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Effect of Fertigation through Drip Irrigation on Yield and Flowering of African Marigold (*Tagetes erecta* Linn)

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A B S T R A C T

The experiment was carried out to "Study of effect of level of fertigation through drip irrigation on yield and Calculation of nutrient use efficiency of Marigold crop in different treatments" November 03 to January 19 at college of Agricultural engineering, Madakasira, Anantapur, (dist). The objective was to work out the four different levels of marigold and to compare the performance of yield, quality parameters, and nutrient use efficiency. The experimental field with 570 m^2 (19 x 30m) installed with drip irrigation system was selected for experimentation. The field was divided into 4 sub plots. Each subplot has dimensions of 19 x 7.5 m. Each subplot was allocated with 16 laterals. For each lateral 64 marigold seedlings were transplanted at 40cm spacing. Each plot was planted with the experiment was a Complete Randomized Design (CRD) with 4 treatments. Inca II variety of marigold crop was selected for experimentation. Inca II variety plants have less height and more number of short branches and are majorly used for growing as cut flowers, land scalping in lawns and gardens. The highest yield was recorded in T1 followed by T3, T2 and T4. The highest contribution of yield was by T1 as 36% of total yield of experimental plot. Next highest yield was observed in T3 as 25% followed by T2 as 24%. Lowest yield was observed in T4. The highest nitrogen use efficiency was observed in T2 followed by T4 and T3. The highest phosphorus use efficiency was observed in T2 followed by T1, T4 and T3. The highest potash use efficiency was observed in T2 followed by T1, T4 and T3. It clearly shows that the nutrient use is high if the fertilizer was applied through drip irrigation. It has also reveals that the requirement of fertilizer is also less through drip irrigation.

Introduction

The quantitative demand of marigold is the highest, particularly in South and in North-east India. Marigold is a seasonal flower and can be grown round the year. Marigold probably ranks next only to jasmine in India. Marigold (*Tagetes* spp.) a member of family Asteraceae, is native of central and South America, especially Mexico. Marigold is broadly divided into two groups, viz., African marigold (*Tagetes erecta* Linn.) And French marigold (*Tagetes patula* Linn). African marigold has the habit of free flowering over a short duration to produce marketable flowers, wide spectrum of attractive colours, shapes,

sizes. Marigold is used as the trap crop in the borders to attract the insects attacking the main crop.

The Drip irrigation provides the most economical method of applying fertilizer by utilizing fertilizer injectors that operate without any external power supply. Fertigation use soluble fertilizer that flow directly towards the plant root zone through the drip system, drip emitters or micro sprinkler system. A liquid fertilizer solution or soluble fertilizer is injected into the system at the desired rate. Soluble fertilizer is generally available in dry, soluble, suspension or solution forms. Solution forms of fertilizer come completely dissolved. Too many nutrients are detrimental to the look of the plant. It causes less flowers to grow and more foliage. Fertigation enhances growth, yield, and xanthophyll contents of marigold. Essential nutrients, like nitrogen, phosphorus, and potassium are most important for plant growth and flowering. These also play a key role in the production of higher flower and seed yield of ornamentals (Kashif 2001). Water Soluble Fertilizers such as Polyfeed (19:19:19), DAP (12:61:0), Potas (0:0:50), Potassium Nitrate (13:0:45) and Urea (46% N) can be used in many different blends. Proper combination of fertilizers plays a vital role in production of vigorous plants having maximum number of shoots and leaves, which have a positive impact on quality flower production and prolonged flowering period. Keeping this in mind Marigold crop was selected for study with different fertigation levels and the field experiment was conducted at College of Agricultural Engineering, Madakasira.

