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MORPHOLOGICAL CHARACTERIZATION AND BIOCHEMICAL ANALYSIS OF XANTHOPHYLL CONTENT IN MARIGOLD GENOTYPES UNDER CHHATTISGARH CONDITIONS

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ABSTRACT

The present study was carried out with 17 genotypes of marigolds was carried out in the horticulture nursery at the college premises, Department of Floriculture and Landscape Architecture, and Biochemical analysis was done at Richaria Research Laboratory, Department of Biotechnology, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the year 2023-24. The experiment was laid out in a Completely Randomized design with two replications. The maximum plant height, number of primary branches per plant, plant spread (E-W) & (N-S), number of flowers per plant, and average weight of flowers per plant were observed in Pusa Arpita and Pusa Deep. The maximum number of numbers of secondary branches per plant was observed in BM-3, maximum flower diameter was observed in BM-2, the minimum days for 50% flowering was observed in Chandini Gainda and maximum was recorded in Pusa Arpita, maximum duration of flowers observed in Pusa Arpita and the highest Xanthophyll content was observed in Pusa Narangi Gainda (511.73 mg/g) and minimum was obtained in KAUM-46) (-125.95 mg/g).

***Key words*:** Morphological characters, Biochemical analysis, Xanthophyll, Marigold

Introduction

Marigold (*Tagetes* spp.) are important commercial annual flower belongs to the family Asteraceae growing for their loose flowers, garland making and decoration apart from that extraction of essential oil, pigments and dyes. Marigold is a most important natural source of xanthophylls which is used as natural food additive to brighten egg yolks and poultry skin (Bosma *et al.*, 2003). Moreover, it is also being used effectively to dye fabrics commercially, the leaves and flowers are valuable for their medicinal properties (Tripathy and Gupta 1991), and they are utilized as food colouring and chicken feed source (Sreekala *et al.*, 2003). The medicinal benefits are Astringent, carminative, stomachic, scabies and liver troubles, eye illnesses, blood purification, bleeding piles, rheumatism, colds, and bronchitis are just some of the conditions for which different plant parts are beneficial. many significant phytochemical elements from the various parts of marigold are present in the plant.

African marigold is rich source of xanthophyll content due to which the flowers are in yellow to orange colour whereas the French marigolds having less xanthophyll content due to their flower are red colour. Nowadays xanthophyll (Lutein) is becoming more popular active ingredient in food and textile industries. The natural dye from flower petals consisting mainly lutein which can be isolated and export commercially and this xanthophyll has strong antioxidant ability hence the study was conducted to identify the suitable genotypes for xanthophyll content and flower yield under pot conditions.

Material and Methods

The present study was carried out with 17 genotypes of marigold *viz.* BM-2, CGFM-1, Pusa Basanti Gainda, Pusa Narangi Gainda, Chandini Gainda, Culcuttia Gainda, Pusa Bhar, Marigold Orange, KM-1, KM-2, BM-1, BM-3, Pusa Arpita, Pusa deep, KAUM-46, Anupam yellow and Orange bunch was carried out in the horticulture nursery at college premises, department of

floriculture and landscape architecture and Biochemical analysis was done at Richaria Research Laboratory, Department of Biotechnology, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the year 2023-24. The experiment was laid out in a completely randomised design with two replications. Regular intercultural practices were done during the crop growth. The observation on plant height, Plant spread along (E-W) & (N-S), number of primary branches per plant, number of secondary branches per plant recorded on 60,90 days after transplanting, Flower diameter, Flower head number of colours, flower head floret type, number of flowers per plant, average weight of flowers per plant, days to 50% flowering, Xanthophyll content and Statistical analysis.

Plant height

The plant height of the tagged 5 randomly selected plants from each treatment was measured in centimeters from the base of the plant from the ground level to the tip of the plant with the help of a measuring scale, and the average was worked out. This was done at all three stages of plant growth, *i.e.*, 60 and 90 days after transplanting.

Number of primary branches per plant

The number of primary and secondary branches arising per plant of 5 randomly selected plants from each treatment was the main stem, primary and secondary branches, respectively, were counted at the bud stage, 60 and 90 days after transplanting.

