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Effect of different spacing on growth of potato cv. Kufri Chipsona-1

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Abstract
The experiment was laid out in Factorial RBD with three replications consisting of thirteen treatment combinations of spacing. The observations of morphological parameters were recorded on different aspects such as days to emergence, days to 50% emergence, plant height, number of shoots per plant and number of compound leaves. Result revealed that minimum and maximum days to emergence, days to 50% emergence, plant height, number of shoots per plant and number of compound leaves per plant in first year, second year and in pooled were found the significantly superior nitrogen level among all levels of nitrogen.

Keywords: Morphological parameters, significantly superior, spacing

Introduction
Potato (*Solanum tuberosum*) is annual plant of the Solanaceae family and the world's most important and widely grown tuber crop ranking fourth after rice, wheat and maize. In terms of human consumption, it ranks third after rice and wheat. The development of low temperature tolerant processing varieties (Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Chipsona-3) by the Central Potato Research Institute, Shimla (Sandhu *et al*., 2010) [6]. Potato yield is affected by many factors including cultivars and nutrient supplies. Nitrogen application plays a key role in crop growth and development resulting in increased size and number of both processing and non-processing grade tubers ultimately enhancing total yield, while excessive application leads to delayed maturity, poor tuber quality and occasional reduction in tuber yield. One of the most important management practices for potato production is plant spacing. It depends on type of variety, fertility status of soil, plant architecture or growth habit etc. Potato varieties also differ on growth habit and other attributes. Therefore, using the same spacing for all varieties may not lead to optimum tuber yields (Binalfew *et al.* 2015) [2].
Plant spacing plays an important role in crop growth and development of potato plant. It depends on type of variety, fertility status of soil, plant architecture or growth habit etc. Potato varieties also differ on growth habit and other attributes. Therefore, using the same spacing for all varieties may not lead to optimum tuber yields (Binalfew *et al*. 2015) [2]. Intra row spacing variations influence the biomass accumulation and subsequently tuber numbers (Santos and Gilreath, 2004) [7]. The absence of optimal intra row spacing could significantly reduce the total tuber yield up to 50 percent. Therefore, optimization of intra row spacing is one of the most important agronomic practices of potato production as it affects the seed cost, plant development and potato tuber yield (Gulluoglu and Arioglu, 2009) [3].

Method and Materials
The present experiment was conducted at the experimental field, Department of Horticulture, College of Agriculture, Gwalior. The soil of the experimental field was sandy loam with good drainage and uniform texture with very low, medium and medium NPK status, respectively. The experiment was laid out in the Factorial RBD with three replications. The experimental area was ploughed and harrowed in order to bring the soil in well-pulverized condition. Each replication was comprised of thirteen treatment combinations involving two level of spacing (45×15 cm^2 and 50×15 cm^2) at the time of planting of potato variety Kufri chipsona-1. The first irrigation was given immediately after planting to ensure proper establishment of sprout. Subsequent irrigation was given at 15 days interval up to month of January. Ear thing-up and weeding of potato are done as soon as weeds emerge.

The observations of morphological parameters were calculated on different aspects such as days to emergence, days to 50%emergence, plant height, number of shoots per plant and number of compound leaves were recorded during research work.

Result and Discussion

Days to emergence

Among in spacing, the minimum days to emergence (7.94, 7.95 and 7.94) in first year, second year and in pooled were observed in treatment S_2 (50×15 cm^2) and it was found the significantly superior spacing level among all spacing levels, whereas the maximum days to emergence (8.12, 8.13 and 8.12) in first year, second year and in pooled were recorded in treatment S_1 (45×15 cm^2).

Days to 50% emergence

It was recorded that the minimum days to 50% emergence (10.31, 10.35 and 10.33) in first year, second year and in pooled were observed in treatment S_2 (50×15 cm^2) and it was found the significantly superior spacing level among all spacing levels, whereas the maximum days to 50% emergence (10.85, 10.85 and 10.85) in first year, second year and in pooled were recorded in treatment S_1 (45×15 cm^2), among in spacing.

Plant height

The maximum plant height (24.83, 25.07 and 24.95 cm) at 30 DAP, (39.48, 39.40 and 39.44 cm) at 45 DAP and (43.45, 43.49 and 43.47 cm) at 60 DAP in first year, second year and in pooled were observed in treatment S_2 (50×15 cm^2) and it was found the best spacing level among all spacing levels, whereas the minimum plant height (24.23, 24.44 and 24.33 cm) at 30 DAP, (38.64, 38.63 and 38.63 cm) at 45 DAP and (42.91, 42.92 and 42.91 cm) at 60 DAP in first year, second year and in pooled were recorded in treatment S_1 (45×15 cm^2). Similarly, the different row spacing strongly affected microclimate, which significantly affected plant height, number of stems and plant biomass (Misovic *et al.* (2000) [5].

