ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 10, Issue, 06(B), pp. 32786-32791, Jun, 2019

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

INTEGRATED MANAGEMENT OF LATE BLIGHT DISEASES OF POTATO CROP GROWN IN NORTHERN INDIA

T. S. Mishra[1], H.M.Singh[2], U.S.Mishra[3] and N. K. Mishra[1]

[1]Krishi Vigyan Kendra, West Kameng, Dirang, Arunanchal Pradesh
[2]National Horticultural Research and Development Foundation, Patna, Bihar
[3]Mahatma Gandhi Chitrakoot Gramodya Vishwavidyalaya, Chitrakoot, Satna, M.P

DOI: http://dx.doi.org/10.24327/ijrsr.2019.1006.3544

ARTICLE INFO

Article History:
Received 4th March, 2019
Received in revised form 25th April, 2019
Accepted 18th May, 2019
Published online 28th Jun, 2019

Key Words:

Potato, varieties, Disease, seed/tuber, management.

ABSTRACT

A field experiment was conducted for Integrated Management of Late Blight Diseases of Potato Crop Grown in Northern India between sowing in Rabi season 2015-16 and 2016-17 at Bioved Research Centre, Allahabad, U.P. The performance of 32 potato varieties/strains/cultures was studied. The Findings of results were drawn on the basis of information gathered in observation recorded and data calculation for significance. Treatment V5, V13, V22, V26, V28 and V29 were found promising. K. Badshah was found the best of all treatments and next best were K. Bahar (V27), K. Alankar (V31) and K. Sundur's (V32).

Copyright © T. S. Mishra, H.M.Singh, U.S.Mishra and N. K. Mishra, 2019, this is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is a top ranking vegetable in India and other different countries (Chaudhary, 1967, 1972 and Chadha, 1998). It is one of the most important and unique crop among vegetables and in the sense it can supplement in a large number of ways (Kumar, 1972; Chandra *et al.,* 1990; Singh, 1996). In fact it is needed in the country in a very substantial measure. It is one of the short duration crops which can be fitted in any intensive crop rotation and gives the highest yield per unit time and area (Singh and Rath, 1983; Singh, 1996; Maruaha, 2009). It also gives more average dry matter, calories, carbohydrate and protein per unit area than cereals. Potato is an annual herbaceous plant, belonging to the family solanaceae. The potato is believed to have been introduced in India in 17th century and now it is cultivated extensively in plains as well as in hilly regions up to the height of 10,000 feet (Chaudhary 1972).

Potato has occupied a central place on tables as it provides all essential ingredients of balanced diet such as starch, protein, minerals and vitamins (Singh, 1959, 1996). At present the potato consumption in our country is only limited per annum per capita as against 75 to175 kg per annum in European and American countries (Singh, 1985). It is a wholesome article of diet for human being. It easily be converted into several dried and processed products in different countries in the world (Subhramaniam, 1966; Shekhawat *et al.,* 1984). Besides, it is a needful raw material for several industrial products (Leela, 1993; Marwaha, 2002; Prajapati *et al.,* 2018). Because of these qualities potato deserves an honourable place in Indian agriculture and needs rapid extension of cultivation. Since per capita consumption of potato in our country is much lower than many developed countries, therefore, it will be advantageous to lay special emphasis on its use in human food (Agrwal and Tiwari, 2004; Prajapati *et al.,* 2018).

During last two decades there has been a continuous increase in both area and production of potato in our country. It is grown in about several Lakhs hectares of land, producing 125 lakh tonnes of potatoes, the average being 180 kg per ha. (Anon, 1986; Pandey, 1996). Some of the Indian potato varieties, like, K. Chandramukhi, K. Sheetman and K Lokar are found suitable for export and can earn foreign exchange in substantial amount (Pushkarnath, 1964; Rai, 1984; Singh, 1992; Basu, 1996; Minhas *et al.,* 2018). At present a large number of high yielding varieties and several hybrids have been developed by central potato Research Institute, Simla and are available for commercial cultivation in the country (ICAR Report, 1981). However, considerable controversy exists about potato

Corresponding author:* **T. S. Mishra
Krishi Vigyan Kendra, West Kameng, Dirang, Arunanchal Pradesh

varieties/strains regarding yield and several qualitative characters which are influenced by soil and environmental factors to a considerable extent. At this stage little is known for about the morphological and physiological factors which allow one variety to out-yield the other when both are grown under the similar set of agro-climatic conditions (Tiwari and Tiwari, 1975; Rai, 1986; Sud, 1996; Taule, 2010).