Number of secondary branches per plant

The number of leaves produced secondary branches per plant of 5 randomly selected plants from each treatment was counted at the bud stage 60 and 90 days after transplanting, and the average was worked out.

Plant spread (cm) (E-W)

The spread of the plant was measured from east to west with the help of a meter scale and expressed in centimeters plant spread was measured in five selected plants with the help of a meter scale in the North-south and East-west directions 30,60,90 days after transplanting.

Plant spread (cm) (N-S)

The spread of the plant was measured from north to south with the help of a meter scale and expressed in centimeters.

Days to 50% flowering

By counting the days since the planting date and expressing the result in days, we could determine how many days it took 50% of the plants in each pot to produce their blossom. When 50 percent of plants start flowering their observation was taken regarding the planting date.

Flower head diameter (cm)

Measuring scales were used to measure the blossom diameter after picking flowers from each plant. Five flowers from each treatment were chosen from pots, and the average value of each bloom was estimated. The diameter of five flowers from 5 tagged plants at the full bloom stage was recorded and then averaged to arrive at flower size.

Number of flowers per plant

The number of flowers per plant produced in each tagged plant was recorded and then averaged to get the value. Flowers are harvested at 100% flowering at two different harvests. The average number of flowers produced per plant was worked out for different treatments.

Average weight of flower per plant (g)

The flowers of 5 tagged plants are weighed after each harvest. then the average weight was calculated as fresh flower weight. The flowers are harvested twice at 100 percent flowering. Flowers were measured independently on each plant using an electronic balance, and the average value of five flowers was calculated.

Duration of flowering (days)

The total blooming time for each potted plant under each treatment was calculated and the average value was determined once it was seen. The number of days taken from the first flowering to the last flowering per plant was recorded as the total duration of flowering for each treatment.

Flower yield (g/pot)

From tagged plants, yield per plant was worked out by recording the fresh weight of flowers from every harvest and the mean value was worked out and expressed in grams. The flower yield per pot was calculated from the flower weight per plant of 5 tagged plants and then averaged to get the value.

Flower head Floret type

The flower head floret type data are as per the DUS guidelines (number 17), the flower head floret type was categorized as All tubulate, tubulate and ligulate, Tubuligulate, All Tubuligulate and All ligulate.

Flower head number of colours

The flower head colour was recorded based on the number of colours present on the flower petals as per the DUS guidelines (number 25), the flower head number of colours was categorized as one or two.

Table 1: Mean performance of the marigold genotypes for vegetative character.

Treatment	PH		NPB		NSB		PS (E-W)		PS (N-S)	
	60DAT	90DAT	60DAT	90DAT	60DAT	90DAT	60DAT	90DAT	60DAT	90DAT
BM-2	28.15	30.2	6.0	5.85	25.5	28.25	23.75	27.25	22.8	28.75
CGFM-2	19.6	23.25	5.5	6.7	15.7	20.35	16.5	16.25	17.9	17.85
Pusa Basanti Gainda	35.6	48.1	5.05	6.7	17.05	19.3	24.35	30.7	23.35	28.6
Pusa Narangi Gainda	35.4	45.7	6.1	7.6	15.7	20.3	22.6	29.5	22.9	27.75
Chandini Gainda	17.3	19.9	5.3	6.3	12.8	15	14.75	15.15	15.3	15.05
Culcutia Gainda	23.3	26.5	3.0	4.2	14.8	17.9	20.1	20.55	19.95	21.5
Pusa Bahar	33.5	38.2	5.55	6.7	21.4	26.1	27.2	28.2	28.1	29.6
Marigold Orange	29.2	30.8	5.5	6.3	20.7	27.4	19.2	19.1	22.55	22.35
KM-1	27.1	30.5	3.5	4.55	16.7	18.6	18.4	21.75	18.6	24.4
KM-2	31.3	37.4	3.4	5.3	23.0	25.5	23.0	28.9	23.1	28.2
BM-1	25.6	27.7	5.7	5.3	19.3	23.8	22.6	26.6	21.9	28.45
BM-3	31.4	30.8	7.3	8.05	28.3	34.7	27.55	27.75	28.8	31.7
Pusa Arpita	52.6	55.3	8.5	8.6	16.4	23.2	35.45	37.45	38.5	38.6
Pusa Deep	46.45	52.9	6.9	5.3	19.3	25.4	34.4	36.25	34.0	34.35
KAMU-46	32.9	39.8	7.05	6.9	13.05	27.9	27.0	28.2	26.6	26.75
Anupam Yellow	41	50.5	3.55	7.1	16.5	21.5	25.4	28.4	26.3	30.15
Orange bunch	33.7	35.3	6.25	7.4	24.5	29	22.0	25.9	22.3	25.85
Mean	32.00	36.63	5.53	6.40	18.86	23.77	23.77	26.34	24.29	27.05
Sem	2.00	1.24	0.43	0.60	1.64	1.09	1.43	1.29	1.02	1.33
C.D at 5%	5.98	3.72	1.28	1.81	4.90	3.27	4.26	3.86	3.04	3.98

