of Agricultural Sciences, Dharwad-580 005 (Karnataka)		
Dr KR Naik	Assoc. Prof of Hort & I/C	**Horticulture**
Department of Horticulture, Trihut College of Agriculture, Rajendra Agricultural University Campus, Dholi-843 121, District Muzaffarpur (Bihar)		
Dr Lal Mani Yadav	Chief Scientist	**Horticulture**
Dr Birendra Kumar	Senior Scientist	**Pathology**

FINANCIAL STATEMENT FOR THE YEAR 2014-15

(Rs in lakhs)

Head of account	Bhubaneshwar		Chhindwara		Deesa	
	Allocated	Distributed	Allocated	Distributed	Allocated	Distributed
Pay & Allow.	24.29	15.00	26.00	15.00	25.88	20.00
T.A	0.30		0.30		0.30	
Contingences	1.50		0.60		1.50	
TSP	0.00		1.78		0.00	
Equipment	0.00		0.00		0.00	
Works	0.00		0.00		0.00	
Total	26.09		28.68		27.68	

Head of account	Dharwad		Dholi		Faizabad	
	Allocated	Distributed	Allocated	Distributed	Allocated	Distributed
Pay & Allow.	18.00	5.00	27.52	15.00	20.00	**15.00**
T.A	0.30		0.30		0.30	
Contingences	1.50		1.50		1.50	
Equipment	0.00		0.00		0.00	
Works	0.00		0.00		0.00	
Total	19.80		29.32		21.80	

Head of account	Hassan		Hisar		Jorhat	
	Allocated	Distributed	Allocated	Distributed	Allocated	Distributed
Pay & Allow.	16.00	5.00	21.61	15.00	26.08	**26.00**
T.A	0.30		0.30		1.13	
Contingences	1.50		1.50		5.17	
Equipment	0.00		0.00		0.00	
Works	0.00		0.00		0.00	
Total	17.80		23.41		32.38	

Head of account	Kalyani		Kanpur		Kota	
	Allocated	Distributed	Allocated	Distributed	Allocated	Distributed
Pay & Allow.	23.00	15.00	14.92	15.00	24.00	**20.00**
T.A	0.30		0.30		0.30	
Contingences	1.57		1.58		2.00	
Equipment	0.00		0.00		0.00	
Works	0.00		0.00		0.00	
Total	24.87		16.80		26.30	

Head of account	Pantnagar		Passighat*		Pune	
	Allocated	Distributed	Allocated	Distributed	Allocated	Distributed
Pay & Allow.	22.27	15.00	20.00	20.00	17.00	15.00
T.A	0.30		1.50		0.30	
Contingences	1.50		5.50		1.50	
Equipment	0.00		0.00		0.00	
Works	0.00		0.00		0.00	
Total	24.07		27.00		18.80	
Head of account	**Raipur**		**Srinagar**			
	Allocated	**Distributed**	**Allocated**	**Distributed**		
Pay & Allow.	27.00	25.00	21.31	15.00		
T.A	0.30		0.37			
Contingences	1.50		1.50			
TSP	3.22		0.00			
Equipment	0.00		0.00			
Works	0.00		0.00			
Total	32.02		23.18			

Plan BE 2014-15 (ICAR Share)	**:**	**Rs 604.00 Lakhs**
Plan RE 2014-15	:	Rs 420.00 Lakhs
Total disbursement	:	Rs 271.00 Lakhs + 149.00 lakhs (used from OB of 2014-15) = Rs 420.00 Lakhs