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Effect of seed size and plant spacing on seed potato production cv. Kufri Khyati

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Abstract

An experiment was conducted to study the effect of seed size and plant spacing on seed potato production cv. Kufri Khyati at Vegetable Seed Production and Research Farm, KVK Sonipat during winter of 2017-18. Fifteen treatment combinations of five different tuber size planted at three different plant spacing were analyzed for twelve growth and yield parameters. Result of this experiment revealed that the cultivar Kufri Khyati produced highest seed tuber yield when 61-90 g seed was planted at spacing 60x20 cm. Maximum net return (Rs. 102431/ha) was also found highest with the same treatment combination.

Keywords: Seed size and plant spacing, seed potato, *Solanum tuberosum* L.

Introduction

Potato (*Solanum tuberosum* L.), also called as white or Irish potato belongs to Solanaceae family, is an annual herbaceous plant. Potato is used as a principal vegetable in most of the tropical countries. As a crop, it possesses the highest production potential per unit area and time. Potato is the third most consumed crop globally after rice and wheat (International Potato Center 2013). Potato originated from the high Andes of central and southern America. China is now the largest potato producer, and almost one third of all potatoes of world are harvested in China and India. Potato acquires fourth position in major food crops of the world after rice, wheat and maize. It is highly nutritious, easily digestible and wholesome food, containing 80% water and 20% dry matter consisting of 14% starch, 2% protein, 2% sugar, 1% minerals, 0.6% fibre, 0.1% fat and trace amount of vitamin B and C. It is utilized as vegetable, stock feed and also in industries for the manufacturing of starch and alcoholic beverages and processed into different commercially used dehydrated, canned and fried products like chips and sliced potato (Hazra *et al.*, 2015) [3]. It has been often addressed as a future food crop by Food and Agriculture Organization due to its tremendous potential of producing highest food, energy and protein per unit area and time. Potato yields about 97 cal/100 g fresh weight, which is much higher than cereal crops.

The yield of potato depends on many factors. It is therefore becomes essential to understand how individual plant interacts with environment and possibly to come up with the ideal crop density levels to optimize yield. It becomes imperative that optimum seed size and spacing levels need to be established to ensure optimum yield performance and better monetary returns to farmers (Kabir *et al.*, 2004) [4] in a given geographic area. Seed spacing has been reported to influence yield, tuber size distribution, stem density and net return of potato cultivars (Love and Thompson, 1999; Zamil *et al.*, 2010) [9, 15]. Despite many investigations carried out over many years on this important crop, more information is required on interrelationships of plant population and tuber sizes with respect to its growth and subsequent yield. Some important studies were done past few decades, while others are recent (Das and Deka, 2002; Khan *et al.*, 2010) [1, 5].

The present study was, therefore, undertaken to study the effect of seed size and plant spacing on seed potato production cv. Kufri Khyati.

Material and Methods

The experiment was carried out at Vegetable Seed Production and Research Farm, KVK Sonipat during winter of 2017-18, located at latitude of 28° 59' North, longitude of 70° 00' East and at an altitude of 249 meter above mean sea level. The experimental material comprised of five different size of tubers *i.e.*, 15-30 g, 31-60 g, 61-90 g, 91-120 g & 121-150 g planted at three different plant spacing of 60 x 20 cm, 60 x 30 cm & 60 x 40 cm. A total of 15 treatment combinations with three replications were planted in Randomized Block Design having plot size of 4.8 m x 3.6 m. During the course of experimentation, various observations were recorded for growth and yield parameters *i.e.*, Plant emergence (%) at 15 and 30 DAP, Plant height (cm) at 45, 60, 75 and 90 DAP, Number of stems per hill at 45 DAP, Number of leaves per hill at 50 DAP, Leaf weight per hill at harvest, Stem weight per hill at harvest, Weight of tubers in different grades (0-25, >25-50, >50-75, >75 g), Number of tuber in different grades (0-25, >25-50, >50-75, >75 g), Total tuber yield (q/ha), Harvest index (%), Tuber dry matter content (%) and Percent seed tuber. All the recommended cultural practices were adopted for raising the crop successfully. The crop was dehaulmed after 100 days of planting. All plots were harvested after ten days of de-hauling to allow tuber hardening (curing). Various treatment combinations were then analyzed to find out the best combination for seed potato production.

