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Effect of seed size-cum-spacing on seedling tubers obtained from true potato (*Solanum tuberosum*) seed

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ABSTRACT

An experiment was conducted during the winter (*rabi*) seasons of 1996–97 and 1997–98 on clayey soil at Parbhani, to find out suitable and economical combination of inter- and intra-row spacing with seedling tuber size in potato (*Solanum tuberosum* L.). Significant increase in the tuber yield was recorded by row spacing of 45 cm. The plant spacing of 10 cm was at par with 15 cm and gave the highest tuber yield of 102.39 and 92.84 q/ha during 1996–97 and in pooled data, respectively, and was significantly superior to that of 20 cm plant spacing. The tuber yield increased with increase in seedling tuber size. Significantly highest tuber yield recorded by large seedling tuber size of 11–15 g over 1–5 g and 6–10 g size. Similarly, 6–10 g seedling tuber size was significantly superior to 1–5 g size. Significantly highest tuber yield of 119.24 q/ha was recorded by the treatment combination of 15 cm plant spacing with 11–15 g seedling tuber size during 1996–97. The highest tuber yield of 36.13 q/ha under medium grade (20–50 g) was recorded by the treatment combinations of 15 cm plant spacing with 11–15 g seedling tuber size under 45 cm row spacing during 1996–97. As regards the net returns and beenfit : cost ratio, plant spacing of 15 cm was advantageous over 10 and 20 cm, whereas row spacing was equally effective and seedling tuber sizes under net returns were equally effective. Benefit : cost ratio was decreased as the seedling tuber size increase from 1 to 15 g. Based on 2 year's pooled data row spacing of 45 cm with 15 cm plant spacing and 11–15 g seedling tuber size was most advantageous and recommended to Marathwada region for cultivation of potato crop during winter season.

Key words : TPS, Seedling tuber size, Spacing, Tuber yield, Economics

The low productivity of potato in the country is mainly due to non-availability of adequate quantity of good quality seeds and transportation. The seed production in India is confined to north-western part because of low incidence of aphids (vector of viral disease) in these regions. The seeds from north are transported over long distances to other potato growing areas resulting in escalation of its cost. Potato seed in these areas often do not reach at optimum time of planting thereby resulting in lower yields. These problems have led to the development of an alternate technology which envisages the use of botanical seed or true potato seed (TPS) for its production. The technology has gained significance because of its several advantages over seed tuber technology (Gaur and Pandey, 1993). Looking to resources, i.e. soil, climate, irrigation and season, there is wide scope for potato cultivation in Maharashtra. Seed is one of the major inputs in potato production accounting for almost 50% of the cost of cultivation. Therefore, to lower the cost of potato cultivation, the present study was undertaken on TPS technology, especially on seedling tuber size with row and plant spacing.

MATERIALS AND METHODS

The field experiment was conducted during *rabi* (winter) seasons of 1996–97 and 1997–98 at Agronomy Department, Marathwada Agricultural University, Parbhani. The soil of experimental plots was clayey in texture and slightly alkaline in reaction having low organic carbon, available nitrogen and phosphorus but high in available potassium. The experiment was laid out in split-plot design replicated 3 times with net plot size 3.6 m × 1.8 m. The treatment consisted of 2 row spacings, i.e. R_1, 45 cm, and R_2, 60 cm and 3 plant spacings, viz. P_1, 10 cm; P_2, 15 cm; and P_3, 20 cm as main plot treatment and 3 seedling tuber sizes, viz. S_1, 1–5 g; S_2, 6–10 g; and S_3, 11–15 g as subplot treatments. Well-sprouted seedling tubers of cv. 'HPS 7/67' were planted in the first week of November. The fertilizer dose applied for the potato crop was 120 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha. At the time of planting, half dose of N and full doses of P and K were applied, remaining N was applied 30 days after planting. To protect the crop from sucking pest in the initial stage, granules of Thimet 10 G were applied around the seedling tuber @ 10

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kg/ha. The tubers were covered by running ridger in 60 cm row spacing and by running plough in 45 cm row spacing with bullock pair. The first irrigation was applied immediately after initial earthing, i.e. ridging and second irrigation on seventh day later, so as to have rapid emergence of the crop. Thereafter irrigations given at an interval of 10–15 days as per requirement of the crop. Plant-protection measures were adopted according to the need. The crop was harvested after full maturity in the first week of February. The produce of each plot graded into 3 grades, viz. A, large (>50 g); B, medium (20–50 g); and C, small (<20 g) and weight of each grade was recorded separately.

