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Effect of planting density and nutrients on growth and seed yield of transplanted balsam (*Impatiens balsamina*) under *Tarai* conditions of Uttarakhand

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ABSTRACT The experiment was conducted at Model Floriculture Centre of GBPUA&T, Patnagar, Uttarakhand, during 2010, to evaluate vegetative and seed characters of balsam (*Impatients balsamina* Linn.) as affected by different agri-inputs. It was laid out in a split plot design with a spacing in main plot and nutrients in sub-plots. The main plot treatment consisted of three spacings 20 cm x 30 cm (S_1), 30 cm x 30 cm (S_2), 40 cm x 40 cm (S_3), whereas sub-plot treatments consisted of three levels of nitrogen (0, 15, 60 g/m^2) and phosphorous (0, 15, 30 g/m^2). Each treatment was replicated thrice. The application of 30 g N+30 g P/m^2 resulted in maximum number of primary branches, plant spread and 1,000-seed weight. Maximum number of secondary branches and seed yield were recorded with 30 g N+15 g P/m^2. Spacing of (30 cm x 30 cm) gave maximum number of primary branches, leaf area and seed yield. Number of secondary branches, plant spread and 1,000-seed weight were found to be highest under 40 cm x 40 cm spacing.

Key words: Spacing, nutrients, growth, seed yield, balsam, plant density

Balsam (*Impatiens balsamina* Linn.) is a widely grown annual flowering plant belonging to the family Balsaminaceae. It is native to tropical and subtropical India, Malaysia and China. In India, it is commonly known as Gulmehndi. Balsam is a short duration, free flowering crop, with compact plant growth in summer season. It can withstand heavy rains and high humidity in atmosphere than any other annuals. On account of available congenial climatic conditions, *tarai* region (Humid subtropical region with hot, dry summers and cool winters) of Uttarakhand is quite suitable for successful cultivation of balsam. Planting method, spacing and optimum doses of nutrients are some factors which had high bearing on its crop production. For producing good quality flowers and seeds, very little scientific information is available on agro-techniques. Therefore, present investigation was undertaken to maximize the growth and seed yield of balsam.

MATERIALS AND METHODS

The present experiment was conducted at the Model Floriculture Centre, Govind Ballabbh Pant University of Agriculture and Technology, Pantnagar, during May to September 2010. The experiment was laid out in a split plot design with a spacing in main plot and nutrients in sub-plots. The main plot treatment consisted of three spacings 20 cm x 30 cm (S_1), 30 cm x 30 cm (S_2) and 40 cm x 40 cm (S_3), whereas sub-plot treatments consisted of three levels of nitrogen (0, 15, 30 g/m^2), and three levels of phosphorous (0, 15, 30 g/m^2). Each treatment was replicated thrice. Open-pollinated variety of balsam was chosen for experiment. The land was brought to a good tilth by two deep ploughing. A spacing of 90 cm between two sub-plots was provided for irrigation channel and working space. Three levels of nitrogen (0, 15, 30 g/m^2) and phosphorous (0, 15, 30 g/m^2) were applied before planting in the form

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of urea and diammonium phosphate.

The planting of uniform-sized balsam seedlings was done on flat beds of 1 m x 1 m size on 17 May 2010. The seedlings were planted at three different spacings of 20 cm x 30 cm (S_1), 30 cm x 30 cm (S_2) and 40 cm x 40 cm (S_3). The cultural operations like irrigation, thinning, weeding and plant-protection methods were performed as and when required. The data were recorded in replication for various vegetative and seed characters *viz.* plant spread, number of primary and secondary branches/plant, number of pods/plant, number of seeds/pod, 1,000-seed weight and seed yield/plant. The data were subjected to statistical analysis and interpretations were made according to results presented (Tables 1 and 2).

RESULTS AND DISCUSSION

The analysis of variance was done. The growth and seed yield of balsam were significantly influenced by spacings and nutrients. The maximum number of primary branches was observed in S_2 spacing (30 cm x 30 cm), followed by S_3 spacing (40 cm x 40 cm) (Table 1). However, higher dose of N and P (T_9) showed maximum number of primary branches. The encouraging effect of fertilizers on primary branches might be due to increased availability of nutrients, especially nitrogen which is an important constitutent of chlorophyll and protein, thus causing more growth. Similar results have been observed in African marigold [1]. Higher number of secondary branches were recorded with wider spacing and closer spacing resulted in minimum number of secondary branches. Wider spacing and closer spacing resulted in minimum number of secondary branches/plant. This may be due to lesser competition between plants for nutrients, water and light in wider spacing. The results were in close conformity with gomphrena [2] and balsam [3]. Increasing dose of nitrogen and phosphorous (T_8) showed maximum number of secondary branches, followed by T_9. Nitrogen and phosphorous are essential plant nutrients, the adequate supply of which results in desirable vegetative growth.

