

EVALUATION OF MARIGOLD VARIETIES FOR GROWTH, FLOWERING, YIELD AND CAROTENOID CONTENT UNDER ASSAM CONDITION

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ABSTRACT

An experiment was laid out in a randomized block design (RBD) with three replications to evaluate growth and yield characters of 12 varieties of marigold at the Experimental farm, Department of Horticulture, Assam Agricultural University, Jorhat. Experiment comprised of 12 different varieties namely Seracole, Pusa Narangi Gainda, Pusa Basanti Gainda, Pusa Arpita, Hawaii Orange, Hajo Yellow, Hajo Orange, Calcutta Orange, Calcutta Yellow, Yellow Babuda, Sunrise Orange and Mumbai Orange. The results revealed that the variety Seracole exhibited maximum for quantitative traits, viz., branches plant⁻¹ (79.80), leaves plant⁻¹ (256.13), flowers plant⁻¹ (111.47), self life (17.66 days), loose flower life (4.93 days), yield (574.20 g plant⁻¹, 2.41 kg m² and 199.52 q ha⁻¹). The variety Seracole exhibited highest carotenoid content (290.50 µg g⁻¹).

(Key words: marigold, growth and flowering yield, carotenoid content)

INTRODUCTION

Marigold (*Tagetes erecta*) is one of the most commonly grown commercial flower crops in India. Marigold is native to Central and South America especially Mexico and belongs to Asteraceae family. Marigold is extensively cultivated for its great demand as loose flower, also used as potted plant as well as bedding plant. It is cultivated commercially in most parts of India for pigment extraction. Palthe *et al.* (2019) reported that Karnataka has 3000 ha under marigold cultivation for carotenoid (xanthophylls) extraction. Presently, in India, the commercial extraction of marigold for carotenoids is done in Cochin (Kerala), Hyderabad (Telangana), near Satyamangalam forest (Tamil Nadu) and Telagi near Harihar and Bangalore (Karnataka), it is being regularly exported to Mexico, Peru, USA, Japan, Spain, Netherlands, Turkey, Italy, Australia, etc. It has been observed that, marigold genotypes exhibit a lot of variation for flower yield, which varies with genotypes (Nalawadi, 1982 and Sreekala *et al.*, 2002). In a systemic breeding programme collection, evaluation and characterization of the germplasm are the most important steps for gathering the basic information about variability existing in a particular crop.

Being a cross pollinated crop there is need of high yielding variety with specific flower colour quality which will fetch remunerative profit to farmers. In the era of globalization value addition to the products of flower crop

could further enhance the commercialization process. Marigold growers could be greatly benefitted through value addition in the form of marigold petals as an additive to poultry feed to improve the pigmentation of the bird's fat, skin and egg yolk. The carotenoids extracted from petals of marigold are the major source of pigment for poultry industry as a feed additive to intensify the yellow colour of egg yolks and broiler skin (Narsude *et al.*, 2010 and Kaul *et al.*, 1997). So, the present investigation was carried out with an objective to evaluate different varieties of marigold for growth, flowering, yield attributes and carotenoid content particularly under Assam condition.

MATERIALS AND METHODS

A field experiment was carried out at Experimental Farm, Department of Horticulture, Assam Agricultural University, *rabi* season of the year 2015-2016 to evaluate the growth and yield characters and carotenoid content of 12 marigold varieties. The experiment was laid out in Randomized Block Design (RBD) with twelve treatments (12 varieties) i.e. Seracole (T₁), Pusa Narangi Gainda (T₂), Pusa Basanti Gainda (T₃), Pusa Arpita (T₄), Hawaii Orange (T₅), Hajo Yellow (T₆), Hajo Orange (T₇), Calcutta Orange (T₈), Calcutta Yellow (T₉), Yellow Babuda (T₁₀), Sunrise Orange (T₁₁) and Mumbai Orange (T₁₂) with three replications. Field preparation was done by ploughing the field with mould board plough once, followed by leveling

