Effect of Drip irrigation and Fertigation levels on yield attributes and yield of African Marigold (*Tagetes erecta* L.) during *rabi*

Abstract

A field experiment was conducted at College farm, College of Agriculture, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Hyderabad, Telangana during *rabi* season 2022 to study the effect of drip irrigation and fertigation levels on yield attributes and yield of marigold. The results revealed that the drip irrigation scheduled at 1.2 Epan recorded significantly higher number of flowers per plant (55.3), flower diameter (5.8 cm), flower fresh weight per plant (557.2 g), flower dry weight per plant (101.9 g) and flower yield (12.11 t ha^{-1}) than 1.0 Epan and 0.8 Epan. Whereas among the fertigation levels, 125% recommended dose of NK recorded significantly higher number of flowers per plant (53.7), flower diameter (5.6 cm), flower fresh weight per plant (538.4 g), flower dry weight per plant (92.8 g) and flower yield (11.48 t ha^{-1}) than 100%RDF and 125%RDF.

Key words: *Fertigation, Irrigation, Marigold, Yield attributes, Yield.*

1. INTRODUCTION

Marigold (*Tagetes erecta* L.*)* belongs to Asteraceae family, native to Central and South America (Mexico). It is a traditional flower crop gaining popularity throughout India because of its hardiness, wide adaptability, high monetary value and suitable to varying climatic and soil conditions. The crop occupies an area of 84.09 lakh $ha^{-1}$and production of 916.24 million tonnes ha^{-1} in India where as an area of 0.76 lakh ha^{-1} and production of 8.68 million tonnes ha^{-1} in Telangana state Indiastat.

Marigold has positive characteristic of high vase life and is used for making garlands and spiritual rituals. It also has many health benefits like skin healing, antiseptic and anti-inflammatory properties. Industrially it is used for its oil and the petals are used for extraction of xanthophyll pigment, an additive in poultry feed, formulation for house fly and cockroach repellents *etc.* and in cropping systems it is used as a popular catch crop. In Indian tradition it plays an important role in weddings and festivals because they represent the sun, symbolizing brightness and positive energy. Both yellow and orange marigolds are widely used in decorations.

“The current problem with large scale cultivation of marigold is that unreasonable water and fertilizer management system (high fertilizer application and inefficient irrigation) not only caused unnecessary waste of water and fertilizer resources, but also led to shallow groundwater nitrate pollution and other environmental problems” (Zhang *et al*., 2010).

Micro-irrigation techniques (like drip irrigation) can reduce water use by 27% to 42%. By lowering losses due to drainage and evaporation it contributes to increasing WUE (Gorantiwar *et al.,* 1991). “Fertigation is a method of fertilization in which nutrients along with water are applied directly to the root zone of the plant in small but required quantities through the drippers. 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 required dose” (Singandhupe *et al*., 2003). “Through method of drip fertigation, fertilizer requirement can be reduced by 15-25 per cent without affecting the yield” (Hongal and Nooli, 2007). The main advantages of fertigation are to reduce fluctuations of nutrient availability in the root zone, enhanced nutrient use efficiency, reduced nutrient leaching-loss, saving of time, labour and cost of application.

2. MATERIALS AND METHODS

The present field investigation was carried out during *rabi*, 2022 to study the performance of Marigold to different drip irrigation and fertigation levels during *rabi* season. The present experiment was carried out at College farm, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana.

The experiment soil was sandy loam with pH 7.1 and EC with 0.25 (ds m^{-1}). The irrigation water utilized have a pH of 7.51, EC 2.58 (ds m^{-1}), RSC -3.6 and SAR value of 2.77. The experiment was laid out in split plot design comprising of nine treatments with three replications. The main plot comprises of three irrigation levels and sub plot comprises of three fertigation levels. The treatment details of main plot: I_1- 0.8 Epan, I_2-1.0 Epan, I_3- 1.2 Epan and sub plot: F_1- 75% RDNK F_2-100% RDNK, F_3-125% RDNK. The required evaporation data was collected from the nearby Agro meteorological station and the Epan was calculated by multiplying the evaporation with irrigation levels. The drip irrigation system and venturi injector fertigation unit were installed as per the experimental layout and treatment plan. Twenty five days old healthy and uniform seedlings were transplanted in the main field in paired row system with a spacing of 50/40 cm between the rows and 40 cm within the row. Irrigation was given on alternate days as per the treatments and fertigation was given at four days interval as per the plant growth stage. Observations were recorded on flowering and yield parameters in different treatments. The statistical analysis was carried out by using "Analysis of variance techniques". The significance was tested by 'F' value at 5 % level of significance. The value of critical difference (C.D.) for examining treatment means for their significance was done at 5 % level (Gomez and Gomez, 1984).