Materials and Methods

The present experiment entitled "Effect of Fertigation through Drip Irrigation on Yield and Flowering of African Marigold (*Tegetes errecta L.*)" was conducted at the Agricultural Farm, College of Agricultural Engineering, and Madakasira. Madakasira was located in Anantapur district of Andhra Pradesh, nearest to Karnataka state border. It is located in arid ecological zone; mainly it is designated as rain shadow region. The area has Latitude of 13°56'56.89" N and longitude of 77°18'42" E. The Eye altitude of experiment location is 710 meters and elevation is 641.604 meters. The annual rainfall of Madakasira is 608.55 mm and it is found to draught prone area. In Madakasira the predominant soils are silt loam soils. The experiment field with 570 m^2 (19x 30m) was selected for experimentation.

African marigold is a popular flower crop grown throughout the world on commercial scale. Marigold stands first among the loose flowers in Goa and its requirement increases in many folds on special occasions like Ganesh Chathurthi, Dussera, Diwali, weddings etc. Flowers are extensively used in the preparation of garlands and as loose flower on the occasion of religious ceremonies, festive occasions, offerings etc. Apart from loose flowers, carotenoids extracted from flowers are used for industrial purpose. It is being used commercially in pharmaceuticals, food supplements, animal feed additives and colorants in food and cosmetics. The commonly cultivated species of marigold are African marigold (*Tagetes erecta*) and French marigold (*Tagetes patula*). The common demand of African marigold (*Tagetes erecta*) is more when compared to French marigold (*Tagetes patula*). African marigold responds well to fertilizers. It gives good yield under drip irrigation. Keeping this in mind Marigold crop was selected for study with different fertigation levels. No of flowers were measured at every 10 days at the time of picking and the number of fresh flowers picked was summed up to the previous number. Finally total number of flowers was calculated. The size of the marigold flower was measured by tracing the flower size and

the diameter was measured with scale. The size of the flower was measured initially in first picking that was noted as Maximum size. Again the flower size was measured at ending stage of flowering and that was noted as Minimum size. Number of fresh flowers per Kilogram was weighed from each plot with weighing balance. The readings were taken two times and averaged to know no of fresh flowers per kg. The readings were taken at the time of first picking and last picking. Yield per each plot was measured at each time of picking and was summed to get total yield per plot.

Nutrient use efficiency was calculated for each treatment, which is the ratio of yield of crop in kg/ha to total quantity of Nitrogen, Phosphorous and Potassium applied in kg/ha

$$NUE = \frac{Y}{NA}$$

Where,

NUE = Nutrient Use Efficiency, %
Y = Yield of the crop, kg/ha
N.A = Total nutrient applied, kg/ha

Analysis of variance

Correction Factor = $\frac{GT^2}{n}$

Total sum of squares (TSS) =$\sum \sum Xj^2 - C.F$

Sum of squares Treatments (SST) = $\frac{1}{r} \times \sum_{T=1}^{4} Ti^2 - C.F$

Thus we have,

Total sum of squares = treatment sum of squares + error sum of squares,

This can be abbreviated as,

TSS = SST + SSE

The degrees of the freedom are t -1. The quantity TSS/t-1 is known the treatment mean square and written has TMS. The quantity SSE/n-t is known has the error mean square and written as MSE.

Therefore, the ratio between two estimates,

F=TMS/MSE

Follows the F–distribution with (t-1) and (n-1) degrees of freedom. The significance of F can be determined in the usual way by using the tables of F. Thus, the F -statistic may be using a two test hypotheses about the equality of the population means of the treatments, that is, to test Ho: μ1=μ2=…=μt. if F is significant the treatment means will be significantly not different. In general, the ANOVA table for one-way classification will be of the form as given in table.

In the present study, Null hypothesis is defined as all treatment means are equal.

