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Effect of planting date on growth, development, aerial biomass partitioning and flower productivity of marigold (*Tagetes erecta* L.) cv. Siracole in Indo-gangetic plains of West Bengal

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Abstract

The investigation was carried out to evaluate the growth, flowering, yield and quality of African marigold cv. Siracole, as influenced by different planting dates. The crop planted on 9th June (T_3) was found to have the highest plant height (96.93 cm). Maximum number of primary (5.3) and secondary (14.15) branches/plant, total fresh weight (502.00 g/plant), contribution by stem (385.00 g/plant) to the total fresh weight, higher dry (126.25 g/plant) matter accumulation and also the dry matter accumulation in stem per plant (98.00 g/plant) were found maximum with 12 April (T_1) planting. The individual leaf area (4.73 sq cm) was significantly higher in the crop planted in February (T_{11}). It took minimum days (13.01 days) from visible bud to colour shown and bud emergence to full bloom (20.16 days), maximum diameter of individual flower (3.99 cm) were found with 12 April (T_1) planting. Heaviest flower (2.55 g) was recorded with October 12 (T_7) planting. 16th May (T_2) planting produced maximum number (7434.67) of flowers per plot (6.4 m^2). Maximum carotene content was noted with 12th October (T_7) planting. Crops planted between 50th MSW (T_9) 2011 to 3rd MSW (T_{10}) 2012 produced very less crop biomass, dry matter content and flower yield.

Key words: Carotene, Meteorological Standard Weeks, planting time, *Tagetes erecta* L. cv. Siracole.

Introduction

Marigold (*Tagetes erecta*) is one of the most important commercially grown flower crops in India. Besides, orange coloured marigold flowers are important source of carotenoid pigments which is mainly used in poultry feed industry. In recent years carotenoid has represented a good alternative for the pharmaceutical and food industries and especially for the human health. It prevents different diseases, such as cancer, mascular degradation and cataracts (Arvayo *et al.*, 2013). The crop is known to respond by day length and temperature. Time of planting (a non monetary input) plays a significant role in improving the yield of many crops and governs the crop phenological development and total biomass production along with efficient conversion of biomass in to economic yield (Khichar and Niwas, 2006). Moreover, meagre information is available about the response of African marigold cv. Siracole to different planting time. Keeping this in view, a study was undertaken to evaluate the growth, flowering, yield and quality of African marigold cv. Siracole, as influenced by different planting dates.

Materials and methods

The study was conducted during April to March (2011 to 2012) at Horticultural Research Station, Mondouri, BCKV, Nadia, (23.5 ^{0}N latitude; 89 ^{0}E Longitude) at about 8.75 m above mean sea level under irrigated condition. The site experiences a mean annual temperature of 26.15 ^{0}C. Rainy season accounts for 35 % of the total rainfall and is associated with low sunshine hours.The treatments comprised of twelve planting dates *viz.*, T_1 - 12 April, T_2 - 16 May, T_3 - 9 June, T_4-12 July, T_5- 9 August, T_6-12 September, T_7-12 October, T_8-12 November, T_9-15 December, T_{10}-20 January, T_{11}- 20 February and T_{12} -13 March, corresponding to15, 20, 23, 28, 32, 37, 41, 46, 50, 3, 8 and 11 meteorological standard weeks (MSW) and were tested in a randomized block design with four replications. The experimental plot size was laid with an area of 6.4 m^2 (3.2 m × 2 m). A basal dose of 23.5 q mustard oil cake ha^{-1}, 100 kg P_2O_5 ha^{-1} and 100 kg K_2O ha^{-1} was applied. Well rooted cuttings of 21-25 days old with more or less uniform growth and vigour were planted at 40 × 20 cm and adopted uniform agronomical practices for all treatments. Top dressing (50 kg N ha^{-1} as urea) was given 30 days after planting. Soluble fertilizers (NPK- 19:19:19) @ 1.5 gm/L of water were sprayed on every 15 days intervals. Plants were pinched 30 days after planting to encourage axillary branches. Periodical observations were taken on vegetative parameters. Reproductive and flowering parameters were recorded at one day interval. The observations recorded on plant height, number of branches, individual leaf area, and dry matter accumulation in leaves, stem and roots were recorded 90 days after planting (DAP). Flower petals were collected randomly on 10 days interval from each treatment and the total carotene content (Swain and Hill, 1959) was estimated and expressed in mg/g. Data on various characters studied during the course of investigation were statistically analysed. The meteorological data of the cropping period and harvesting week are given in Fig. 1.

