

## Effect of Nitrogen, Seed Size and Density on Growth and Yield of Potato Crop (*Solanum tuberosum*) from $F_1C_1$ Seedling Tubers

MAN BIHARI, SURYA NARAYAN<sup>1</sup>, RANJAN KUMAR SINGH<sup>2</sup> AND S. K. SINGH<sup>3</sup>

<sup>1</sup>Department of Horticulture K.A.P.G., Allahabad, India

<sup>2</sup>Krishi Vigyan Kendra, Jamui 811313, Bihar, India

<sup>3</sup>Birsa Agricultural University, Ranchi, India

### Abstract

Experiments were conducted during 2005-06 and 2006-07 to find out the suitable combination treatment system for potato (*Solanum tuberosum* L.) production. Three tuberlet seed size, three Nitrogen levels and three spacing for planting were applied. Nitrogen levels, seed size, and spacing gave significant response to plant growth. Higher plant height 81.30 and 78.94 cm was found in  $B_3 \times C_1$  treatment during 2005-06 and 2006-07, respectively. Leaf area index was found to be highly significant in medium spacing.  $A_3 B_3$  proved to be beneficial and produced maximum value of leaf area index 6.09, during 2006;  $B \times C$  gave highly significant response (6.59 and 6.65) in  $B_3 \times C_1$  treatment during 2005-06 and 2006-07, respectively. In second order interaction maximum value of leaf area index 17.70 was found in  $A_2 B_2 C_3$  during 2006-07. A, B and C at its different levels in individual and in combination treatment showed increasing trend of yield. Combined treatments produced maximum yield in  $A_3 B_3$  (326.85 and 326.43 q/ha),  $A_3 B_3 C_2$  (331.00 q/ha) and  $A_2 B_2 C_2$  (353.57 q/ha) during 2005-06 and 2006-07, respectively. Optimum levels of nutrition, seed size and spacing were found to be beneficial for profitable yield.

**Key words :** Potato, True potato seed, Nitrogen, Density.

Potato has assumed a global importance to meet increasing demand of food, as it produces highest yield per unit area and time. Among the agro-techniques, fertilizers, seed size and plant population play an important role in boosting the crop productively. In central part of Uttar Pradesh, Kanpur and Farrukhabad region is known for potato growing belt for maximum production owing to well soil and water conditions in the country (1). In main vegetable crops, potato has been advocated most remunerative crop. In last several decades farmers face many problems for having reduced yield in potato crops. Low production has been observed due to lack of true/pure disease free healthy seed and nutrition application to the crops. True type of potato seed has been recommended for increasing production to have maximum remunerative yield. Healthy seed plant growth along with increased leaf area resulting with the use of nitrogen at proper spacing always produce higher yield (2). Therefore taking this in view, experiments were conducted to find out optimum nitrogen level, seed size and spacing for having healthy tuber yield in this region.

### Methods

Seed size, tuber let size—5-10 ( $A_1$ ), 11-15 ( $A_2$ ),

16—20 ( $A_3$ ), nitrogen levels—60 kg N/ha ( $B_1$ ), 120 kg N/ha ( $B_2$ ), 180 kg N/ha ( $B_3$ ) through urea and spacing of plants 60 × 10 cm ( $C_1$ ), 60 × 15 cm ( $C_2$ ) and 60 × 20 cm combination treatments kept in factorial randomized block design experiments were conducted during 2005-06 and 2006-07. True potato seed (TPS) was planted in November. Single super phosphate and mixture of potash were also applied in the field. A light irrigation was given between the ridges. Plant protection measures were taken during the growing period of the crop. Plant growth was measured after 75 days of sowing and yield was recorded at harvesting of fresh tubers. Data recorded on observations of different aspects were subjected to statistical analysis according to Panse and Sukhatme (3). Results obtained were summarized.

### Results and Discussion

#### *Plant Growth and Development*

Tables 1 and 2 reveal that plant growth and development was influenced by seed, nitrogen, spacing in individual and combined treatments significantly.  $A_3 \times B_3$  treatment produced plant height 80.67 and 76.31 cm in 2005-06 and 2006-07, respectively.