3. RESULTS AND DISCUSSION

3.1 Number of flowers plant^{-1}

Number of flowers plant^{-1} was significantly influenced by both drip irrigation and fertigation levels. Interaction was found to be non-significant (Table 1)

Drip irrigation scheduled at 1.2 Epan recorded significantly higher number of flowers plant^{-1} (55.3) than 1.0 Epan (49.3) and 0.8 Epan (48.6) and number of flowers plant^{-1} were comparable between 1.0 Epan and 0.8 Epan. These results were in conformity with the observations of Raj *et al.* (2021). Increased drip irrigation levels result in more flowers because the root zone's surrounding soil is kept at the ideal moisture level throughout the crop growth period, which promotes the crop's vegetative growth and increases photosynthesis and the efficient translocation of photosynthates towards the development of reproductive organs. The number of flowers per plant significantly increased as a result of this action.

Among the fertigation levels, number of flowers plant^{-1} was significantly higher at 125% recommended dose of NK (53.7) than 75% (47.9) and on par with 100% (51.6). These results were similar with the observations of Snehitha *et al.* (2019) and Reza *et al.* (2011). Since drip fertigation results in higher nutrient uptake by plants, higher doses of fertigation levels may enhance the total solubility, mobilisation, and availability of nutrients at regular short intervals in the appropriate quantity, which may increase the number of flowers per plant.

3.2 Flower diameter (cm)

Drip irrigation and fertigation levels significantly influenced the flower diameter. Interaction was found to be non-significant (Table 1).

Flower diameter recorded was significantly higher at drip irrigation scheduled at 1.2 Epan (5.8 cm) than 1.0 Epan (5.0 cm) and 0.8 Epan (4.7 cm) and flower diameter were akin between 1.0 Epan and 0.8 Epan. These results were in conformity with the observations of Raj *et al.* (2021). Increased drip irrigation levels result in higher flower diameter because the root zone's surrounding soil is kept at the ideal moisture level throughout the crop growth period, which promotes the crop's vegetative growth and increases photosynthesis and the efficient translocation of photosynthates towards the development of reproductive organs. The flower diameter significantly increased as a result of this action.

Among the fertigation levels, flower diameter was significantly higher at 125% recommended dose of NK (5.6 cm) than 75% (4.5 cm) and on par with 100% recommended dose of NK (5.3 cm). These results were similar with the observations of Naik *et al.* (2019), Salma *et al.* (2014) and Kumar *et al.* (2011). Since drip fertigation results in higher nutrient uptake by plants, higher doses of fertigation levels may enhance the total solubility, mobilisation, and availability of nutrients at regular short intervals in the appropriate quantity, which may increase the flower diameter.

3.3 Flower pedicel length (cm)

Drip irrigation and fertigation levels have no significant influence on flower pedicel length. Interaction was also found to be non-significant (Table 1).

3.4 Flower fresh weight plant^{-1} (g)

Flower fresh weight plant^{-1} was significantly influenced by both drip irrigation and fertigation levels. Interaction was found to be non-significant (Table 1).

Drip irrigation scheduled at 1.2 Epan recorded significantly higher flower fresh weight plant^{-1} (557.2 g) than 1.0 Epan (499.5 g) and 0.8 Epan (465.4 g) and flower fresh weight plant^{-1} were comparable between 1.0 Epan and 0.8 Epan. Similar findings were reported by Vashista *et al.* (2020). Higher flower fresh weight per plant at higher drip irrigation levels may be caused by the root zone being kept at the ideal moisture level throughout the crop's growth period, which increased plant height, dry matter production, leaf area and the number of branches per plant. This increased photosynthesis and the efficient translocation of photosynthates towards the reproductive parts, which increased the number of flowers and finally resulted in increased flower yield of marigold.

Flower fresh weight plant^{-1} recorded was significantly higher at 125% recommended dose of NK (538.4 g) than 75% (471.3 g) and on par with 100% recommended dose of NK (512.4 g). These results were similar with the observations of Naik *et al.* (2019) and Vashista *et al.* (2020). This might be due to the continuous supply of nutrients in the root zone of the crop through drip fertigation, which created favourable conditions for growth and development by way of increasing metabolic activities in the plant system.

3.5 Flower dry weight plant^{-1} (g)

Flower dry weight plant^{-1} was significantly influenced by both drip irrigation and fertigation levels. Interaction was found to be non-significant (Table 1).

