

# Subsurface drip fertigation, irrigation regimes and short duration pulses on productivity of cotton-Maize cropping sequence

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## ABSTRACT

Fertigation, a latest technology wherein nutrients are applied along with irrigation water and fertigation opens new possibilities for controlling water and nutrient supplies to crops besides maintaining the desired concentration and distribution of water and nutrients to the soil. Research works on drip fertigation under intercropping situation is very limited. Input information on optimal schedules for micro-irrigation and fertigation to cotton and maize with intercropping of pulses will have to be generated, thus enabling the option of micro irrigation under intercropping situation. In this study Crop sequencing of Subsurface drip fertigation, irrigation regimes and short duration pulses on productivity of cotton-Maize was studied. Results revealed that In cotton based intercropping, cotton + blackgram intercropping would be the ideal Irrigation at 100 % PE with 125 % RDF (150:75:75 kgs NPK/ha) resulted in higher cotton yield (3860 kg/ha cotton equivalent yield) and with water saves saving of 24 per cent. 75 % PE - yield increase in cotton 18.9 % with water saving of 40.6 %. In maize based intercropping system, maize + black gram intercropping would be the best system. Irrigation at 100 % PE irrigation regime with 100 % RDF (250: 75: 75 Kgs NPK) gave higher maize yield (7735kg/ha maize equivalent yield). In cotton – maize sequence, intercropping of black gram found to be best suitable system with the irrigation level of 100 % PE and 125 % RDF (150:75:75 kg NPK/ha) for cotton and 100 % PE irrigation regime with 100 % RDF (250: 75: 75 kg NPK/ha) for maize is recommended to get higher yield in the system.

*Keywords: Fertigation, Recommended Dose of Fertilizer, InterCropping*

## 1. INTRODUCTION

Cotton - maize is one of the important cropping systems practiced in India. The productivity of the system mainly depends on proper irrigation and nutrient management practices. For that every attempt is necessary for achieving the objective of higher use efficiency of water and fertilizer. Under these circumstances drip irrigation is one such hi-tech system and reported that the water use efficiency is as high as 70-90 percent. Drip irrigation has proved its superiority over other methods of irrigation due to the direct application of water and nutrients in the vicinity of root zone. Addressing these issues requires an integrated approach to soil-water-plant nutrient management in the plant-rooting zone.

Fertigation, a latest technology wherein nutrients are applied along with irrigation water and fertigation opens new possibilities for controlling water and nutrient supplies to crops besides maintaining the desired concentration and distribution of water and nutrients to the soil. Research works on drip fertigation under intercropping situation is very limited. Input information on optimal schedules for micro-irrigation and fertigation to cotton and maize with intercropping of pulses will have to be generated, thus enabling the option of micro irrigation under intercropping situation. The drip system installed for cotton and maize crop can be used for intercrops too simultaneously which helps to reduce the payback period. Considering the above points in view, the present study was undertaken to assess the feasibility of drip fertigation in maize based inter cropping system. Intercropping is one of the potential areas to achieve sustainability with respect to soil fertility and productivity of maize growing areas (Yosef, 1999).

Intercropping of suitable genotypes of pulses with maize not only provide nutritional security and improve the productivity but also result in soil improvement. It has been well documented that legumes favorably improve the physical, chemical and biological aspects of the soil. Intercropped cause improvement in soil structure, as judged from the decrease in the bulk density, hydraulic conductivity, and available water besides increasing organic carbon content compared to pure maize cropped soils (Zhang *et al.*, 2007). The beneficial effects must be perhaps due to root exudates, root and shoot residue addition and their decay. Inclusion of legumes in the cropping system benefits through nitrogen fixation by them and improves the soil fertility. These benefits are largely due to increased total biomass production, amount of N fixed, amount of N added to soil through root nodules, increased biological activity and increased availability of nutrients other than N.

## 2. MATERIAL AND METHODS

The field investigations were carried in field Number D 42 of AICRP on Water Management Research block, Agricultural College and Research institute, Tamil Nadu Agricultural University, Madurai. The experiment was carried at consecutive two years (2016 and 2017) during *Kharif* season in cotton and *rabi* season in maize to evaluate the subsurface drip fertigation, irrigation regimes along with growing short duration pulses as intercrop.

