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**Research article**

# Enhancing the productivity of Maize - Blackgram cropping system through drip fertigation

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**Abstract:** Field experiments were carried out at Agricultural Research Station, Tamil Nadu Agricultural University, Bhavanisagar during 2013 and 2014 to optimize the fertilizer level and form of fertilizers for maize - blackgram cropping system under drip fertigation. The experiment consisted of five treatments with two levels of recommended dose of fertilizer (RDF) *viz.*, 100% and 75% by means of normal fertilizer and water soluble fertilizers (WSF) and drip irrigation with surface application of 100% RDF. The experiment was laid out in Randomized Block Design with four replications. The cropping system followed was maize (*kharif*) - blackgram (*rabi*). Among the fertigation treatments studied, the drip fertigation with 100% RDF as WSF recorded the highest yield parameters followed by drip fertigation with 75% RDF as WSF and both the treatments were statistically on par. However, drip fertigation with 100% RDF as WSF recorded significantly higher grain yield of 6144 kg $ha^{-1}$ in maize and 807 kg $ha^{-1}$ in black gram with total net income of Rs.50,473 $ha^{-1}$ for the cropping system as a whole.

**Keywords:** Cropping system, Drip fertigation, Maize - Blackgram.

## INTRODUCTION

The demand for water is increasing in all sectors. More than 95% of surface water and about 85% of ground water are exploited in Tamil Nadu. Intensive agriculture with large fertilizer input is one of the major sources of soil and groundwater contamination with nitrates (Schepers & Marter, 1986). This trend is enhanced by mismanaged irrigation practices and induced groundwater recharge (Toussaint, 2000). In furrow and border irrigation systems, loss of applied irrigation water from reservoir to the field under unlined irrigation system is 71% (Navalawala, 1991). Such huge amount of water loss causes abundant nutrient loss through seepage and percolation.

Microirrigation has emerged as an appropriate water saving technique for row crops especially for wide spaced high value crops in water scarcity, undulated, sandy and hilly areas of India. By introducing drip with fertigation, it is possible to increase the yield potential by three times from the same quantity of water; and also by saving about 45-50% of irrigation water and increasing the productivity of crops by about 40% with saving of 30% of fertilizers (Sivanappan, 2012). According to Agarwal (1973), multiple cropping was not only an important means of increasing food supply, but also an instrument for further economic utilization of available farm resources. Thus, of late the importance of intensive cropping system had been well understood by the agricultural scientists. The area under maize is expected to increase in future due to ever increasing demand of maize grains in poultry and animal feed industries. Among sixteen different maize - based cropping systems studied incorporation of pulses / oilseeds / green manures as a second or third crop in a cropping system, maintained the soil fertility and generated additional income (Kaore, 2002). Double cropping usually offers the potential to increase nitrogen (N) use efficiency in a multicrop sequence because the successive crops benefit from the residual N of the first crop (Clough *et al*., 1990). Considering all these factors, the present study was conducted to determine the effect of different levels and form of fertilizers on productivity of maize-blackgram cropping system through drip fertigation.

## MATERIAL AND METHODS

Field experiments were carried out at Agricultural Research Station, Tamil Nadu Agricultural University, Bhavanisagar during 2013 and 2014 to optimize the fertilizer levels and form of fertilizers for maize - blackgram cropping system under drip fertigation. The experiment was laid out in Randomized Block Design with four replications. The experiment consisted of five treatments *viz.*, drip irrigation with surface application of 100% RDF ($T_1$), drip fertigation with 100% RDF - Normal fertilizers (NF) ($T_2$), drip fertigation with 100% RDF - Water soluble fertilizers (WSF) ($T_3$), drip fertigation with 75% RDF - NF ($T_4$) and drip fertigation with 75% RDF - WSF ($T_5$). The cropping system followed was maize (*kharif*) - blackgram (*rabi)*. The fertilizer sources for supplying nitrogen (N), Phosphorus (P) and Potassium (K) through drip irrigation with normal fertilizers were urea, single super phosphate and

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muriate of potash, whereas for treatments with WSF, the sources of fertilizers used were urea, mono ammonium phosphate (12:61:0 NPK) and white potash (60% K), respectively.