Flower dry weight plant^{-1} recorded was significantly higher at drip irrigation scheduled at 1.2 Epan (101.9 g) than 1.0 Epan (80.0 g) and 0.8 Epan (73.7 g) and flower dry weight plant^{-1} were comparable between 1.0 Epan and 0.8 Epan. Higher flower dry weight per plant at higher drip irrigation levels may be caused by the root zone being kept at the ideal moisture level throughout the crop's growth period, which increased plant height, dry matter production, leaf area, and the number of branches per plant. This increased photosynthesis and the efficient translocation of photosynthates towards the reproductive parts, which increased the number of flowers and finally resulted in increased flower yield of marigold.

Among the fertigation levels, flower dry weight plant^{-1} was significantly higher at 125% recommended dose of NK (92.8 g) than 75% (75.9 g) and on par with 100% recommended dose of NK (86.9 g). This might be due to the continuous supply of nutrients in the root zone of the crop through drip fertigation, which created favourable conditions for growth and development by way of increasing metabolic activities in the plant system.

3.6 Flower yield (t ha^{-1})

Flower yield was significantly influenced by both drip irrigation and fertigation levels. Interaction was found to be non-significant (Table 1).

Flower yield recorded was significantly higher at drip irrigation scheduled at 1.2 Epan (12.11 t ha^{-1}) than 1.0 Epan (10.33 t ha^{-1}) and 0.8 Epan (10.05 t ha^{-1}) and flower yield was akin between 1.0 Epan and 0.8 Epan. Similar findings were reported by Raj *et al.* (2021) and Jawaharlal *et al.* (2017). "Higher flower yield at increased drip irrigation level might be due to that, the optimum moisture in the vicinity of root zone throughout the crop growth period enhanced the vegetative growth in the form of higher plant height, dry matter production, leaf area and number of branches per plant of the crop thereby increase in the photosynthesis and efficient translocation of photosynthates towards the reproductive parts which increased the number of flowers per plant, flower diameter and flower fresh weight per plant and finally resulted into increased flower yield of marigold" [15].

Flower yield was recorded significantly higher at 125% recommended dose of NK (11.48 t ha^{-1}) than 75% (9.98 t ha^{-1}) and on par with 100% recommended dose of NK (11.03 t ha^{-1}). These results are similar with the findings of Naik *et al.* (2019) and Snehitha *et al.* (2019). Flower yield is a cumulative effect of yield attributes like number of flowers per plant, flower diameter and flower fresh weight. Flower yield increased gradually with increase in 125% recommended dose of the N and K fertigation levels. ~~This might be due to the continuous supply~~

Table 1: Yield attributes and Yield of marigold as influenced by varied drip irrigation and fertigation levels.

Treatments	No.of flowers plant^{-1}	Flower diameter (cm)	Flower pedicel length (cm)	Flower fresh weight plant^{-1} (g)	Flower dry weight plant^{-1} (g)	Flower yield (t ha^{-1})
Main plots - Irrigation levels						
I1: Drip irrigation at 0.8 Epan	48.6	4.7	5.0	465.4	73.7	10.05
I2: Drip irrigation at 1.0 Epan	49.3	5.0	5.0	499.5	80.0	10.33
I3: Drip irrigation at 1.2 Epan	55.3	5.8	5.2	557.2	101.9	12.11
SEm ±	1.4	0.1	0.1	12.5	2.4	0.35
C.D (P=0.05)	5.3	0.6	NS	48.9	9.5	1.36
Sub plots - Fertigation levels						
F1:75% Recommended dose ($N_{131.25}$, K_{150})	47.9	4.5	4.9	471.3	75.9	9.98
F2:100% Recommended dose (N_{175}, K_{200})	51.6	5.3	5.1	512.4	86.9	11.03
F3:125% Recommended dose ($N_{218.75}$, K_{250})	53.7	5.6	5.2	538.4	92.8	11.48
SEm ±	1.1	0.2	0.2	11.6	3.4	0.30
C.D (P=0.05)	3.5	0.7	NS	35.8	10.6	0.92
Fertigation at same level of irrigation						
SEm ±	2.0	0.4	0.3	20.1	5.9	0.52
C.D (P=0.05)	NS	NS	NS	NS	NS	NS
Irrigation at same or different fertigation levels						
SEm ±	2.1	0.4	0.3	20.6	5.4	0.55
C.D (P=0.05)	NS	NS	NS	NS	NS	NS

This could be due to the constant supply of nutrients in the crop's root zone via drip fertigation, which generated favorable conditions for growth and development by enhancing metabolic processes in the plant system. of nutrients in the root zone of the crop through drip fertigation which created favourable conditions for growth and development by way of increasing metabolic activities in the plant system.

CONCLUSION

The findings of the present investigation revealed that the yield attributes and yield of African Marigold was significantly influenced with drip irrigation and fertigation treatments. Irrigation at 1.2 Epan and Fertigation with 125% recommended dose of NK (Urea and SOP) was found superior in yield attributes and yield by African Marigold.

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