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Studies on Response of African Marigold (*Tagetes erecta*) to NPK, Humic Acid and Zinc Sulphate in Red and Lateritic Soils of Jhargarm District of West Bengal

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Authors' contributions

This work was carried out in collaboration among all authors. Author SD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author FHR managed the analyses of the study and edited the whole draft. Authors TS and KN managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was carried out at Kapgari village of Jhargram district of West Bengal, to study the effects of NPK, humic acid and zinc sulphate on the growth and yield of African marigold (*Tagetes erecta* L.), during the year 2018 and 2019. The experiment included three treatments with ten replications were designed in Randomized Block Design. First treatment (T1) was with the recommended doses of NPK (120: 120: 100 kg/ha). Second treatment (T2) was to apply fertigation of 75% of the recommended doses in three splits whereas the third treatment (T3) was to apply fertigation of 75% of the recommended doses in five splits along with foliar application (30 and 45 days after planting) of humic acid (0.2%) and Zinc Sulphate (0.2%). Results revealed that the plants treated with T3 found to have maximum plant height (67.6 cm), plant spread (45.2 cm^2) and number

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of branches per plant (27.2) as well as the number of flowers plant^{-1} (21.7), flower diameter (5.4 cm), individual flower weight (6.6 g) and yield of flower (230.6 q/ha) were also found highest by applying the same.

Keywords: Humic acid; zinc sulphate; marigold; red and lateritic soils; Jhargram.

1. INTRODUCTION

Tagetes sp. belonging to family *Asteraceae*, are most common in flower trade, which is used in different areas like pot plant, garland, cosmetic preparation, medicines as well as it is most widely used as ornamentals. Marigold (*Tagetes erecta* L.) gained popularity amongst flower growers and dealers on account of its easy culture, short duration to produce marketable flowers and wide adaptability. It can be grown commercially in different types of soil conditions. However, a deep, fertile, sandy loam and friable soil having good water holding capacity with proper drainage and near to neutral in reaction (pH 7.0-7.5) is most desirable for marigold cultivation [1]. Marigold can also be adopted and grown profitably in various weather conditions though mild climate during growing period (14.5-28.6°C) greatly improve flowering while higher temperatures (26.2-34.4°C) adversely affected flower production [2].

Jhargram is the district in West Bengal with least recorded flower cultivated area, whereas, a massive scope of flower cultivation can be observed in several areas of the district. Proper cultivation practices can give high yield of marigold production. Optimal fertilizer management impulse good flower production to attain a high ornamental value and to reduce production cost of plant [3]. Sufficient quantities of macro nutrients like nitrogen and phosphorus are required to attain better growth of marigold and promote flowering [4]. It was also observed that application of macro and micronutrients increase the flower quality and total flower production. Studies revealed beneficial effects of $FeSO_4$ and Zinc Sulphate on marigold with maximum growth, flowering, yield and quality parameters, like plant height, plant spread, number of branches, early flowering, number of flowers per plant, flower weight, flower yield, flower diameter and leaf chlorophyll content [5]. The same was found with application of humic acid in case of marigold production in pot [6].

In this context, it was necessary to establish improved recommended dose of fertilizer for commercial marigold production in red and lateritic zone of Jhargram district of West Bengal. Present investigation was undertaken to evaluate the response of marigold (*Tagetes erecta* L.)to NPK, Humic acid and Zinc sulphate and to find out their optimum and economic doses for maximizing yield of marigold in red and lateritic soil of Kapgari village of Jhargram district of West Bengal, India.

2. MATERIALS AND METHODS

The experiment was conducted in an open field of Seva Bharati Krishi Vigyan Kendra, at Kapgari village of Jhargram district of West Bengal, India (86°52'32.97" E latitude and 22°31'32.48" N longitude), during kharif seasons of 2018 and 2019. The area comes under red and lateritic agro climatic zone with the average rainfall of1200 mm (+ 236.14 mm SD) of which 80% received during June to September. Soil analysis data revealed that research plot was slightly acidic (pH 6.01) in nature with low EC value (0.23 dS m^{-1}). Organic carbon content as well as nutrient (N, P, K and zinc) availability was lower. Beside these high porosity and low cation exchange capacity makes the soil poor absorbers of added nutrients. So, proper nutrient management was in great concern for better productivity of African marigold.

The study was carried out with three treatments with ten replications. Marigold cuttings of 6 inches length were planted at 30 cm x 30 cm spacing in 1 m x 1 m plot in first week of July in both 2018 and 2019. The treatments of the experiment are mentioned here under.

2.1 Treatment 1

Recommended doses of NPK (120: 120: 100 kg/ ha).

2.2 Treatment 2

Fertigation of 75% of recommended doses of NPK (N:P:K: 90:90:75 kg/ha) were applied in three split doses (50% basal and 50% at 30 days and 45 days after planting in two equal amount).