Results and discussion

Vegetative attributes: Data presented in Table 1 revealed that planting time of marigold cv. Siracole significantly influenced the plant height, number of primary and secondary branches, leaf area, and weight of plant parts *i.e.* fresh and dry weight of plants. Plant height (96.93 cm) was significantly higher in 9thJune (T_3) transplanting as compared to other planting dates. It may be due to

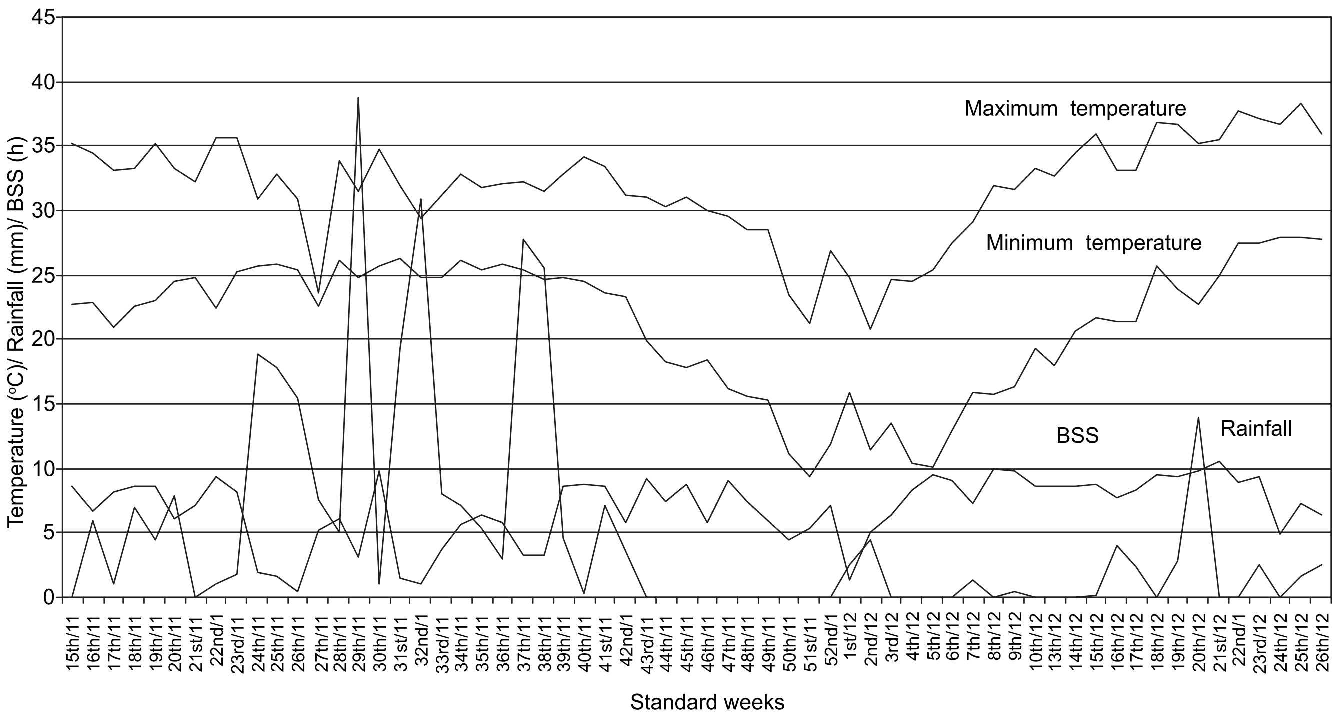

Fig. 1. Meteorological data of the growing period

the fact that 23rd MSW planted crop grew under high temperature range (average day 32.56 to 24.84^{0}C and night 31.08 to 14.15^{0}C) and long day condition, consequently registered longer duration (82 days) of vegetative phase, enhanced the linear growth of the plant. This is in conformity with the findings of Nair *et al*. (1985) and Yulian *et al*. (1995). The crop planted on 20th January (T_{10}) showed minimum plant height (14.10cm). During the growth phase plants exposed to low temperature range (average DT 20.2 to 29.4 ^{0}C and NT 7.6 to 14.5 ^{0}C) and short day condition. Low temperature can result in poor growth. Another cause may be the severe blight infestation. The number of both primary (5.3) and secondary (14.15) branches/plant, total fresh weight (502.00 g/plant) and contribution by stem (385.00 g/plant) to the total fresh weight was maximum with 12 April (T_1) planting. The increase in fresh weight of plant may be due to formation of more number of primary and secondary branches per plant in *T. erecta* cv. Siracole. The crop planted on 12th November (T_8) recorded significantly lower number of branches and total fresh weight (38.25 g/plant, compared to others but remained statistically at par with 15th December (T_9) and 20th January planting (T_{10}). At 90 DAP, the individual leaf area (4.73 sq cm) were significantly higher in the crop planted in February (T11) followed by June (T3) planting (4.35sq cm). The crop which were planted on 15th December (T_9) (1.06 sq cm), 20th January (T_{10}) (1.14 sq cm) and 12th November (T_8) (1.67 sq cm) remained at par with each other but recorded significantly lower leaf area than others, which might be accumulated lesser number of degree days and resulted in poor growth. The accumulation of crop biomass ultimately depends on the interception of solar radiation by leaf canopy and