MATERIAL AND METHODS

The experiment was conducted in Randomized Block Design with thirty two treatments in three replication sown at experimental field of Bioved Research Centre, Allahabad, Uttar Pradesh during Rabi 2015-16 to 2016-17. The general characteristic features related to tuber, plant type, maturity and yield potential of all the 32 varieties/strains/cultures are planted in field disease free medium sized, just to sprout whole tubers of potato material were selected for seed. Seed tubers were treated with 0.25% arctan solution to avoid any possible damage due to rotting in the soil and to check the infection of black scurf disease. Whole seed tubers were planted in furrows and covered immediately by making a light ridge. The row to row and plant to plant distances were maintained at 60 and 20 cm, respectively. Data were recorded for observations five randomly selected plant each plot with different stage, obtained was statistical analysis method was applied for quantitative characters to derive the results of certain information at varietal level (Panse and Sukhatme, 1961).

RESULT AND DISCUSSION

It is apparent from the data presented in Table -1 & 2. The sprouting was found variable which showed considerable range of variation. It was found to vary from 46.33 to 77.67 per cent in the treatments V_{16} and V_{23} during 2015-16, respectively. In the second year of trial it was recorded to range from 49.00 to 75.00 per cent in V_{19} and V_{12} treatments during 2016-17, respectively. The range of sprouting in varieties/strains /cultures thus had significant differences in the plant material which indicated an effective range of variability in the present germplams material of potato crop. Similar range of variation was observed by Azariah and Saptharishi (1956), Pushkarnath (1976), Bhattacharya *et al.* (1978), Bisen and Barhalia (1990), Birhman (1996), Sharma (1996) and Prajapati *et al.* (2018). The potato sprouting was found to be affected by certain factors which were also reported by Pushkarnath (1967). Prakash Rao and Arora (1979), Rai *et al.* (1980), Singh *et al.* (1985), Stewart and Bradshaw (1993) and Kaul (1996).

Shoot growth in numbers was recorded per plant which was found variable under the different treatments of varieties/strains/cultures of potato taken in the present investigations. Production of shoots varied from 4.73 (V_9) to 8.40 per plant (V_{27}, V_{29}) in first year of the experiments. Similarly the production of shoots was found also to vary in number from 4.50 (V_1) to 8.60 per plant in (V_{28}) treatments during second year in 2016-17. In previous studies growth behaviour of multiple shoots per plant had also been observed in certain potato varieties as it was reported by Bartholdi (1972), Azariah and Saptharishi (1956), Kabir (1990) and Kaul (196). Tubers of potato showed several eyes which used to produce shoots after sowing. Such shoots were found to grow upto a certain length but it revealed variation in different varieties/strains and cultures. 78.43 cm was found the maximum length i.e. height of shoot in treatment V_2 in the first year trial. The next to maximum height of shoot was found 77.87 cm in treatment V_{11}. Similar variation was recorded in second year experiment where the maximum height was found 80.30 cm in treatment V_{25} during 2016-17. The variation in shoot growth had also been observed in certain varieties/cultures by the scientists who conducted experiments in this crop (Bartholdi, 1942; Davis, 1969; Challaish, 1973-74; Verma and Shekhawat, 1991; Singh and Chand, 2004). The growth behaviour in shoots gave apparent foliage character which might affect the physiological process for tuber growth and development as had been reported by Sikka (1996), Gaur (1998) and Kumar *et al.* (2006).

Growth of shoots at minimum status was also found in varying trend in certain treatments. The minimum plant height 44.37 cm (V_{21}) and 47.20 cm (V_{17}) was found during 2015-16 and 2016-17, respectively. Present findings in shoot height are in accordance with the findings observed by Levy (1978), Seekamani and Abraham (1985); Kabir (1990) and Marwaha *et al.* (2009).

It is evident from the data of Table-1 and 2 that there was a considerable variation in plant growth behaviour of different shoots in varieties/strains and cultures taken under investigations. The maximum height of plant was observed 78.43 cm in JI-585 (V2) treatment which was followed by 77.87 cm in JG-1334(V11)treatment during 2015-16. In the next year trial the maximum height of plant was recorded 80.30 cm in V25 (K. Sheetman) treatment and it was followed by 80.17 cm in JG-1334 (V11) treatment during 2016-17. The minimum plant height was observed 44.37 and 47.20 cm in FR-B-4(V21) and JF-4915(V17)treatments during 2015-16 and 2016-17 respectively. Thus varying range of growth behaviour was from 44.37 FR-B-4 (V21) to 78.43 cm JI-5857 (V2) and 47.20 cm JF-4915 (V17) to 80.30 cm K. Sheetman (V25) in the years 2015-16 and 2016-17, respectively. There were significant differences in different treatments.

