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Effect of different fertigation levels on flower yield, soil and leaf nutrient status of marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda

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Abstract
An experiment was conducted to find the optimum dosage of fertigation for marigold cv. Pusa Narangi Gainda. A field experiment was carried out at Floricultural Research Station, Rajendranagar, Hyderabad, during the year 2016 -17. The bio chemical status of soil before and after harvesting of crop was found non-significant due to fertigation treatments in marigold. At first flower bud appearance stage leaf NPK status differed significantly with levels of fertigation. The highest NPK content in leaf was recorded in 75 per cent of recommended dose of fertilizers (RDF) using water soluble fertilizers (WSF). Higher available nitrogen content (3.82%), phosphorus content (0.26 %) and potassium content (1.37 %) in leaf were recorded in 75 per cent of RDF using WSF. Further, the flower yield per hectare (14.42 t) was maximum with the same treatment in marigold cultivated under open conditions.

Keywords: marigold, water soluble fertilizer, leaf nutrient content and soil nutrient status

Introduction

African marigold (*Tagetes erecta* L.) is an important traditional exploited flower crop grown extensively in India belongs to the family Asteraceae. Marigold flowers are extensively used for making garlands, aesthetic, religious offerings, social functions and other purposes such as pigment and oil extraction and therapeutic uses.

Fertigation is a method of fertilization in which nutrients along with irrigation water are applied directly to the root zone of the plant in small but frequent quantities through the drippers (Bittalani, 1997 and Raina, 2000) [2, 14]. Drip fertigation has the potential to improve crop quality, yield thereby enhancing productivity. Fertigation allows nutrient placement directly into the plant root zone during critical periods in the required dose (Sigandhupe *et al*. 2003 and Jat *et al*. 2011) [8, 17], enhanced fertilizer use efficiency, fertilizer saving, reduced nutrient leaching, saving of time, labour and cost of application and uniformity in application. Through this method, fertilizer requirement can be reduced by 15 – 20 per cent without affecting the yield (Hongal and Nooli, 2007) [7].

In this context, the present investigation was conducted on marigold cv. Pusa Narangi Gainda to study the impact of levels of fertigation on leaf and soil nutrient status.

Material and Methods

The present investigation was conducted at Floricultural Research Station, Rajendranagar, Hyderabad, during the year, 2016 -17 to optimize the fertigation schedule for marigold grown under open conditions. Soil samples were collected at random from the 20 cm depth, before the layout of experiment and were analysed for their physical and chemical properties. Soil pH (1: 2.5 soil: water) was 7.38, EC (1:2.5 soil: water) = 0.33 dS m^{-1}, organic carbon=0.85 per cent, mineralizable N = 313.60 kg/ha, available P (Olsen's P) = 31.5 kg/ha and Ammonium acetate extractable K^+ in soil was 506.97 kg/ha.

The experiment was laid out in Randomized Block Design (RBD) comprising seven treatments with three replications and RDF of 90:90:75 kg NPK ha^{-1}. The treatments consists of T_1: 75% of RDF with Water soluble fertilizers (WSF), T_2: 100% of RDF with WSF, T_3: 125% of RDF with WSF, T_4: 75% of RDF as WSF + 25 % of RDF as straight fertilizers (SF), T_5: 50% of RDF as WSF + 50% of RDF as SF, T_6: 25% of RDF as WSF + 75% of RDF as SF and T_7: 100% of RDF as SF (control). At the time of last ploughing 20 tonnes of Farm yard manure and 422 kilo grams of Single super phosphate (75% RDF) applied as basal, along with this each 2 kilo grams of *Azospirillum*, 2.5 kilograms of *Pseudomonas fluorescens* and *Phospho bacteria* were mixed with 50 kg of FYM per hectare was applied uniformly for all treatments. Water soluble fertilizers and straight fertilizers were applied as per the treatmental combinations. The water soluble fertilizer grade used for the study were Poly feed (19:19:19), KNO_3 (13:0:45) and Urea (46% N) and straight fertilizers were Urea (46% N), SSP (16% P) and MOP (60%K). The stage of crop growth was divided in to transplanting to establishment (20 days), vegetative (45 days) and flowering stage (55 days). So based on the growth stage the percent requirement of fertilizer was calculated and applied through fertigation twice in a week. 10 per cent of RDF were applied at transplanting to establishment stage, 40 per cent of RDF were applied at vegetative stage and remaining 50 per cent of RDF were applied at flowering stage.