The experimental farm is geographically located at 9°54' N latitude and 78°54' E longitude at an elevation of 147 m above mean sea level located in the Southern Agro climatic zone of the Tamil Nadu. The normal weather condition of the location is as follows. The mean annual rainfall is 856 mm, out of which 39.8 per cent is distributed during South West Monsoon, 42 per cent during North East Monsoon, 2.1 per cent during winter and 16.2 per cent during summer. The daily mean maximum and minimum temperature are 35.5°C and 25.3°C during SWM, 30.9°C and 21.1°C during NEM, 30.9°C, and 20.8°C during winter and 36.4°C and 24.7°C during summer respectively.

The experiment was laid out in split split plot design with three replications. The main plot consist as tow irrigation levels 75 and 100 per cent based pan evaporation (PE) reading, sub plot contains three drip fertigation levels of 75, 100 and 125 per cent and sub sub plot consist intercropping with short duration pulses viz., C1 – sole crop of maize/cotton, C2 – intercrop with cow pea, C3-intercrop with blackgram and C4- intercrop with cluster bean.

Initially, one life saving irrigation was given uniformly to entire field. Subsequent irrigations were scheduled as per the assigned PE ratios with once in three days based on PE. The daily pan evaporation data were obtained from standard USWB Class A pan evaporimeter located at AC&RI, Madurai agromet observatory.

Recommended dose of fertilizer for cotton is 120:60:60 kg NPK ha<sup>-1</sup> and maize is 250:75:75 kg NPK ha<sup>-1</sup>. Fertigation was given as per the treatment schedule. Fertigation was scheduled once in days starting from 15 DAS to 120 days after sowing for cotton and from 15 DAS to 90 DAS for maize. The required quantity of N, P and K are given in the form of urea (46 % N), MAP (12 % N and 61 % P<sub>2</sub>O<sub>5</sub>) and SOP (50 % K<sub>2</sub>O). Each plot consists of laterals for fertigation and irrigation. A tap was provided at the beginning of the each lateral for giving controlled fertigation. Short duration pulses were grown as intercrop with ratio of 1:1 in between two main crops. For comparing the performance of intercrop the sole maize / cotton plot also maintained.

The yield attributes of cotton viz., number of bolls, boll weight, seed cotton yield and cotton equivalent yield were recorded. The observations on maize cob length, cob girth, grain and stover yield and maize equivalent yield were recorded at different stages of crop growth. The crop equivalent yield (CEY) was calculated using the following formulae.

$$\text{Crop equivalent yield (CEY)} = \frac{\text{Intercrop yield (kg ha}^{-1}\text{)} \times \text{Price of Intercrop (Rs kg}^{-1}\text{)}}{\text{Price of cotton / maize}}$$