## RESULTS AND DISCUSSION

### *Influence of drip fertigation on growth parameters*

The statistically analysed data on growth parameters of maize are presented in table 1. The analysed data revealed that, drip fertigation with 100% RDF as water soluble fertilizer (WSF) ($T_3$) recorded the higher plant height and LAI on 30 days after sowing (DAS) and it was significantly comparable with drip fertigation with 75% RDF as WSF ($T_5$). The same trend was observed during other stages of observation. However on 60 DAS, the higher LAI obtained from drip fertigation with 100% RDF as water soluble fertilizer (WSF) ($T_3$) was comparable with drip fertigation with 75% RDF as WSF ($T_5$) and drip fertigation with 75% RDF as Normal fertilizers ($T_4$). The lowest plant height was recorded by drip irrigation with surface application of 100% RDF ($T_1$).

**Table 1.** Effect of drip fertigation on plant height and LAI of maize (Mean of two years).

| Treatments | Plant height (cm) | | | LAI | | |
|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | Harvest | 30 DAS | 60 DAS | Harvest |
| $T_1$ | 78.5 | 198.4 | 217.3 | 1.29 | 3.30 | 2.24 |
| $T_2$ | 94.9 | 209.6 | 239.9 | 1.86 | 3.47 | 2.37 |
| $T_3$ | 100.1 | 221.2 | 253.0 | 2.68 | 4.09 | 2.42 |
| $T_4$ | 88.7 | 202.3 | 231.5 | 1.35 | 3.75 | 2.27 |
| $T_5$ | 96.6 | 216.0 | 249.5 | 2.46 | 3.93 | 2.40 |
| **SEd** | **2.4** | **3.7** | **4.3** | **0.17** | **0.20** | **0.11** |
| **CD (P=0.05)** | **5.0** | **7.6** | **8.7** | **0.37** | **0.43** | **NS** |

The higher plant height was observed in the treatment drip fertigation with 100% RDF ($T_3$) as water soluble fertilizer (WSF). Increased plant height in 100% RDF through water soluble fertilizers, might be due to the presence of favourable microclimate to the plants and application of sufficient nutrients in readily available form leading to accelerated production of growth regulators such as auxins (IAA) and cytokinins which in turn stimulated the action of cell elongation and cell division and resulted in increased plant height. Similar findings of higher plant height and LAI were obtained by Vadivel *et al.* (2001) and Ramah (2008) in maize.

### *Influence of drip fertigation on yield parameters*

The yield parameters *viz.*, number of grain rows $cob^{-1}$, number of total grains $cob^{-1}$ and cob weight (g) were recorded and analysed statistically and presented in table 2. The drip fertigation treatments significantly influenced the yield parameters of maize. Among the fertigation treatments studied, the drip fertigation with 100% RDF as WSF ($T_3$) recorded the highest yield parameters which was followed by drip fertigation with 75% RDF as WSF ($T_5$) and both the treatments were statistically on par. The lowest yield parameters were recorded by drip irrigation with surface application of 100% RDF ($T_1$).

**Table 2.** Effect of drip fertigation on yield parameters of maize (Mean of two years).

| Treatments | Number of grain rows / cob | Number of grains / cob | Cob weight (g) |
|---|---|---|---|
| $T_1$ - Drip Irrigation with surface application of 100% RDF | 10.9 | 416 | 182.7 |
| $T_2$ - Drip fertigation with 100% RDF - Normal fertilizers | 12.7 | 474 | 207.8 |
| $T_3$ - Drip fertigation with 100% RDF - WSF | 14.1 | 512 | 227.8 |
| $T_4$ - Drip fertigation with 75% RDF - Normal fertilizers | 11.9 | 458 | 200.8 |
| $T_5$ - Drip fertigation with 75% RDF - WSF | 13.4 | 492 | 220.14 |
| **SEd** | **0.6** | **12** | **7.5** |
| **CD (P=0.05)** | **1.2** | **28** | **16.4** |

Application of 100% RDF and 75% RDF as WSF through fertigation resulted in higher yield parameters. Better crop growth at recommended nutrient levels might have influenced the yield attributes favourably. Also the nutrients were applied in adequate quantity and were in easily available form (WSF) which created more conducive environment for the roots to absorb the nutrients more effectively when compared to normal fertilizers. The growth parameters were also higher under these treatments which might have contributed to higher yield parameters. All these reasons coupled together and resulted in higher yield attributing characters in maize. This finding was in accordance with the findings of Singh (1983) and Narayanaswamy *et al.* (1994).