Available nitrogen in the soil was determined by alkaline potassium permanganate method as described by Subbaiah and Asija, 1956 [20]. Available phosphorus in the soil was developed following ascorbic acid method of Watanabe and Olsen, 1965 and the intensity of blue colour was determined using Spectrophoto meter at 640 nm and expressed in kg per ha. The available potassium in the soil was extracted by using neutral normal ammonium acetate and was determined by using Flame photo meter. The results were expressed in kg per ha.

For estimating leaf nitrogen, phosphorus and potassium contents in leaf, at the time of first flower pea bud stage, freshly matured leaves from all replications in each treatment were collected for analysis. The leaves were washed, oven dried at 65°C and then pounded using agate mortar and pestle. The petiole samples were digested with di acid and analyzed for P and K nutrients using standard procedures. Potassium was estimated by Vanado molybdate yellow colour method using Spectrophotometer and potassium by using flame photometer. Total nitrogen content in leaves was determined by the Kjeldahl distillation method and digesting with sulphuric acid (Tandon, 1993) [22].

Based on total net plot yield, yield per hectare was calculated and was expressed in tonnes. The data was subjected to “Analysis of variance” as recommended by Panse and Sukhatme (1978) [10] and significance was tested by ‘F’ value at 5 per cent level of probability and wherever the results were significant the critical differences were worked out at 5 per cent level of probability.

Results and Discussion

Effect of different fertigation treatments on soil physico chemical properties

Soil pH

The results in table 1 indicated that the pH of soil did not differ significantly due to fertigation and its combination treatments. This might be due to buffering capacity of soil because of which takes long time to bring in significant changes in pH. Since the duration of the crop is 3 months after transplanting no statistically difference could be observed on soil reaction with different levels of fertigation. Similar results were reported in carnation by Arvinder (2011) [1]. On contrary to the present finding, Jhuma das *et al*. (2012) [9] in anthurium reported significant difference in soil reaction with different levels of fertigation.

Soil EC (dS m^{-1})

The data pertaining to the effect of fertigation treatments on soil EC is given in table 1.

The results revealed (table 1) that there was no significant difference on electrical conductivity of soil among the treatments. This might be because the applied nutrients have not affected the salt levels in soil significantly. Similar results were found with Arvinder Singh (2011) [1] in carnation who reported earlier non-significant effect on soil EC under different levels of fertigation.

Nitrogen (mg kg^{-1} of soil)

The results on nitrogen content of soil as a response to different fertigation treatments were recorded and furnished in table 1.

Statistically there was no significant influence of treatments on the available soil N status (table 1). This might be attributed due to the mobile nature of nitrogen in soil and its uptake by plants as well as the various losses effecting nitrogen because of which there is less buildup of residual nitrogen. Similar findings were reported by Vijaya *et al* in grape (2017) [24], Hanuman Naik *et al.* (2016) [6] in banana and Singh *et al.* (2014) [18] also reported non-significant effect on soil nitrogen content with different levels of fertigation.

Phosphorus (mg kg^{-1} of soil)

The results showed that statistically there was no significant impact of treatments on the available soil P status. This might be due to its uptake by plants, as well as the fixation of P. Since 75 per cent of recommended dose of P in all the treatments was applied as basal dose, the P remaining after its uptake by plants might have been fixed. Similar reports were quoted earlier by Prabhu *et al*. (2016) [12] in chilli who recorded non-significant differences in available soil P status with different levels of fertigation. In contrary, Jhuma das *et al*. (2012) [9] in anthurium and Shiva kumar (2010) [15] in maize reported significant difference in available soil P status with different levels of fertigation.

Potassium (mg kg^{-1} of soil)

The results showed that statistically there was no significant difference on soil potassium content among the treatments. This might be due to less buildup of residual K after its uptake by the crop. Similar results were earlier reported by Hanuman Naik *et al.* (2016) [6] in banana who reported non-significant effect on soil K content with different levels of fertigation. In contrary, Jhuma das *et al*. (2012) [9] in anthurium reported significant difference in available soil K status with different levels of fertigation.

Effect of different fertigation treatments on leaf chemical composition of marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gainda.

Nitrogen (%)

The results pertaining to the nitrogen content of leaf are worked out and are furnished in table 2 and illustrated in fig.1.