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and weeding manually. Harrowing was done to break the clods followed by criss- cross ploughing by cultivator, then the field was pulverized by rotavator. During harrowing, well rotten FYM was incorporated in the soil. Well rotten farmyard manure was incorporated @ 5 kg m² into the soil at the time of field preparation. Fertilizer is applied as NPK @ 10:10:10 kg ha⁻¹. Half the quantity of nitrogen and full dose of phosphorus and potash were applied at the time of transplanting, while the remaining dose of nitrogen was applied one month after transplanting. Planting was done at a spacing of 45 cm x 45 cm, and the plot size was 3 m x 2.5 m. Five plants were sampled randomly in each treatment plot and tagged for the purpose of recording data on various parameters. Various observations were taken on growth and flowering parameters viz., plant height (cm), number of branches plant⁻¹, number of leaves plant⁻¹, leaf length (cm), leaf breadth (cm), plant spread (cm), days to bud visibility, days to full boom, number of flowers plant⁻¹, flower diameter (cm), fresh weight of flower (g), self life (in days), loose flower life (in days), number of ray florets, number of disc florets, yield plant⁻¹, yield per m² (kg), yield ha⁻¹ (q) and carotenoid content (µg g⁻¹). The data obtained on various characters were subjected to statistical analysis as per randomized block design and interpretation of the data was carried out in accordance with Panse and Sukhatme (1978). Total Carotenoid content was determined according to Rodriguez-Amaya (1999).

RESULTS AND DISCUSSION

The performances of the twelve marigold varieties for different characters are present below:

Growth parameters

The mean performance for growth characters viz., plant height, branch number, leaf number, leaf length, leaf breadth and plant spread observed on all individual varieties are presented in Table 1. The results showed that there were significant differences among the varieties for plant height. Significantly taller height was observed for Mumbai Orange (75.40 cm), Hawaii Orange (74.53cm) and Pusa Narangi Gainda (73.07) which were at par. The minimum plant height was recorded for Calcutta Yellow (25.13cm) and Calcutta Orange (25.60cm), both of them were at par. Plant height is attributed to be an important varietal character that depends upon the genetic constitution. The variation in plant height among the different varieties might be due to genotypic differences in phenotypic expression of plant height and variation in environmental effects on plant height. Similar variation in plant height due to genotypes was also reported by Rao *et al.* (2005), Singh and Singh (2006) and Khanvilkar *et al.* (2003) in marigold.

Maximum number of branches plant-1 was recorded for the variety Seracole (79.80) followed by Pusa Arpita (31.87). The variety Yellow Babuda recorded minimum number of branches plant-1 (11.47) and variety Mumbai Orange (12.13), both of them were at par. Variety Seracole

exhibited highest number of leaves plant-1 (256.13) followed by the variety Pusa Arpita (115.73). Similar results were recorded by Nilima *et al.* (2017). They revealed that maximum branches plant-1 was recorded in genotype NAM-2 in marigold.

The variety Pusa Arpita exhibited highest leaf length (23.70 cm), leaf breadth (12.05 cm) and minimum was recorded for the variety Seracole (3.47 cm and 2.46 cm respectively). Maximum plant spread was exhibited by the variety Pusa Arpita (57.33 cm), whereas lowest plant spread was recorded for the variety Mumbai Orange (22.70 cm).

The variation in growth characters might be due to their genetic makeup that could have also been influenced by the environmental conditions. Variation in vegetative growth parameters had also been reported by Singh and Singh (2010), who observed significant variation in vegetative growth parameters among marigold germplasm.

Flower parameters

The data illustrated in Table 1 revealed that the minimum days taken for bud visibility (70.33 days) and for full bloom (77.13 days) was recorded for the variety Pusa Basanti Gainda which was followed by Pusa Narangi Gainda (75.33 days and 81.20 days respectively); whereas maximum days taken for bud visibility (113.67 days) and for full bloom (116.67 days) were exhibited by the variety Pusa Arpita. The time required for days taken to first flower opening is an important genotypic character in marigold that might be primarily governed by the genetic makeup of the genotypes. The results observed were in line with earlier findings of Beniwal and Dahiya (2012). They evaluated 38 genotypes of marigold and observed that five genotypes of African marigold (MGH 133-1, 133-1-1, 160-8-2, 160-8 and 160-9-1) showed promising results in respect to number of flowers plant⁻¹, flower size, fresh weight of flower, days to first flower and flowering duration. Nilima *et al.* (2017) also observed that different period required for bud initiation in marigold genotypes which might be due to varied growth rate and their different genetic makeup. Bhuyar *et al.* (2004) reported that gerbera cultivar Ruby Red showed best results in terms of bud initiation of flower under polyhouse.

