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Influence of integrated nutrient management on sustainable production of *Tagetes erecta* (Marigold) – in semi-arid eastern plain of Rajasthan

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Abstract

Tagetes erecta (Marigold, African yellow) are commercially and medicinally important plants and are cultivated in varied agro-climatic condition of India. Investigations were carried out for three consecutive years to study the effect of FYM and Zn fertilization on the yield and yield attributes of Tagetes erecta. Application of either Zn or FYM was beneficial to the plant but their interactions were non-significant. The quality of flowers improved by the application of Zn and FYM. The dry seed yield was correlated significantly with uptake of Zn. The DTPA extractable Zn and Organic Carbon were significantly correlated with Zinc uptake in dry seeds.

Key Words- Integrated nutrient management, Zinc, FYM, *Tegetes erecta* dry seed yield, uptake of nutrients.

Introduction

Tagetes erecta (Marigold) belongs to family composite and are adaptable to wide variety of soil conditions. Tagetes are commercially and medicinally important aromatic flowering ornamentals with tremendous economic value. Incorporation of organic manures had significant increase in numbers of flower, fresh and dry weight of flowers (Atiyeh *et.al* 2002, Baily, *et. al* 1976). Although *Tagetes erecta* responds to fertilizer application but information on its requirement of macro and micronutrient fertilization is scanty and fragmentary. Increase in yield, nutrient concentration, uptake of nutrients, no. of flowers/plant, plant height, was reported by many scientists, (Achla Kumar , 1998), Chamani *et. al* 2008). Use of FYM in combination with inorganic fertilizer use improve soil mircobial biomass, crop productivity, and provide an increase in soil organic carbon. Addition of organic manures to the soil resulted in increased mineral contents and higher concentration of nutrients in shoot tissues. Only few

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investigations were carried out on ornamental flowering plants. The objective of this experiment was to obtain higher yields and higher returns to generate a wealth of understanding on its nutritional needs and minimum nutrient requirement (MNR). The information regarding the mineral nutrition to floral crops in semi-arid eastern plain zone of Rajasthan is unexplored.

Materials and Methods

The soils of experimental fields were light textured sandy loams belonging to Torripssamments with irrigated coarse textured (I-CT) micro-farming situations. The soils were Zinc (0.49 ppm DTPA extractable) which can be easily identified by reduced vigour, stunted growth, and small flowers. The addition of organic manures to sandy soils increase the moisture and availability of nutrients. Investigations were carried out for three consecutive years to evaluate the optimum rate of FYM and fertilizer Zinc and their integrated effect on *T. erecta*. The main treatments were comprised of three levels of each 0, 5, 10 kg Zn ha^{-1} as Zinc sulphate, 10, 20, 30 t ha^{-1} FYM. The treatments included a basal dose of 100 Kg N ha^{-1}, 60 Kg K_2O ha^{-1} , 60 Kg P_2O_5 ha^{-1}. The statistical design of the experiment was R.B.D. with nine treatments replicated four times well decomposed FYM was broadcasted and mixed in plough layer before transplanting the seedlings. Equal no. of plants was grown in all plots, row to row and plant to plant distance were maintained. All improved agro-techniques were followed throughout the season. Five pickings of fresh flowers were taken. Dry seed yield was recorded at the time of harvesting. Initial soil samples and samples after harvesting the crop were collected and analyses for their soil available Zinc and Organic carbon. Removal of nutrients by dry seeds of *Tagetes* were also analysed. Organic carbon was determined by the Walkley and Black method. DTPA (Diethenetriaminepenta acetic acid) Zinc was determined in soil samples by using (Perkin Elmer Atomic Absorption Spectroscopy) Lindsay and Norwell (1978).The nutrient concentrations in dried seeds which were rinsed with deionised water, dried at 55ºC in oven grinded in steel grinder and digested in diacid mixture HNO_3:$HClO_4$(4:1). Oil was extracted by Petroleum ether. Experimental data were analyses statistically by ANOVA and least significant difference (LSD) (P = 0.05) values were calculated for comparison of treatment means. Initial characteristics of the soil are shown in Table-1.

Table-1 Physico-chemical Initial properties of experimental site

Micro-farming situation	Irrigated coarse textured (I-CT)
pH	8.2
E.C. (dSm^{-1})	0.18
Organic Carbon (%)	0.28
Available Nitrogen ($Kgha^{-1}$)	183.0
Available Phosphorus ($Kgha^{-1}$)	24.0
Available Potash ($Kgha^{-1}$)	125.0
Available Zinc (ppm)	0.49