Table 1. Effect of different treatments on growth and yield of African marigold at Jhargram district of West Bengal

	Plant height (cm)	Plant Spread (sq. cm)	No. of Branches/Plant	Flower initiation(days)	Duration of flowering(days)	Flower stalk length(cm)	No. of flowers/plant	Flower diameter(cm)	Flower weight (g)	Flower yield (q ha^{-1})
T1	51.7[c]	34.9[c]	23.0[c]	52.9[a]	37.0[c]	6.0[c]	16.0[c]	4.2[c]	5.4[c]	139.1[c]
T2	65.9[b]	42.2[b]	25.4[b]	47.1[b]	41.5[b]	7.1[b]	19.7[b]	4.5[b]	5.7[b]	179.9[b]
T3	67.6[a*]	45.2[a]	27.2[a]	46.0[c]	45.5[a]	8.0[a]	21.7[a]	5.4[a]	6.6[a]	230.6[a]

**Figures denoted by different alphabets are statistically different at 5% probability level by DMRT*

2.3 Treatment 3

Fertigation of 75% of recommended doses of N,P,K (N:P:K: 90:90:75 kg/ha) were applied in five split doses (50% basal and remaining 50% at 15, 30, 45 and 60 days after planting in equal amounts) along with foliar application of humic acid (0.2%) and Zinc Sulphate (0.2%) at 30 and 45 days after planting.

Intercultural operations like three weeding, irrigation etc. was same for all treatments. Plants were irrigated preferably once a day (and as and when required) because of the porosity and very poor water holding capacity of the soil. Harvesting started from mid-September and continued up to mid-October in both year of experiment.

The data on ten vegetative as well as flowering parameters, such as plant height, plant spread, number of branches per plant, flower initiation, duration of flowering, flower stalk length, number of flowers per plant, flower diameter, flower weight and flower yield were recorded from three randomly selected plants from each replications of each treatment in both year of experiment. IBM SPSS var. 22.0 was used for all data analysis.

3. RESULTS AND DISCUSSION

During both of the experimental year all of the treatments influenced the vegetative (Plant height, Plant Spread, No. of Branches/Plant), flowering (Flower initiation, Duration of flowering, No. of flowers/plant, Flower diameter, Flower weight) as well as yield (Flower yield) parameters significantly, as shown in the Table 1. Maximum plant height (67.6 cm) was observed applying T3 [7], the performance of plant growth parameters changed with humic acid and the NPK application rate and the plants had better growth under maximum concentration. Nutrient uptake, especially of nitrogen, phosphorous and sulfur is improved by the activity of humic acid [8]. These results may be due to the combined application of NPK, humic acid and micro nutrient, which helps to transport vital sugars through plant membranes and promotes proper cell division, cell wall formation and also acts as an enzyme activator in protein and hormones. Different levels of humic acid significantly increased stem length of marigold [9]. Maximum plant spread (45.2 sq. cm) and number of branches per plant (27.2) were also obtained with T3, might have resulted in better growth and converted vegetative growth in early stages due to balanced nutrition and also had sufficient food material to produce the flower earlier. Better availability of nutrients would have helped in protein synthesis resulting in production of taller plants with larger leaves and more number of branches [10] and pronounced effects of these parameters are due to application of nitrogen and phosphorus [11]. Nitrogenous fertilizer application significantly enhanced the plant growth parameters in African marigold [12]. Significant increase in plant height and spread in case of T3 resulted due to combined application of NPK, Humic acid and Zinc sulphate. The number of flowers/plant (21.7), flower diameter (5.4 cm) and individual flower weight (6.6 g) were also found the highest applying T3. This might be due to fact that, application of NPK together at proper time and growth stage of plant and also due to supplying sufficient quantity of these essential nutrients seems to be very helpful for improving photosynthesis, cell division, root growth and ultimately plant growth is stimulated which may contributed in increasing the weight of flowers [13]. On the other hand split doses of nutrient application might be enhanced nutrient use efficiency by increasing availability during the growth period. In case of T1 nutrients might have loosed due to low cation exchange capacity of the soil. Earliest flowering (46 days after planting) was found in the plants applying T3. The same results were found in dahlia by applying urea, DAP and farm yard manure in a combination [14]. Application of humic acid may lead to improved production of marigold bedding plants and earlier flowering [15]. Highest yield (230.6 q/ha) was found applying T3. Similar results were found with humic acid when applied at higher concentrations increases the flowering and yield of common bean, gerbera, and gladiolus [16, 17,18] and also in lettuce [19].

4. CONCLUSION

The main aim of this experiment was to find out the optimal doses of few fertilizers to increase the yield of marigold in the red and lateritic zones of Jhargarm. This investigation reached to a conclusion that Nitrogen, humic acid and Zinc Sulphate played an important role in growth and yield of African marigold. Though nitrogen, humic acid as well as Zinc Sulphate individually have significant effects on the vegetative and reproductive phases of marigold, but highly desirable results can be obtained by combined application of these elements. This study also concluded that balanced combination of these

elements have very good effect on the plant growth, yield and quality of flowers. Best results were obtained through fertigation of 75% of recommended doses of N, P and K (N:P:K-90:90:75 kg/ ha) in five split doses (50% basal and remaining 50% at 15, 30, 45 and 60 days after planting in equal amounts) along with foliar application of humic acid (0.2%) and Zinc Sulphate (0.2%) at 30 and 45 days after planting.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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