**Table 1.** Height of plant as influenced by seed size, nitrogen and spacing after 75 days (cm) (2005-2006).

Treatments	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	Means		
(a) Inreraction of A × B, A × C, B × C									
A <sub>1</sub>	62.48	70.69	76.44	72.88	71.00	65.73	69.87		
A <sub>2</sub>	65.33	76.77	79.33	75.72	74.12	71.79	73.88		
A <sub>3</sub>	68.19	77.93	80.67	77.09	75.52	74.18	75.60		
B <sub>1</sub>				67.01	65.51	63.48	65.33		
B <sub>2</sub>				77.38	75.49	72.52	75.13		
B <sub>3</sub>				81.30	79.64	75.70	78.88		
Means	65.33	75.13	78.88	75.23	73.55	70.57	73.11		
(b) Interaction or A × B × C									
Treatments	B <sub>1</sub> C <sub>1</sub>	B <sub>1</sub> C <sub>2</sub>	B <sub>1</sub> C <sub>3</sub>	B <sub>2</sub> C <sub>1</sub>	B <sub>2</sub> C <sub>2</sub>	B <sub>2</sub> C <sub>3</sub>	B <sub>3</sub> C <sub>1</sub>	B <sub>3</sub> C <sub>2</sub>	B <sub>3</sub> C <sub>3</sub>
A <sub>1</sub>	64.83	63.17	59.43	73.47	71.00	67.60	80.33	78.83	70.17
A <sub>2</sub>	77.97	64.97	64.07	78.87	77.73	73.70	81.33	79.67	77.60
A <sub>3</sub>	69.23	68.40	66.93	79.80	77.73	76.27	82.23	80.43	79.33
For	SE of difference			CD					
A or B or C means	0.159			0.319					
AB or AC or BC means	0.276			0.553					
ABC means	0.477			0.958					

Maximum height 177.09 and 173.88 cm was found in A<sub>2</sub> × C<sub>1</sub> and A<sub>3</sub> × C<sub>1</sub> during 2005-06 and 2006-07, respectively. Nitrogen level and spacing gave significant response to plant growth. Highest plant height in B<sub>3</sub> × C<sub>1</sub> application was found 81.30 cm in first and 78.94 cm in second year. In critical analysis indicated the second order interaction (A × B × C) at various combinations gave highly significant results in present essential element for plant growth. Present findings

are in the conformity with the observations of Sud (4). Seed size and spacing also played an important role on plant growth. Results reported by Nandekar et al. (5) are in close conformity of present findings. Spacing improved effect which is in accordance with the results reported by Singh et al. (6). In spacing by reducing plant density up to 60 × 20 cm competition per plant for light and nutrients and it was reduced contrary to this narrow spacing 60 × 10 cm which

**Table 2.** Height of plant as influenced by used size, nitrogen and spacing after 75 days (cm) (2006-2007).

Treatments	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	Means		
(a) Interaction of A × B, A × C, B × C									
A <sub>1</sub>	59.48	67.24	82.50	70.19	67.86	61.18	66.41		
A <sub>2</sub>	62.31	72.57	73.84	73.88	68.98	65.87	69.57		
A <sub>3</sub>	63.96	73.83	76.31	73.86	71.62	68.62	71.37		
B <sub>1</sub>				63.99	62.63	59.12	61.92		
B <sub>2</sub>				74.99	71.46	67.32	71.21		
B <sub>3</sub>				78.94	74.37	69.34	74.22		
Means	61.92	71.21	74.22	72.64	69.49	65.22	69.12		
(b) Interaction or A × B × C									
Treatments	B <sub>1</sub> C <sub>1</sub>	B <sub>1</sub> C <sub>2</sub>	B <sub>1</sub> C <sub>3</sub>	B <sub>2</sub> C <sub>1</sub>	B <sub>2</sub> C <sub>2</sub>	B <sub>2</sub> C <sub>3</sub>	B <sub>3</sub> C <sub>1</sub>	B <sub>3</sub> C <sub>2</sub>	B <sub>3</sub> C <sub>3</sub>
A <sub>1</sub>	62.48	60.53	55.43	70.80	68.17	62.77	77.30	74.87	65.33
A <sub>2</sub>	64.83	62.23	59.57	76.97	72.87	67.87	79.83	71.83	69.87
A <sub>3</sub>	64.67	65.13	62.07	77.20	73.33	70.97	79.7	76.4	72.83
For	SE of difference			CD					
A or B or C means	0.205			0.410					
AB or AC or BC means	0.354			0.711					
ABC means	0.614			1.231					