$H_0 = \mu_1 = \mu_2 = \mu_3 = \mu_4$

If Fcal>Ftab, Null hypothesis is accepted, there is no significant difference between treatment means

$H_1 = \mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4$

If Fcal<Ftab Null hypothesis is rejected, there is significant difference between treatment means. If there is significant difference between treatments means, to know difference between individual means LSD was performed as below

Standard error of difference

A statistical index of the probability that a difference between the statistical means of two

samples is greater than zero. The difference between the mean values of two sets of data, the standard deviations of which are known. The standard error of the difference *SE(d*) is given by

Standard error difference SE(d) = $\sqrt{EMS \times \left(\frac{1}{r_1} + \frac{1}{r_2}\right)}$

Least Significant Difference (LSD)

When the result of Analysis of Variance test is significant i.e., when null hypothesis is rejected, that means at least one of the groups tested differs from the other groups. To make direct comparisons between two means from two individual groups LSD was performed. Any difference larger than the LSD is considered a significant result. The formula for the least significant difference is as follows

Least significant difference LSD = SE(d) $\times$ t

Where,

t = critical value from the t-distribution table

Coefficient of variation (CV)

The coefficient of variation (CV) is defined as the ratio of the standard deviation σ to the mean μ:

$$c_v = \frac{\sigma}{\mu}$$

It shows the extent of variability in relation to the mean of the population. Coefficient of variation upto 25 % is acceptable range.

Results and Discussion

The average number of flowers per plant was calculated. The average number of flowers per plant fully opened was highest in treatment-1 is 44.13. The average number of flowers in treatment-2 is 35.63 and treatment 3 is 36.19 and lowest number was recorded was in treatment 4 is 28.75. The ANOVA for number of flowers was performed.1 Fcal>Ftab and null hypothesis was rejected. Least significant difference was 2.19. On comparison of means, the means of treatments in T2 and T3 was on par. There is significant difference between remaining all treatments. The sizes of flowers were taken at initial and final stage of the crop period. The maximum size of flower 8.5 cm was recorded in T1 in second picking, the maximum size of flower in the remaining treatments was 8 cm, 7.4 cm, 7.1cm in T2, T3, and T4 respectively. The minimum size of flower was 3.4 cm, 3.3 cm, 3.1cm and 2.6 cm in treatments T1, T2, T3 and T4 respectively. In minimum mean flower size there is significant difference between all treatment means. Coefficient of variation is 0.53 % for initial size and 10.43 % for final size.

The number of flowers was 125 at initial stage of crop and it has been increased to 189 at the end of crop in T1 (Fig. 1). As the flower size decreased the no of flowers decreased (Fig. 2 and 3). The market value of the flowers also decreased with decreasing the flower size. The number of flowers in T4 is more than T1, T2 and T3 in initial stage. The same result observed at all stages. The highest yield was recorded in T1 as 222.76 kg followed by T3 as 157.75 kg, T2 as 153 kg and T4 91.50 kg (Fig. 4). The results are in agreement with Ayyanna *et al.*, (2004).

It has been observed that as the dose of fertilizer decreases the yield also decreases and for the same dose of fertilizers, yield increases if it was applied through drip irrigation. The percent yield of marigold crop in different treatments is given in figure 5. The highest contribution of yield was by T1 as 36% of total yield of experimental plot.

Table.1 Yield of marigold plants in different treatments

Sl. No	Treatment	Yield per plot, kg	Yield, kg/ha	Productivity, t/ha
1	T1	222.76	15632.28	15.632
2	T2	153. 00	10736.84	10.736
3	T3	157.75	11066.66	11.066
4	T4	91.50	6421.05	6.421
Grand total		**625.01**	**43860.35**	**43.860**

