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Effect of Planting Date on Growth and Yield of Potato (*Solanum tuberosum* L.) in Semi-arid Tropics of Central India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present experiment was carried out at the Research Farm of ICAR-Central Potato Research Institute (Regional Station), Gwalior (M.P.) during the *Rabi* season of 2021-22 to study the influence of planting dates on performance of potato crop. Total seven different planting date as treatments viz., D1- 15/09/2021; D2- 30/09/2021; D3- 15/10/2021; D4- 30/10/2021 (Timely planting); D5- 14/11/2021; D6- 29/11/2021 and D7-14/12/2021 were tested in randomized block design (RBD) with four replications. The potato (cv. Kufri Mohan) was planted with a seed rate of 3.5 t ha^{-1} and with a spacing of 60 cm x 20 cm. The recommended dose of chemical fertilizers viz., 180:80:120 kg ha^{-1} $N:P_2O_5:K_2O$, respectively was applied to the crop. The various growth and yield

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attributes and yield viz., plant height, number of stem plant^{-1}, haulm yield, tuber yield, biological yield and harvest Index were recorded. The results revealed that the timely planting treatment recorded 18.6-69.0% and 13.1-52.5% higher yield than early and late planting, respectively. Thus, the timely planting of potato (D4) showed significant positive effect on growth and yield of potato crop whereas the early (D2 and D2) and late planting (D6 and D7) treatments showed poor growth and yield performance.

Keywords: Planting date; potato; yield; plant height; tuber yield; harvest index.

1. INTRODUCTION

The potato (*Solanum tuberosum* L.) is an annual herbaceous tuber crop of the Solanaceae family that contains all the essential food ingredients required for maintaining proper human health. Potato is the staple food of almost half of the world's population [1]. Potato is the fourth most important food crop in the world, after corn, rice, and wheat. It is known as a protective food because potato protein is rich in lysine, which is one of the most important amino acids. It is also the most important food crop in the world, and it contains approximately 78% water, 22% dry matter, 20.6% carbohydrates, 2.1% protein, 1.1% crude fiber, 0.9% ash, and 0.3% fat [2]. In India, about 68% of potatoes are utilized for table purposes, 7.5% for processing, 8.5% for seed, and the remaining 16% of produce goes waste during pre- and post-harvest handling [3]. In India, it is grown on an area of 2.14 million hectares with a production of 51.31 million tonnes and a productivity of 24.0 tonnes ha^{-1}. Currently, Madhya Pradesh contributes about 6.96 percent of area and 6.58 percent of production of potatoes in the country. Its productivity in Madhya Pradesh is 22762 kg ha $^{-1}$.

The optimum growth and production largely depend upon prevailing weather conditions and use of improved inputs like use of improved varieties, time of planting, good seed quality and other cultural practices till harvesting contribute in increasing potato yield. Among them, the optimum time of planting is major limiting factor for maximum production of potato. Planting at optimum time result in maximum emergence, good crops growth and better utilization of light and temperature and minimum pest problem would enhance the yield. For best yields, potato crop requires long day conditions for good growth and short-day conditions for tuberization [4]. Optimum tuber formation takes place at 20^{0}C. Increase in temperature beyond 21^{o}C cause sharp reduction in the tuber initiation and yield and at 30^{o}C complete inhibition of tuber formation [5]. Therefore, standardization of the optimum date of planting is not only important for yield but also to ensure better tuber quality. Therefore, keeping in view all above facts, the present investigation was carried out at ICAR-Central Potato Research Institute –Regional station Gwalior, Madhya Pradesh to study the influence of planting dates on performance of potato crop.

2. MATERIALS AND METHODS

2.1 The Field Experiment

The present experiment was carried out at the Research Farm of ICAR-Central Potato Research Institute (Regional Station), Gwalior (M.P.) during the *Rabi* season of 2021-22. Geographically, Gwalior is located at 26^{o}13' North latitude and 78^{o}14' East longitude and 206 meters above mean sea level (AMSL) which lies in the North tract of M.P. enjoying subtropical climate, with extreme hot up to 48°C in summer and minimum temperature as low as 4.0°C during winter season. The annual rainfall ranges between 750 to 800 mm, most of which received from end of June to end of September, with few showers in winter months.