Table 1. Effect of planting dates on vegetative parameters of marigold

Treatment	Plant height (cm)	Number of branches/ plant		Leaf area (cm^2) 90 DAP	Fresh weight g/plant (90 DAP)			Total fresh weight (g/plant)	Dry weight g/plant (90 DAP)			Total dry weight (g/plant)
		Primary	Secondary		Leaf	Stem	Root		Leaf	Stem	Root	
T_1	72.75	5.3	14.15	3.88	79.25	385.00	37.75	502.00	20.00	98.00	8.25	126.25
T_2	91.10	3.5	12.60	3.75	73.50	319.00	51.75	444.25	19.75	93.25	12.00	125.00
T_3	96.93	3.25	10.60	4.35	105.25	195.25	54.25	354.75	20.25	41.75	13.75	75.75
T_4	91.05	2.65	8.85	2.67	60.50	172.75	20.75	254.00	11.75	40.25	4.25	56.25
T_5	74.10	2.85	9.80	2.90	17.25	103.00	19.00	139.25	6.25	28.25	4.00	38.50
T_6	56.50	2.7	10.90	2.93	23.75	71.25	5.25	100.25	9.75	19.25	2.00	31.00
T_7	39.25	2.4	7.10	2.84	17.50	35.25	5.75	58.50	4.42	9.25	1.75	15.42
T_8	18.00	1.6	3.70	1.67	10.00	25.00	3.25	38.25	1.75	3.25	0.25	5.25
T_9	19.85	1.75	4.45	1.06	12.00	25.00	2.25	39.25	1.50	3.00	0.25	4.75
T_{10}	14.10	1.7	4.00	1.14	19.00	30.25	1.50	50.75	5.25	7.92	0.25	13.42
T_{11}	74.15	3.25	6.35	4.73	29.00	36.75	8.75	74.50	9.00	14.25	1.75	25.00
T_{12}	70.60	3.3	7.30	3.83	75.75	340.00	30.25	446.00	20.25	95.00	8.00	123.25
LSD(0.05)	4.72	0.67	1.30	0.84	5.11	19.81	7.67	27.58	1.87	2.43	1.58	3.02

on active photosynthesis by the individual leaves. Dry matter accumulation in different plant parts of *T. erecta* cv. Siracole *viz*., leaves, stem and roots and total biomass was significantly influenced by planting dates. The crop planted on April 12 (T_1) recorded significantly higher dry matter accumulation (126.25 g/plant) as compared to others but remained at par with May 16 (T_2) and March 13 (T_{12}). Whereas, December 15th (T_9) planted crop recorded significantly lower dry matter accumulation (Table 1). The total energy available to any crop is never completely converted to dry matter under even most favourable conditions. Efficiency of conversion of heat energy into dry matter depends upon genetic factors, sowing time and crop type (Hundal *et al*., 2004). Dry matter accumulation in stem per plant was significantly highest in April 12 (98.00 g/plant) followed by13 March (95.00 g/plant) and16 May (93.25 g/plant), respectively. This may be attributed to the fact that lesser dry matter was accumulated in different plant parts of *T. erecta* cv. Siracole planted beyond Oct 12 to Dec 15. Willits and Bailey (1999) observed increased plant weight with increasing temperature of both heat sensitive and heat tolerant chrysanthemum. The crops planted at 46th MSW (T_8) partitioned more towards leaf (86.89%) followed by 47th MSW (82.62%).The marigold planted on 3rd MSW (T_{10}) partitioned more towards stem (71.66%) and least towards root (1.99%). The crop planted on April 12 (T_1) recorded significantly higher fresh (502.00 g/plant) and dry (126.25 g/plant) matter accumulation as compared to all other treatments. Whereas, December 15th (T_9) planted crop recorded significantly lower dry matter accumulation.