Leaf growth and development behaviour was found in a considerable range of variation. The number of leaves ranged from 67.33 to 89.00 per plant in V_{17} and V_{29} treatments during 2015-16 and 2016-17, respectively. After the highest number of leaves per plant, there was not much range of difference in the second line of following as it was found that in first trial the maximum number was followed by 88.67, 88.33 and 86.00 in the treatments V_{32}, V_{27} and V_{28}, respectively. The results were found significant when compared with the minimum number of leaves per plant. The variability in production of leaves per plant was also observed by the other research workers in potato varieties (Bisen and Barhalia, 1991; Bhutani *et al.,* 1991; Dwivedi and Dwivedi, 1991; Agrawal and Tiwari, 2004; Marwaha *et al.,* 2009). Sometimes in certain conditions of climatic factors also had a considerable effect on growth behaviour apart from genetic constitution of a variety/culture/strain. Such situations have also been discussed by previous scientists (Pushkarnath, 1976 and Sikka, 1977; 1996).

After number of leaves/plant its growth and development was also recorded where length of leaf exhibited considerable difference. The varying length of leaf was found to reveal

positive response as per the variety/strain/culture in present investigations during both years of trails. The length of leaf ranged from 18.37 to 24.31 cm in treatments V20 to V9 during 2015-16. In the next year it was found to range from 17.97 to 23.77 cm in variety V_{20} to V_{13}, V_{16} during 2016-17. Length of leaf variation had also been reported at varietal level in other tuber crops by Azariah and Saptharishi (1956); Anon. (1970) and Chandra *et al.* (1990). Present findings of length of leaf in potato in accordance with the results reported by Kumar (1972), Gasti (1994) and Mishra and Prasad (1995) in their experiments of potato crop. The vegetative growth is affected by a large number of factors which create certain causes for adverse effect beyond the normal growth and development in performance of crop germplasm crop. Such variations have also been observed by the other scientists engaged in researches in different crops and also in tuber crops (Bushnell, 1925; Donny, 1929; Singh *et al.,* 1974, Ereklay, 1977; Tyagi, 1985; Singh and Chandra, 2004).

In vegetative growth behaviour width of leaf was found variable like its length in different varieties/strains/cultures under present investigations. The width was found in considerable difference which was found the maximum 15.97 and 15.40 cm in treatments V_{10} and V_9 during 2015-16 and 2016-17, respectively. After the record of maximum width of leaf, it was also found that minimum width was found variable in different treatments during both the years of investigations. Treatments V_{10}, V_9 and V_7 were found statistically at par in results during 2015-16. Similarly it was further found that treatment V_1 and V_{10} were in highly significant differences with each other during 2015-16. Similar observations were reported by Vogol (1982), Thompson (1984), Tripathi (1985) and Velayudhan *et al.* (1991).

Table 1 Effect of Integrated crop Management of Late Blight Diseases of Potato on vegetative growth characters (2015-16)

Treatment	Tuber Sprouting (%)	Number of shoots/plant	Plant height (cm)	Number of leaves/plant	Length of leaf (cm)	Width of leaf (cm)
V_1	58.00	5.00	76.13	78.00	20.27	10.53
V_2	71.00	5.03	78.43	75.00	19.90	12.83
V_3	53.00	5.70	71.40	74.00	21.51	14.40
V_4	73.33	5.70	48.23	70.00	22.27	13.97
V_5	66.67	5.67	45.50	72.00	23.20	14.53
V_6	72.00	6.27	44.57	70.33	22.13	14.97
V_7	66.33	6.23	53.00	72.33	22.77	15.23
V_8	71.67	6.83	72.07	74.33	21.71	14.40
V_9	54.33	4.73	73.73	72.67	24.31	15.37
V_{10}	75.00	5.30	74.37	75.67	21.63	15.97
V_{11}	71.67	5.40	77.87	76.00	22.43	12.60
V_{12}	70.67	7.23	68.00	76.00	20.43	12.73
V_{13}	68.33	7.17	75.00	75.67	23.51	12.13
V_{14}	69.67	6.13	74.30	82.67	21.17	11.60
V_{15}	66.00	6.50	51.43	79.00	23.27	11.30
V_{16}	46.33	6.97	74.77	76.33	22.83	10.90
V_{17}	62.33	7.23	49.50	67.33	21.53	12.14
V_{18}	65.00	7.87	73.43	70.00	23.63	14.53
V_{19}	65.67	6.97	74.40	74.00	22.20	13.13
V_{20}	71.00	6.57	61.90	74.33	18.37	11.30
V_{21}	72.33	5.50	44.37	72.67	20.27	11.38
V_{22}	60.00	5.13	51.23	70.33	19.89	12.65
V_{23}	77.67	5.93	74.23	74.67	22.22	12.26
V_{24}	66.67	6.27	72.03	79.00	21.50	22.10
V_{25}	73.33	6.00	74.23	77.00	23.73	13.32
V_{26}	74.00	6.90	69.07	70.33	22.16	12.73
V_{27}	70.67	8.40	74.20	88.33	21.23	12.65
V_{28}	67.67	8.37	75.37	86.00	18.32	11.72
V_{29}	69.00	8.40	74.37	89.00	23.23	13.17
V_{30}	69.00	7.73	48.73	81.67	22.53	12.25
V_{31}	72.00	6.30	69.53	79.00	21.35	12.14
V_{32}	69.00	7.30	62.57	88.67	18.37	11.26
C.D. at 5%	**12.72**	**0.64**	**2.80**	**5.85**	**0.96**	**0.54**