Results and Discussion

Percent plant emergence

In the present study, smallest seed size 15-30 g showed significantly maximum plant emergence (79.32%) followed by seed size 31-60 g (75.00%) whereas minimum plant emergence was found in the treatment with seed size 121-150 g (58.01%) at 15 DAP agreed with Kumar *et al.* (2010). The maximum plant emergence (99.23%) was recorded with seed size 121-150 g which was at par with the seed size 91-120 g (98.17%) at 30 DAP. There was increasing trend of emergence with increase in seed size at 30 DAP agreed with Divis and Barta (2001)^[2] and Patel *et al.* (2008)^[12]. In the case of plant spacing, emergence percentage was non-significant having maximum (69.47% & 92.40%) in the treatment with spacing 60x20 cm at 15 DAP and 30 DAP, respectively which was found similar with the findings of Khan *et al.* (2010)^[5].

There was non-significant effect of seed size on plant height at different intervals. Plant height was observed at 45, 60, 75 and 90 DAP and the height increased at all the crop growth stages as the size of the tubers was increased. This effect may be due to availability of more nutrients and moisture in large size tubers to individual plant. Similar results were noticed by Lal *et al.* (1981)^[8] and Kumar *et al.* (2009)^[6]. There was significant effect of plant spacing on plant height at all the stages of plant growth. The plant height was increased with the decrease in the plant spacing. Similar results were noticed by Suman *et al.* (2003)^[16].

Seed size and plant spacing showed significant differences for number of stems per hill, number of leaves per hill, stem weight per hill and leaf weight per hill as shown in table no. 1. Among the seed size, maximum number of stems, leaves, stem weight and leaf weight per hill (4.73, 52.85, 96.92 g and 229.77 g, respectively) was recorded with highest seed size (121-150 g) followed by seed size 91-120 g (4.32, 49.69, 84.21 g and 199.52 g, respectively). These results are agreed with those of Lal *et al.* (1981)^[8] and Nandekar (2005)^[11]. In

case of plant spacing, the treatment 60x40 cm exhibited significantly maximum number of stems, leaves, stem weight and leaf weight per hill (4.00, 49.88, 78.65 g and 202.21 g, respectively) followed by 60x30 cm (3.78, 47.29, 73.71 g and 189.33 g, respectively). These results are in agreement with the finding of Lal *et al.* (1981)^[8] and Zamil *et al.* (2010)^[15]. Interaction effect of seed size and plant spacing was recorded significant. Maximum number of stems, leaves, stem weight and leaf weight per hill (4.93, 58.11, 102.61 g and 258.60 g, respectively) was recorded when 121-150 g seed size tubers were planted at plant spacing 60x40 cm plant spacing and found at par with the treatment, using same seed size with spacing 60x30 cm (4.87, 54.62, 98.28 g and 235.96 g, respectively). The stems, leaves, stem weight and leaf weight per hill increased remarkably with the increase in seed size as well as plant spacing along with different treatments.

Seed size and plant spacing varied considerably with respect to number and weight of tubers of different grades *i.e.* up to 25 g, >25-50 g, >50-75 g and >75 g grade per hectare as depicted in table no. 2 & 3. Seed size 121-150 g significantly produced maximum number and weight of tuber up to 25 g grade per hectare (308.64 k and 38.12 q, respectively) with spacing of 60x20 cm followed by the seed size 91-120 g (265.73 k and 34.80 q, respectively) with 60x20 cm spacing. Tuber number and weight in >25-50 g and >50-75 g grade was noted significantly highest in the treatment with 61-90 g seed size and 60x20 cm spacing followed by the treatment where 91-120 g seed size was planted at spacing of 60x20. Number and weight of tubers in >75 g grade was recorded significantly highest (166.21k and 215.55 q, respectively) in the treatment with 91-120 g seed size and 60x20 cm spacing which was observed statistically at par with treatment of 61-90 g seed size and 60x20 cm spacing (156.93 k) for number of tubers only. The results of this study are similar with the finding of Kumar *et al.* (2009)^[6].