The experiment was laid out with seven different planting dates viz., D1- 15/09/2021; D2- 30/09/2021; D3- 15/10/2021; D4- 30/10/2021 (Timely planting); D5- 14/11/2021; D6- 29/11/2021 and D7-14/12/2021 in randomized block design (RBD) with four replications. The potato (cv. Kufri Mohan) was planted with a seed rate of 3.5 t ha^{-1} and with a spacing of 60 cm x 20 cm. The recommended dose of chemical fertilizers viz., 180:80:120 kg ha^{-1} N:P_2O_5:K_2O, respectively was applied before planting. Seed treatment was done with 3.0 % boric acid solution by dipping tubers for 30 minutes for controlling soil and tuber born diseases before keeping seed tubers in cold store. Seed treatment was performed at shady place and immediate after treatment, tuber were treated and covered with soil to protect the tubers from sun light. Seed tubers were planted manually at

a uniform distance of 60 cm between row to row and 20 cm between plant to plant. The planting was done as per the designed treatments during first and second years. A uniform seed rate of 35 q ha^{-1} was used for planting. Weed was managed using Metribuzin 70%WP as a pre-emergence herbicide (one day after planting) @ 500g a.i. ha^{-1} in all treatments. Imidachloprid (17.8% SL) insecticide was used for controlling pest population at the 45 DAP. The first irrigation was given immediately after planting since planting was done under dry soil condition. It ensures proper establishment of potato plant. Subsequent irrigations were given at about 10-15 days interval using ridge - furrow irrigation method as per crop requirement.

2.2 Observations Recorded

Five potato plants were randomly selected from the inner rows of each plot. The sampled plants were carefully dugged up, the roots thoroughly washed under running water, put in labeled envelop bags and taken to the laboratory where the growth and yield parameters were recorded. After sun drying samples were oven-dried at65°C until a constant weight was attained. Completely dried samples were weighed and the dry matter (DM) content of different plant parts was measured and expressed in g $plant^{-1}$. The various growth and yield attributes and yield viz., plant height, number of stem $plant^{-1}$, haulm yield, tuber yield, biological yield and harvest Index were recorded. All data related to the study were collected, compiled and statistically analyzed by using the analysis of variance technique [6]. Data so computed was subjected to Fisher's analysis of variance for judging the effect of various treatments.

3. RESULTS AND DISCUSSION

3.1 Plant Height

The plant height during 2021-22 at 30 DAP ranged 19.1-31.1 cm under various planting dates (Table 1). The highest plant height of potato was recorded in the treatment D4 (planting date 30 October) followed by the treatment D5 (14 Nov) and D3 (15 Oct) however these treatments found statistically at par with each other. The lowest plant height was recorded for the treatment D6 (29 Nov) followed by the treatment D1 (21.2 cm). The plant height recorded at 60 DAS and at harvest found statistically at par. Further, the plant height during 2022 at 30 DAP ranged 19.6-28.7 cm with a mean value of 23.8 cm under various planting dates. The plant height was found highest under timely planting treatment i.e. planting at 30 Oct (D4) whereas the lowest plant height was recorded for D2 (30 Sept planting). The plant height of potato did not show significant influence of planting dates except recorded at 30 DAP. The pooled data of 2 years also reflected the similar trend. The plant height recorded at 30 DAP showed significant effect of planting dates in both the years of study including pooled data of two years.

The plant height was significantly influenced under various planting dates. The better plant height under the timely planting treatment might be the effect of favorable temperature. Modisane [7] reported taller plants at optimum temperature. Singh et al. [8] reported maximum plant height (43.6 cm) under timely planting treatment. Similar findings were also reported by Vishwas et al. [9] at Instructional Farm of Potato Research Station, Mainpat, Chhattisgarh. Yenagi et al. [10] reported that the delayed planting negatively influence the plant height of potato. The results of present study are in line with these reported findings.

3.2 Stems per Plant

In 2021-22, the stems $plant^{-1}$ at 30 DAP, 60 DAP and at harvest ranged 1.50-3.42, 1.58-3.74 and 1.58-3.83, respectively. At 30 DAP, the treatment D4 (30 Oct) found statistically significant over D1, D2 and D7. The treatments D1, D2 and D7 found statistically at par. Similarly, the treatments D3, D4, D5 and D6 were also found statistically at par. At 60 DAP, the treatments D3, D4 and D5 found statistically significant over the treatments D1, D2 and D7. The treatments D2, D6 and D7 were found statistically at par with each other. The treatment D4 found statistically significant over the treatments D1, D2, D6 and D7 with respect to stems $plant^{-1}$ in potato at harvest during 2021-22.The stems $plant^{-1}$ in potato in 2022 recorded at 30 DAP, 60 DAP and at harvest ranged 1.60-3.35, 1.80-3.10 and 1.80-3.10, respectively (Table 2).