RESULTS AND DISCUSSION

Tuber yield of Potato

The tuber yield was significantly increased due to row spacing of 45 cm during 1996–97 and in pooled analysis (Table 1). The plant spacing of 10 cm was at par with 15 cm and produced the highest tuber yield of 102.39 and 92.84 q/ha during 1996–97 and in pooled data, respectively, and was significantly superior over 20 cm plant spacing. Tuber yield was influenced significantly due to varying seedling tuber size during both the years as well as in pooled analysis. The yield of tuber increased as the seedling tuber size increased from 1 to 15 g. The large seedling tuber size of S_3 (11–15 g) gave the highest tuber yield of 108.81, 97.14 and 102.98 q/ha during 1996–97, 1997–98 and pooled results, respectively. Similarly, medium seedling tuber size of S_2 (6–10 g) recorded significantly higher yield over S_1 (1–5 g). The more tuber yield due to large size seedling tuber was mainly due to more eye buds and more food material in it resulting in early and higher sprout emergence and subsequently more growth in terms of growth characters and yield-contributing characters which finally resulted in higher tuber yield. Similar observations were recorded by Batra *et al.* (1992) and Lopes *et al.* (1994).

Table 1. Yield of potato tuber (q/ha) as influenced by different treatments during 1996–97, 1997–98 and on pooled basis

Treatment	1996–97	1997–98	Pooled
Row spacing			
R_1, 45 cm	98.75	81.76	90.26
R_2, 60 cm	90.06	74.77	82.42
CD (P=0.05)	5.87	NS	6.04
Plant spacing			
P_1, 10 cm	102.39	83.28	92.84
P_2, 15 cm	99.31	78.72	89.01
P_3, 20 cm	81.50	72.81	77.15
CD (P=0.05)	7.21	NS	9.89
Seedling tuber size			
S_1, 1–5 g	79.31	60.30	69.80
S_2, 6–10 g	95.09	77.38	86.24
S_3, 11–15 g	108.81	97.14	102.98
CD (P=0.05)	5.02	5.34	6.10

Tuber yield was significantly influenced by plant spacing and seedling tuber size during 1996–97 (Table 2). Significantly more tuber yield was obtained due to plant spacing of 15 cm with 11–15 g seedling tuber size and which was at par with plant spacing of 10 cm with 11–15 g seedling tuber size. Our results confirm the findings of Singh (1989).

Table 2. Potato tuber yield (q/ha) as influenced by P × S interaction during 1996–97

Plant spacing (cm)	Seedling tuber size (g)		
	S_1 (1–5 g)	S_2 (6–10 g)	S_3 (11–15 g)
P_1, 10 cm	85.05	105.88	116.26
P_2, 15 cm	81.18	97.54	119.24
P_3, 20 cm	71.70	81.88	90.95
CD (P=0.05)	8.69		

Grade-wise tuber yield

Significantly more tuber yield was recorded under small (C) grade tuber due to row spacing of 45 cm over 60 cm during both the years (Table 3). Similar trend was also observed in percentage contribution in aggregate produce. Tuber yield under large and medium size was not influenced by row spacings. Plant spacings of 10 and 15 cm were at par and gave significantly more tuber yield than plant spacing of 20 cm under large grade tuber during 1996–97. Per cent contribution of large grade (A) tuber yield in aggregate produce increased with the increase in plant spacing during 1997–98. Yield of medium grade tuber was significantly more due to plant spacing of 15 cm than 20 cm but at par with 10 cm. The plant spacing of 15 cm contributed more per cent of medium grade tuber yield than plant spacing of 10 and 20 cm during 1996–97, whereas during 1997–98, per cent contribution of medium grade tuber yield in aggregate yield decreased as the plant spacing increased. Yield of small grade tuber was significantly more due to plant spacing of 10 cm than 20 cm but at par with 15 cm. The per cent contribution of small grade tuber yield in aggregate produce was decreased as the plant spacing increased. Sharma and Lal (1996) reported that the per cent contribution of 'A' grade tuber increased with increase in plant spacing, while Celp and Vokal (1994) reported that, as spacing decreased yield of unmarketable tuber increased.

