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Short communication

Effect of growth retardants (Alar and Cycocel) on flower yield and carotenoid content in African marigold (*Tagetes erecta* L.) varieties

S. Sunayana[1*], A.V. Meera Manjusha[2], A. Rajagopalan[1] and Ashok Madala[1]

[1]*College of Agriculture, Padannakkad, Kerala Agricultural University, Kasargod 671328, Kerala, India*; [2]*Regional Agricultural Research Station, Pilicode, Kasargod 670353, Kerala, India*

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Abstract

A field study was conducted to assess the effect of growth retardants in African marigold (*Tagetes erecta* L.). The effect of Alar and Cycocel on flower yield and carotenoid content in two varieties of African marigold was studied. The experiment was carried out in split plot design during two seasons *viz.*, May sown crop and January sown crop. The main plots included two popular varieties Pusa Narangi Gainda and Maxima Yellow F_1 and sub plot treatments comprised of Alar @ 500, 1000 and 1500 ppm, Cycocel @ 1000, 1500 and 2000 ppm and distilled water as control applied as foliar spray. The number of flowers per plant, total flower yield per plant and carotenoid content of flower petals were significantly influenced by growth retardant application during both the seasons. Maximum carotenoid content was recorded in plants treated with Cycocel 1000 ppm in May sown crop and with Cycocel 2000 ppm in January sown crop.

Keywords: African marigold, Alar, Carotenoid, Cycocel

African marigold (*Tagetes erecta* L.) belonging to family Asteraceae is one of the most popular annual flower crop grown on a commercial scale. Besides being an important crop for landscaping, it is commercially grown for loose flowers, cut blooms, oil and pigment extraction, perfumery and cosmetics as well as for medicinal purposes. Nowadays, African marigold is recognized as a potential source of carotenoid pigments such as lutein and zeaxanthin. They are currently used as food colourants, nutritional supplements and poultry feed additives to improve the colour of egg yolk and poultry skin colour and in ophthalmology for the treatment of diseases like cataract and age related macular degeneration (ARMD) (Gupta, 2014).

Growth regulators find their extensive use in ornamental crops for modifying their developmental processes including growth and flowering. Plant growth retardants are growth regulating chemical substances that find extensive use in the field of floriculture for modifying plant growth and development. Alar and Cycocel are two well-known growth retardants used for producing quality plants that are now being tried in African marigold. A study was carried out at Padannakkad during 2015-2017 with the objective of assess the response of marigold in terms of number of flowers per plant, total flower yield per plant and carotenoid content as influenced by foliar application of growth retardants Alar and Cycocel.

The study was conducted during two seasons *viz*., May - October of 2016 and January – April of 2017. The field is located in the northern part of Kerala at 12°15' 20.58" N latitude, 75° 8' 2.63" E longitude and altitude of 20 m above mean sea level. The experimental design was split plot with 2 main plots, 7 subplots and 3 replications. The two marigold varieties were the main plots: V_1 – Pusa Narangi

*Author for correspondences: Phone: 91- 8129511722, Email: sunayanasuja@gmail.com

Gainda and V_2 – Maxima Yellow F_1.Their response to growth retardants was evaluated with subplot treatments *viz.*, C_1: Alar 500 ppm, C_2: Alar 1000 ppm, C_3 : Alar 1500 ppm, C_4 : Cycocel 1000 ppm, C_5 : Cycocel 1500 ppm, C_6 : Cycocel 2000 ppm and C_7 : Water spray (control). Pusa Narangi Gainda variety is a hybrid between Cracker Jack and Golden Jubilee and produces deep orange flowers with ruffled florets. The variety is widely used for loose flower production as well as in poultry industry, food, pharmaceutical and nutraceutical industries as it is rich in carotenoids. The variety, Maxima Yellow F_1, produces medium bushy type plants. Flowers are yellow in colour fully double petaled, very compact, 7.5 – 9 cm diameter. It is an all-round outstanding variety suitable for harvesting flowers and also as a pot plant.

The seedlings were transplanted to the main field, 30 days after germination, at a spacing of 30 x 30 cm. All fertilizers, farmyard manure and lime were given as basal dose as per Kerala Agricultural University, Package of Practices (2011) recommendation. The subplot treatments were applied as foliar spray at 30 days after transplanting. Planting was done on raised beds for May sown crop and for January sown crop, ridges and furrows were prepared and planting was done in furrows.

Observations on flowering and yield parameters and carotenoid content were recorded from five randomly selected and tagged plants per replication from each treatment. Total carotenoids were estimated by the method suggested by Arnon (1949). The data obtained were subjected to statistical analysis using OPSTAT software.

Data regarding number of flowers per plant, flower yield per plant and carotenoid content as influenced by varying concentrations of growth retardant treatments in African marigold varieties are presented hereunder.

On comparing the two main plot treatments (Table 1), Maxima Yellow F_1 (V_2) recorded highest number of flowers per plant (46.50 and 34.44) and flower yield per plant (603.74 g and 279.40 g) during the first and second season respectively as compared to Pusa Narangi Gainda (V_1). Pusa Narangi Gainda recorded maximum carotenoid content (25% more than Maxima Yellow F1) in flower petals (40.35 mg 1000 g^{-1} and 74.28 mg 1000 g^{-1} during the first and second season respectively). The orange colour of the variety may be attributed to the higher content of carotenoid pigment.

