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Effect of Levels of Fertigation on Growth and Flowering of Marigold (*Tagetes erecta* L.) CV. Pusa Narangi Gainda

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A B S T R A C T

An experiment was conducted to study the effect of levels of fertigation on vegetative and flowering characters of marigold cv. Pusa Narangi Gainda under open conditions. The experiment was laid out with seven treatments at Floricultural Research Station, Rajendranagar, Hyderabad during 2016-2017. The results indicated significant difference among the treatments with respect to plant height at flower harvesting stage, number of primary branches, days to first flower bud initiation, full bloom, number of flowers per plant, flower yield per plot and flower yield per hectare. Application of 75% of recommended dose of fertilizers (RDF) in water soluble form (WSF) promoted maximum plant height and number of primary branches per plant. Further, application of 75% of RDF in WSF also resulted in early flower bud initiation, maximum number of flowers per plant, flower yield per plot and flower yield per hectare and recorded a benefit cost ratio of 2.10.

Introduction

African marigold (*Tagetes erecta* L.) is one of the traditional flower crops grown extensively in India. Marigold belonging to 'Asteraceae' family has tremendous demand in flower markets. It has gained popularity among the flower growers and gardeners on account of its easy cultivation, long flowering duration and wide adaptability.

Fertigation which combines irrigation with fertilizer application is well recognized as the most effective and convenient means of maintaining optimum fertility level and water supply according to the specific requirements of each crop and soil, resulting in good vegetative growth and flowering. Fertigation has flexibility, cost effectiveness and the potential for improved seasonal fertilizer application efficiency over traditional fertilizer application methods (Jaynes *et al.*, 1992). The fertilizers applied through this system reach the active root zone, thus helping easy absorption and its efficient utilization, besides, it also helps in economizing the use of water and fertilizers and reducing the cost of cultivation by reducing the cost of water, fertilizers, labour and energy (Khan *et al.*, 1997). Inadequate plant nutrition causes serious disorders in marigold cultivation and may eventually lead to decline of plant vigour and ultimately reduction of yield.

Marigold has gained great economic importance due to its high market value and a better understanding of the effects of fertigation frequency on growth, flower production and quality can help to propose optimal fertigation scheduling in marigold.

Materials and Methods

The experiment was conducted during the year, 2016 -17 to study the effect of levels of fertigation on vegetative and flowering characters of marigold grown under open conditions at Floricultural Research Station, Rajendranagar, Hyderabad.

The soil of experiment site was red sandy loam soil with a pH of 7.38 and EC is 0.33. The experiment was laid out in Randomized Block Design (RBD) comprising seven treatments with three replications. 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, T_7: 100% of RDF as SF (control).

The land was brought to a fine tilth by repeated ploughing and harrowing. All the weeds and stubbles of previous crop were completely removed and at the time of last ploughing 20 tonnes of Farm yard manure and 422 kilo grams of Single super phosphate (75% RDF) were 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 were applied uniformly for all the treatments.

The drip irrigation system and venturi injector fertigation unit were installed as per the experimental layout and treatmental plan. The inline drippers were placed in 16 mm lateral pipes at an interval of 30 cm spacing with 4 litres per hour discharge capacity. The entire experimental land was divided and raised beds were prepared measuring 18 m × 0.9 m (16.2 m^2) at a height of 15 cm and spaced at 30 cm between the beds. Twenty five days old healthy and uniform seedlings of cv. Pusa Narangi Gainda were transplanted in the main field in double row system of planting at four leaf stage with a spacing of 60 cm between the rows and 30 cm between the plants was adapted to accommodate about 120 plants per bed (16.2 m^2) during evening hours. Light irrigation was given after transplanting for better establishment of seedlings in the main field. Water soluble fertilizers and straight fertilizers were applied as per the treatmental combinations. Fertigation was given twice a week as per the plant growth stage. Gap filling was done ten days after transplanting to maintain 100 per cent plant population in all the plots. Observations were recorded on growth, flowering and yield under different treatments. The data collected were subjected to statistical analysis as per Panse and Sukhatme (1978).

Results and Discussion

The data pertaining to the vegetative growth, flowering characters and economics of marigold cv. Pusa Narangi Gainda are presented in Tables 1, 2 and 3 respectively. The fertigation levels resulted in significant differences among the treatments with respect to height of plant at final flower harvesting stage (Table 1). Levels of fertigation had no significant effect on plant height at the time of first flower bud appearance. It is obvious that the levels of fertigation did not exert their influence on plant height during the initial stages of plant growth and development in marigold. Similar observations were earlier reported by Hemanta *et al.*, (2012) in carnation.

However, at the final flower harvesting stage, there was a significant increase in the plant height with the application of different levels of fertigation treatments. Among them, application of 75 % of recommended dose of fertilizers (RDF) in water soluble form (T_1) resulted in maximum plant height (81.57cm) and the possible reason for the increase in the plant height can be attributed to the application of optimum dose of water soluble fertilizers (WSF) at critical stages of plant growth at frequent intervals. This might have increased the production of IAA which consequently showed stimulatory action, in terms of cell elongation and thus resulting in increased plant height. The results obtained are in accordance with the findings of Ganesh *et al.,* (2014) in chrysanthemum and Palanisamy *et al.,* (2015) in gerbera who reported significant difference in plant height under different levels of fertigation.