Number of shoots per plant

It was recorded that the treatment S_2 (50×15 cm^2) was found the best spacing treatment for influencing the number of shoots per plant and it gave the maximum number of shoots per plant (3.75, 3.75 and 3.75) at 30 DAP, (4.35, 4.34 and 4.34) at 45 DAP and (4.94, 4.95 and 4.95) at 60 DAP in first year, second year and in pooled, however the minimum number of shoots per plant (3.56, 3.58 and 3.57) at 30 DAP, (4.16, 4.18 and 4.17) at 45 DAP and (4.77, 4.76 and 4.77) at 60 DAP in first year, second year and in pooled were noted in treatment S_1 (45×15 cm^2), among in spacing. Similarly, the number of stems per hill, tuber yield per plant and tuber yield per hectare were higher under 60x20 plant spacing and using 60-90 g seeds (Malik *et al*. (2002) [4].

Number of compound leaves per plant

It was recorded that the treatment S_2 (50×15 cm^2) was found the best spacing treatment for influencing the number of compound leaves in potato and it gave the maximum number of compound leaves per plant (12.09, 12.10 and 12.10) at 30 DAP, (18.65, 18.65 and 18.65) at 45 DAP and (26.44, 26.45 and 26.44) at 60 DAP in first year, second year and in pooled, however the minimum number of compound leaves per plant (11.64, 11.62 and 11.63) at 30 DAP, (18.14, 18.16 and 18.15) at 45 DAP and (25.84, 25.86 and 25.85) at 60 DAP in first year, second year and in pooled were noted in treatment S_1 (45×15 cm^2), among in spacing. Similarly, Ananda and Krishnappa (1999) [1] observed that the number of leaves, leaf area per plant and dry weight of plant per hill at 60 days after transplanting were higher at wider spacing than at narrow spacing.

Table 1: Days to emergence

Treatment	Ist Year	IInd Year	Pooled
S_1	8.12	8.13	8.12
S_2	7.94	7.95	7.94
SEM(d)	0.043	0.094	0.052
CD (AT 5%)	0.088	0.195	0.104

Table 2: Days to 50% emergence

Treatment	Ist Year	IInd Year	Pooled
S_1	10.85	10.85	10.85
S_2	10.31	10.35	10.33
SEM(d)	0.134	0.178	0.111
CD (AT 5%)	0.277	0.367	0.225

Table 3: Plant height (cm)

Treatment	30 DAP			45 DAP			60 DAP		
	Ist Year	IInd Year	Pooled	Ist Year	IInd Year	Pooled	Ist Year	IInd Year	Pooled
S_1	24.23	24.44	24.33	38.64	38.63	38.63	42.91	42.92	42.91
S_2	24.83	25.07	24.95	39.48	39.40	39.44	43.45	43.49	43.47
SEM(d)	0.024	0.013	0.014	0.009	0.016	0.009	0.142	0.126	0.095
CD (AT 5%)	0.049	0.027	0.028	0.019	0.033	0.019	0.293	0.259	0.191

Table 4: Number of shoots per plant

Treatment	30 DAP			45 DAP			60 DAP		
	Ist Year	IInd Year	Pooled	Ist Year	IInd Year	Pooled	Ist Year	IInd Year	Pooled
S_1	3.56	3.58	3.57	4.16	4.18	4.17	4.77	4.76	4.77
S_2	3.75	3.75	3.75	4.35	4.34	4.34	4.94	4.95	4.95
SEM(d)	0.089	0.021	0.046	0.088	0.024	0.045	0.095	0.022	0.049
CD (AT 5%)	0.185	0.043	0.093	0.181	0.049	0.091	0.196	0.045	0.098

Table 5: Number of compound leaves per plant

Treatment	30 DAP			45 DAP			60 DAP		
	Ist Year	IInd Year	Pooled	Ist Year	IInd Year	Pooled	Ist Year	IInd Year	Pooled
S_1	11.64	11.62	11.63	18.14	18.16	18.15	25.84	25.86	25.85
S_2	12.09	12.10	12.10	18.65	18.65	18.65	26.44	26.45	26.44
SEM(d)	0.167	0.161	0.116	0.138	0.166	0.108	0.152	0.167	0.113
CD (AT 5%)	0.345	0.333	0.234	0.284	0.343	0.217	0.314	0.344	0.228

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