The variety Seracole recorded maximum number of flowers plant⁻¹ (111.47) followed by Pusa Arpita (88.00), Hajo Yellow (84.87), both these two varieties were at par. The minimum number of flowers plant⁻¹ was exhibited by the variety Mumbai Orange (32.93). Pusa Basanti Gainda recorded the maximum flower diameter (6.98 cm) followed by Pusa Narangi Gainda (6.45cm) and Seracole (6.19cm), both these two varieties were at par. Lowest flower diameter was recorded for the variety Hajo Orange (3.56 cm).

Maximum fresh weight of flower was exhibited by the variety Pusa Basanti Gainda (7.80g) and Pusa Narangi Gainda (7.63g), both were at par. The minimum fresh weight was recorded for the variety Calcutta Yellow (3.46g). Highest self-life was recorded for the variety Seracole (17.66 days), for Calcutta Orange (16.66 days) followed by Pusa Basanti Gainda (15.93 days) and Mumbai Orange (15.80 days), both these varieties were at par.

The maximum loose flower life was recorded for the variety Seracole (4.93 days), followed by Hajo Yellow (3.93 days), Calcutta Orange (3.87 days), Sunrise Orange (3.80 days), Yellow Babuda (3.73 days) and Pusa Basanti Gainda (3.67 days), all of them were at par. The minimum loose flower life was recorded for Hajo Orange (2.33 days).

Maximum number of ray florets was recorded for the variety Hajo Yellow (236.07) and Yellow Babuda (222.67) both of them were at par, while Hajo Yellow recorded highest number of disc florets (83.33) followed by Yellow Babuda (74.27), Pusa Narangi Gainda (72.93) and Pusa Basanti Gainda (70.00).

The variety Seracole exhibited the highest yield plant⁻¹ (574.20g), per m² (2.41kg) and ha⁻¹ (199.52 q). This was followed by Pusa Narangi Gainda exhibiting 544.9 g yield plant⁻¹, 2.30 kg yield per m² which were at par with variety Seracole and 167.29 q yield ha⁻¹. The lowest was recorded for the variety Hajo Orange (160.8 g yield plant⁻¹,

0.68 kg per m² and 43.72 q ha⁻¹). The variation in flower characters might be due to the genetic variation of the varieties. Rao *et al.* (2005) suggested that the superior performance of the cultivar might be due to its genotype x ideal allelic interaction in heterozygous conditions. Amit *et al.* (2018) observed that out of five different varieties namely, Pusa Narangi Gainda, Seracole, Inca Orange, Sun Set Orange and Cracker Jack, the highest yield of flowers plant⁻¹ was observed in Seracole (449.77g).

The total carotenoid content ($\mu\text{g g}^{-1}$) of fresh Petals

The total carotenoid content ($\mu\text{g g}^{-1}$) of fresh flower petals of twelve marigold varieties are presented in Table 2.

The maximum carotenoid content was present in fresh petals of variety Seracole (290.50 $\mu\text{g g}^{-1}$) followed by Pusa Narangi Gainda (285.53 $\mu\text{g g}^{-1}$) and Pusa Arpita (78.39 $\mu\text{g g}^{-1}$). The lowest carotenoid content was recorded for Yellow Babuda (55.76 $\mu\text{g g}^{-1}$).

Table 2. Total carotenoid content ($\mu\text{g g}^{-1}$) of fresh petals of twelve marigold varieties

Treatments		Mean
T ₁	Seracole	290.50±1.12a
T ₂	Pusa NarangiGainda	285.53±2.54b
T ₃	PusaBasantiGainda	64.65±0.60e
T ₄	PusaArpita	78.39±1.09c
T ₅	Hawaii Orange	73.13±0.15d
T ₆	Hajo Yellow	60.75±0.64f
T ₇	Hajo Orange	73.04±0.08d
T ₈	Calcutta Orange	74.51±0.66d
T ₉	Calcutta Yellow	73.83±0.52d
T ₁₀	Yellow Babuda	73.67±0.43d
T ₁₁	Sunrise Orange	55.76±0.69g
T ₁₂	Mumbai Orange	73.81±0.34d
	SEd(±)	0.79
	CD at 5%	1.63