Results and Discussion

Tagets erecta shows a significant response to direct application of FYM and Zinc in all the three years on yield and yield attributing characters. The application @ 5 KgZn ha^{-1} significantly increased fresh flower yield (Table-2) further addition of zinc sulphate @ 10 KgZnha^{-1} did not make any substantial difference statistically and treatments were at par with the lower level of application. Ravindran et. al (1986).The percent increase in fresh flower yield due to application of Zn @ 5 Kgha^{-1} was 11.78%. Application of FYM @ 20 tha^{-1} significantly increased the fresh flower yield by 7.97% as compared to 10 tha^{-1} FYM application. Inclusion of organic manures i.e. FYM with inorganic fertilizers at variable rates increased organic carbon and available N, P, K, Zn content in the soil thereby improves the soil health (Suresh *et. al*, 1999, Channabasavanna *et.al*, 2001). A steady increase in fresh flower yield was observed upto the level of 30 t ha^{-1} FYM application but the application @ of 20 t ha^{-1} FYM was at par with 30 t FYM ha^{-1}. The interactive effects of FYM and Zn were significant for first year only. The dry seed yield shows a significant increase in yield (0.63 qha^{-1}) and (0.28 qha^{-1}) by the application of Zn and FYM @ 5 KgZnha^{-1} and 20 t ha^{-1} FYM respectively as compared to control (2.55 qha^{-1} and 2.81 qha^{-1}) (Table 3).

Table-2 Average effect of FYM and Zinc application on fresh flower yield q ha^{-1} of *Tagetes erecta*

Treatments	Flower Yield qha^{-1}			Pooled
Levels of FYM	First Year	Second Year	Third Year	
10 t ha^{-1}	64.63	59.35	70.50	64.83
20 t ha^{-1}	70.23	67.15	72.60	69.99
30 t ha^{-1}	70.12	66.88	73.73	70.24
LSD (P=0.05)	0.98	3.96	1.77	2.072
Levels of Zinc				
0 kg ha^{-1}	62.82	59.35	66.86	63.012
5 kg ha^{-1}	71.21	67.02	74.61	70.94
10 kg ha^{-1}	70.95	67.01	75.36	71.11
LSD 0.05	0.98	3.96	1.77	2.072
FYM × Zn	Significant	NS	NS	NS
LSD (P=0.05)	1.71			
B:C ratio				1:475

Application of Zn and FYM significantly influence the fodder yield and other yield attributes of the *Tagetes erecta.* Green fodder yield increased significantly 15.79 qha^{-1} and 2.46 qha^{-1} due to application of Zn @ 5 Kgha^{-1} and FYM @ of 20 t ha^{-1}respectively as compared to without application of Zn and FYM (160.60 q ha^{-1} and 158.39 q ha^{-1}) (Table 3).

Table-3 Yield attributes as influenced by application of FYM and Zinc in Torripssamments in semi arid eastern plain zone of Rajasthan

Treatments	Fodder Yield (q ha^{-1})	No. of flowers/ Plant	Height of Plant (cm)	Size of Flower (cm)	Wt. of 5 Dry Flowers (gm)
Levels of FYM t ha^{-1}					
10.00	158.39	125.87	87.07	8.48	99.69
20.00	179.21	128.33	87.63	9.16	101.37
30.00	176.82	128.87	87.95	9.94	102.50
LSD (P=0.05)	6.42	0.32	0.68	0.46	0.66
Levels of Zinc kg ha^{-1}					
0.00	160.60	125.83	86.99	8.33	98.60
5.00	176.39	126.71	87.84	9.40	101.79
10.00	177.44	130.54	87.83	9.85	103.02
LSD (P=0.05)	6.42	0.32	0.68	0.46	0.66
FYM × Zinc	N.S.	N.S.	N.S.	N.S.	N.S.

The application of Zn and FYM on Tagetes erecta significantly increased number of flowers per plant, height of plants, size of flowers and weight of 50 dry flowers. Incorporation of Zn @ of 10 $KgZnha^{-1}$ shows a significant increase (130.64) in number of flowers per plant as compared to no application of Zn (125.83) while addition of FYM although shows an increase upto the level of 20 t FYM ha^{-1} (128.33) but it was at par at higher level of FYM application Chamani *et. al* (2008) reported an significant increase in shoot fresh and dry weight, leaf numbers and flower numbers. Significant increase was noticed by incorporation of Zn @ 5 $Kgha^{-1}$ and FYM 30 t ha^{-1} on height of plants, size of flowers, and dry weight of flowers as compared to no Zn application. Results are in agreement with Gajalaxmi and Abbassi (2002). Increasing trend of flower numbers by addition of organic manures was observed by Gajalakshmi and Abbasi (2002) where use of organic manure leads to significant improvement as compared to untreated control. (Table-3).

Substitution of organic manures was associated with increased germination, growth, flowering yield of ornamentals as they independently supply nutrients Atiyeh et.al (2001) uptake of Zn by dry seeds of *Tagetes erecta* shows a linear increase upto 30 t FYM ha^{-1} and 10 $KgZnha^{-1}$. Zn applied and Zn stress condition are well defined. The uptake of Zn significantly correlated with seed yield (r=940)*. (Table-4) concentrations of Zn in dry seeds and plant shoots increased significantly with the application of organic manures Chamani et.al (2008).