As shown in table no. 4, the total tuber yield was noted significantly highest (287.93 q) for the seed size 91-120 g, which was followed by the treatments having seed sizes 121-150 g (270.57 q). The significantly lowest yield (169.12 q) was registered with the treatment where seed size 15-30 g was used. Among the plant spacing, the highest tuber yield was observed at the spacing of 60x20 cm (295.80 q) which was followed by plant spacing of 60x30 cm (235.90 q). The lowest tuber yield (183.32 q) was observed with the treatment where the spacing was 60x40 cm. Among different treatment combinations, seed size of 91-120 g at 60x20 cm spacing produced significantly maximum total tuber yield (358.60 q) per hectare over small and large seed size tubers which was found at par with the seed size 61-90 g (338.61q) at spacing 60x20 cm. The lowest tuber yield (132.51 q) was recorded with the treatment where seed size 15-30 g was used with 60x40 cm spacing. Total yield of tuber increased significantly with increase in seed size except 121-150 g. Malik *et al.* (2002)^[10] also reported that the yield per plant and tuber yield per hectare were recorded higher with larger seed size tubers as compare to smaller seed size tubers. The significant increase in tuber yield per hectare under larger seed size tubers was due to their favourable effect on tuber yield per plant. The better growth in terms of stem per hill appeared to have been due to more photosynthesis and eyes presents in the larger size tubers, which resulted in higher yield per plant and finally accompanied by a corresponding increase in tuber yield per hectare. Lal *et al.* (1981)^[8] reported that the increase in stem per hill has also been reported as an attributed to higher tuber yield per plant.

There was significant difference for harvest index among different seed sizes as shown in table no. 5. Treatment with 61-90 g seed size had significantly maximum harvest index (64.98%) followed by the treatment with seed size 91-120 g (61.48%). It was lowest (55.26%) for the treatment where 121-150 g seed size was used for planting. The difference was non-significant among plant spacing and Interaction effect of size of seed & spacing of plant for harvest index.

Tuber dry matter content was maximum (20.16%) with treatment having 121-150 g seed size and found statistically at par with the seed size 61-90 g (19.83%). It was lowest (18.37%) for the treatment having 15-30 g seed size. Plant spacing and Interaction effect among the treatments was found not-significant for dry matter content of tuber.

The percent seed tuber was significantly influenced by

different seed size and plant spacing as shown in table no. 5. Treatment with 61-90 g seed size had significantly maximum percent seed tuber (17.62%) followed by the treatment with seed size 91-120 g (17.29%). It was lowest (14.82%) for the treatment where 15-30 g seed size was used for planting. Among plant spacing significantly maximum percent seed tuber (17.25%) was recorded with spacing of 60x20 cm, while minimum percent seed tuber (15.47%) was resulted with spacing of 60x40 cm. The interaction effect between seed size and plant spacing was observed non-significant for Percent seed tuber. Narrow plant spacing resulting more number of seed size tuber. The results of this study are cooperated with finding of Kushwah (2008) [7] revealed that for producing seed size potato the plant spacing of 60 x 20 cm was found to be best.