PH- plant height, **NPB**- number of primary branches, **NSB**- number of secondary branches, **PS (E-W)**- plant spread along east-west, **PS (N-S)**- plant spread along north-south

Xanthophyll estimation

The dried flower petals were grind to a fine powder. Then, 50mg (0.05g) of petal meal was weighed into the test tube, 1 ml of Acetone and Hexane was added, and the sample was kept for 24 hours with an airtight cap. Filter the sample by adding 1ml acetone and hexane. Add 1 part of the sample and 4 parts of hexane and Acetone. Take 1 ml of each sample, add 2 ml of Acetone and Hexane to make a (1:4) ratio, and measure the absorbance at 436 nanometres.

Result and Discussion

Plant height

The maximum plant height at 60DAT (52.60cm) was recorded at Pusa Arpita, followed by Pusa deep (46.45cm) and the minimum plant height (17.30cm) was recorded in Chandini Gainda. At 90DAT the maximum plant height (55.30cm) was recorded in Pusa Arpita which was at par with Pusa Deep (52.90cm) and the minimum plant was recorded in Chandini Gainda (19.90cm). These differences in plant height may be due to agroclimatic conditions Sharma and Jadagoudar (2021); Manik and Sharma (2016), and due to varietal character Nagashree and Kulkarni, 2019) and Bhusaraddi *et al.*, (2021).

Number of Primary branches per plant

The maximum number of primary branches per plant at 60DAT was observed in Pusa Arpita (8.5) which was at par with BM-3 (7.3) and the minimum was observed in Culcuttia Gainda (3.0). At 90 DAT the maximum Number of Primary Branches was recorded in Pusa Arpita (8.60) which was at par BM-3 (8.05), Pusa Narangi Gainda (7.6) and Orange Bunch (7.4), the minimum number of primary branches was recorded in Culcuttia Gainda (4.20). The variation might be due to the genetic makeup of the variety Mahanta *et al.*, (2020), Number of primary branches can be affected by agroclimatic conditions Manik and Sharma (2016).

Number of Secondary branches per plant

The maximum number of Secondary branches at 60 DAT was observed in BM-3 (28.30) which was at par BM-2 (25.50) and Orange Bunch (24.50) and the minimum number of secondary branches was recorded in Chandini Gainda (12.80). At 90 DAT the maximum Number of Secondary Branches was recorded in BM-3 (34.70) followed by BM-2 (28.25) and the minimum number of Secondary branches was recorded in Chandini Gainda (15.00). The differences in the Number of Secondary branches can be affected by agroclimatic conditions Manik and Sharma (2016), Poornachandragowda *et al.*, (2016), and variation might be due to the genetic makeup of the variety Mahanta *et*

Table 2: Mean performance of the marigold genotypes for flowering character.