### *Influence of drip fertigation on yield of maize and blackgarm*

The yield data of maize and blackgram showed the favourable effect of drip fertigation (Table 3). Drip fertigation given based on 100% RDF as WSF ($T_3$) produced higher yield (6144 kg $ha^{-1}$ in maize and 807 kg $ha^{-1}$ in blackgram)

which was significantly superior to all the other fertilizer treatments. However, the stover yield of maize in $T_3$ was comparable with $T_5$. The lowest yield of maize and blackgram were recorded in drip irrigation with surface application of 100% RDF ($T_1$). Recommended quantity of nutrients supplied at regular intervals as WSF ($T_5$) with favourable moisture status under drip irrigation resulted in better translocation of assimilates from source to sink. This might be the reason for higher yield in maize and blackgram. This was in concordance with the findings of Ramah (2008) and Fanish (2013).

**Table 3.** Effect of drip fertigation on yield of maize - blackgram (Mean of two years).

| Treatments | Maize | | Blackgram |
|---|---|---|---|
| | Grain Yield (kg ha$^{-1}$) | Stover yield (kg ha$^{-1}$) | Seed yield (kg ha$^{-1}$) |
| $T_1$ - Drip Irrigation with surface application of 100% RDF | 4462 | 8324 | 507 |
| $T_2$ - Drip fertigation with 100% RDF - Normal fertilizers | 5242 | 9065 | 660 |
| $T_3$ - Drip fertigation with 100% RDF - WSF | 6144 | 9586 | 807 |
| $T_4$ - Drip fertigation with 75% RDF - Normal fertilizers | 4677 | 8967 | 570 |
| $T_5$ - Drip fertigation with 75% RDF - WSF | 5368 | 9353 | 613 |
| **SEd** | **106** | **158** | **11** |
| **CD (P=0.05)** | **232** | **326** | **24** |

Application of 100% RDF through fertigation ($T_3$) as WSF resulted in 27% and 37% higher yield in maize and blackgram, respectively when compared to the same dose of fertilizer applied as surface application with drip irrigation ($T_1$). Under fertigation, the water soluble fertilizers were applied at the site of high concentration of active roots with more number of splits *i.e.* once in three days upto reproductive stage which might have resulted in higher availability and higher uptake by the roots and ultimately resulted in higher yield characters and yield of the crop. Whereas in the surface applied plots, the fertilizers were dumped on the soil with minimum number of splits *viz.*, one basal and two top dressings for maize. So the availability of nutrients would be very high during first 20 to 30 days, but at reproductive stage the applied nutrients would have been depleted or leached off and not available to the crops which might have resulted in lower yield attributing characters and yield of the crops. Similar findings of higher yield in maize with drip fertigation of 100% RDF as WSF was obtained by Ramah (2008) and Fanish (2013).

***Influence of drip fertigation on economics of maize - blackgram cropping system***

The economics of drip fertigation system for maize - blackgram cropping system is presented in table 4. Among the treatments drip fertigation with 100% RDF as WSF ($T_3$) recorded the higher income and B:C ratio. The yield and income was high in the fertigated plots, possibly due to higher uptake and nutrient use efficiencies from the water soluble fertilizers, which obtained a very meager difference of B:C ratio when compared to conventional fertilizers and soil applied plots. Thus the additional expenditure towards the drip fertigation system and water soluble fertilizers was well compensated through greater additional income.

**Table 4.** Economics of the drip fertigation system for maize - blackgram cropping system (Mean of two years).

| Treatments | Gross income (Rs. ha$^{-1}$) | Cost of cultivation (Rs. ha$^{-1}$) | Net income (Rs. ha$^{-1}$) | B:C ratio |
|---|---|---|---|---|
| $T_1$ | 84249 | 46465 | 52827 | 1.8 |
| $T_2$ | 103151 | 51665 | 70495 | 2.0 |
| $T_3$ | 122703 | 59163 | 81195 | 2.1 |
| $T_4$ | 91152 | 50386 | 60550 | 1.8 |
| $T_5$ | 101285 | 55986 | 66803 | 1.8 |

**Note:** Cost of drip system Rs. 96,000/- was included in the cost of cultivation at the rate of Rs. 19,200 ha$^{-1}$ yr$^{-1}$ considering the life span of the system as 10 years.

## DISCUSSIONS

To conclude, drip fertigation at 100% RDF as water soluble fertilizer could enhance the productivity and income of maize - blackgram cropping pattern. Even though the yield and income obtained in maize - blackgram cropping system was higher with WSF, considering the higher cost of it, phosphorus fertilizer i.e. single super phosphate may be applied as soil application.

## CONCLUSION

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