As regards seedling tuber size, 11–15 g resulted in significantly more A, B and C grade tuber yield than seedling tuber size of 1–5 and 6–10 g during both the seasons. However, in B and C grade tuber yield, seedling tuber sizes of 6–10 g and 11–15 g were at par during 1996–97. Similarly, seedling tuber size of 6–10 g was significantly superior to 1–5 g under all grade tuber yield. The contribution of A grade tuber yield during 1997–98 was less than that during 1996–97 which resulted in less tuber yield in 1997–98. It was mainly due to occurrence of early blight at 50 days, which affected the bulking stage of crop, which resulted in higher tuber yield under B and C grade in 1997–98 than 1996–97. In general, A grade tuber yield increased with the increase in size of seedling tuber. The contribution of large grade tubers in aggregate produce was increased as the seedling tuber size increased from 1 to 15 g.

Interaction of row spacing × plant spacing × seedling tuber size was found significant in medium grade tuber yield (q/ha) (Table 4). Row spacing of 45 cm with 15 cm plant spacing and 11-15 g seedling tuber size ($R_1P_2S_3$) resulted in significantly higher tuber yield than all other treatment combinations and it was followed by $R_1P_2S_2$ (45 cm × 15 cm with 6–10 g seedling tuber size). This indi-

Table 3. Grade-wise tuber yield (q/ha) and percentage in aggregate produce as influenced by different treatments during 1996–97 and 1997–98

Treatment	Grade-wise tuber yield (q/ha)					
	1996–97			1997–98		
	A	B	C	A	B	C
Row spacing						
R_1, 45 cm	48.27	27.92	22.56	11.23	36.94	33.58
	(48.88)	(28.28)	(22.84)	(13.73)	(45.18)	47.33)
R_2, 60 cm	46.59	25.45	18.33	11.68	37.48	25.59
	(51.74)	(28.26)	(20.00)	(15.62)	(50.12)	(34.22)
CD (P=0.05)	NS	NS	2.78	NS	NS	5.89
Plant spacing						
P_1, 10 cm	51.56	27.02	23.87	9.87	40.98	32.41
	(50.35)	(26.34)	(23.31)	(11.85)	(49.21)	(38.92)
P_2, 15 cm	49.11	29.23	20.99	10.82	37.73	30.15
	(49.45)	(29.43)	(21.12)	(13.74)	(47.93)	(38.30)
P_3, 20 cm	41.68	23.35	16.48	13.69	32.95	26.17
	(51.15)	(28.65)	(20.20)	(18.80)	(45.25)	(35.94)
CD (P=0.05)	6.50	3.77	3.40	2.59	NS	NS
Seedling tuber size						
S_1, 1–5 g	37.90	23.97	17.44	7.95	28.18	24.17
	(47.79)	(30.20)	(22.01)	(13.18)	(46.73)	(40.08)
S_2, 6–10g	46.39	26.84	21.88	10.34	37.51	29.52
	(48.78)	(28.20)	(23.02)	(13.36)	(48.47)	(38.15)
S_3, 11–15 g	58.01	28.80	22.02	16.11	45.97	35.06
	(53.31)	(26.47)	(20.22)	(16.58)	(47.32)	(36.09)
CD (P=0.05)	5.08	2.84	2.85	1.40	4.30	3.95

Figures in parentheses indicate percentage in aggregate produce
Grade A (> 50 g), B (20–50 g) and C (< 20 g)

Table 4. Potato tuber yield (q/ha) under medium grade as influenced by row spacing (R) × plant spacing (P) × seedling tuber size (S) interaction at harvest during 1996–97

Seedling tuber (g)	Row spacing (cm)					
	R_1, 45 cm			R_2, 60 (cm)		
	Plant spacing (cm)			Plant spacing (cm)		
	P_1, 10	P_2, 15	P_3, 20	P_1, 10	P_2, 15	P_3, 20
S_1, 1–5	16.47	32.19	23.67	29.97	22.25	19.03
S_2, 6–10	30.22	33.04	19.96	27.65	26.23	23.66
S_3, 11–15	32.42	36.13	26.96	25.40	25.51	26.67
CD (P=0.05)	6.94					

Table 5. Gross returns, cost of cultivation, net returns (Rs '000/ha) and benefit : cost ratio as influenced by different treatments during 1996–97 and 1997–98