The results indicated that statistically there was significant difference on nitrogen content of leaf with levels of fertigation. Higher N content in leaf (3.82 %) was found in plants fertigated with T_1 (75% of RDF using WSF) which was found on par with 25 per cent of RDF as WSF + 75 per cent of RDF as SF (3.73%) and (T_7) 100 per cent straight fertilizers (3.70%). This attributes might be due to balanced supply of readily available nutrient application to the soil in

T_1 that resulted in rapid absorption of nutrients and their translocation within the plant. Nitrogen is highly mobile element in the plant tissues, its efficient translocation under abundant moisture and nutrient supply from root to leaves could have added to its enhanced accumulation in the leaves (Smith, 1962) [19]. Similar results were earlier found with Qasim *et al*. (2008) [13] in rose, Arvinder (2011) [1] in carnation, Polara *et al*. (2014) [11] in marigold, Dilip singh and Chandel (2015) [3] in strawberry and Prabhu *et al*. (2016) [12] in chilli, who reported significant differences in leaf N content with different levels of fertigation.

Phosphorus (%)

The results revealed that there was a significant difference on phosphorus content of leaf with different levels of fertigation (table 2 & fig. 2). Higher P content of leaf (0.26 %) was found in the plants fertigated with T_1 (75% of RDF using WSF) which was on par with (T_6) 25 per cent of RDF as WSF + 75 per cent of RDF as SF (0.24%). This can be attributed to balanced continuous supply of readily available nutrient application in the soil which might have resulted in higher uptake of P whereas the decrease of leaf P content in T_2, T_3, T_4 and T_5 could be due to imbalanced fertilizer application which reduces the fertilizer use efficiency hence resulted in lower the nutrient uptake. Similar results were earlier reported by Qasim *et al*. (2008) [13] in rose, Shiva kumar (2010) [15] in maize and Dilip singh and Chandel (2015) [3] in strawberry who reported earlier significant difference in leaf P content with different levels of fertigation.

Potassium (%)

There was significant difference among the various treatments with respect to potassium content of leaf. The results are furnished in table 2 and depicted fig. 3.

Significant difference was recorded among treatments on potassium content of leaf due to different fertigation treatments. Higher K content of leaf (1.37 %) was found in the plants fertigated with T_1 (75% of RDF using WSF) which was statistically on par with (T_6) 25 per cent of RDF as WSF + 75 per cent of RDF as SF (1.33%) and minimum K content of leaf (1.02%) was observed in (T_5) 50 per cent of RDF as WSF + 50 per cent of RDF as SF. This may be attributes to the fact that the treatments which recorded higher nitrogen and phosphorus improve the K nutrition by synergistic effect and enhance the uptake of K by the plants (Polara *et al*., 2014) [11]. The findings of the present experiment are in accordance with the results obtained by Qasim *et al*. (2008) [13] in rose, Arvinder (2011) [1] in carnation and Dilip singh and Chandel (2015) [3] in strawberry.

Flower yield (t ha^{-1})

Similarly the fertigation at various concentrations has significant influence on flower yield per hectare of marigold. The maximum flower yield per hectare (14.42 t) was obtained with 75 per cent of RDF with WSF. Increase in yield may be due to the continuous supply of optimum dose of water soluble fertilizers in available form through fertigation at critical stages of plant growth. This might have resulted in higher uptake and better translocation of assimilates from source to sink which in turn increased the yield. The results obtained are in accordance with the findings of Gopinath and Chandra Shekar (2009) [5] in carnation, Thamara *et al*. (2010) [23] in china aster, Ganesh *et al*. (2014) in chrysanthemum, Shrikant *et al*. (2014) [16] and Suresh (2015) [21] in gerbera.

From the above results, it can be concluded that the application of fertilizers at 75 per cent of recommended dose in water soluble form through drip irrigation as well as 25 per cent of RDF with WSF along with 75 per cent of RDF with straight fertilizers was found to be most optimal dose for increasing nutrient content in marigold cv. Pusa Narangi Gainda during rabi season and may be recommended for marigold cultivation.

Table 1: Effect of levels of fertigation on soil characteristics

Treatments	EC (ds/m)	pH	N (kg/ha)	P (kg/ha)	K (kg/ha)
T_1	0.61	7.34	152.81	34.90	615.14
T_2	0.71	7.38	140.47	25.81	583.27
T_3	0.73	7.48	144.22	31.05	562.27
T_4	0.71	7.49	144.68	33.90	580.14
T_5	0.71	7.50	144.92	26.19	562.05
T_6	0.63	7.39	150.53	31.31	583.14
T_7	0.64	7.23	146.70	26.33	567.75
S.Em ±	0.06	0.11	6.17	3.97	19.73
CD(P= 0.05)	N.S.	N.S.	N.S.	N.S.	N.S.

