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Effect of different sources and levels of potassium on growth, flowering and yield of African marigold (*Tagetes erecta* Linn.) cv. 'Siracole'

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A field experiment was conducted at Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal during two winter seasons (2003-2005) to investigate the sources (as potassium chloride and potassium sulphate) and optimum potassium level (0, 50, 100, 150 and 200 kg/ha) for irrigated African marigold, *Tagetes erecta* Linn. cv. 'Siracole'. Sources of potassium failed to influence the plant growth, flower yield, leaf N, P, K and chlorophyll content and anthocyanin in petals. The characters showed a positive response to different levels of potassium fertilizer application. Yield of flowers increased with increased quantity of potassium fertilization from zero to 200 kg/ha. Plant height, both primary and secondary branches, plant spread, flowers size, nitrogen, phosphorus, potassium and chlorophyll content of leaf and anthocyanin content in petals were also directly related to potassium level.

Keywords: African marigold, *Tagetes erecta* cv. 'Siracole', Potassium, Chlorophyll, Anthocyanin.

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Introduction

Marigold is one of the most important commercially grown flower crops in India. Incorporation of marigold wastes with soil significantly reduces the nematode (*Meloidogyne incognita*) population. Akhtar and Alam[2] observed that amendment of agro-waste of *Tagetes erecta* @100g/kg of pot mixture significantly reduced the *M. incognita* population. Small and marginal farmers of West Bengal grow this crop due to its easy culture, wide adaptability and short term lucrative return. The area under marigold cultivation is about 950 ha[4]. *T. erecta* cv. 'Siracole' produces orange red, medium size compact flowers with good keeping quality (Plate 1). The cultivar 'Siracole' is having a good potential for year round flower production and gaining popularity among the flower growers of West Bengal. Till date no systematic work has been taken up to standardize its potassium sources and requirements. Therefore, this study was undertaken to standardize the sources and levels of potassium on growth, flowering and yield of African marigold, *T. erecta* Linn. cv. 'Siracole'.

Materials and Methods

The experiment was laid out in sandy loam soil (*p*H 6.2, organic carbon 0.47%, 150 kg available nitrogen, 82.4 kg available phosphorus and 110 kg available potassium/ha) at Horticulture Research Farm, Mondouri, Bidhan Chandra Krishi Viswawidyalaya, West Bengal under irrigated conditions adopting split plot design with sources of potassium in main plots and levels of potassium in sub-plots with three replications during 2003-2004 and 2004-2005. The treatments consisting of two sources of potassium, viz. K_1-Potassium chloride as Muriate of potash (60% K_2O) and K_2-Potassium sulphate (48% K_2O) and five

Plate 1—*Tagetes erecta* Linn. cv. 'Siracole' in bloom

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levels of potassium, viz. D_0-0 kg, D_1-50 kg, D_2-100kg, D_3-150 kg and D_4-200 kg/ha. The treatment includes all possible combinations of the above mentioned treatments. The plot size was 2.4×2.4m and the treatments were allotted randomly in each plot.

Well rooted terminal cuttings with uniform growth and vigour were planted at 30 × 40 cm spacing as per treatment combinations during the month of September and uniform agronomical practices were adopted for all treatments. Immediately after transplanting, water was given for plant establishment. Later watering through flood irrigation was followed as per requirement of plants. All the plots received FYM, nitrogen and phosphorus @ 20 tonnes, 200 kg and 80 kg/ha, respectively. The entire quantity of FYM and phosphorus was applied as basal. Half of nitrogen was applied during planting, remaining half was top dressed in two equal split doses at 20 and 40 days after transplanting. Potassium was applied during planting according to the treatment combinations discussed above. Tip of the plants were pinched 20 days after planting.

Leaf samples were collected randomly at every blooming stage (40 days after transplanting) in each treatment and leaf nitrogen, phosphorus, potassium (expressed in per cent)[6] and chlorophyll[12] content was estimated and expressed in mg/g. At peak flowering stage, flower petals were collected randomly in each treatment and anthocyanin content[13] was estimated and expressed in percent (mg/100g). The data on crop character and yield were pooled over two years and analyzed statistically [9].