At 30 DAP, the treatment D4 (30 Oct) found statistically significant over D1, D2, D3, D6 and D7. The treatments D1 and D2 found statistically at par. Similarly, the treatments D2, D3, D6 and D7 were also found statistically at par. At 60 DAP and at harvest, the treatments D2, D3, D4, D5. D6 and D7 found statistically significant over the treatments D1. The treatments D2, D3, D4, D5,

Table 1. Effect of planting dates on plant height of potato

Treatment	Plant height (cm)								
	2021-22			2022-23			Pooled		
	30 DAP	60 DAP	harvest	30 DAP	60 DAP	harvest	30 DAP	60 DAP	harvest
D1	21.2	56.1	66.3	22.5	57.3	62.4	21.8	56.7	64.3
D2	22.6	58.4	67.6	19.6	54.9	65.9	21.1	56.6	66.7
D3	28.0	60.8	71.3	24.2	59.5	70.7	26.1	60.1	71.0
D4	31.1	62.7	74.5	28.7	61.6	73.4	29.9	62.2	73.9
D5	29.0	61.6	73.3	27.8	61.4	72.5	28.4	61.5	72.9
D6	19.4	54.4	70.7	21.2	53.8	68.7	20.3	54.1	69.7
D7	22.2	53.6	69.6	22.5	53.0	67.2	22.3	53.3	68.4
SEm±	1.47	3.28	2.56	1.26	3.04	3.20	1.05	2.41	2.51
CD at 5%	4.38	NS	7.65	3.77	NS	9.56	3.12	NS	7.49

Table 2. Effect of planting dates on number of stems in potato

Treatment	Stems per plant								
	2021-22			2022-23			Pooled		
	30 DAP	60 DAP	harvest	30 DAP	60 DAP	harvest	30 DAP	60 DAP	harvest
D1	1.50	1.58	1.58	1.60	1.80	1.80	1.55	1.69	1.69
D2	1.92	2.25	2.25	2.00	2.60	2.60	1.96	2.43	2.47
D3	2.83	3.08	3.08	2.55	2.80	2.80	2.69	2.94	2.90
D4	3.42	3.58	3.58	3.35	3.10	3.10	3.38	3.34	3.47
D5	3.17	3.74	3.74	3.15	2.85	2.85	3.16	3.29	3.09
D6	2.67	2.83	2.83	2.55	2.60	2.60	2.61	2.72	2.68
D7	2.58	2.53	2.53	2.50	2.55	2.55	2.54	2.54	2.59
SEm±	0.267	0.263	0.263	0.239	0.218	0.218	0.212	0.195	0.195
CD at 5%	0.798	0.786	0.786	0.714	0.650	0.650	0.634	0.583	0.583

Table 3. Effect of planting dates on halum and tuber yield in potato

Treatment	Halum yield (t ha-1)			Tuber yield (t ha-1)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
D1	9.60	7.80	8.70	19.41	17.41	18.41
D2	9.88	8.27	9.07	21.41	18.41	19.91
D3	15.57	14.02	14.80	50.63	46.07	48.35
D4	16.88	14.46	15.67	61.46	57.35	59.41
D5	16.71	13.41	15.06	52.76	50.47	51.61
D6	12.71	10.69	11.70	32.44	30.28	31.36
D7	11.57	8.50	10.03	29.33	27.16	28.24
SEm±	0.73	0.47	0.44	1.14	0.99	1.03
CD at 5%	2.17	1.41	1.33	3.39	2.95	3.06

D6 and D7 were found statistically at par with each other. The pooled data of two years pertaining to stems plant^{-1} recorded at 30 DAP, 60 DAP and at harvest ranged 1.55-3.38, 1.69-3.34 and 1.69-3.47, respectively. The treatment D4 found statistically significant over all the treatments except D5 recorded at 30 DAP. Similarly, at 60 DAP, the treatment D4 found superior over D1, D2, D6 and D7. At harvest, the stems plant^{-1} showed significant effect of planting dates as D4 found significant over D1, D2, D6 and D7.