Table-4 Dry seed yield protein, oil yield and uptake of Zn in T. Erecta as influenced by application of FYM and Zinc in Torripassamments in semi arid plain zone of Rajasthan

Treatments	Dry Seed Yield (Q ha^{-1})	Uptake of zinc (g ha^{-1})	Protein (%)	Oil Yield (kg ha^{-1})
Levels of FYM				
10 t ha^{-1}	2.81	24.13	8.91	30.111
20 t ha^{-1}	3.09	33.02	10.12	35.79
30 t ha^{-1}	3.18	33.78	10.24	37.87
LSD (P=0.05)	0.192*	1.59*	0.48*	2.89*
Levels of Zinc				
0 kg ha^{-1}	2.55	21.31	8.56	26.29
5 kg ha^{-1}	3.28	33.98	10.12	37.57
10 kg ha^{-1}	3.25	35.63	10.59	39.88
LSD (P=0.05)	0.192*	1.593*	0.35*	2.89*
Interaction				
FYM × Zn		Significant	NS	
LSD (P=0.05)		0.48*	NS	2.758*

Atiyeh *et. al* (2002) reported significant increase in N concentrations in the leaves of marigold plants grown in the base media of vermicompost which evidently resulted in greater root and shoot growth and higher uptake of Zn and other nutrients. The Zn concentrations in plant tissues tended to increase with increasing dose of FYM as compared to no application of Zn. The results were found highly significant and both the variables are dependent on each other.Addition of FYM and Zn increased the uptake of N which tended to increase the percent protein in dry seeds. The percent increase in protein due to 20 tFYM ha^{-1} and 5 KgZnha^{-1} was 13.58% and 18.22% respectively. FYM addition improves the soil physico-chemical properties which increase mineralization of nitrogen and hence improve quality of seeds, pigmentation, optimum growth and flower production. The results are in fair agreement with Ravindran *et.al* (1986), Carter *et. al* (1973), Aracnon *et.al* (2004).The essential oil present in different species of *Tagetes* has a strong sweet and lasting odour. It is a yellow-reddish liquid readily polymerises on standing and turned into solid gel. Oil of *Tagetes erecta* has multiple commercial uses, Sharma *et. al* (1961), Gupta *et. al* (1975), Basalas *et. al* (1988). The oil yield shows a substantial increase with levels of FYM and Zn when compared with Zinc stress condition, and was significantly correlated with dry seed yield (r=973*). The percent increase due to application of 20 and 30 t FYM ha^{-1} was 18.86% and 25.77% respectively while 5 and 10 Kg Znha^{-1} recorded a higher increase upto 32.80% and 51.64% respectively which proves a positive significant role of Zinc on oil content of *Tagetes erecta*.

Addition of Zn and FYM increased the DTPA extractable Zn and organic carbon in post-harvest soils. The combined application increased the yield and Zn availability (Mann *et.al*, 1978). The DTPA extractable Zn shows an increase with 5 Kg Zn ha^{-1}. The application of higher level of Zn i.e. 10 Kg ha^{-1} was found at par statistically, which indicates that additional Zn application, did not make any substantial difference. DTPA extractable Zn ranged from 0.66 mg Kg^{-1} in Zinc stress condition to 4.66 mg Kg^{-1} where 10 Kg Zn ha^{-1} was applied. DTPA extractable Zn was significantly correlated with Zn-uptake in plants (r=0.853*) (Table-5). Devrajan *et. al* (1987). Organic carbon also increased significantly with the

application of FYM @ 30 t ha^{-1} by 17.81% while percent increase due to addition of @ 10 $KgZnha^{-1}$ was 17.74%. The interactive effects of FYM and Zn in most of the parameters were found non-significant., but uptake of Zn, percent protein and dry seed yield were found significant.

Table 5. DTPA extractable Zinc and organic carbon after Hharvesting Tagetes Erecta as influenced by application of FYM and Zinc in Torripssamments in semi-arid eastern plain zone of Rajasthan

Treatments	DTPA Extractable Zinc	Organic Carbon
Levels of FYM (t ha^{-1})	(mg kg^{-1})	%
10.00	3.038	0.320
20.00	3.324	0.325
30.00	3.447	0.377*
LSD (P=0.05)	0.592	0.027
Levels of Zinc kg ha^{-1}		
0.00	0.667	0.310
5.00	4.482*	0.346*
10.00	4.660*	0.365*
LSD (P=0.05)	0.592	0.027
Interaction		
FYM × Zinc	N.S.	N.S.

A perusal of data in Table-6 shows the correlation of various parameters with FYM and Zn application.

Table-6 Various parameters for *Tagetes erecta* as influenced by FYM and Zn application in semi-arid eastern plain zone of Rajasthan

S.No.	Factors correlated	"r" values
1.	Zn uptake Vs. Dry seed yield	r = 0.940*
2.	Zn uptake Vs. DTPA extractable Zn	r= 0.853*
3.	Oil yield Vs. Dry seed yield	r = 0.973*
4.	% organic carbon Vs. Dry seed yield	r = 0.682*

Conclusion

Floriculture is an important sector of horticultural crops in India. The studied showed that *Tagetes erecta* is a plant of tremendous economic and medicinal value (fig. 1). Application of Zinc @ 5 $KgZnha^{-1}$ and FYM @ 20 t ha^{-1} shows significant increase in yield and other yield attributes and is beneficial for the plant but 10 kg Zn and 30 t ha-1 FYM application will be promised for nutrient enrichment in soil.

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