Table 1: Effect of seed size and plant spacing on number of leaves per hill at 50 DAP, number of stem per hill at 45 DAP, Stem weight (g) per hill and leaf weight (g) per hill at harvest of potato variety *Kufri Khyati*

Seed size (g)	Number of leaves per hill at 50 DAP				Number of stem per hill at 45 DAP				Stem weight (g) per hill				Leaf weight (g) per hill			
	Plant spacing (cm)				Plant spacing (cm)				Plant spacing (cm)				Plant spacing (cm)			
	60x20	60x30	60x40	Mean	60x20	60x30	60x40	Mean	60x20	60x30	60x40	Mean	60x20	60x30	60x40	Mean
15-30	31.71	34.82	36.80	35.11	2.67	2.73	3.07	2.82	50.56	51.90	58.26	53.58	127.41	131.98	139.82	133.07
31-60	43.14	46.13	49.60	46.29	2.93	3.00	3.27	3.07	55.85	57.18	62.33	58.45	166.08	178.06	192.45	178.86
61-90	43.36	48.23	51.98	47.86	3.77	3.87	4.27	3.97	72.42	74.36	82.13	76.30	169.98	190.03	205.34	188.45
91-120	43.50	52.65	52.91	49.69	4.07	4.42	4.47	4.32	78.89	85.83	87.91	84.21	173.11	210.61	214.83	199.52
121-150	45.82	54.62	58.11	52.85	4.40	4.87	4.93	4.73	88.88	99.28	102.61	96.92	194.74	235.96	258.60	229.77
Mean	41.91	47.29	49.88		3.57	3.78	4.00		69.32	73.71	78.65		166.26	189.33	202.21	
C.D at 5% level	Seed size: 1.27	Plant spacing: 0.98	Seed size x Plant spacing: 2.20		Seed size: 0.09	Plant spacing: 0.07	Seed size x Plant spacing: 0.15		Seed size: 2.04	Plant spacing: 1.58	Seed size x Plant spacing: 3.53		Seed size: 5.10	Plant spacing: 3.95	Seed size x Plant spacing: 8.83	

Table 2: Effect of seed size and plant spacing on number (000) of tubers up to 25 g per ha, 25-50 g tubers per ha, 50-75 g tubers per ha and tubers of > 75 g per ha of potato variety *Kufri Khyati*

Seed size (g)	Number (000) of tubers up to 25 g per ha				Number (000) of 25-50 g tubers per ha				Number (000) of 50-75 g tubers per ha				Number (000) of tubers of > 75 g per ha			
	Plant spacing (cm)				Plant spacing (cm)				Plant spacing (cm)				Plant spacing (cm)			
	60x20	60x30	60x40	Mean	60x20	60x30	60x40	Mean	60x20	60x30	60x40	Mean	60x20	60x30	60x40	Mean
15-30	198.32	122.34	83.23	134.63	86.53	59.45	48.31	64.76	77.64	50.64	42.54	56.94	81.34	77.35	71.59	76.76
31-60	236.44	148.83	100.23	161.83	90.35	68.65	48.45	69.15	83.53	58.21	43.64	61.79	103.70	85.18	79.26	89.38
61-90	248.74	150.95	112.34	170.68	126.53	104.54	72.63	101.23	107.54	71.76	45.12	74.81	156.93	132.62	95.26	128.30
91-120	265.73	162.45	149.74	192.64	118.72	101.73	71.48	97.31	101.51	85.63	48.12	78.44	166.21	131.18	101.23	132.87
121-150	308.64	179.41	151.56	213.20	111.53	96.74	69.75	92.67	95.27	71.89	50.38	72.51	146.37	106.74	88.41	113.84
Mean	251.58	152.80	119.42		106.73	86.22	62.12		93.10	67.63	45.97		130.91	106.62	87.17	
C.D at 5% level	Seed size: 9.17	Plant spacing: 7.69	Seed size x Plant spacing: 17.19		Seed size: 4.19	Plant spacing: 3.24	Seed size x Plant spacing: 7.25		Seed size: 3.63	Plant spacing: 2.81	Seed size x Plant spacing: 6.28		Seed size: 5.79	Plant spacing: 4.48	Seed size x Plant spacing: 10.02	

Table 3: Effect of seed size and plant spacing on weight (q) of up to 25 g tubers per ha, tubers (q) >25-50 g per ha, tubers (q) >50-75 g per ha and tubers of > 75 g per ha of potato variety *Kufri Khyati*.