Treatments	Flower Dia-meter	No. of flowers per plant	Average weight of flowers	No. of days taken 50% flowering	Flower head number of colours	Flower head floret type	Xanthophyll content mg/g
BM-2	5.75	12.5	200.25	45.5	Orange	All Ligulate	351.83
CGFM-2	3.65	17	123.05	33	Red + Yellow	Ligulate + Tubulate	293.40
Pusa Basanti Gainda	5.45	9.2	183.25	45.5	Yellow	Ligulate + Tubulate	310.91
Pusa Narangi Gainda	5.3	9.35	234.75	45.5	Orange	All Ligulate	511.13
Chandini Gainda	3.85	16.05	144.25	29.5	Red	Ligulate + Tubulate	432.29
Culcutia Gainda	4.5	5.75	145.5	45.75	Orange	All Ligulate	456.99
Pusa Bahar	5.3	8.6	188.75	41.6	Yellow	Ligulate + Tubulate	172.74
Marigold Orange	4.9	5.4	123.0	44.75	Orange	All Ligulate	491.77
KM-1	4.95	7.95	352.5	42.6	Orange	All Ligulate	418.29
KM-2	5.3	8.95	144.25	43.8	Orange	All Ligulate	450.12
BM-1	4.8	8.15	121.5	44.75	Yellow	All Ligulate	196.58
BM-3	4.6	9.3	229.75	43.65	Orange	All Ligulate	398.52
Pusa Arpita	5.07	24.2	599	52.75	Light Orange	Ligulate + Tubulate	489.11
Pusa Deep	5.25	27.9	491.5	50.65	Red	Ligulate + Tubulate	485.04
KAMU-46	4.505	13.75	120.65	31.9	White	All Tubuligulate	-125.95
Anupam Yellow	5.55	8.0	123.0	45.1	Yellow	Ligulate + Tubulate	273.15
Orange bunch	4.65	9.7	202.0	41.3	Orange	Ligulate + Tubulate	472.42
Mean	4.90	11.86	219.23	42.80			
Sem	0.20	0.98	26.93	0.97			
C.D at 5%	0.61	2.92	80.37	2.92			

al., (2020), Bharathi and Jawaharlal (2014).

Plant spread (E-W) & (N-S)

The maximum Plant spread (E-W) & (N-S) at 60 DAT was observed in Pusa Arpita (35.45) (E-W) & (38.50) (N-S) which was at par and followed by Pusa Deep (34.40) (E-W) & (34.00) (N-S) and the minimum number of secondary branches was recorded in Chandini Gainda (14.75) (E-W) & (15.30) (N-S). At 90 DAT the maximum Plant spread (E-W) & (N-S) was observed in Pusa Arpita (37.45) (E-W) & (38.60) (N-S) which was at par and followed by Pusa Deep (36.25) (E-W) & (34.35) (N-S) and the minimum number of secondary branches was recorded in Chandini Gainda (15.15) (E-W) & (15.05) (N-S). The differences in the plant spread (E-W) & (N-S) due to agroclimatic conditions, Nagashree and Kulkarni (2020) and Sharma *et al*., (2019).

Flower diameter (cm)

The Flower Diameter ranges from 3.65cm to 5.75cm. In the second harvest, the maximum flower diameter was observed in BM-2 (5.75cm) which is at par with Anupam yellow (5.55cm), Pusa Basanti Gainda (5.45cm), Pusa Bhar (5.30cm), Pusa Narangi Gainda (5.30cm) and KM-2 (5.3cm) and the minimum flower diameter was observed in CGFM-1 (3.65cm). The flower Diameter of each cultivar showed significant variation. Based on these results, we can conclude that flower diameter can vary due to agroclimatic conditions and Biotic and Abiotic stress Sharma and Jadagoudar (2021).

Number of Flowers per Plant

The Number of flowers per plant ranges from 27.90 to 5.40. The maximum number of flowers per plant was observed in Pusa Deep (27.90) followed by Pusa Arpita (24.20), CGFM-1 (17.00), and Chandini Gainda (16.05), and the minimum number of flowers was observed in Marigold Orange (5.40). The Number of flowers per plant of each cultivar showed significant variation. The Number of flowers per plant can vary due to agroclimatic conditions and Biotic and Abiotic stress Sharma and Jadagoudar (2021).