In general, the timely planting significantly influenced the stems plant^{-1} in potato as compared to far early planting and far late planting whereas the planting difference near 15 days either early or late showed non significant effect on stems plant^{-1} in potato during both the years of study including pooled data. Khan et al. [11] reported that the number of stems were significantly higher at optimum planting date treatment i.e. Oct 15 as compared to the early and late planting. Nandekar et al. [12]; Sandhu et

al. [13]; Haile et al. [14] and Singh et al. [8] also reported the similar findings.

3.3 Halum Yield

The halum yield of potato recorded at harvest during 2021-22 and pooled of two years ranged 9.60-16.81 t ha^{-1}, 7.80-14.46 t ha^{-1} and 8.70-15.67 t ha^{-1} with mean of 13.27 t ha^{-1}, 11.02 t ha^{-1} and 12.15 t ha^{-1}, respectively. During the study the highest and lowest halum yield was recorded in the treatment D4 (timely planting) and D1 (15 Sept), respectively.

The pooled data showed that, the halum yield of potato revealed that the treatments D3, D4 and D5 were found statistically at par but significant over all other treatments under study. The lowest halum yield of potato was observed in the treatment D1. The treatment D6 showed significantly higher halum yield as compared to the treatments D1, D2, and D7. Similarly, the treatment D7 found superior as compared to the D1. Thus, the planting dates significantly influenced the halum yield of potato tuber recorded at harvest during the study period.

3.4 Tuber Yield

The tuber yield of potato recorded at harvest during 2021-22 and pooled of two years ranged 19.41-61.46 t ha^{-1}, 17.41-57.35 t ha^{-1} and 18.41-59.41 t ha^{-1} with mean of 38.21 t ha^{-1}, 35.31 t ha^{-1} and 36.76 t ha^{-1}, respectively. During the study the highest and lowest tuber yield was recorded in the treatment D4 (timely planting) and D1 (15 Sept), respectively.

The pooled data on tuber yield of potato revealed that the treatment D4 was found statistically significant over all other treatments under study. The lowest tuber yield of potato was observed in the treatment D1. The treatment D5 showed significantly higher tuber yield as compared to the treatments D1, D2, D3, D6 and D7. Similarly, the treatment D3 found superior as compared to the D1, D2, D6 and D7. The treatment D1 and D2 found statistically at par. Thus, the planting dates significantly influenced the tuber yield of potato recorded at harvest during the study period. Yenagi et al. [10] reported higher yield with early planting of Kufri Chandramukhi and the higher yield was mainly attributed to higher plant height, more number of stems and increase in total dry matter production. Further, Khan et al. [11] also reported significantly higher tuber yield including halum yield at optimum planting date treatment i.e. Oct 15 as compared to the early and late planting. Nandekar et al. [12]; Sandhu et al. [13]; Haile et al. [14] and Singh et al. [8] also reported the similar findings.

3.5 Biological Yield

The biological yield of potato recorded at harvest during 2021-22 and pooled of two years ranged 19.0-78.3 t ha^{-1}, 25.2-71.8 t ha^{-1} and 27.1-75.1 t ha^{-1} with mean of 51.5 t ha^{-1}, 46.3 t ha^{-1} and 48.9 t ha^{-1}, respectively. During the study the highest and lowest biological yield was recorded in the treatment D4 (timely planting) and D1 (15 Sept), respectively.

The pooled data on biological yield of potato revealed that the treatment D4 was found statistically significant over all other treatments under study. The lowest biological yield of potato was observed in the treatment D1. The treatment D5 showed significantly higher biological yield as compared to the treatments D1, D2, D3, D6 and D7. Similarly, the treatment D3 found superior as compared to the D1, D2, D6 and D7. The treatment D1 and D2 found statistically at par. Thus, the planting dates significantly influenced the biological yield of potato recorded at harvest during the study period.