Table 2 Effect of Integrated crop Management of Late Blight Diseases of Potato on vegetative growth characters (2016-17)

Treatment	Tuber Sprouting (%)	Number of shoots/plant	Plant height (cm)	Number of leaves/plant	Length of leaf (cm)	Width of leaf (cm)
V_1	71.67	4.50	79.07	76.00	19.29	10.60
V_2	66.00	4.90	76.83	77.33	19.33	12.83
V_3	59.33	5.37	75.43	77.33	21.33	14.30
V_4	68.57	5.63	51.70	70.67	22.23	14.60
V_5	64.00	5.47	49.60	68.33	23.19	14.83
V_6	66.00	6.47	56.30	71.67	21.80	14.97
V_7	70.67	6.37	52.30	72.67	22.83	14.20
V_8	71.67	7.23	74.90	71.00	21.27	14.47
V_9	60.67	5.70	72.03	71.33	23.03	15.40
V_{10}	73.67	5.30	79.30	72.00	21.33	14.67
V_{11}	73.00	5.10	80.17	73.67	22.17	12.23
V_{12}	75.00	7.00	72.80	76.83	19.80	12.83
V_{13}	74.67	6.67	80.30	78.00	23.77	12.10
V_{14}	72.67	6.23	72.83	81.67	21.31	11.73
V_{15}	73.33	6.43	76.70	79.67	22.37	12.30
V_{16}	72.33	6.27	74.90	81.00	23.77	11.10
V_{17}	72.67	6.97	47.20	71.67	22.03	12.30
V_{18}	56.33	7.33	73.60	67.00	23.77	14.70
V_{19}	49.00	6.63	73.47	73.67	21.53	13.31
V_{20}	62.33	6.17	79.03	80.33	17.97	11.41
V_{21}	72.67	5.93	73.90	73.00	19.67	11.58
V_{22}	64.67	5.47	59.67	70.33	19.56	12.36
V_{23}	64.67	6.13	54.90	85.33	22.43	12.17
V_{24}	66.67	6.47	74.50	84.00	22.12	22.47
V_{25}	69.33	6.17	80.30	80.33	23.76	13.64
V_{26}	71.67	6.50	79.27	69.33	22.43	12.53
V_{27}	71.67	8.30	70.60	90.33	21.41	12.33
V_{28}	67.67	8.60	76.80	90.33	18.76	11.55
V_{29}	70.00	8.43	54.87	88.33	23.15	12.79
V_{30}	70.00	7.37	53.70	85.67	21.63	12.52
V_{31}	69.00	6.50	78.03	80.00	22.11	12.14
V_{32}	69.33	7.27	75.40	80.00	18.85	11.28
C.D. at 5%	**16.11**	**0.58**	**5.11**	**4.47**	**0.93**	**0.54**

After vegetative growth, maturity of plant reaches to give appearances for certain changes in related aspects. Like that reproductive growth appears after the blossom bud differentiation. The pointed reproductive buds were found in plants of different varieties/strains/cultures. The period for appearance showed difference in days in different treatments. The minimum period 93.11 and 93.47 days was found in treatment V_{13} and V_{13} during 2015-16, respectively. 110.82 and 110.76 days were found maximum period observed as for blossom bud appearance in treatment V_{25} and V_{24} during 2015-16 and 2016-17, respectively. Similar variation of period for reproductive bud appearance had also been observed at different research stations i.e. like Bahugarh, Meerut and Central Potato Research Institute, Shimla (Pushkarnath, 1964; Sikka, 1977; Singh, 1984).