Seed size (g)	Weight (q) of up to 25 g tubers per ha				Weight of tubers (q) >25-50 g per ha				Weight of tubers (q) >50-75 g per ha				Weight of tubers (q) >75 g per ha			
	Plant spacing (cm)				Plant spacing (cm)				Plant spacing (cm)				Plant spacing (cm)			
	60x20	60x30	60x40	Mean	60x20	60x30	60x40	Mean	60x20	60x30	60x40	Mean	60x20	60x30	60x40	Mean
15-30	24.50	15.12	10.12	16.58	31.47	21.67	17.75	23.63	46.83	30.05	25.15	34.01	103.45	101.78	79.48	94.90
31-60	30.09	18.61	12.34	20.35	33.31	24.77	17.78	25.28	51.83	35.56	25.77	37.72	127.56	110.48	98.41	112.15
61-90	32.68	19.85	14.15	22.23	46.77	38.59	26.12	37.16	66.45	44.85	27.98	46.42	192.71	166.92	128.36	162.66
91-120	34.80	20.64	19.18	24.87	44.52	37.45	25.48	35.82	63.73	53.87	31.11	49.57	215.55	171.04	131.51	172.70
121-150	38.12	22.75	18.86	26.58	42.45	37.72	24.28	34.15	60.27	45.66	32.95	46.29	191.93	145.48	123.56	153.66
Mean	32.04	19.39	14.93		39.70	31.64	22.28		57.82	42.00	28.59		166.24	139.14	112.26	
C.D at 5% level	Seed size: 0.96	Plant spacing: 0.74	Seed size x Plant spacing: 1.66		Seed size: 0.69	Plant spacing: 0.53	Seed size x Plant spacing: 1.19		Seed size: 1.30	Plant spacing: 1.00	Seed size x Plant spacing: 2.25		Seed size: 5.98	Plant spacing: 4.63	Seed size x Plant spacing: 10.36	

Table 4: Effect of seed size and plant spacing on total tuber yield (q/ha) of potato variety *Kufri Khyati*

Seed size (g)	Plant spacing (cm)			
	60x20	60x30	60x40	Mean
15-30	206.24	168.62	132.51	169.12
31-60	242.79	189.41	154.30	195.50
61-90	338.61	270.54	196.61	268.59
91-120	358.60	287.70	217.47	287.93
121-150	332.77	263.22	215.71	270.57
Mean	295.80	235.90	183.32	
C.D at 5% level	Seed size: 13.06	Plant spacing: 10.12	Seed size x Plant spacing: 22.62	

Table 5: Effect of seed size and plant spacing on harvest index (%), tuber dry mater content (%) and percent seed tuber (%) of potato variety *Kufri Khyati*

Treatments	Harvest index (%)	Tuber dry mater content (%)	Percent seed tuber (%)
Seed size (g)			
15-30	60.12	18.37	14.82
31-60	58.49	19.51	15.04
61-90	64.98	19.83	17.62
91-120	61.48	19.79	17.29
121-150	55.26	20.16	16.82
C.D. at 5% level	3.14	0.61	0.32
Plant spacing (cm)			
60x20	58.37	19.93	17.25
60x30	60.17	19.50	16.15
60x40	61.67	19.17	15.47
C.D. at 5% level	2.43	0.47	0.38

Conclusion

Based on the finding of one season study conducted during *rabi* season, it may be concluded that among different treatments, seed size of 91-120 g planted at 60x20 cm spacing produced significantly maximum total yield per hectare (358.60 q) which was found at par with the seed size 61-90 g at spacing 60x20 cm (338.61 q), while the highest seed tuber yield was produced when 61-90 g seed was planted at spacing 60x20 cm as shown in table no. 5.

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