With respect to the different subplot treatments (Table 2), the yield parameters and carotenoid content of petals were significantly improved by the application of Alar and Cycocel at different concentrations. The foliar spray of Cycocel at 1000 ppm recorded significantly higher number of flowers per plant and total flower yield per plant (46.86 and 469.69 g during first season) and Cycocel at 2000 ppm (26.78 and 202.41 g during second season). The analysis of data showed that application of Alar and Cycocel had significant effect on carotenoid content of petals in African marigold varieties. Total flower yield per plant was on par treatments Cycocel 1000 ppm and Alar 1000 ppm during first season. During second season the total flowers yield was on par in treatments Cycocel 2000 ppm, Alar 1500 ppm, Cycocel 1500 ppm and Cycocel 1000 ppm.

Table1. Effect of main plot treatments (varieties) on flowering, yield and carotenoid content

Main plot treatments	Number of flowers per plant		Flower yield per plant (g)		Carotenoid (mg 1000 g^{-1})	
	May sown	January sown	May sown	January sown	May sown	January sown
V_1- Pusa Narangi Gainda (PNG)	32.26	14.59	177.87	73.37	40.35	74.28
V_2-Maxima Yellow F_1 (MYF)	46.50	34.44	603.74	279.40	32.57	21.08
SE m(±)	1.44	1.27	22.41	12.49	0.16	3.65
CD (0.05)	6.65	5.87	103.81	57.86	0.77	16.94

Table 2. Effect of sub-plot treatments (growth retardants) on flowering, yield and carotenoid content

Subplot treatments	Number of flowers per plant		Flower yield per plant (g)		Carotenoid (mg 1000 g^{-1})	
	May sown	January sown	May sown	January sown	May sown	January sown
C_1 : Alar – 500 ppm	35.08	24.70	379.83	169.35	26.04	42.49
C_2 : Alar – 1000 ppm	40.75	24.28	432.50	169.20	29.44	48.10
C_3 : Alar – 1500 ppm	42.68	24.88	427.00	187.32	40.78	58.20
C_4 : Cycocel – 1000 ppm	46.86	24.76	469.69	181.88	45.15	42.49
C_5 : Cycocel – 1500 ppm	35.50	24.58	326.25	182.00	43.34	49.92
C_6 : Cycocel – 2000 ppm	39.15	26.78	355.33	202.41	40.14	55.65
C_7: Water spray	35.67	21.62	345.05	142.53	31.04	37.18
SE m(±)	1.91	0.83	19.36	13.46	2.25	1.56
CD (0.05)	3.96	1.72	40.19	27.94	4.67	3.24

The interaction between varieties and growth retardants revealed that Cycocel at 1000 ppm resulted in higher number of number of flowers, yield and carotenoid content in both the varieties for May sown crop and Cycocel at 2000 ppm for January sown crop. Regarding carotenoid content, spraying of Cycocel 1000 ppm on variety Pusa Narangi Gainda gave higher carotenoid content during first season, and the same variety with Cycocel 2000 ppm spray was better during second season (Table 3).

Increase in number of flowers and flower yield in African marigold with the application of Cycocel was previously reported by Kumari et al. (2013) and this could be attributed to increased mobilization of biomass to flowers from the source.The increase in carotenoid content might be due to overall effect of increase in flower yield associated with growth retardant application as reported by Kazemi et al. (2014) in pot marigold and also due to the enhanced production of cytokinins with growth retardant spray which in turn

Table 3: Effect of interaction (Varieties x Growth retardants) on flowering, yield and carotenoid content

Interactions	Number of flowers per plant		Flower yield per plant (g)		Carotenoid (mg 1000 g^{-1})	
	May sown	January sown	May sown	January sown	May sown	January sown
V_1C_1 : PNG x Alar 500 ppm	26.75	13.83	147.05	70.68	28.31	68.48
V_1C_2 : PNG x Alar 1000 ppm	31.37	12.89	183.00	67.98	30.47	73.36
V_1C_3 : PNG x Alar 1500 ppm	35.00	15.10	195.40	77.24	42.37	85.57
V_1C_4 : PNG x Cycocel 1000 ppm	36.91	15.20	229.72	74.34	53.13	68.32
V_1C_5 : PNG x Cycocel 1500 ppm	32.33	15.17	172.37	74.39	49.36	78.46
V_1C_6 : PNG x Cycocel 2000 ppm	36.63	17.30	181.12	90.68	40.41	85.74
V_1C_7: PNG x Water spray	26.83	12.67	136.40	58.31	38.42	60.64
V_2C_1: MYF x Alar 500 ppm	43.40	35.57	612.61	268.01	23.76	16.30
V_2C_2 : MYF x Alar 1000 ppm	50.13	35.67	681.99	270.42	28.41	22.85
V_2C_3 : MYF x Alar 1500 ppm	50.37	34.67	658.59	297.4	39.18	30.54
V_2C_4: MYF x Cycocel 1000 ppm	56.80	34.32	709.65	289.43	37.17	16.67
V_2C_5: MYF x Cycocel 1500 ppm	38.67	33.99	480.13	289.61	37.33	21.38
V_2C_6: MYF x Cycocel 2000 ppm	41.67	36.27	529.53	314.15	39.27	25.56
V_2C_7: MYF x Water spray	44.50	30.57	553.70	226.76	23.47	13.73
SE m (±)	2.70	1.17	27.38	19.03	3.18	2.21
CD (0.05)	7.32	NS	87.54	NS	6.64	8.90

increases the carotenoid pigments as reported by Fletcher et al. (2010).

Flower yield and carotenoid content of flower petals were significantly influenced by varieties and growth retardant application during both the seasons. Maximum carotenoid content was recorded in plants treated with Cycocel 1000 ppm during May season and with Cycocel 2000 ppm during January season.

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