Plant growth behaviour was found to indicate the maturity of different shoots in the treatments. The shoots produced reproductive growth of buds which used to give rise to matured form of flowering buds. These reproductive buds produce flowers on the shoots. Such appearance of reproductive buds was found in variability in different genotypes during both years of investigations. In this aspect maximum number of days were found 117.16 and 120.30 in the treatment V_{16} and V_{16} during 2015-16 and 2016-17, respectively. Such variations regarding growth behaviour for photoperiadic response was also observed by Purohit (1970), Purohit *et al.* (1973) and Pushkarnath (1976) in their investigations.

Potato plant growth was recorded alongwith to produce potato tubers. Plant growth parameters were found to response to the potato tuber production. However, several factors also affect the similarity have different genetic constitution (Pushkarnath, 1976; Sikka, 1977). In present investigations such variability

was observed in different treatments of potato taken in these investigations. In fact tuber production was found variable in different treatments. Tuber production varied from 7.30 (V_1) to 15.51 (V_{32}) per plant during 2015-16. Similarly it was also found to range from 7.93 (V_1) to 15.70 (V_{32}) during 2016-17. This range of variation in performance was in case of varietal investigations where some unknown factors also had their response for producing tubers per plant in experiments. Present findings are in accordance with the results observed by the scientists (Pushkarnath, 1964; Purohit *et al.* 1970; Pandita, 1974; Sharma *et al.,* 1978; Sindhu and Pandita, 1979). Not only potato such variability has also been found in other crops which has the basis of different factors. (Agrawal and Dwarst, 2004, Singh and Chand, 2004; Tauk, 2010).

Tuber formation was found in variable number per plant in different genotypes of treatments in present investigations. Potato size was observed variable which affect their yield per plant. Total yield became the final contribution in yield. Potato tuber growth and development led to their maturity which required variable period for the maturity of tubers. Young tubers in matured stage contribute the actual yield of the crop (Pushkarnath, 1970; Pandita, 1974; Singh and Chand, 2004). Young tubers do'not give the actual form of yield (Sindhu and Pandita 1979). In the present findings period for tuber maturity was found variable in different treatments. Tuber maturity period was found to range from 95.23 to 114.67 days in treatments V_{12} and V_{20} during 2015-16. Similar range of variation was also found in next year experiment during 2016-17. Such maturity period variation have been observed by different scientists in case of potato crop (Purohit *et al.,* 1972; Pushkarnath, 1976; Tyagi, 1985). In a recent study, Prajapati *et al.* (2018) reported the variations for maturity and quality of garlic crop.

Yield is the result of the crop which comes by the contribution of plant parts and other factors (Pushkarnath, 1970). In potato also plant parameters, soil and atmospheric factors etc. contributed the yield in different genotypes. It was a variable quantity in different treatments which varied from 187.43 (V_{18}) to 413.90 (V_5) in 2015-16. In next year it was also recorded variable yield in different varieties/strains/cultures. Such variations have also been observed by the scientists who worked in potato crop (Pushkarnath, 1964; Purohit *et al.,* 1973; Sindhu and Pandita, 1979; Singh 1983; Shekhawat, 1996; Sood, 1996).

Dry matter content in potato tuber has the impact on the quality factor of the crop of different genotypes. Present findings revealed the variation in the content of dry matter in different treatments. It was found to range from 13.73 (V_{13}) to 15.63 per cent (V_{22}) during 2015-16. In the year 2016-17, it was found also variable from, 13.80 (V_{13}) to 15.73 per cent (V_{29}). Such range of variation was found depending upon the maturity of the crop too. Its similar range has also been observed by the other research workers engaged in potato crop (Bird, 1952; Purohit *et al.,* 1972; Pandita and Sindhu, 1981, Kabir, 1990; Jha *et al.,* 1991; Marhwaha, 1996).

Table 3 Effect of Integrated crop Management of Late Blight Diseases of Potato on Re-productivity & yield characters (2015-16)