Table 2: Effect of levels of fertigation on flower yield and leaf nutrient content of marigold cv. Pusa Narangi Gainda

Treatments	N (%)	P (%)	K (%)	Flower yield (t ha^{-1})
T_1 **:** 75% of RDF using WSF	3.82	0.26	1.37	14.42
T_2 : 100% of RDF using WSF	3.34	0.19	1.10	12.80
T_3 : 125% of RDF using WSF	3.43	0.19	1.04	11.96
T_4 : 75% of RDF as WSF + 25 % of RDF as SF	3.46	0.20	1.16	12.73
T_5 : 50% of RDF as WSF + 50% of RDF as SF	3.35	0.18	1.02	12.77
T_6 : 25% of RDF as WSF + 75% of RDF as SF	3.73	0.24	1.33	14.28
T_7 : 100% straight fertilizers (Control)	3.70	0.24	1.31	14.23
S.Em ±	0.08	0.01	0.05	0.07
CD (P= 0.05)	0.26	0.02	0.15	0.20

T_1: 75% of RDF with WSF T_5: 50% of RDF as WSF + 50% of RDF as SF T_2: 100% of RDF with WSF
T_6: 25% of RDF as WSF + 75% of RDF as SF T_3: 125% of RDF with WSF T_7: 100% of RDF as SF (control)
T_4: 75% of RDF as WSF + 25 % of RDF as SF

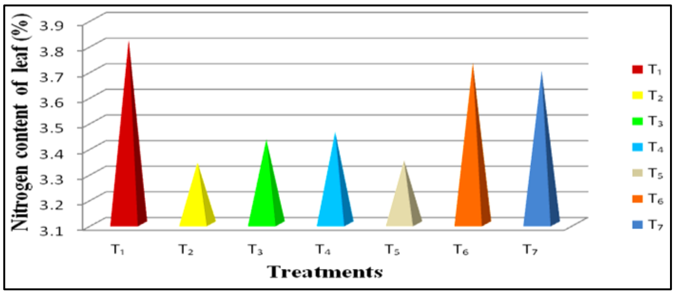

Fig 1: Effect of different levels of fertigation on nitrogen content of leaf (%)

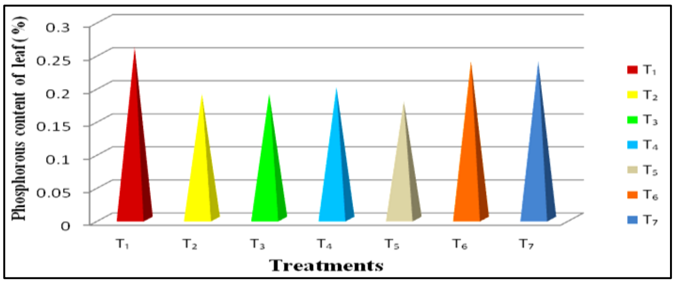

Fig 2: Effect of different levels of fertigation on phosphorus content of leaf (%)

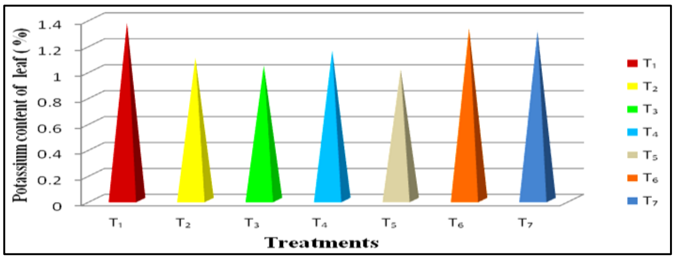

Fig 3: Effect of different levels fertigation on potassium content of leaf (%)

***T_1* -** 75% of RDF using WSF, **T_2 -** 100% of RDF using WSF, **T_3 -** 125% of RDF using WSF, **T_4 -** 75% of RDF as WSF + 25 % of RDF as SF, **T_5 -** 50% of RDF as WSF + 50% of RDF as SF, **T_6 -** 25% of RDF as WSF + 75% of RDF as SF, **T_7 -** 100% of RDF as SF (control).

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