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Evaluation of double whorled balsam (*Impatiens balsamina* L.) genotypes for growth, flowering and seed attributes

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Abstract
A study was conducted to evaluate the different balsam genotypes for their growth, flowering and seed attributes during the year 2014-15. Eighteen double whorled genotypes of balsam which were collected from different parts of country and maintained at Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, U.P., India were evaluated in a Randomize Block Design with three replications. Results of study showed that genotype BD2 resulted in maximum number of branches per plant both primary (11.50) and secondary (18.05), leaf length (14.80 cm), number of flowers/plant (345.66), number of seeds/plant (4025.00), number of pods/plant (345.66) and weight of seeds/plant (55.66 g), whereas, earliest bud initiation (26.33) and early flowering (29.66 days), among all the genotypes. Genotype BD13 showed minimum plant height (46.20 cm) and earliest seed ripening (25.33 days) after pod formation.

Keywords: balsam, double whorled, flowering annual, seed

Introduction
Balsam (*Impatiens balsamina* L.) is an erect, annual herb which is one of the widely grown flowering plant in India. It is short duration, semi hardy, free flowering and compact plant (Singh and Singh, 2007) [13]. The stem is glabrous or weakly pubescent when young, succulent and sparsely branched with swollen nodes. It is known by different names in the different countries e.g. *Pacar Banyu* in Indonesia, *Balsamine Des Jardins* in France, *Balsamine* in Germany, *Tsurifune-Sō* in Japan, *Dau Dalet* in Burma and *Gulmendhi* in India (Lim, 2014) [7]. The plant is widely cultivated as an ornamental herb. This annual is ideal for beds and is also grown in mixed borders and along walks, whereas the dwarf genotypes make excellent pot plants. The flowers are used to prepare a red dye and used as a substitute for Henna (*Lawsonia inermis*) in cosmetics. The seeds of garden balsam are edible whereas, the seed oil can be used for burning lamps and in the surface-coating industry (Chen *et al*., 2010) [3]. The deep red flowers contain a monoglycoside anthocyanin based on pelargonidin, whereas, the roots and stems contain cyaniding monoglycoside. The flowers are mucilaginous and cooling and used for lumbago and inter coastal neuralgia. They are reported in improve blood circulation and relieve stress (Singh, 2014) [10]. Evaluation of genotypic performances of balsam in a number of environments provide useful information to identify their adaptation and stability. The information regarding suitable genotype under eastern Uttar Pradesh conditions is lacking. Hence, to assess the suitability of balsam germplasm for different purposes, the present investigation was undertaken.

Materials and Methods
The present investigation was conducted at Horticulture Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, U.P. during rainy season 2014. Eighteen double whorled genotypes (Table 1) of balsam collected from different parts of country were evaluated in a Randomize Block Design with three replications. The seedlings having uniform growth and vigour were transplanted with a spacing of 60 cm × 60 cm and plot size of 2.40 m × 2.40 m each. Standard cultural practices recommended for balsam were followed uniformly for all the experimental plots. Data on randomly selected plants of each germplasm were taken on the various parameters of growth, flowering and seed yield and statistical analysis were done at 5% level of significance (Panse and Sukhatme, 1985) [9].

Table 1: Genotypes of *Impatiens balsamina* under study (double whorled)

Genotype	Flower colour
BD1	Red group 40 A
BD2	Red group 40 A
BD3	Purple group 77 A
BD4	Red group 40 A
BD5	Red group 40 A
BD6	Violet group 85 D
BD7	Red group 41 A
BD8	Red group 43 B
BD9	Purple group 77 A
BD10	Red group 40 A
BD11	Purple group 77 A
BD12	Red group 40 A
BD13	Red group 40 A
BD14	Red group 40 A
BD15	Purple group 77 A
BD16	Purple group 77 A
BD17	Purple group 77 A
BD18	Red group 43 A

Results and Discussion

The analysis of variance at 5% level of significance revealed significant differences among the genotypes for all the sixteen characters studied indicating the presence of wide range of genetic variability in the genotypes of double whorled balsam which indicate the considerable scope for their improvement through selection.