Treatment	No. of days required for bud growth	No. of days for 1st bud opening	Number of tubers/ plant	No. of days for tuber maturity	Yield in q/ha	Dry matter content (%) in tuber 75 DAT
V_1	97.33	93.00	7.30	103.63	340.57	15.00
V_2	100.20	113.37	10.40	111.23	315.10	13.93
V_3	97.13	112.23	10.37	104.33	349.77	14.57
V_4	105.50	115.67	9.93	113.30	370.17	14.37
V_5	107.13	113.23	13.73	112.40	413.90	14.93
V_6	103.67	111.53	14.80	110.50	325.57	14.57
V_7	100.03	103.27	15.27	103.51	322.93	14.50
V_8	103.43	111.57	14.80	100.37	332.87	14.80
V_9	102.90	110.07	14.40	104.33	324.00	14.47
V_{10}	103.43	110.83	14.17	107.11	330.90	15.07
V_{11}	100.00	105.60	13.93	114.57	318.17	14.37
V_{12}	99.23	104.87	14.13	95.23	337.43	14.87
V_{13}	93.11	99.90	14.50	99.53	350.40	13.73
V_{14}	100.41	104.23	14.40	107.33	309.27	14.57
V_{15}	101.70	115.07	14.50	103.03	187.43	14.70
V_{16}	110.23	117.50	14.60	114.50	289.40	14.23
V_{17}	107.51	116.63	12.03	112.63	290.17	14.03
V_{18}	104.40	115.23	12.90	110.80	235.80	14.80
V_{19}	104.53	115.50	14.37	113.27	248.17	15.10
V_{20}	107.27	114.27	14.80	114.67	267.63	14.53
V_{21}	100.12	100.23	12.77	109.86	245.10	14.67
V_{22}	104.53	104.86	13.57	110.25	232.50	15.63
V_{23}	110.72	107.65	14.57	107.35	277.93	15.10
V_{24}	107.36	110.29	10.80	95.27	240.43	14.90
V_{25}	110.82	112.33	10.53	109.31	343.50	14.97
V_{26}	103.63	115.25	9.83	103.63	375.57	15.10
V_{27}	102.35	110.76	11.07	112.35	336.47	14.80
V_{28}	104.51	107.65	11.40	110.22	363.47	15.30
V_{29}	107.45	108.74	10.73	112.65	345.47	15.83
V_{30}	101.58	112.57	11.67	114.21	262.37	15.10
V_{31}	104.27	113.25	12.20	113.27	383.67	14.60
V_{32}	105.62	110.43	15.57	110.67	345.73	15.23
C.D. at 5%	**1.25**	**2.32**	**1.05**	**1.06**	**19.05**	**0.56**

Table 4 Effect of Integrated crop Management of Late Blight Diseases of Potato on Re-productivity & yield characters (2016-17)

Treatment	No. of days required for bud growth	No. of days for 1st bud opening	Number of tubers/ plant	No. of days for tuber maturity	Yield in q/ha	Dry matter content (%) in tuber 75 DAT
V_1	100.00	93.07	7.93	113.33	326.50	15.03
V_2	104.10	115.63	10.13	112.00	242.40	14.23
V_3	99.71	112.77	10.37	100.33	255.77	14.63
V_4	107.93	114.27	9.90	113.30	244.77	14.77
V_5	105.13	116.67	12.90	112.10	258.57	15.30
V_6	103.53	112.73	14.64	111.73	254.63	14.97
V_7	100.13	104.83	14.83	100.43	308.83	14.73
V_8	103.33	113.43	14.93	107.90	312.60	14.80
V_9	103.13	114.00	14.80	100.20	311.07	16.00
V_{10}	101.53	110.27	13.83	110.10	327.73	14.60
V_{11}	99.53	107.27	14.60	109.17	316.37	13.87
V_{12}	99.33	106.23	14.07	98.20	316.80	14.07
V_{13}	93.47	101.03	13.83	93.93	331.99	13.80
V_{14}	100.70	104.00	13.68	100.93	328.90	14.67
V_{15}	100.10	119.33	13.83	107.00	218.73	14.00
V_{16}	107.21	120.30	13.23	114.27	244.93	14.57
V_{17}	105.73	110.47	12.70	112.17	217.43	14.77
V_{18}	103.53	115.10	13.73	110.23	214.80	15.33
V_{19}	100.21	115.47	13.77	114.30	248.40	15.17
V_{20}	100.77	115.13	13.90	114.60	219.60	14.73
V_{21}	105.47	102.75	13.13	110.24	226.37	15.27
V_{22}	106.18	105.13	13.63	110.86	214.47	15.23
V_{23}	109.28	106.43	12.77	109.85	241.27	14.97
V_{24}	110.76	109.74	11.00	98.61	239.97	15.07
V_{25}	110.36	111.65	10.27	104.66	268.47	14.93
V_{26}	101.46	113.19	10.40	104.34	284.20	14.53
V_{27}	105.26	109.28	11.07	112.48	245.38	15.00
V_{28}	106.83	110.62	10.90	110.78	241.70	15.07
V_{29}	103.28	109.73	10.20	112.31	239.27	15.73
V_{30}	103.12	114.35	11.37	113.23	258.30	15.10
V_{31}	103.31	110.28	11.53	114.31	251.80	14.37
V_{32}	103.86	109.87	15.70	112.54	259.80	15.47
C.D. at 5%	**1.58**	**2.10**	**0.94**	**1.26**	**20.39**	**0.53**