Fig.1 Average no. of flowers per plant of marigold crop in different treatments

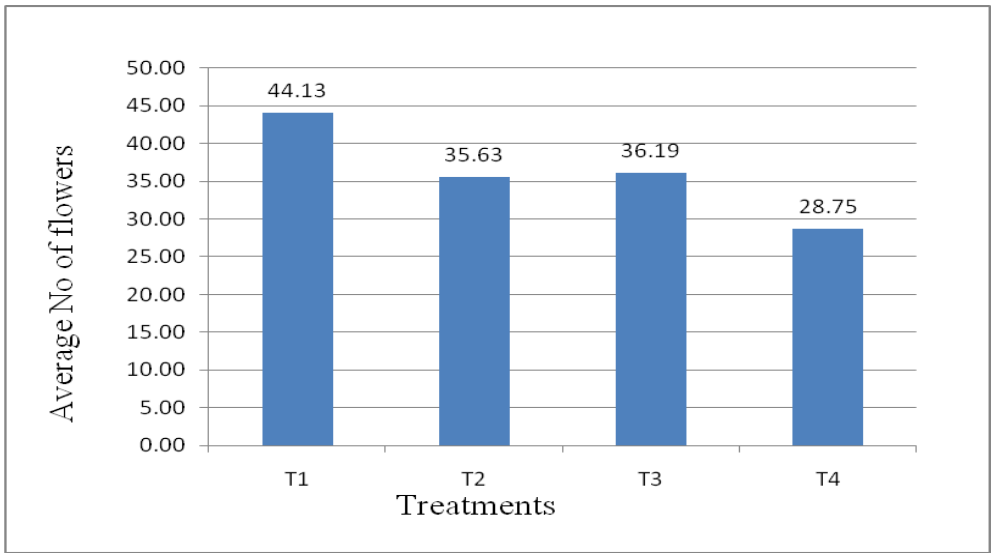


Fig.2 Average maximum flower size in different treatments

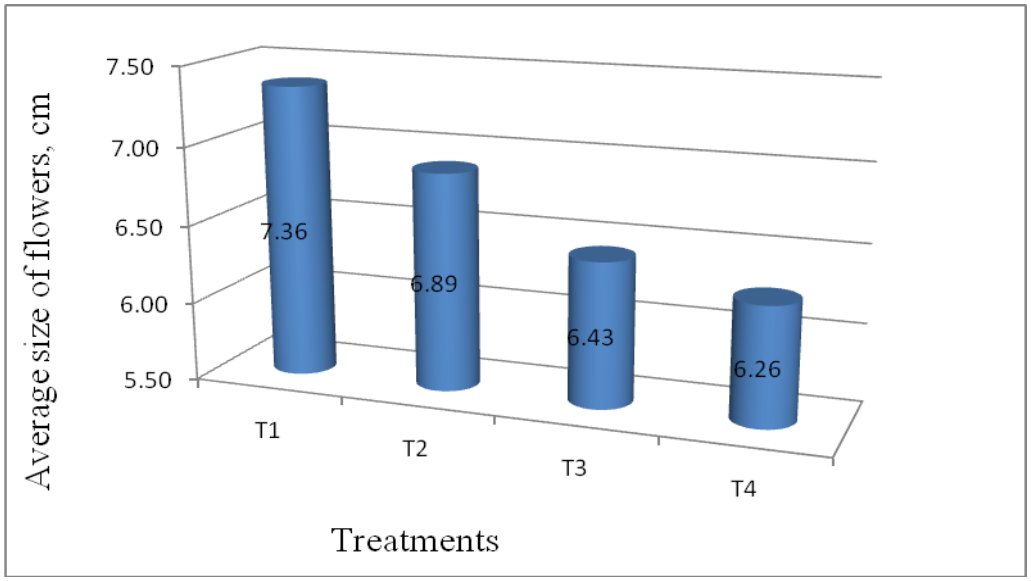


Fig.3 Average minimum flower size in different treatments

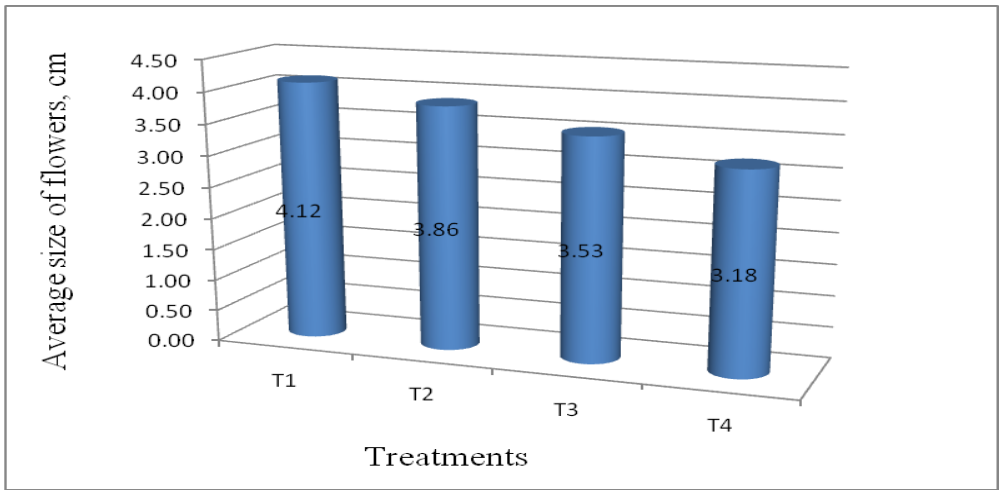


Fig.4 Average number of flowers per kilogram in different treatments

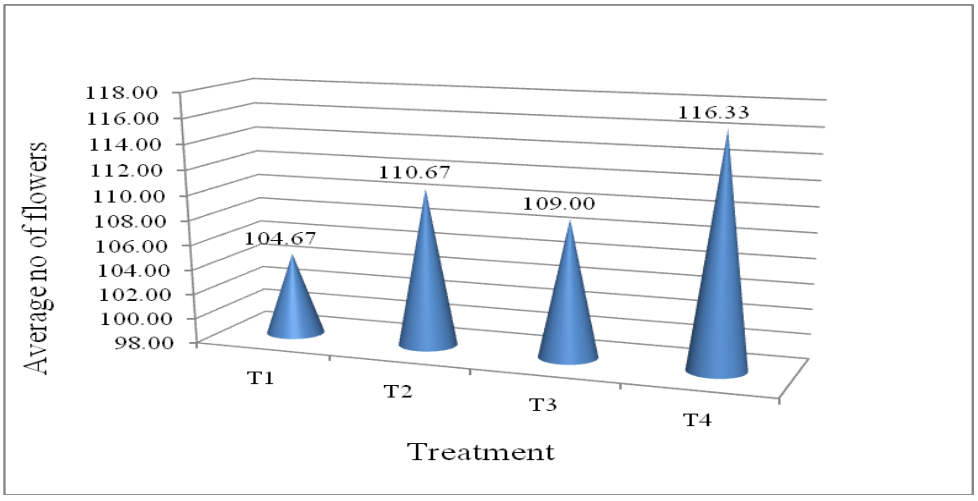


Fig.5 Percentage yield of marigold crop in different treatments

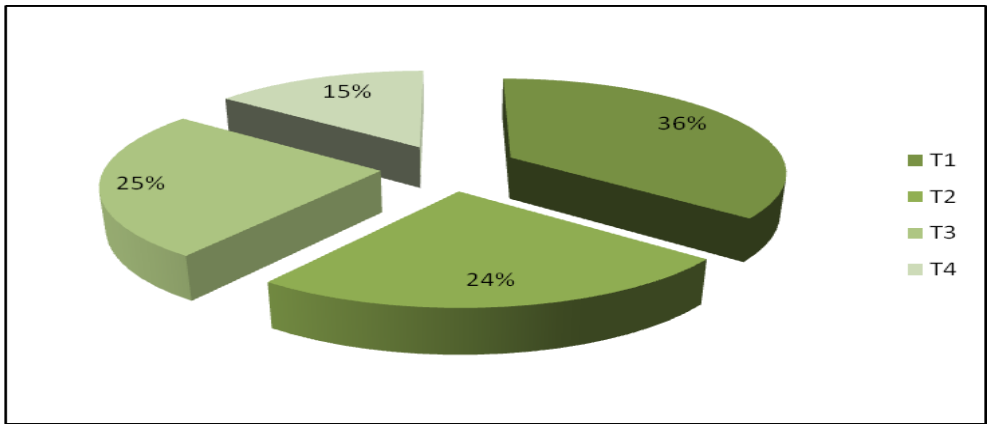
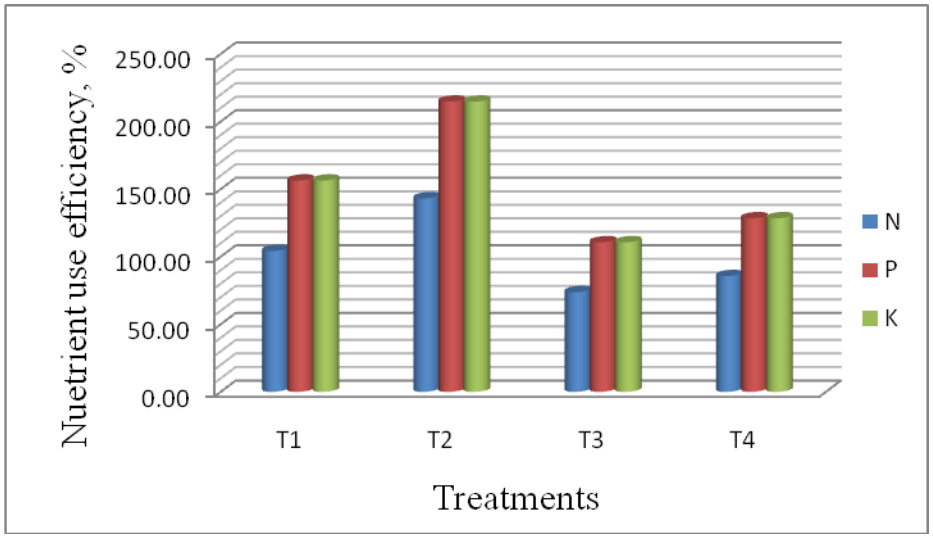


Fig.6 Nutrient use efficiency of different nutrients in different treatments



Next highest yield was observed in T3 as 25% followed by T2 as 24%. Lowest yield was observed in T4 (Table 1).

As the study is related to response of crop to different fertigation levels and different methods of application, Nutrient use efficiency is very important parameter to be considered (Fig. 6). The nutrient use efficiency was calculated for the following