The data showed that plant spread was significantly affected by nitrogen, phosphorous and spacing (Table 1). Maximum plant spread was recorded with S_3 (40 cm x 40 cm), followed by S_2 (30 cm x 30 cm). The plant spread increased with increased spacing. These results were in close compliance with the findings in China aster [4]. It might be due to lesser competition between plants for nutrients, water and light at lower plant density due to wider spacings. Treatment (T_9) recorded maximum plant spread. These results were in close compliance with the findings in chrysanthemum [5] and African marigold [6].

The data showed that leaf area of plant was significantly affected by nitrogen, phosphorous and spacing. Maximum leaf area was recorded with S_2 spacing. Increase in leaf area with increasing level of nitrogen and phosphorous up to 30 g N/m^2 and 30 g P/m^2 (T_9) was observed. This was due to increased nitrogen and phosphorous nutrition which had accelerated the process of cell division and differentiation. Significant increase in leaf area by application of higher doses of N and P had been reported [7] in *Zinnia elegans*. The interaction of nitrogen, phosphorous and spacing was found to be significant. The S_2T_9 showed maximum leaf area. This might be due to better availability of space and nutrients for growth of plants.

It is evident from the data that number of pods/plant and number of seeds/pod varied significantly due to nitrogen, phosphorous and spacing (Table 2). The maximum number of pods/plant was recorded with S_2 spacing (30 cm x 30 cm), followed by S_3 (40 cm x 40 cm), whereas, minimum was observed in S_1 spacing (20 cm x 30 cm). This might be due to less competition among plants for light, soil moisture and nutrients under plant density of 30 cm x 30 cm. So, there might have been more number of primary and secondary branches under wider spacing. Treatment (T_9) gave maximum number of pods/plant (680.03), followed by treatment T_8 (669.44). Combination treatment of S_2T_9 reported maximum number of pods/plant. This might be due to more availability of nitrogen and phosphorous which enhanced plant growth, leading to more number of branches and flowers/plant under wider spacing. Maximum number of seeds/plant was observed in S_2 spacing (30 cm x

Table 1. Effect of spacing and nutrients on primary branches, secondary branches, plant spread and leaf area of balsam

Treatment	Primary branches (number)				Secondary branches (number)				Plant spread (cm)				Leaf area (cm^2)			
	Spacing (cm)															
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
T_2 : 0 nitrogen + 15 phosphorous	4.33	4.66	5.00	4.66	19.33	20.44	19.55	19.77	39.86	45.6	40.80	42.08	9.03	9.46	8.92	9.13
T_3 : 0 nitrogen + 30 phosphorous	5.00	5.33	5.44	5.26	20.00	20.66	19.66	20.11	41.63	48.3	42.76	44.23	9.13	9.72	9.20	9.35
T_4 : 15 nitrogen + 0 phosphorous	4.33	5.00	4.66	4.66	19.00	19.55	19.00	19.18	43.56	45.76	44.90	44.74	9.63	10.00	9.83	9.82
T_5 : 15 nitrogen + 15 phosphorous	5.55	6.33	5.55	5.81	19.66	20.33	20.00	20.00	47.73	48.2	47.63	47.85	10.02	11.08	11.00	10.70
T_6 : 15 nitrogen + 30 phosphorous	5.66	6.66	6.00	6.11	20.00	21.66	20.66	20.77	49.63	51.03	49.90	50.18	11.00	11.29	11.26	11.18
T_7 : 30 nitrogen + 0 phosphorous	5.00	5.44	5.33	5.26	19.33	19.00	19.33	19.22	51	53.4	50.46	51.62	10.82	11.23	12.36	11.47
T_8 : 30 nitrogen + 15 phosphorous	6.11	7.33	7.00	6.81	20.55	21.33	20.55	20.81	53.62	55.6	56.00	55.07	12.63	13.85	13.96	13.48
T_9 : 30 nitrogen + 30 phosphorous	6.66	8.55	8.33	7.85	20.66	21.66	21.44	21.25	54.06	60.06	59.76	57.96	14.65	15.23	15.44	15.10
T_1 : Control	4.00	4.33	4.00	4.11	18.00	19.33	18.00	18.44	39.46	42.73	39.50	40.56	7.62	7.92	7.69	7.75
Mean	5.18	5.96	5.70		19.61	20.44	19.79	19.95	55.07	58.54	59.43		10.50	11.08	11.07	
CD4 (5%)																
Spacing	0.40				0.76				2.08				0.25			
N and P	0.55				1.07				2.37				0.40			
Interaction	NS				NS				NS				0.70			