Results and Discussion

Growth attributes

The data presented in Table 1 revealed that plant height, number of primary and secondary branches and plant spread of the upper portion of the plant under different sources of potassium did not show any significant differences in both the years of investigation. Application of different levels of potassium significantly influenced all the vegetative growth characters in this experiment (Table 1). Plant height increased with increasing levels of potassium fertilization from 0 to 200 kg/ha. Maximum plant height (63.52 cm) was recorded under D_4 (200 kg/ha potassium) treatment. The difference between D_2 and D_3 as well as D_3 and D_4 was not significant. The maximum number of primary and secondary branches (5.69 and 22.11) were recorded under D_4 (200 kg /ha potassium) treatment. Plants treated with 200 kg/ha potassium (D_4) recorded 33.93% more spread over untreated control (D_0). The difference between D_3 (150 kg/ha potassium) and D_4 (200 kg/ha potassium) was, however, not statistically significant. The beneficial effects of potassium in promoting the growth of marigold plants may be explained from the fact that potassium involved in synthesis of peptide bond and protein and carbohydrate metabolism and also participates in rapid cell division and differentiation[3].

Reproductive attributes

Data on flower bud emergence after planting, diameter and weight of individual flower and yield of flowers are presented in Table 2. It can be seen that there was no significant differences on the above mentioned characters due to different sources of potassium in any of the years and also in pooled data.

Table 1—Effect of different sources and levels of potassium on vegetative growth of African marigold, *Tagetes erecta* Linn. cv 'Siracole'

Year	Plant height (cm)			Primary branches/plant			Secondary branches/plant			Plant spread (cm)		
Treatment	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2003-04	Pooled
Sources												
K_1	57.13	59.87		5.07	5.11		18.67	18.97		50.29	51.37	
K_2	57.10	59.46		5.13	5.16		18.92	19.15		51.77	52.49	
S. Em(±)	0.91	0.88		0.04	0.02		0.13	0.10		0.62	1.68	
C.D. at 5%	N. S.	N. S		N. S.	N. S.		N. S.	N. S.		N. S.	N. S.	
Levels of potassium												
D_0	51.58	52.66	52.12	4.23	4.38	4.43	15.20	16.30	15.75	41.95	44.17	43.06
D_1	54.74	57.03	55.88	4.75	4.83	4.79	16.83	17.17	17.00	47.84	49.71	48.77
D_2	57.90	60.14	59.02	5.17	5.27	5.22	19.25	19.60	19.42	51.98	53.05	52.51
D_3	59.39	63.40	61.39	5.40	5.52	5.46	20.43	20.25	20.34	55.52	55.25	55.39
D_4	61.97	65.08	63.52	5.65	5.73	5.69	22.25	21.97	22.11	57.85	57.48	57.67
S. Em (±)	1.60	2.33	1.41	0.14	0.13	0.10	0.22	0.13	0.19	1.58	1.44	1.07
C.D. at 5%	4.97	6.98	4.23	0.43	0.40	0.28	0.64	0.38	0.55	4.73	4.31	3.08

Application of different levels of potassium significantly influenced the days required to flower bud emergence from planting in both the years of investigation. Flower bud emergence was delayed gradually with the increase in levels of potassium fertilizer. The variation between D_3 (150 kg/ha potassium) and D_4 (200 kg/ha potassium) was at par. Different levels of potassium significantly influenced the diameter and fresh weight of individual flower and yield per plot. The diameter of flowers and fresh weight of individual flower showed a range of 4.60 to 5.87 cm and 4.43 to 5.58 g, respectively. Similar trend was also reported in chrysanthemum[1]. Maximum diameter (5.87 cm) and heaviest flower was recorded under D_4 (200 kg/ha potassium) treatment. A gradual increase in flower yield (kg/plot) was also recorded with higher levels of potassium. In pooled data, 24.45kg flowers/plot (5.76m^2) was obtained by treatment with 200 kg/ha potassium (D_4) while the untreated (D_0) plants in the same plot size produced only 13.70 kg flowers. The magnitude of flower yield increase (4.78 kg/plot) was largest from zero to 50 kg/ha potassium. This is in conformity with the findings of Penningsfeld [10].