The application of different levels of fertigation in water soluble and straight fertilizers resulted in non-significant differences in plant spread and stem girth during initial stages of plant growth (in both directions E-W and N-S). This might be due to the reason that the various levels of fertigation had no significant influence on growth and development at early stages of plant growth. Similarly Henny (1999) who observed non-significant difference at initial stages in anthurium plants under different fertigation levels.

The number of primary branches plant^{-1} in marigold was significantly influenced by levels of fertigation. Application of 75 % of RDF as WSF had recorded the maximum number of primary branches plant^{-1} (6.18) in marigold. This increase in the number of primary branches plant^{-1} may be due to easier and quicker availability of nitrogen in water soluble fertilizers at critical stages of plant growth might be due to the increased nitrogen uptake at optimum fertigation levels (75% of RDF as WSF).

Secondly, the nitrogen supplied to the roots might have resulted in stimulation of the production and export of cytokinin to the shoots. The increased levels of cytokinin in plants due to nitrogen application at optimum dosage at effective root zone resulted in well distribution to above ground parts and promoted the lateral buds to sprout producing more number of lateral branches.

Table.1 Effect of levels of fertigation on vegetative growth characters of marigold cv. Pusa Narangi Gainda

Treatments	Plant height (cm)		Plant spread (cm)		Stem girth (mm)	No. of primary branches plant^{-1}
	At first flower bud initiation	At final flower harvesting	(E-W)	(N – S)		
T_1	64.00	81.57	41.00	39.13	11.52	6.18
T_2	58.87	78.55	36.27	34.10	9.97	4.40
T_3	61.87	76.20	36.82	34.80	10.62	4.53
T_4	65.73	78.44	37.13	36.36	10.32	4.40
T_5	60.47	75.23	39.90	37.10	10.65	4.53
T_6	61.52	79.23	38.10	37.24	11.21	6.13
T_7	63.13	78.55	37.43	38.33	10.60	5.77
S.Em ±	1.60	0.82	1.57	1.15	0.46	0.22
CD (P= 0.05)	N.S.	2.57	N.S.	N.S.	N.S.	0.67

T_1: 75% of RDF with 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 SF; E-W: East – West, N- S: North.
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)

Table.2 Effect of levels of fertigation on flowering characters of marigold cv. Pusa Narangi Gainda

Treatments	First flower bud initiation (days)	Days taken for full bloom	No. of flowers plant^{-1}	Flower yield (kg plot^{-1})	Flower yield (t ha^{-1})
T_1	29.12	41.07	23.50	23.37	14.42
T_2	31.60	42.37	17.18	20.74	12.80
T_3	32.26	43.27	16.48	19.37	11.96
T_4	31.35	42.27	18.27	20.63	12.73
T_5	32.20	42.33	16.98	20.69	12.77
T_6	30.90	41.77	20.67	22.84	14.28
T_7	31.33	41.80	20.24	22.82	14.23
S.Em ±	0.57	0.34	1.02	0.25	0.07
CD (P= 0.05)	1.78	1.04	3.18	0.78	0.20

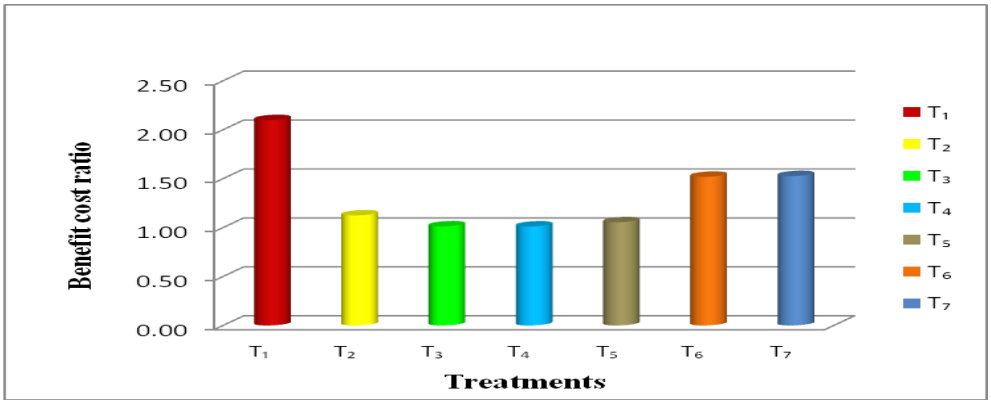
T_1: 75% of RDF with WSF
T_2: 100% of RDF with WSF
T_3: 125% of RDF with WSF
T_4: 75% of RDF as WSF + 25 % of RDF as SF
T_5: 50% of RDF as WSF + 50% of RDF as SF
T_6: 25% of RDF as WSF + 75% of RDF as SF
T_7: 100% of RDF as SF (control)