Table 4. Effect of planting dates on biological yield and harvest index in potato

Treatment	Biological yield (t ha-1)			Harvest index (%)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
D1	29.0	25.2	27.1	67.0	69.2	68.1
D2	31.3	26.7	29.0	68.5	69.0	68.8
D3	66.2	60.1	63.1	76.5	76.7	76.6
D4	78.3	71.8	75.1	78.5	79.9	79.2
D5	69.5	63.9	66.7	75.9	79.0	77.5
D6	45.1	41.0	43.1	71.7	73.9	72.8
D7	40.9	35.7	38.3	71.7	76.2	73.9
SEm±	1.2	1.3	1.1	1.72	0.97	1.19
CD at 5%	3.5	3.8	3.3	5.13	2.89	3.54

3.6 Harvest Index

The harvest index of potato recorded at harvest during 2021-22 and pooled of two years ranged 67.0-78.5%, 69.0-79.9% and 68.1-79.2% with mean of 72.8%, 74.8% and 73.8%, respectively. During the 2021-22 and pooled data the highest and lowest harvest index was recorded in the treatment D4 (timely planting) and D1 (15 Sept), respectively whereas during 2022 the lowest harvest index was recorded in the treatment D2 (30 Sept).The pooled data on harvest index of potato revealed that the treatments D4 and D5 were found statistically significant over all other treatments under study. The lowest harvest index of potato was observed in the treatment D1. The treatments D3, D4 and D5 found statistically at par. Similarly, the treatment D3 and D7 were also found statistically at par. Further, the treatment D1 and D2 found statistically at par. Thus, the planting dates significantly influenced the harvest index of potato computed at harvest during the study period. Haile et al. [14] reported highest harvest index (0.84) in potato planted on 30 Oct compared to early/late planting. The results of present study are in line with these findings.

4. CONCLUSION

Potato plants are sensitive to several climatic factors, such as temperature, rainfall, humidity and photoperiod which exert a considerable influence on its growth and tuber development. The results revealed that the timely planting treatment recorded 18.6-69.0% and 13.1-52.5% higher yield than early and late planting, respectively. Thus, the timely planting of potato showed significant positive effect on growth and yield of potato crop whereas the early and late planting treatments performed poor in growth and yield. The planting of potato between 15 Oct and 15 Nov is recommended to achieve better yield of potato.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Thiele G, Theisen K, Bonierbale M, Walker T. Targeting the poor and hungry with potato science. Potato J. 2010;37:75-86.
2. Zhang H, Fen XU, Yu WU, Hu HH, Dai XF. Progress of potato staple food research and industry development in China. Journal of Integrative Agriculture. 2017;16(12):2924-2932.
3. Gupta VK, Das BK, Pandey SK. Performance of local potato varieties in Meghalaya hills. Potato Journal. 2009;36(1-2).
4. Chadha KL. Handbook of Horticulture, ICAR, New Delhi; 2009.
5. Shekhawat GS. Potato production, utilization and marketing in India. Indian Journal of Agronomy. 2001;28(2-4):185–93.
6. Fisher WD. On grouping for maximum homogeneity. Journal of the American statistical Association. 1958;53(284):789-798.
7. Modisane PC. Yield and quality of potatoes as affected by calcium nutrition, temperature and humidity (Doctoral dissertation, University of Pretoria); 2007.
8. Singh N, Amandeep Singh, Kanwaljit Singh. Effect of Time of planting on growth and yield parameters of potato Crop. Int. J. Curr. Microbiol. App. Sci. 2020;9(05):2847-2851.
9. Vishwas U, Rathiya PS, Sinha AK, Verma C, Gupta A. Response of different date of planting on growth, yield and economics of potato (*Solanum tuberosum* L) genotypes under Northern hill region of Chhattisgarh. Journal of Pharmacognosy and Phytochemistry. 2020;9(3):1203-1205.
10. Yenagi BS, Meli SS, Angadi SS. Response of potato to spacing, planting date and nitrogen fertilization under rain-fed conditions. Karnataka Journal of Agricultural Sciences. 2005;18:(2):482-493.
11. Khan AA, Jilani MS, Khan MQ, Zubair M. Effect of seasonal variation on tuber bulking rate of potato. The Journal of Animal & Plant Sciences. 2011;21(1):31-37.
12. Nandekar DN, Dubey KC, Upadhyay PC. Performance of potato varieties in rabi under Satpura of Madhya Pradesh. J. Indian Potato Assoc. 1994;21(3-4):237-239.
13. Sandhu KS, Marwaha RS, Kumar P. Processing attributes of potato varieties stored at ambient conditions of north-western plains. Potato Journal. 2014;41(1).

14. Haile B, Mohammed A, Woldegiorgis G. Effect of planting date on growth and tuber yield of potato (*Solanum tuberosum* L.) varieties at Anderacha District, Southwestern Ethiopia. Int. J. Res. Agric. Sci. 2015;2(6):2348-3997.

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