CONCLUSION

It is concluded that important information on different aspects of seed tubers-sprouting, plant growth and development of parameters was gathered in all the treatments. All 32 varieties/strains/cultures grown in performance were found to express normal information for benefits of farmer. Finings of results were drawn on the basis of information gathered in observation recorded and data calculation for significance. Treatment V_5, V_{13}, V_{22}, V_{26}, V_{28} and V_{29} were found promising. K. Badshah was found the best of all treatments and next best wered K. Bahar (V_{27}), K. Alankar (V_{31}) and K. Sundur's (V_{32}).

References

Anonymous (1970). Evaluation of potato varieties and hybrids. *Ann. Sci. Report, Central Potato Research Institute, Shimla, pp* : 78-81.

Agrawal, A. and R.S. Tiwari (2004). Genetic variability in Garlic (*Allium sativum* L.). *Indian J. Agri. Sci.* 74 : 164-165.

Azariah, M.D. and K. Saptharishi (1956). A review of some recent annual trials on Potato at Agriculture Research Station, Nunjanand. *Madras Agric. J.,* 43 : 407-409.

Basu, P.S. (1996). Photosynthesis in relation to tuber yield. *Potato Res. Methodol AICPIP, Sci. C.P.R.I., Shimla, pp* : 101-104.

Bisen, A.L and A.K. Barhalia (1990). Note on performance of Potato during autumn crop season. *Indian J. Hort.*, 47 (1) : 104-106.

Bartholdi, W.I. (1942). Influence of flowering and fruits upon vegetative growth and tuber yield in the Potato. *Minn. Tech. Bull., pp* : 50.

Bhattacharya, S.K.; Sheo Raj; D.S. Singh; S.C. Khanna and Shiv Ram (1978). *Proc. Int. Seminar* : Potato production in Developing Countries, Nov. 20-23, held at Jullunder, India, *pp* : 67 (Abst.).

Birhman, K.R. (1996). Breeding for Resistance late blight. *Potato Res. Methdol. AICPIP Sci. C.P.R.I., Shimla*, *p* : 24-25.

Chaudhary, H.C. (1967). Potato varietal test in West Bengal. *Amer. Potato J.,* 44 : 204-208. Chaudhary, B. (1972). Vegetables. *National Book Trust, India, pp* : 95-103.

Donny, F.E. (1929). Role of mother tuber in growth of potato plant. *Bot. Gaz.,* 88 (1) : 66-68.

Chadha, K.L. (1998). Delayed recognition of potential in horticulture. *The Hindu Survey of Indian Agric.,* 111-117.

Chandra, A.; V.K. Verma and B.K Neema (1990). Studies on sweet potato germplasm (Abst.). *The Int. Sem. New Frontier Hort.* held at Bangalore, *pp* : 71.Davis, H.T. (1969). The influence of stem thinning on tuber size. *Amer. Potato J.*, 46 : 287-290.

Dwivedi, G.K. and M. Dwivedi (1991). Mode of application of micronutrients of potato in acid soil of Garhwal, Himalaya. *Indian J. Hort.,* 48 (3) : 258-263.

Gaur, P.C. (1998). Morphology and genetic variability for some quantitative characters in potato. *J.I.P.A.S.,* 5 (2) : 70-75.

Kabir, M.H. (1990). Studies on population density of hybrid True Potato Seed (TPS) progeny. *Haryana J. Hort. Sci.,* 20 (1 & 2) : 125-128.

Kaul, H.N. (1996). Dormancy and sprouting behaviour of potatoes. Training Course, *Potato Res. Methodol. AICPIP Sci. held at Shimla*, pp : 105-109.

Kumar, J.S. (1972). Response of potato varieties to different planting dates under force condition. *M.Sc. Thesis submitted to G.B.P.U.A. & T., Pant Nagar, Nainital.*

Leela, D., (1993). Present status and future scenario of weed control in Horticultural crops. Golden Jubilee Symposium Horticulture Research A Chaning Scenario. Bangalore (May, 24-26).

Levy, D. (1978). Vegetative development and tuber yield of potato. *C.F. Fld. Crop,* 33 : 163 (1503).Marwaha, R.S., S.V. Singh, S.K. Pandey, D. Kumar and V.K. Gupta (2009). Evaluation of advanced potato hayfield MP/97-644 and processing varieties for yield and chipping quality in North-Eastern- hills. *Indian J. Hort.* 66 (3) : 367-373.