Table.3 Effect of levels of fertigation on benefit cost ratio of marigold Cv. Pusa Narangi Gainda

Treatments	Fertlizer cost (Rs ha^{-1})	Total cost (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	BCR
T_1 **:** 75% of RDF using WSF	27,514	1,25,552	2,63,502	1,37,950	2.10
T_2: 100% of RDF using WSF	36,523	1,30,841	1,47,139	1,629,7	1.12
T_3: 125% of RDF using WSF	45,713	1,39,991	1,41,738	1,746	1.01
T_4: 75% of RDF as WSF + 25 % of RDF as SF	29,348	1,32,426	1,33,888	1,462	1.01
T_5 : 50% of RDF as WSF + 50% of RDF as SF	21,994	1,25,232	1,32,106	6,874	1.05
T_6 : 25% of RDF as WSF + 75% of RDF as SF	14,350	1,23,248	1,87,247	63,999	1.52
T_7 : 100% straight fertilizers (Control)	6,761	1,15,583	1,76,477	60,894	1.53

RDF- Recommended Dose of Fertilizers, SF- Straight Fertilizers, WSF- Water soluble fertilizers

Fig.1 Effect of different levels of fertigation on benefit cost ratio of marigold cultivation



T_1: 75% of RDF with 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 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)

These findings are in conformity with the earlier reports of Hemanta *et al.,* (2012) and Gopinath and Chandra Shekar (2009) in carnation, Palanisamy *et al.,* (2015) in gerbera.

Early flower bud initiation in marigold checks the prolonged vegetative growth of the plant and this diverts the available photosynthates to the flower bud differentiation resulting in the early and higher flower yields for longer duration. Significant differences were observed in number of days to first flower bud initiation due to various fertigation levels in marigold. Among the different fertigation levels tested, application of 75% of RDF with WSF has significantly reduced the number of days taken to first flower bud initiation and the minimum number of days were taken (29.12 days) from the date of transplanting (DAT) and this might be attributed to reduced dose of N which in turn have resulted in earliness of all the flowering characters. Higher the level of fertigation, better the vegetative growth and hence delay in flowering. The results are in conformity with the earlier findings of Ganesh *et al.,* (2014) and Hemanta *et al.,* (2012) in carnation.

The days taken for full bloom after transplanting were minimum with the application of 75% of RDF with WSF in marigold (41.07 days). The application of higher doses of fertilizers in water soluble form (125% RDF in WSF) resulted in more vegetative growth rather than flowering, thus resulting in delay in flower blooming in marigold. Similar results were earlier reported by Hemanta *et al.,* (2012) in carnation, Ganesh *et al.,* (2014) in chrysanthemum.

Increase in the number of flowers plant^{-1} is desirable as it enhances the ultimate yield and net returns of the crop. The results indicated that application of 75 % of RDF using WSF (T_1) recorded maximum number of flowers plant^{-1} (23.50 flowers) and this may be due to higher uptake of phosphorous and potassium at level which might have increased growth and metabolic transport that lead to proper vegetative growth and ultimately increased flower yield and excess application of fertilizers more than recommended has given negative response. These results are in conformity with the earlier findings of Thamara *et al.,* (2010) in China aster.

Marigold flower yield per plot was significantly influenced by levels of fertigation. Maximum flower yield per plot (23.37 kg) was recorded with 75% of RDF with WSF (T_1) and application of nutrients at higher levels decreased the flower yields in marigold hence the flower yields are minimum with the application of 125% of RDF using WSF (19.37 kg) and increased yield might be due to the fact that continuous supply of optimum dose of water soluble fertilizers through fertigation at critical stages of plant growth. The results obtained are in accordance with the findings of Vijay Kumar *et al.,* (2010) and Thamara *et al.,* (2010) in China aster.

The different levels of fertigation had significant influence on flower yield per ha of marigold. The results revealed that application of 75 % of RDF as WSF has resulted in maximum flower yield hectare^{-1} (14.42 t) and this increase in the yield might be attributed to the supply of optimal doses of nutrients in available form.

This might have resulted in higher uptake and better translocation of assimilates from source to sink which in turn increased the yield (Gopinath and Chandrashekar, 2009). The result obtained in the current experiment are in close agreement with the results reported by Ganesh *et al.,* (2014) in chrysanthemum, Gopinath and Chandra Shekar (2009) in carnation. Benefit cost ratio decides the economic feasibility of the treatment. Fertigation at various concentrations have

significant influence on net returns and benefit cost ratio of marigold. Among all the fertigation treatments, maximum net returns and benefit cost ratio (Rs. 1,37,950 and 2.10 respectively) were recorded with the application of 75 % of RDF using WSF compared to all other fertigation treatments. Similar results were also reported by Varsha *et al.*, (2015) in jasmine (Fig. 1).

Thus application of fertilizers at 75% of recommended dose of fertilizers was found to be most optimal dose for increasing yield in marigold cv. Pusa Naragi gainda during rabi season and may be recommended for marigold cultivation.

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