

Original Research Article

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Effect of Drip Fertigation on Productivity and Economics of Maize (*Zea mays* L.) in Eastern Dry Zone of Karnataka, India

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ABSTRACT

Drip fertigation is known to enhance the growth and productivity of various crops. Since maize is a heavy feeder of nutrients and water, thus, proper management of these resources is the key to successful growth of maize. Keeping this in view, a field experiment was conducted at Zonal Agricultural Research Station, UAS, GVKK, Bangalore, during *kharif* season of 2012, to study the effect of drip irrigation and fertigation with different levels and sources of fertilizers on productivity and economics of maize. The experiment consisted of ten treatments laid out in Randomized Complete Block Design with three replications. The experimental results indicated that drip fertigation with 125 % RDF through water soluble fertilizers produced the maximum grain yield (11.9 t ha⁻¹), which was on par with drip fertigation with 100 % RDF through water soluble fertilizers (11.3 t ha⁻¹). The lowest grain yield was recorded with surface irrigation with 100 % RDF through normal fertilizers (7.9 t ha⁻¹). Decrease in RDF to 50 % in drip fertigation system has resulted in lower grain yields with both water soluble and normal fertilizers. However, highest net returns and B: C ratio was obtained with drip fertigation with 125 % RDF through NF (Rs 92734 ha⁻¹ and 3.46, respectively) which was on par with 100 % RDF through NF (Rs 90614 ha⁻¹ and 3.46, respectively).

Keywords

Maize, Drip fertigation, Water soluble fertilizers, Cob yield, Net returns, B: C ratio

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Introduction

Maize (*Zea mays* L.) is an important cereal crop after wheat and rice and being the queen of cereal crops it is known for its higher productivity. In India maize is grown on an area of 8.7 million ha with a production of 21.8 million tonnes and Karnataka is one of the major maize producing states of India where maize is grown on an area of 1.2 million ha with a production of 3.3 million tonnes (Mahajan, 2017). In Karnataka maize

has recorded a productivity of 2773 kg/ha which is even higher than the national average of 2509 kg/ha (Mahajan, 2017). The production potential of hybrid maize is not fully harnessed even under irrigated conditions. This might be due to improper management of resources like nutrients and water. In intensive agriculture, the key contributing factors are nutrient and water but, the optimum and précised use of these inputs are of utmost importance because they are scarce as well as costly. Therefore, it is

becoming essential to use agro techniques which can save these precious inputs. The introduction of simultaneous micro irrigation and fertilizer application opens new possibilities for controlling the water and nutrient supplies to crops. It is based on the principle of précised application of water and nutrients to plants in the root zone through drip irrigation system. Drip fertigation offers several advantages like higher yield and productivity (Fanish *et al.*, 2011), enhanced nutrient and water saving, uniform availability of water and nutrients by maintaining their desired concentration in the soil (Douh and Boujelben, 2011 and Hassanli *et al.*, 2009). From environmental point of view drip fertigation offers an advantage of reduced nitrate leaching and thereby reducing the ground water pollution. Asadi *et al.*, (2002) also reported that maize crop produced same yield with application of 150 and 200 kg N/ha. They also observed higher amount of nitrate leaching with application of 200 kg N/ha as compared to 150 kg N/ha. Drip fertigation enables us to get higher yield with low doses of nutrients applied. So, they not only results in nutrient savings but also minimize environmental hazards.

Materials and Methods

The field experiment was done at Zonal Agricultural Research Station, UAS, GKVK, Bangalore, India, which is situated in the Eastern Dry Zone (Zone – 5) of Karnataka between 12° 51' N Latitude and 77° 35' E Longitude at an altitude of 930 m above MSL, during *kharif* 2012.

The objective was to find out the best water and nutrient management practices that enhances the productivity of maize crop and provides maximum returns. The experimental site had a sandy clay loam soil, which had 0.56 % available organic carbon (Walkley and Black, 1934), 362.49 kg/ha available N

(Subbiah and Asija, 1956), 62.33 kg/ha available P (Oleson *et al.*, 1954) and 273.20 kg/ ha available K (Black, 1971). The soil reaction was acidic with a pH of 5.56 (Jackson, 1973). The total rainfall received during the period of experiment (August to December) was 354.70 mm which was 39.1 % less as compared to normal average rainfall of that season (582.30 mm). The mean maximum and minimum temperature ranged from 27.2 to 28.3 °C and 15.7 to 19.4 °C, respectively.