Reproductive attributes: The crop transplanted on June 10 (T_3) initiated flower buds on 60 days after planting (DAP), whereas, only 33 days were required for those planted on September12 (T_6) followed by T_1 (34 days). It may be due to shortening of the vegetative phase and period between budding and flowering is curtailed due to minimum DIF, which might have shortened the phenophase duration of late transplanted crop. Significant variation was noted in days taken from flower bud emergence to colour shown and flower bud emergence to full bloom under different planting dates (Table 2). Crops planted on 12thApril (T_1) took minimum days (13.01 days) from visible bud to colour shown and bud emergence to full bloom (20.16 days) than other dates of transplanting but remained at par with the crop planted on13 March (T_{12}). During this period plants were exposed to favourable high temperature regime (35/ 25.4 ^{0}C). Crops planted on 12 November (T_8) took more days from visible bud to colour shown and bud emergence to full bloom (42.77 days). Low temperature (22/9.2 ^{0}C) during vegetative phase delayed the visibility of colour. Karlsson *et al*. (1989) and Wilkins *et al.* (1990) concluded that low night temperatures of 5 ^{0}C or 13 ^{0}C had delaying affects on flowering of chrysanthemum. Diameter and weight of individual flower also varied significantly due to different planting dates. Maximum diameter of individual flower (3.99cm) was noted with 12 April (T_1) planting whereas November 12 (**T_8**) planted crop produced small size (0.62 cm) flowers compared to other planting dates. Higher atmospheric temperature during vegetative stage and lower diurnal variation and bright sun shine (BSS) hours during reproductive stage lead to greater flower diameter. Heaviest flower (2.55 g) was recorded with October12 (T_7) planting. Individual flower weight was favoured by lower atmospheric temperature. Among the different planting dates, 16th May (T_2) planting produced maximum number (7434.67) of flowers per plot (6.4m^2). In terms of flower weight, maximum yield was recorded with 12th Sept (T_6) planting. This may be due to availability of lower atmospheric temperature. This allows the plant to photosynthesize (build up) and respire (break down) during an optimum daytime temperature, and to curtail the rate of respiration during a cooler night. Yield potential of a crop is resultant effects of growth, development and qualitative performance of the plant in a particular agro-climatic condition. Crop growth and yield are the results of the interaction of weather that prevail during the crop growth period and genetic constitution of the crop plants. Carotene content in the florets varied significantly due to different planting dates. Maximum carotene content was noted with 12th October (T_7) planting. Carotene content showed higher values when the plants received lower atmospheric temperature.

The study clearly indicated that planting dates and weather variables like rainfall, temperature and bright sunshine hours had profound influence on growth and development of *T. erecta* cv.

Table 2. Effect of planting dates on reproductive parameters of marigold

Treatment	Days to colouration from bud emergence	Day from bud emergence to full bloom	Vegetative stage (days)	Reproductive stage (days)	Total duration of crop in field (days)	Individual flower weight (g/plot)	Individual flower diameter (cm)	Number of flowers	Weight of flowers (g/plot)	Total carotene contents (mg/g)
T_1	13.01	20.15	52.00	78.00	130.00	2.18	3.99	3369.24	7329.25	0.31
T_2	15.16	22.86	70.00	88.00	158.00	1.24	3.23	7434.67	9164.00	0.84
T_3	15.37	22.54	82.00	78.00	160.00	1.80	3.65	5552.68	10015.00	1.35
T_4	15.81	22.89	72.00	68.00	140.00	1.74	3.48	6810.51	11851.75	1.48
T_5	19.43	26.95	59.00	68.00	127.00	1.68	3.45	6325.58	10572.75	1.81
T_6	20.33	28.86	48.00	68.00	116.00	2.46	3.47	5027.16	12312.75	1.80
T_7	20.89	30.56	46.00	46.00	92.00	2.55	3.79	3319.66	8445.00	2.68
T_8	33.19	42.77	60.00	48.00	108.00	1.14	0.62	255.10	289.75	1.20
T_9	28.63	37.80	64.00	38.00	102.00	0.57	0.63	209.10	102.00	1.00
T_{10}	29.41	39.09	63.00	58.00	121.00	0.33	0.83	667.03	214.50	1.24
T_{11}	15.59	23.76	52.00	58.00	110.00	1.19	3.69	2188.74	2587.50	1.01
T_{12}	13.97	21.37	54.00	59.00	113.00	1.16	3.77	965.57	1117.25	0.74
LSD(0.05)	2.06	2.07	2.09	2.54	2.93	0.24	0.07	794.14	1280.25	0.78

Siracole as reflected from the significant variation in growth phase duration, biomass partitioning, dry matter content, flower size, yield of flowers and carotene content of florets. Crops planted between 50th MSW (T_9) 2011 to 3rd MSW (T_{10}) 2012 produced very less crop biomass, dry matter content and flower yield.

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