three major Nutrients. The highest nitrogen use efficiency was observed in T2 as 143.16% followed by T1 as 104.21%, T4 as 85.61% and T3 as 73.78%.It clearly show that the nutrient use is high if the fertilizer was applied through drip irrigation. It has also reveals that the requirement of fertilizer is also less through drip irrigation. The highest phosphorus use efficiency was observed in T2 as 214.73% followed by T1 as 156.32%, T4 as 128.42% and T3 as 110.66%. It clearly shows that the nutrient use is high if the fertilizer was applied through drip irrigation. It has also reveals that the requirement of fertilizer is also less through drip irrigation. The highest potash use efficiency was observed in T2 as 214.73% followed by T1 as 156.32%, T4 as 128.42% and T3 as 110.66%. It clearly shows that the nutrient use is high if the fertilizer was applied through drip irrigation. It has also reveals that the requirement of fertilizer is also less through drip irrigation. In the comparison of nutrient use efficiency of three major nutrients it was high in T2 for all three nutrients and least in T3, the nutrient use efficiency of P and K is high than N in all treatments.

From this study it can be concluded that application fertilizers though drip irrigation improves the flower yield (*Tagetees erecta L*.) The results also indicate that there is significant difference between treatment means in case of Number of flowers per plant, Size of flowers, Number of flowers per Kilogram, Yield per plot, Nutrient use efficiency. There is no effect of fertigation on plant population. It has been finally concluded that the plant yield was highest in T1 i. e 100 recommended fertigation though drip irrigation. Highest nutrient use efficiency was observed in 100 recommended fertigation though drip irrigation. It clearly shows that the nutrient use is high if the fertilizer was applied through drip irrigation. It has revealed that the requirement of fertilizer was less through drip irrigation.

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