Pigment of leaves and flowers

Total chlorophyll content in *T. erecta* Linn. cv. 'Siracole' leaf tissues at active vegetative growing stage showed a gradual increase with increasing levels of potassium application in both the years of the investigation (Figure 1a). The magnitude of chlorophyll increase was maximum, from 0 kg/ha (1.15 mg/g of leaf) to 50 kg/ha potassium (1.24 mg/g of leaf), in the pooled data. Potassium has also been reported to be involved in maximum increase in nutrient uptake by virtue of more photosynthesis resulting in more chlorophyll formation with an increased leaf area[3]. Like chlorophyll content of the leaf, anthocyanin content in petal tissues also increased with increasing levels of potassium application (Figure 1b). These results are in line with the findings of Hend[5] and Shalan *et al*[11].

Table 2—Effect of different sources and levels of potassium on flowering attributes and flower yield of African marigold, *Tagetes erecta* Linn. cv. 'Siracole'

Year	Days to flower bud emergence			Diameter of flower (cm)			Weight of individual flower (g)			Yield of flowers (kg/plot) (5.76m^2)		
Treatment	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2003-04	Pooled
Sources												
K_1	46.79	45.63		5.46	5.48		5.09	5.12		19.84	20.78	
K_2	46.99	46.04		5.47	5.48		5.13	5.13		19.96	2.86	
S. Em(±)	0.67	1.07		0.02	0.04		0.01	0.02		0.22	0.33	
C.D. at 5%	N. S.	N. S		N. S.	N. S.		N. S.	N. S.		N. S.	N. S.	
Levels of potassium												
D_0	43.25	40.33	41.79	4.60	4.62	4.60	4.43	4.42	4.43	13.64	13.76	13.70
D_1	45.96	43.92	44.94	5.49	5.38	5.44	4.91	4.87	4.89	17.96	19.00	18.48
D_2	47.16	45.55	46.35	5.62	5.70	5.66	5.22	5.28	5.25	21.25	22.52	21.88
D_3	48.27	48.92	48.59	5.74	5.78	5.76	5.43	5.46	5.45	22.72	23.86	23.29
D_4	49.80	50.45	5012	5.84	5.90	5.87	5.56	5.59	5.58	23.94	24.96	24.45
S. Em (±)	0.45	0.78	0.64	0.09	0.08	0.06	0.07	0.08	0.07	0.53	0.52	0.58
C.D. at 5%	1.35	2.34	1.92	0.27	0.25	0.18	0.22	0.23	0.21	1.59	1.56	1.67

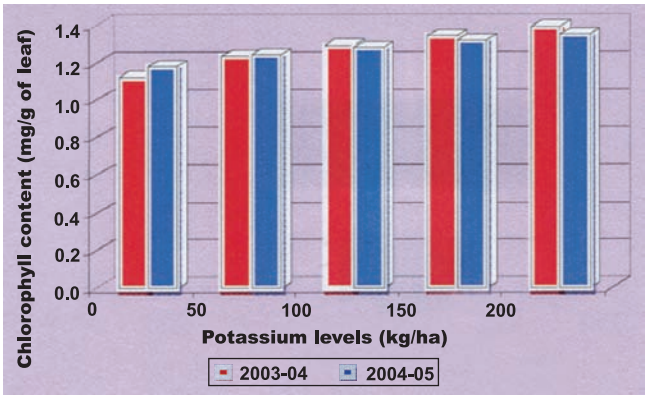

Fig. 1a

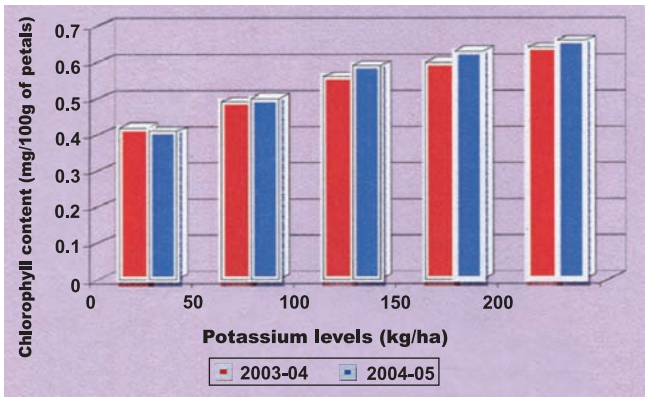

Fig. 1b

Fig. 1 (a & b)—Effect of different levels of potassium (kg/ha) on chlorophyll (mg/g) in leaves and anthocyanin (mg/100g) content in petals of African marigold, *Tagetes erecta* Linn. cv. 'Siracole'