S_1, 20 cm x 30 cm; S_2, 30 cm x 30 cm; S_3, 40 cm x 40 cm; NS, Non-significant

Table 2. Effect of spacing and nutrients on number of pods/plant, number of seeds/pod, seed yield/plant and 1000-seed weight of balsam

Treatment	No. of pods/plant				No. of seeds/pod				Seed yield/plant				1000-seed weight (g)			
	Spacing (cm)															
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
T_1 : Control	430.00	450.00	440.00	440.00	8.23	9.31	9.17	89.11	21.67	26.28	24.81	24.25	6.15	6.25	6.15	6.18
T_2 : 0 nitrogen + 15 phosphorous	482.00	492.44	490.44	488.14	10.70	10.30	10.10	10.37	33.09	31.46	31.88	32.14	6.42	6.69	6.58	6.56
T_3 : 0 nitrogen + 30 phosphorous	500.00	533.00	498.66	510.55	14.27	13.73	11.13	13.04	48.46	49.34	37.55	45.11	6.79	6.80	6.76	6.79
T_4 : 15 nitrogen + 0 phosphorous	430.00	509.33	470.33	469.89	13.77	12.67	11.00	12.48	39.14	42.76	34.75	38.88	6.60	6.63	6.74	6.66
T_5 : 15 nitrogen +15 phosphorous	537.10	610.33	628.33	591.92	14.23	14.37	13.00	13.87	55.56	64.35	59.59	59.83	7.27	7.34	7.30	7.30
T_6 : 15 nitrogen + 30 phosphorous	563.00	673.66	656.00	630.89	14.67	14.53	14.27	14.49	62.07	73.88	71.11	69.02	7.52	7.55	7.60	7.56
T_7 : 30 nitrogen + 0 phosphorous	518.44	600.00	588.33	568.92	12.57	12.73	11.93	12.41	42.39	49.47	47.28	46.39	6.50	6.48	6.74	6.56
T_8: 30 nitrogen + 15 phosphorous	650.33	685.00	673.00	669.44	14.77	15.03	14.73	14.84	75.33	81.82	79.30	78.81	7.85	7.95	8.00	7.93
T_9: 30 nitrogen + 30 phosphorous	665.00	689.66	685.43	680.0	14.83	13.53	13.53	14.34	77.67	81.61	75.04	78.10	7.88	8.05	8.08	8.00
Mean	53.65	582.60	570.01		13.11	12.09	12.10		50.60	55.66	51.26		7.00	7.08	7.10	
CD (5%)																
Spacing	18.18				0.21				2.26				0.07			
N and P	14.81				0.51				3.12				0.23			
Interaction	25.64				0.89				5.41				NS			

S_1, 20 cm x 30 cm; S_2, 30 cm x 30 cm; S_3, 40 cm x 40 cm; NS, Non-significant

30 cm). Treatment (T_8) yielded maximum number of seeds/plant which was statistically at par with T_9. The interaction of nitrogen, phosphorous and spacing was found to be significant. Treatment combination of S_2T_8 recorded maximum number of seeds/plant. The increase in number of seeds/plant under S_2 spacing and higher dose of N and P is due to increase in plant spread, which further encouraged the production of branches and hence more pods, because of better accumulation of photosynthates.

It is evident from the data that S_3 spacing (40 cm x 40 cm) gave maximum 1000-seed weight, followed by S_2 spacing (30 cm x 30 cm). Wider spacing might be attributed to higher 1,000-seed weight at wider spacing. This might be due to less competition among plants for light, soil moisture and nutrients under plant density of 30 cm x 30 cm. These results were in conformity with the findings in China aster [8] and in marigold [9]. Higher does of N and P up to 30 g N + 30 g P/m^2 (T_9) gave maximum 1,000-seed weight. Nitrogen is a component of amino acids, cytochrome and chlorophyll which are essential for protein synthesis and photosynthesis. Phosphorus forms a source of energy in the form of ATP, ADP and cell division is also influenced by phosphorus. It is also a component of many enzymes, co-enzymes, nucleic acids and phospholipids. This helped for proper development of seed resulting in increased 1,000 seed weight in zinnia [10].

It is evident that nitrogen, phosphorous and spacing significantly affected seed yield (Table 2). Among different spacings, S_2 (30 cm x 30 cm) gave maximum seed yield/plant. Treatmet (T_8) recorded maximum seed yield which was statistically at par with treatment T_9. This higher seed yield/plant may be due to the benefits of wider spacing, as discussed above. These results were in close compliance with the findings in China aster [11] and in gaillardia [12]. Combination treatment of S_2T_8 recorded maximum seed yield, which was statistically at par with S_2T_9, S_3T_8 and S_1T_9.

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