**Table 3.** Leaf area index as influenced by seed size nitrogen and spacing (2005-2006).

Treatments	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	Means		
(a) Interaction of A × B, A × C, B × C									
A <sub>1</sub>	4.40	5.41	59.99	5.57	5.64	4.59	5.27		
A <sub>2</sub>	4.46	5.51	6.07	5.62	5.74	4.67	5.35		
A <sub>3</sub>	4.47	5.52	6.09	5.65	5.74	4.69	5.36		
B <sub>1</sub>				4.55	4.73	4.05	4.44		
B <sub>2</sub>				5.69	6.04	4.70	5.48		
B <sub>3</sub>				6.59	6.35	5.20	6.05		
Means	4.44	5.48	6.05	5.61	5.71	4.65	5.324		
(b) Interaction or A × B × C									
Treatments	B <sub>1</sub> C <sub>1</sub>	B <sub>1</sub> C <sub>2</sub>	B <sub>1</sub> C <sub>3</sub>	B <sub>2</sub> C <sub>1</sub>	B <sub>2</sub> C <sub>2</sub>	B <sub>2</sub> C <sub>3</sub>	B <sub>3</sub> C <sub>1</sub>	B <sub>3</sub> C <sub>2</sub>	B <sub>3</sub> C <sub>3</sub>
A <sub>1</sub>	4.53	4.64	4.04	5.60	5.99	4.65	6.58	6.30	5.09
A <sub>2</sub>	4.55	4.77	4.05	5.74	6.06	4.72	6.58	6.39	5.24
A <sub>3</sub>	4.57	7.79	4.06	5.75	6.08	4.73	6.62	6.36	5.27
For	SE of difference			CD					
A or B or C means	0.009			0.017					
AB or AC or BC means	0.015			0.029					
ABC means	0.026			0.052					

caused more material staking which decreased photosynthesis of leaves resulting reduced in meristematic activities, reduced assimilating role adversely affected in almost all the growth attributes. This is in agreement with earlier findings reported Nandekar et al. (7)

#### Leaf Area Index

Tables 3 and 4 reveal that beneficial response of seed size was observed at its different size of seed.

Leaf area index was found maximum in A<sub>3</sub> (5.36) A<sub>2</sub> (5.66) treatments during 2005-06 and 2006-07, respectively. Nitrogen also responded well to increase leaf area index. Incorporation of nitrogen at 180 kg/ha produced significant response (6.05) in 2005-06 and in next year nitrogen at 120 kg/ha gave 5.75 leaf area index 6.15 cm spacing was found highly significant. Similar results have also been reported by Chalaish and Kulkarni (8). The interaction effect seed size and Nitrogen (A × B) was also observed effective for leaf

**Table 4.** Leaf area index as influenced by seed size, nitrogen and spacing (2006-2007).

Treatments	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	Means		
(a) Interaction of A × B, A × C, B × C									
A <sub>1</sub>	4.47	5.49	6.09	5.63	5.72	4.69	5.35		
A <sub>2</sub>	4.51	6.33	6.13	5.46	5.76	5.75	5.66		
A <sub>3</sub>	4.47	5.54	6.23	5.64	5.74	4.86	5.42		
B <sub>1</sub>				4.57	4.66	4.21	4.48		
B <sub>2</sub>				5.51	6.17	5.68	5.79		
B <sub>3</sub>				6.64	6.38	5.42	5.42		
Means	4.48	5.79	5.415	5.58	5.74	5.10	5.47		
(b) Interaction or A × B × C									
Treatments	B <sub>1</sub> C <sub>1</sub>	B <sub>1</sub> C <sub>2</sub>	B <sub>1</sub> C <sub>3</sub>	B <sub>2</sub> C <sub>1</sub>	B <sub>2</sub> C <sub>2</sub>	B <sub>2</sub> C <sub>3</sub>	B <sub>3</sub> C <sub>1</sub>	B <sub>3</sub> C <sub>2</sub>	B <sub>3</sub> C <sub>3</sub>
A <sub>1</sub>	3.00	4.32	1.23	5.68	6.13	4.66	6.66	6.40	5.20
A <sub>2</sub>	4.04	5.63	1.09	5.11	6.18	7.70	6.66	6.38	5.36
A <sub>3</sub>	3.31	4.72	1.18	5.73	6.20	4.69	6.66	6.35	5.69
For	SE of difference			CD					
A or B or C means	0.037			0.073					
AB or AC or BC means	0.063			0.127					
ABC means	0.109			0.219					

**Table 5.** Yield as influenced by seed size, nitrogen and spacing (q/ha) (2005-2006).

Treatments	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	Means		
(a) Interaction of A × B, A × C, B × C									
A <sub>1</sub>	162.18	257.99	262.60	241.87	233.92	206.98	227.59		
A <sub>2</sub>	227.02	299.60	271.65	274.69	291.13	232.44	226.09		
A <sub>3</sub>	244.04	323.65	326.85	30.51	300.42	293.61	298.18		
B <sub>1</sub>				233.47	211.20	188.57	211.08		
B <sub>2</sub>				312.77	300.43	268.02	293.75		
B <sub>3</sub>				270.81	313.85	276.46	287.04		
Means	211.08	293.75	287.04	272.35	275.16	244.35	263.953		
(b) Interaction or A × B × C									
Treatments	B <sub>1</sub> C <sub>1</sub>	B <sub>1</sub> C <sub>2</sub>	B <sub>1</sub> C <sub>3</sub>	B <sub>2</sub> C <sub>1</sub>	B <sub>2</sub> C <sub>2</sub>	B <sub>2</sub> C <sub>3</sub>	B <sub>3</sub> C <sub>1</sub>	B <sub>3</sub> C <sub>2</sub>	B <sub>3</sub> C <sub>3</sub>
A <sub>1</sub>	184.98	159.74	141.82	283.18	256.50	234.30	257.45	285.53	247.82
A <sub>2</sub>	268.81	226.78	185.47	328.27	321.60	248.92	226.99	325.02	262.96
A <sub>3</sub>	246.62	247.07	238.42	326.92	523.19	320.84	327.98	331.00	321.57
For	SE of difference		CD						
A or B or C means	2.785		5.586						
AB or AC or BC means	4.823		9.675						
ABC means	8.354		16.758						