The experiment was laid out in Randomized Complete Block Design with ten treatments and three replications. The treatments were: T₁- surface irrigation with soil application of 100% RDF (Normal Fertilizers: NF), T₂- Drip irrigation with soil application of 100% RDF (NF), T₃ -Drip fertigation with 50 % RDF (NF), T₄ -Drip fertigation with 75 % RDF (NF), T₅ -Drip fertigation with 100 % RDF (NF), T₆ -Drip fertigation with 125 % RDF (NF), T₇ -drip fertigation with 50 % RDF (Water Soluble Fertilizers: WSF), T₈ -Drip fertigation with 75 % RDF (WSF), T₉ - Drip fertigation with 100 % RDF (WSF), T₁₀ -Drip fertigation with 125 % RDF (WSF).

Seeds of hybrid maize 'Hema' ('NAH 1137') were sown on 17th August 2012, at a spacing of 60 × 20 cm. In treatments T₁ and T₂ fertilizers were applied as per package of practices *i.e.* 50 % of nitrogen along with entire dose of phosphorus and potassium as basal dose and remaining 50 % was applied in two equal splits at 25 and 45 DAS. In rest of the treatments whole amount of fertilizer was applied through drip fertigation. Recommended dose of fertilizer was 150:75:40 kg N, P₂O₅ and K₂O, ha⁻¹. Zinc Sulfate @ 10 kg ha⁻¹ was applied uniformly to all the treatments through surface application. Normal fertilizers used were: Urea, Diammonium Phosphate, Single Super Phosphate and water soluble fertilizers used were: Calcium Nitrate, 19:19:19 and 12:61:0.

Two irrigations of 3 cm each were given in general to all the plots after sowing. Drip irrigation was started on 16th DAS *i.e.* on 2nd September 2012. Water through drip system was provided on the basis of CPE values at an interval of 2-3 days. The drip discharge was 2 lph and emitter spacing was 30 cm. Fertigation treatments were also imposed on same day and whole amount of fertilizer was divided into 8 equal splits and they were given to crop at an interval of every 8 days through drip. The irrigation to T₁ was provided on the basis of visual observations and critical stage approach.

To ensure proper weed management, pre emergence application of atrazine was done @ 1 kg *a.i./ha* by mixing it with sand and spreading it uniformly over the cropped area which was followed by one hand weeding at 25 DAS. To control the incidence of downy mildew disease, two sprays of Ridomil MZ @ 3 g/l were done. Earthing up was done at 45 DAS to ensure protection against lodging. Harvesting was done on 16th December 2012. For data collection five tagged plants were selected from every plot and all the observations were recorded using the same plants. The data were analyzed using analysis of variance (ANOVA) technique as applicable for Randomized Complete Block Design (Rangaswamy, 2006). The results were interpreted on the basis of F- test and critical difference at 5% was used for calculating the significant difference between the means of two treatments (Gomez and Gomez, 1984).

Results and Discussion

Yield contributing characters and yield

Crop productivity is affected by both internal and external factors; nutrient and water availability are the most dominant external factors among them. The crop received 39.1 per cent less rain fall as compared to normal

rainfall of that season, still the crop responded very well to drip fertigation. Data collected on yield attributes (Table 1) revealed that significantly highest cob length was obtained with drip fertigation with 125 % RDF through WSF which was at par with drip fertigation with 100 % RDF through WSF. Similar trend was recorded by cob weight per plant. The significantly higher number of rows per cob was observed with drip fertigation with 125 % RDF through WSF followed by drip fertigation with 100 % RDF through NF. This may be due to increased availability of water and nutrients in the soil and their uptake by crop, thus resulted in better yield attributes. Similar results were recorded by Patil *et al.*, (2011) in maize.

An increase in the maize yield was observed due to increased doses of fertilizers (Table 2). Drip fertigation with 125 % RDF through WSF has recorded 49.4 % higher yield as compared to surface irrigation and 29.47 % higher as compared to drip irrigation (in both treatments soil application of 100 % RDF through NF was done). However, yield obtained in drip fertigation with 125 % RDF through WSF was statistically at par with drip fertigation with 100 % RDF through WSF and drip fertigation with 125 per cent RDF through NF.