Growth parameters

A wide range of variability in respect of various growth parameters, *viz*. number of primary and secondary branches/plant, length of leaves, width of leaves, fresh weight of leaves, plant spread and plant height were recorded. Genotype BD2 showed maximum number of branches primary (11.50) and secondary (18.05) branches/plant and significantly lengthy leaves (14.80 cm) among all the genotypes. Leaf width was found maximum (2.90 cm) in genotype BD18. Genotype BD3 showed maximum fresh weight of leaves (0.33 g) whereas, plant spread was found maximum (53.27 cm) in genotype BD12 and minimum spread was observed in genotype BD6 (29.43 cm) among all the genotype under investigation. Plant height is an important parameter which decides various metabolic activities of plant to be planted for different purposes, in the present investigation, genotype BD17 shows maximum plant height (79.33 cm) and genotype BD13 showed minimum plant height (46.20 cm) which makes it suitable for indoor planting (Table 2). Singh and Singh (2006) [15], Rao and Pratap (2006) in chrysanthemum, Munikrishnappa *et al*. (2013) in China aster and Kumar *et al*., 2014 [6] in tuberose who found significant variation among different genotypes.

Flowering parameters

For any ornamental herb, attributes related to flowering and their physical appearance is always an important factor to decide the utility in any garden and landscaping. Here, parameters related to flowering in double whorled genotypes of balsam were studied. For days to bud initiation genotype BD2 found earliest (26.33) in term of days after sowing, whereas, it takes 31.33 days in genotype BD17 which was significantly more than any other genotype, similarly, earliest flowering was found in genotype BD2 (29.66), whereas, BD17 showed late (37.66) flowering. During the investigation genotype BD8 showed maximum diameter of the flower bud (0.91 cm), whereas, maximum flower diameter was observed in the genotype BD11 (5.14 cm). Flower longevity and flowering duration are utmost important parameters along with number of flowers/plant. Flower longevity was found maximum in genotype BD6 with an average of 7.26 days which was at par with the genotype BD18 followed by others. Flowering duration was found maximum in genotype BD8 (62.00 days) whereas, number of flowers per plant was found maximum in genotype BD2 (345.66) followed by genotype BD4 (Table 3). Observation made in this experiment is similar to earlier workers (Hegde and Gopinath, 2003 [5] in gaillardia, Nair *et al*., 1999 [8], Singh and Singh 2005 [14] in marigold, Singh *et al*., 2013 [11] in tuberose and Singh *et al*., 2012 [12] in gladiolus), who noticed significant variation in various flowering parameters among different flower crops under different agro climatic conditions.

Table 2: Performance of different genotypes of *Impatiens balsamina* for growth parameters.

Genotypes	No of primary branches/plant	No of secondary branches/plant	Length of leaves (cm)	Width of leaves (cm)	Fresh weight of leaves (g)	Plant spread (cm)	Plant height (cm)
BD1	9.33	14.62	11.80	2.08	0.23	36.00	59.93
BD2	11.50	18.05	14.80	2.00	0.28	44.60	60.44
BD3	8.16	15.11	10.20	2.05	0.33	37.33	79.00
BD4	7.00	15.93	9.10	1.74	0.20	46.83	58.73
BD5	5.00	14.85	9.30	1.85	0.22	35.83	46.76
BD6	3.83	13.23	10.33	2.22	0.32	29.43	61.20
BD7	8.33	15.03	8.83	2.06	0.29	45.16	48.13
BD8	6.16	11.05	10.43	2.24	0.31	39.44	72.83
BD9	6.16	10.32	9.80	1.94	0.25	43.16	77.43
BD10	8.33	14.05	10.60	2.12	0.32	46.66	51.26
BD11	4.66	13.16	8.00	1.69	0.23	37.50	69.07
BD12	6.83	13.50	9.34	1.96	0.28	53.27	46.76
BD13	7.83	12.54	8.74	2.04	0.24	44.16	46.20
BD14	8.66	13.50	9.27	2.00	0.27	41.57	49.86
BD15	4.50	11.44	9.34	2.00	0.25	34.18	72.66
BD16	4.00	13.55	9.20	1.96	0.25	31.50	70.46
BD17	5.66	11.56	10.26	2.22	0.25	45.10	79.33
BD18	6.33	13.62	7.06	2.90	0.20	41.23	48.66
S.Em±	0.61	0.87	0.34	0.16	0.018	1.49	1.00
C.D. at 5%	1.83	2.58	1.01	0.48	0.054	4.41	2.96

Table 3: Performance of different genotypes of *Impatiens balsamina* for flowering parameters.