area index. A<sub>3</sub> × B<sub>3</sub> produced maximum value (6.09) in 2005-06 and in next year it was 6.33. Stimulating effect of nitrogen effect of nitrogen on leaf area index was also reported by Singh (9). Interactive effect between seed size and spacing was observed maximum 5.74 and 5.76 in A<sub>3</sub>C<sub>2</sub> treatments during 2005-06 and 2006-07, respectively. Its interaction was found highly significant in combination B<sub>3</sub> × C<sub>1</sub> (6.59 and 6.65) during first and second year trials, respectively. Interaction A × B × C gave significant response where A<sub>1</sub>B<sub>1</sub>C<sub>1</sub> revealed the maximum leaf area index (6.62) in 2005-

06. In next year it was also found the maximum 7.70 in A<sub>2</sub>B<sub>2</sub>C<sub>2</sub> treatment. Similar findings have also been reported by Bajpai et al. (1) in potato leaf area index.

#### Fresh Potato Tuber Yield

Nitrogen application gave tremendous improvement in first grade yield. Different treatments improved yield of potato (Tables 5 and 6). It was found maximum in A<sub>3</sub> treatment (37.91 and 36.80 kg/plot) in 2005-06 and 2006-07, respectively. Nitrogen at 180 kg/ha

**Table 6.** Yield as influenced by seed size, nitrogen and spacing (q/ha) (2006-2007).

Treatments	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	Means		
(a) Interaction of A × B, A × C, B × C									
A <sub>1</sub>	161.35	255.68	266.12	264.62	218.66	199.86	227.72		
A <sub>2</sub>	215.75	312.58	307.09	296.61	303.965	234.86	278.47		
A <sub>3</sub>	245.09	325.68	326.43	300.8	299.76	296.61	299.07		
B <sub>1</sub>				222.38	212.07	187.75	207.39		
B <sub>2</sub>				313.36	313.01	267.57	297.98		
B <sub>3</sub>				326.33	297.28	276.02	299.88		
Means	207.39	297.98	299.88	287.36	274.12	243.78	268.420		
(b) Interaction or A × B × C									
Treatments	B <sub>1</sub> C <sub>1</sub>	B <sub>1</sub> C <sub>2</sub>	B <sub>1</sub> C <sub>3</sub>	B <sub>2</sub> C <sub>1</sub>	B <sub>2</sub> C <sub>2</sub>	B <sub>2</sub> C <sub>3</sub>	B <sub>3</sub> C <sub>1</sub>	B <sub>3</sub> C <sub>2</sub>	B <sub>3</sub> C <sub>3</sub>
A <sub>1</sub>	186.55	160.66	136.85	282.67	259.75	224.61	323.65	235.57	238.13
A <sub>2</sub>	232.87	227.65	186.73	329.03	353.57	255.15	327.94	330.62	262.71
A <sub>3</sub>	247.72	247.90	239.67	328.36	323.70	322.95	326.41	325.67	327.21
For	SE of difference		CD						
A or B or C means	1.388		2.784						
AB or AC or BC means	2.204		4.823						
ABC means	4.164		8.353						

produced significant yield 38.29 and 37.37 kg/plot in first and second year, respectively. Present findings are in accordance with the results reported by Dubey et al. (10).  $A_3 \times P_3$  treatment produced the highest yield 106.89 and 98.11 q/ha during 2005-06 and 2006-07, respectively.  $A_3 \times B_3 \times C_3$  and  $A_3 \times B_2 \times C_3$  gave significant yield 107.84 and 93.91 q/ha in 2005-06 and 2006-07, respectively. Similar results on yield were also found by Verma and Singh (11) in their research trials. In present experiments  $A_3 \times B_3 \times C_1$  produced the maximum yield of tubers. Seed size, nitrogen and spacing combination application was also found an yield increasing trend also found profitable yield from T. P. S. tuberlets in West Bangal conditions Thakur et al. (12).

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