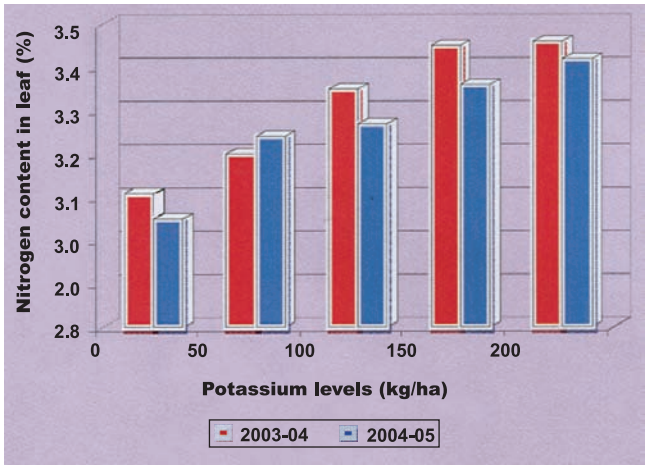

Fig. 2a

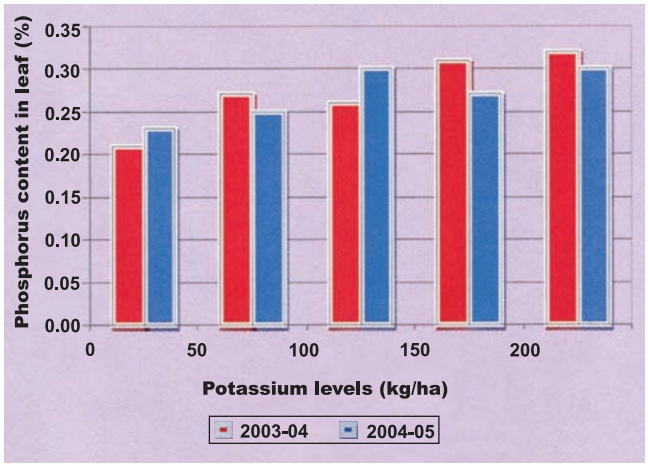

Fig. 2b

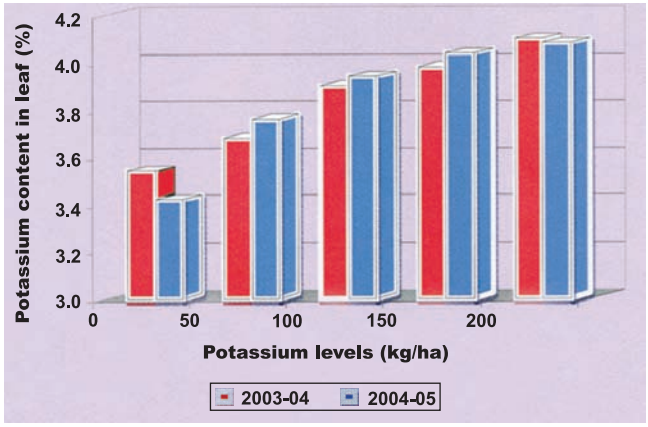

Fig. 2c

Fig. 2 (a, b & c)—Effect of different levels of potassium (kg/ha) on nitrogen (%), phosphorus (%) and potassium (%) content on African marigold, *Tagetes erecta* Linn. cv. 'Siracole' leaves

Nitrogen, Phosphorus and Potassium content in leaf tissues

Treatment with different levels of potassium showed gradual increase in nitrogen, phosphorus and potassium content of the leaf tissues of *T. erecta* Linn cv. 'Siracole' in both of the years of investigation (Fig. 2a,b,c), irrespective of the sources of potassium. The magnitude of nitrogen (%) content increase was maximum, from 0 kg/ha (3.08%) to 50 kg/ha potassium (3.22%), in the pooled data. The variation of phosphorus content was not so pronounced (0.22% to 0.31%). The magnitude of potassium content (%) increase was maximum, from 0 kg/ha to 50 kg/ha potassium (0.24%) closely followed by from 50 kg/ha to 100 kg/ha potassium (0.20%). Lunt & Kofranek[8] and Joiner & Smith[7] reported similar findings in chrysanthemum.

Conclusion

From this study it can be concluded that potassium application improves the flower yield and quality of *T. erecta* Linn. cv. 'Siracole'. The results also indicate that application of 100 kg/ha potassium would be more remunerative in respect to flower yield and quality, irrespective of sources.

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