Average weight of flowers per plant (g)

The Average weight of flowers per plant ranges from 599.0g to 123.0g. The maximum Average weight of flowers per plant was observed in Pusa Arpita (599.00g) followed by Pusa Deep (491.00g), KM-1 (352.50g), and Pusa Narangi Gainda (234.75 g) and the minimum Average weight of flowers was observed in Anupam Yellow and CGFM-1(123.00g). The Average weight of flowers per plant of each cultivar showed significant variation. The plants which are having maximum number of flowers show highest average weight of flowers the Average weight of flowers per plant can vary due to

agroclimatic conditions and Biotic and Abiotic stress Sharma and Jadagoudar (2021) and Manik and Sharma (2016).

Number of days taken for 50% Flowering

The minimum number of days taken for 50% flowering ranged from (29.50days) in Chandini Gainda to (45.5days) in Pusa Basanti ainda and Pusa Narangi Gainda and the maximum number of days for 50% flowering was observed in Pusa Deep (50.65days) and Pusa Arpita (52.75 days). It was observed that potted marigolds took fewer days to 50% flowering due to unfavourable agroclimatic conditions and there is no long blooming period in the case of pot condition compared to field. These variations due to agroclimatic conditions were similar to findings found by Nagashree and Kulkarni (2019) and Tiwari *et al.*, (2020).

Flower head number of Colours

The flower head's number of colours varied with different varieties. African marigold varieties have only one colour on the head, and French marigold varieties have two colours on the flowers.

Flower head Floret Type

The flower head floret type data was recorded on the Visual appearance of the flower based on the DUS Guidelines of Marigold. The flower head floret type was categorized as All tubulate, tubulate and ligulate, Tubuligulate, All Tubuligulate, and All ligulate. Comparably, utilizing the DUS principle, the protection of Plant Varieties and Farmers Rights Authority (PPV & FRA) classified several genotypes of marigold.

Duration of Flowering (in days)

The maximum duration of flowering was observed in Pusa Arpita (57.3 days) which was at par with Pusa Deep (57.1 days). The minimum duration of flowering was observed in CGFM-1 (40.75 days). Marigold varieties have some slightly shorter flowering spans due to space and nutrition limitations in pot conditions. Marigold varieties have some slightly shorter flowering spans due to space and nutrition limitations in pot conditions. These variations due to agroclimatic conditions were similar to findings by Nagashree and Kulkarni (2019).

Flower yield (g)

The maximum flower yield was observed in Pusa Arpita (406.00g), which showed at par to Pusa Deep (390.50g). The minimum flower yield was observed in Chandini Gainda (135.75g). The flower yield per pot of each cultivar showed significant variation; the plants that show a higher number of flowers per plant and the average weight of flowers per plant have the highest flower yield per pot. These variations are due to agroclimatic conditions. Similar findings were found by Sharma and Jadagoudar (2021), Manik and Sharma (2016), Bharathi and Jawaharlal (2014), and Singh *et al.*, (2008).

Xanthophyll content among different genotypes of Marigold

Xanthophyll content was estimated using the spectrophotometer method. The Xanthophyll content ranges from -125.958mg/g to 511.73mg/g. The maximum Xanthophyll content was observed in Pusa Narangi Gainda (511.73 mg/g) followed by Marigold Orange (491.778 mg/g), Pusa Arpita (489.113 mg/g) and Pusa Deep (485.046 mg/g). The minimum xanthophyll content was observed in Pusa Bhar (172.74 mg/g), and there is no Xanthophyll content in KAUM-46 (-125.958 mg/g). Xanthophyll content was found more in dark Orange coloured flowers than the Light orange or Yellow-coloured flowers Kasemsap *et al.*, (1990); Pusa Narangi Gainda, Pusa Arpita has the highest carotenoid content these varieties are suitable for commercial production of carotenoid Akshaya *et al.*, (2016); The flower colour, which is a heritable character and such differences in the pigments might be due to gene action Lydia, (2019); The variation in the xanthophyll content might be due to the genetic makeup of the genotypes also the orange colour flowers produce more xanthophyll than the yellow colour flowers Deineka (2007).

Conclusion

The result obtained from the investigation, it can be concluded that Pusa Arpita and Pusa deep were the suitable for loose flower production and the varieties Pusa Narangi Gainda, Marigold Orange, Pusa Arpita and Pusa Deep for xanthophyll content in pot condition under Chhattisgarh condition.

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