Marwaha, R.S. (2002). Chipping quality of potato cultivars during short term storage at warm temperature. *J. Food. Sci. Tchnol.* 39 : 489-495.

Minhas, J.S., P. Kumar, D. Kumar, V.K. Dua and Y.K. Gupta (2018). Respone of potato to elevated CO_2 under short days growth physiological parameters and tuber yield. 70 (1) : 82-86.

Pushkarnath (1964). Potato in India : varieties. *Indian Council of Agricultural Research, New Delhi, pp* : 493.Pandey, S.K. (1996). Methodology for economics and marketing. *Training Course : Potato Res. methodol AICPIP Sci.,* held at *Shimla*, *pp* : 148-151.

Prajapati, S.K., A. Tiwari and S. Prajapati (2018). Evaluation and variability study in Garlic. *Indian J. Hort.* 70 (1) : 161-164.

Panse, V.G. and P.V. Sukhatme (1961). Statistical methods for Agricultural workers. *Indian Council Agric. Res., New Delhi.*

Prakasa Rao, E.V.S. and P.D. Arora (1979). Studies on uptake of nitrogen by potato crop. *Indian J. Agron.,* 24 : 441-444.

Rai, P.P. (1984). Effect of formation on soil borne pathogen of potato. *Indian Phytopath.,* 37 (4) : 649.

Rai, M. (1986). A comparative performance of sweet potato varieties, hills condition of Arunanchal Pradesh. Paper presented in Seminar on Economic Relevance of Agric. and Hort. Thesis potentialities and prospect. *C.T.C. Pass Ghat 4-6 February, 1986, pp* : 47-48.

Rai, M.; S.P. Verma; A.K. Ghosh and D.C. Dhankar (1980). Optimum planting time of high yielding sweet potato varieties for upland of Tripura. *Nat. Sem. Tuber Crop Produc. Tech., T.N. Agric. Univ. Coimbtore, pp* : 126-127.

Singh, B.P. (1996). Late blight and other foliar diseases of potato. *Res. Methodol. AICPIP Sci., C.P.R.I., Shimla, pp* : 61-66.

Singh, R.C. (1983). Studies on effect of important rabi crops on growth and yield of potato. *M.Sc. (Ag.) Thesis submitted in C.S.A.U.A. & T., Kanpur.*

Singh, J. (1996). Potato harvest handling of potato. *Potato Res. Methodol. AICPIP Sci., C.P.R.I., Shimla, pp* : 98-100.

Singh, R.P., V.P. Pandey and H.N. Tatoo (1985). Studies on the performance of potato varieties in Tarai. *Ann. Report. G.B. Pan Univ. of Agric. & Tech., Pantnagar, Nainital, pp* : 181-183.

Shekhawat, C.S.; S. Piplani and M.M. Ansari (1984). Endophytic bacterial flora of potato plant in relation to soft rot disease. *Indian Phytopath.,* 37 (3) : 501-505.

Sharma, R.C. (1996) Tuber cropping and potato based cropping systems. *Potato Res. Methodol. ICPIP Sci., held at Shimla, pp* : 74-76.

Sud, K.C. (1996). Soil and plant tests for potato. *Potato Res. Methodol. AICPIP Sci., held at Shimla pp* : 84-88.

Sikka, L.C. (1996). International Experience useful for Indian Programme. *Potato Res. Methodol. for AICPIP Scientist C.P.R.I. held at Shimla, pp* : 14-16.

Sindhu, A.S. and M.L. Pandita (1979). Genetic variability and correlation studies in potato. *J. Indian Potato Assoc.,* 6 : 103-108.

Tauk, D. (2010). Effects of rising atmospheric concentration of carbon dioxide on plants. *Nat. Edu. Knew.* 3 : 21.

Tiwari, D.K. and J.P. Tiwari (1975). Ecophysiological adoptability of new potato varieties at Jabalpur. *Rez. J.,* 9 : 44-49.

Verma, R.K. and G.S. Shekhawat (1991). Effect of crop rotation and chemical soil treatment on bacterial wilt of potato. *Indian Phytopath.,* 44 (1) : 5-8.

Velayudhan, K.C.; V.K.K. Murlidharan and V.A. Amalraj (1991). Genetic diversity in country potato and under utilized tuber for the tropics. *Indian Hort.,* 36 (1) : 27-31.

How to cite this article:

T. S. Mishra, H.M.Singh, U.S.Mishra and N. K. Mishra., 2019, Integrated Management of late Blight Diseases of Potato Crop Grown in Northern India. *Int J Recent Sci Res.* 10(06), pp. 32786-32791. DOI: http://dx.doi.org/10.24327/ijrsr.2019.1006.3544

****