Genotypes	Days to bud initiation	Days to flowering	Floral bud diameter(cm)	Flower diameter (cm)	Flower longevity	Total Flowers/ plant	Flowering duration
BD1	26.66	30.66	0.78	3.76	4.30	220.00	39.66
BD2	26.33	29.66	0.81	4.41	6.60	345.66	39.33
BD3	27.00	31.66	0.86	4.49	5.46	218.00	53.66
BD4	28.00	34.33	0.68	3.61	4.33	300.33	42.66
BD5	29.33	35.33	0.72	3.18	4.60	164.66	37.00
BD6	28.33	35.66	0.69	3.94	7.26	221.00	33.00
BD7	27.33	33.33	0.84	4.09	6.26	287.00	45.33
BD8	29.66	33.00	0.91	3.95	4.06	193.00	62.00
BD9	29.00	34.66	0.86	4.85	3.80	233.33	60.33
BD10	28.00	33.66	0.72	4.37	5.90	203.00	46.00
BD11	28.66	34.00	0.85	5.14	6.76	215.33	51.00
BD12	28.00	33.33	0.72	5.06	6.33	242.66	51.66
BD13	29.66	35.66	0.78	3.76	6.53	262.33	48.66
BD14	28.00	32.33	0.85	4.59	6.20	243.66	46.66
BD15	29.00	36.33	0.90	4.52	5.33	185.66	54.66
BD16	28.33	36.66	0.79	3.52	4.80	157.66	49.00
BD17	31.33	37.66	0.85	4.77	6.20	231.66	55.66
BD18	28.33	33.66	0.78	4.64	7.23	231.66	56.66
$S.Em_{\pm}$	0.59	1.34	0.03	0.14	0.39	9.06	4.90
C.D. at 5%	1.75	3.96	0.08	0.41	1.16	26.79	14.49

Table 4: Performance of different genotypes of *Impatiens balsamina* for seed parameters.

Genotypes	Seed yield per plant (g)	1000 seed weight (g)	No. of seeds/plant	Days to seed ripening	Seeds/pod	Pods/plant
BD1	23.93	8.67	2764.33	33.16	12.56	220.00
BD2	55.66	10.03	4025.00	30.16	11.60	345.66
BD3	22.38	9.56	2382.66	29.66	11.06	218.00
BD4	27.14	6.83	4009.00	30.50	13.33	300.33
BD5	13.07	8.30	1577.00	27.16	9.60	164.66
BD6	15.23	7.10	2147.33	30.66	9.76	221.00
BD7	28.43	9.10	3126.66	30.00	10.90	287.00
BD8	23.23	9.33	2488.33	28.16	12.90	193.00
BD9	28.33	9.60	2951.00	29.33	12.70	233.33
BD10	19.94	9.13	2204.66	29.16	10.90	203.00
BD11	27.05	9.53	2834.66	28.66	13.16	215.33
BD12	24.16	9.20	2698.66	28.65	11.93	242.66
BD13	21.81	10.03	2174.66	25.33	8.30	262.33
BD14	30.17	11.56	2606.00	28.16	10.70	243.66
BD15	19.87	9.30	2139.00	27.16	12.43	185.66
BD16	19.81	9.43	2108.33	29.16	13.03	157.66
BD17	37.58	11.36	2955.33	28.00	14.50	231.66
BD18	25.11	11.16	2248.00	29.66	9.26	231.66
$S.Em_{\pm}$	0.92	0.14	152.98	0.72	0.43	9.02
C.D. at 5%	2.74	0.42	456.35	2.17	1.30	26.90

Seed parameters

Among various seed parameters, genotype BD2 resulted in maximum number of seeds/plant (4025.00) which was statistically at par with the genotype BD4 (4009.00). Earliest seed ripening was observed in genotype BD13 (25.33 days), whereas, it was observed late (33.16) in genotype BD1. Genotype BD17 has maximum seeds/pod (14.50) however, maximum number of pods/plant was observed in genotype BD2 (345.66) which were statistically superior over other genotypes (Table 4). Maximum seed yield/plant was observed in the genotype BD2 (55.66 g) followed by genotype BD17 (37.58 g) and BD14 (30.17 g). In terms of 1000 seed weight, genotype BD14 was found superior (11.56 g) which was at par with the genotype BD17 (11.36 g) and BD18 (11.16 g). Variation for these parameters due to germplasm of plant was also coincide with the result of Baskaran *et al*. (2009) [2] in chrysanthemum, Arulmani *et al*. (2016) in gaillardia and Feng *et al*. (2012) [4] in Dahlia.

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