Treatment	(1996–97)				(1997–98)			
	Gross returns	Cost of cultivation	Net returns	Benefit : cost ratio	Gross returns	Cost of cultivation	Net returns	Benefit : cost ratio
Row spacing								
R_1, 45 cm	44.416	31.021	13.394	0.47	40.884	33.753	8.967	0.31
R_2, 60 cm	40.530	27.244	13.286	0.52	37.388	28.091	9.408	0.34
CD (P=0.05)	2.643	0.276	NS	NS	NS	4.232	NS	NS
Plant spacing								
P_1, 10 cm	46.074	34.145	11.926	0.40	41.643	35.029	6.726	0.20
P_2, 15 cm	44.693	28.223	16.471	0.60	39.359	31.825	10.312	0.36
P_3, 20 cm	36.653	25.029	11.624	0.49	36.409	25.914	10.522	0.41
CD (P=0.05)	3.024	0.339	3.367	0.10	NS	5.190	NS	0.15
Seedling tuber size								
S_1, 1–5 g	35.684	21.443	14.242	0.67	30.151	25.049	7.934	0.36
S_2, 6–10 g	48.967	36.840	12.127	0.35	48.572	37.722	10.961	0.31
S_3, 11–15 g	48.967	36.840	12.127	0.35	48.572	37.722	10.961	0.30
CD (P=0.05)	1.840	0.380	NS	0.06	2.671	3.863	NS	NS

NS, Not significant

cated the plant spacing of 15 cm with medium (6-10 g) to large (11–15 g) tuber size under closer row spacing of 45 cm was most effective in yield of medium grade tubers.

Net returns

Row spacing of 45 cm gave significantly more gross returns than row spacing of 60 cm during 1996–97 (Table 5). Similar results were found under cost of cultivation during both the years. Plant spacing of 10 cm gave significantly more gross monetary returns (Rs 46,074) over plant spacing of 20 cm (Rs. 36,653) and was at par with plant spacing of 15 cm (Rs 44,693) during 1996–97. Similarly, cost of cultivation was more due to plant spacing of 10 cm. It was only due to more number of seedling tubers required for planting at 10 cm as against 15 and 20 cm. In respect of net returns, plant spacing of 15 cm gave significantly more returns over 10 and 20 cm which were at par with each other during 1996–97. Similar results also observed under benefit : cost ratio. Solanke (1989) reported that 15 cm intra-row spacing gave maximum profit to the tune of Rs 30,674/ha. Seedling tuber size of 11–15 g was significantly superior to 1–5 and 6–10 g seedling tuber size during both the seasons. Similarly, the maximum cost of cultivation was also recorded by 11–15 g seedling tuber size which was reflected in non-significant result in net returns during both the seasons. In respect of benefit : cost ratio seedling tuber size of 1–5 g recorded significantly more value of benefit : cost ratio than 6–10 and 11–15 g seedling tuber size. Valueu and Yukhnevich (1994) reported that use of mini-tubers was economically justified as the amount of planting material was reduced by 2 to 2.5 times.

REFERENCES

Batra, V.K., Malik, Y.S., Pandita, M.L. and Khurana, S.C. 1992. Effect of seedling tuber size, spacing and method of planting on potato production. *Journal of Indian Potato Association* **19** : 166–170.

Celp, J. and Vokal, B. 1994. The effect of various spacing on the yield and size of potato tubers. *Restlinna Vyroba* **41** : 149–155.

Gaur, P.C. and Pandey, S.K. 1993. *True Potato Seed (TPS) Technology. Advances in Horticulture,* Vol. 7, pp. 85–111. Chadha, K.L. and Grewal, J.S. (Eds). Malhotra Publishing House, New Delhi.

Lopes, H.M., Mizubuti, A., Puiatti, M., Cardoso, A.A., Silva, R.F. and Galvao, J.D. 1994. Evaluation of size and planting density of small potato tubers derived from true potato seed under nursery condition. *Revista Ceres* **41** : 57–66.

Sharma, R.P. and Saheb, Lal. 1996. Effect of spacing on yield of potato grown through seedling tubers. *Indian Journal of Agronomy* **41** : 342–343.

Singh, Kamla. 1989. Performance of potato cv. Kufri Sinduri in relation to varying seed size and spacing. *Journal of Indian Potato Association* **16** : 120–121.

Solanke, A.V. 1989. 'True potato seed technology for intercropping in pre seasonal sugarcane (CO-7219).' Ph.D. (Agriculture) thesis, Marathwada Agricultural University, Parbhani, Maharashtra (Unpublished).

Valueu, V.V. and Yukhnevich, M.I. 1994. The effectiveness of using minitubers in potato production. (In) *Vestsi Akademu Agrarnykh Navuk Belorusi* Vol. 2, pp. 40–44. Belarussian Potato Research Institute, Minsk, Belarusi.