The variation in the total carotenoid content ($\mu\text{g g}^{-1}$) observed in the present study might be due to different genetic makeup of the varieties. Kumar and Sharma (2013) reported significant responses in carotenoid contents in fresh petals of different marigold cultivars. The different

varieties of marigold showed considerable variation in their carotenoids concentrations, ranging from 7.49 to 25.71 mg 100⁻¹ g (or 74.9 to 257.1 $\mu\text{g g}^{-1}$) fresh flowers of *T. erecta*, and from 36.2 to 240.25 mg100⁻¹g (or 362 to 2402.5 $\mu\text{g g}^{-1}$) dried flowers of *T. erecta*. (Toiu *et al.*, 2008).

Table 1. Performance of marigold varieties for different growth and flower characters

Variety	Plant ht (cm)	Number of branches plant ⁻¹	Leaf length (cm)	Leaf breadth (cm)	Plant spread (cm)	Days to bud visibility	Days to full bloom	Number of flowers plant ⁻¹	Flower diameter (cm)	Fresh flower weight (g)	Self life (in days)	Loose flower						
												Number of ray florets	Number of disc florets	Yield plant ⁻¹ (g)				
												Yield per m ² (kg)	Yield ha ⁻¹ (t)					
Seracole	47.20	79.80	256.13	3.47	2.46	34.51	76.53	82.60	111.47	6.19	5.69	17.66	4.93	152.27	59.93	574.20	2.41	199.52
PusaNarangiGainda	73.07	21.00	76.00	7.73	7.06	47.75	75.53	81.20	63.53	6.45	7.63	14.13	3.53	201.00	72.93	544.93	2.36	167.29
PusaBasantiGainda	66.93	28.80	67.60	10.83	9.15	34.73	70.33	77.13	51.07	6.98	7.80	15.93	3.67	186.93	70.00	399.07	1.61	99.81
PusaArpita	49.53	31.87	115.73	23.70	12.05	57.33	113.67	116.67	88.00	5.07	4.50	12.66	3.53	144.13	59.67	398.33	2.01	159.96
Hawaii Orange	74.53	20.87	82.73	13.47	6.03	36.57	79.13	82.53	51.67	5.22	4.33	9.33	2.53	132.87	56.20	226.00	0.92	96.67
Hajo Yellow	47.73	25.73	93.06	10.21	5.36	46.33	77.33	83.73	84.87	5.82	4.09	13.66	3.93	236.07	83.33	349.33	1.43	86.73
Hajo Orange	58.20	19.47	52.53	9.94	5.80	27.77	78.87	83.07	47.13	3.56	3.67	12.33	2.33	120.07	41.07	160.81	0.68	43.72
Calcutta Orange	25.60	14.53	29.60	5.94	3.48	35.47	80.06	91.53	48.93	3.63	3.82	16.66	3.87	153.00	39.47	179.17	0.73	49.60
Calcutta Yellow	25.13	13.60	27.40	5.47	3.31	32.07	77.47	86.00	44.33	3.67	3.46	15.33	3.33	141.60	37.27	194.27	0.77	49.32
Yellow Babuda	43.87	11.47	20.87	8.30	5.76	35.87	82.67	87.20	51.67	6.05	4.80	12.60	3.73	222.67	74.27	248.67	1.60	118.33
Sunrise Orange	46.87	14.67	20.33	17.67	3.87	26.13	77.93	85.40	46.13	5.03	5.13	13.66	3.80	124.67	37.53	235.00	1.21	103.67
Mumbai Orange	75.40	12.13	23.80	19.09	5.37	22.70	86.53	93.20	32.93	5.45	5.53	15.80	3.53	116.67	34.13	246.69	0.98	62.61
SEd(±)	2.08	0.68	1.02	0.47	0.20	1.17	1.35	0.86	2.29	0.13	0.12	0.67	0.18	8.74	3.36	5.03	0.16	1.16
CD at 5%	4.32	1.41	2.12	0.97	0.41	2.43	2.80	1.77	4.77	0.27	0.25	1.38	0.37	18.12	6.96	10.44	0.34	2.42

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