This may be attributed to the reason that plants have efficiently utilized the higher concentration of nutrients present in the root zone. Higher nutrient uptake has resulted in more biomass accumulation and more translocation of photosynthates towards the sink *i.e.* grains. Hassanli *et al.*, 2009 also reported that maize crop irrigated with sub surface drip and surface drip methods have shown statistically similar yield but it was significantly higher as compared to surface furrow irrigation method; which was attributed to uniform distribution of irrigation water and lesser evapotranspiration.

Table.1 Effect of water and nutrient management practices on yield attributes of maize crop

Treatments	Cob length (cm)	Number of rows	Number of Grains per row	Cob weight/ plant (g)	Grain weight/ plant (g)
T ₁ : Surface irrigation with soil application -100 % RDF (NF)	12.3	15.3	30.7	159.9	108.3
T ₂ : Drip irrigation with soil application- 100 % RDF (NF)	12.9	15.6	35.2	172.2	110.5
T ₃ : Drip fertigation - 50 % RDF (NF)	11.6	13.8	26.0	155.9	101.8
T ₄ : Drip fertigation- 75 % RDF (NF)	12.0	15.1	31.6	168.8	113.1
T ₅ : Drip fertigation -100 % RDF (NF)	13.9	17.9	36.8	180.7	128.6
T ₆ : Drip fertigation -125 % RDF (NF)	14.1	18.6	39.1	184.4	134.4
T ₇ : Drip fertigation - 50 % RDF (WSF)	11.8	14.9	28.8	149.2	106.8
T ₈ : Drip fertigation - 75 % RDF (WSF)	14.3	17.8	38.7	182.1	135.1
T ₉ : Drip fertigation - 100 % RDF (WSF)	14.9	18.3	39.8	186.3	137.1
T ₁₀ : Drip fertigation - 125 % RDF (WSF)	15.6	19.3	41.8	196.5	147.8
S.Em ±	0.3	0.3	1.5	4.4	4.4
C.D. at 5 %	0.9	0.9	4.5	13.2	13.6

Table.2 Effect of water and nutrient management practices on yield and economics of maize crop

Treatments	Grain yield (t ha ⁻¹)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C Ratio
T ₁ : Surface irrigation with soil application -100 % RDF (NF)	7.9	32643	95280	62637	2.9
T ₂ : Drip irrigation with soil application- 100 % RDF (NF)	9.2	37726	109920	72194	2.9
T ₃ : Drip fertigation - 50 % RDF (NF)	7.1	35060	84840	49780	2.4
T ₄ : Drip fertigation- 75 % RDF (NF)	9.0	35942	108000	72058	3.0
T ₅ : Drip fertigation -100 % RDF (NF)	10.6	36826	127440	90614	3.5
T ₆ : Drip fertigation -125 % RDF (NF)	10.9	37706	130440	92734	3.5
T ₇ : Drip fertigation - 50 % RDF (WSF)	8.6	58825	103560	44735	1.8
T ₈ : Drip fertigation - 75 % RDF (WSF)	10.3	71534	123960	52426	1.7
T ₉ : Drip fertigation - 100 % RDF (WSF)	11.3	84355	135480	51125	1.6
T ₁₀ : Drip fertigation - 125 % RDF (WSF)	11.9	96919	142320	45401	1.5
S.Em ±	0.4	NA	4524.6	4524.6	0.1
C.D. at 5 %	1.1	NA	13443	13443	0.3

Economics

Drip fertigation with 125 % RDF through NF resulted in higher net returns and B: C ratio (Table 2) but it was on par with drip fertigation with 100 % RDF through NF. Drip fertigation through water soluble fertilizers resulted in lower net returns and B: C ratio because of higher cost of water soluble fertilizers. Fanish *et al.*, 2011 also reported that use of normal fertilizers for drip fertigation was more economical as compared to water soluble fertilizers due to cost factor.

The study inferred that drip fertigation is beneficial in maize and application of 100 % RDF through normal fertilizers gives maximum benefits in terms of yield and economic point of view. Further we can conclude that use of normal fertilizers are more economical for drip fertigation as compared to water soluble fertilizers in maize.

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