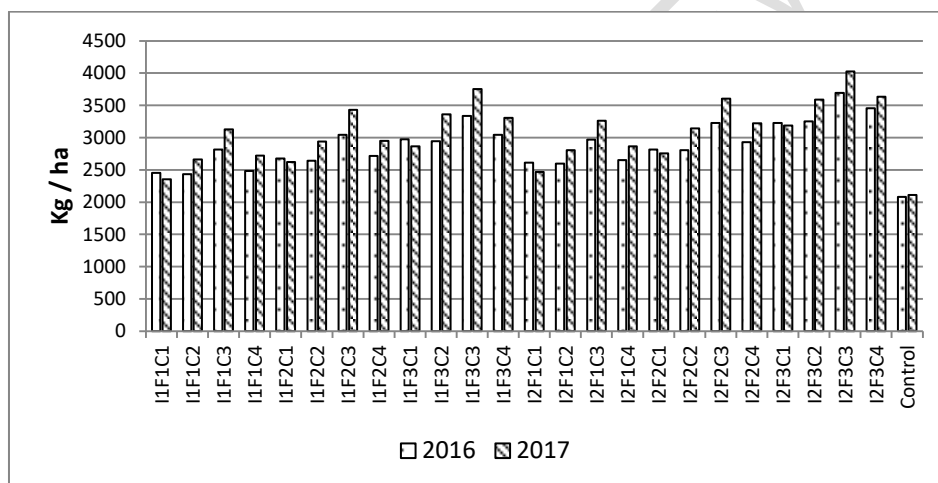
regimes			mean			mean			mean
I1 – 75 % PE	46.18	44.77	45.48	3.23	3.56	3.40	2584	2585	2585
I2 – 100 % PE	48.74	47.34	48.04	3.43	3.75	3.59	2737	2760	2749
SEd	<b>0.962</b>	<b>0.967</b>		<b>0.07</b>	<b>0.076</b>		<b>54.30</b>	<b>43.53</b>	
CD (P=0.05)	<b>NS</b>	<b>NS</b>		<b>NS</b>	<b>NS</b>		<b>NS</b>	<b>NS</b>	
Fertigation levels									
F1 – 75 % RDF	44.31	41.66	42.99	3.24	3.46	3.35	2466	2382	2424
F2 – 100 %RDF	47.98	45.78	46.88	3.36	3.66	3.51	2707	2645	2676
F3 – 125 %RDF	50.09	49.62	49.86	3.52	3.85	3.69	2808	2987	2898
SEd	<b>1.012</b>	<b>0.872</b>		<b>0.072</b>	<b>0.078</b>		<b>56.60</b>	<b>47.73</b>	
CD (P=0.05)	<b>2.335</b>	<b>2.012</b>		<b>0.166</b>	<b>0.180</b>		<b>130.40</b>	<b>110.10</b>	
Intercrops									
C1- Cotton	48.53	46.75	47.64	3.41	3.73	3.57	2732	2710	2721
C2 -Cotton + cowpea	47.93	45.61	46.77	3.39	3.65	3.52	2704	2660	2682
C3-Cotton+ black gram	47.05	45.45	46.25	3.36	3.63	3.50	2635	2665	2650
C4-Cotton + Cluster bean	46.33	44.95	45.64	3.35	3.61	3.48	2570	2651	2610
SEd	1.18	1.096		0.084	0.087		65.93	54.69	
CD (P=0.05)	<b>NS</b>	<b>NS</b>		<b>NS</b>	<b>NS</b>		<b>NS</b>	<b>NS</b>	
Control	36.8	34.43	35.62	3.13	3.21	3.17	2086	2112.	2099

### 3.3. Cotton equivalent yield

The cotton equivalent yield was worked out for two different years, among the treatment combinations irrigation given at 100 per cent based PE and fertigation with 125 per cent RDF and intercropped with blackgram recorded higher cotton equivalent yield of 3693 and 4028 kg ha<sup>-1</sup> at 2016 and 2017, respectively (Figure 1). The increase in yield under 125 per cent RDF might be due to the fact that fertigation at higher dose obviously resulted in higher availability of all the three major nutrients in the soil solution which led to higher uptake and better translocation of assimilates from source to sink thus in turn increased the yield. Similar linear response to higher doses of fertilizers was obtained in under drip fertigation by Sundar Raman *et al.*, (2000).

With respect to intercropping system due to the higher yield from blackgram and lesser reduction in cotton yield compared with greengram and cluster bean intercrops. This is similar to the findings of Chellaiah and Gopalaswamy (2000).

**Figure 1. Effect of irrigation regimes and fertigation levels on the cotton equivalent yield under sub surface drip irrigation in cotton-maize cropping sequence**



### 3.4. Maize grain and stover yield

Among the irrigation regimes, maize grain and stover yield there was no significant difference between the treatments in both years 2016 and 2017 (Table 2). Whereas in 2017 irrigation based on 125 per cent PE recorded higher grain and stover yield of 7008 and 15498 kg ha respectively.

With respect to subsurface drip fertigation application of 125 per cent RDF recorded grain and stover yield of 6946 and 15705 kg ha<sup>-1</sup>, respectively in 2016. However, it was significantly on par with fertigation at 100 per cent RDF. In the year 2017 also the similar trend of grain and stover yield was recorded. These results were attributed due to application of higher and optimum dose (125 and 100 per cent) of fertilizers through fertigation resulted in maximum uptake of nutrients at all the stages. Thus significantly influence the yield attributes which in turn resulted in higher yield. The similar results were also reported by Tumbare and Nikam (2004). There was no significant difference were noted down in grain and stover yield when different pulses were grown as intercrop. However the mean values shows that higher growing blackgram as intercrop recorded higher grain and stover yield of 6706 and 14864 kg ha<sup>-1</sup>, respectively.

**Table. 2 Effect of irrigation regimes and fertigation levels on the yield of maize under sub surface drip irrigation in cotton-maize cropping sequence**

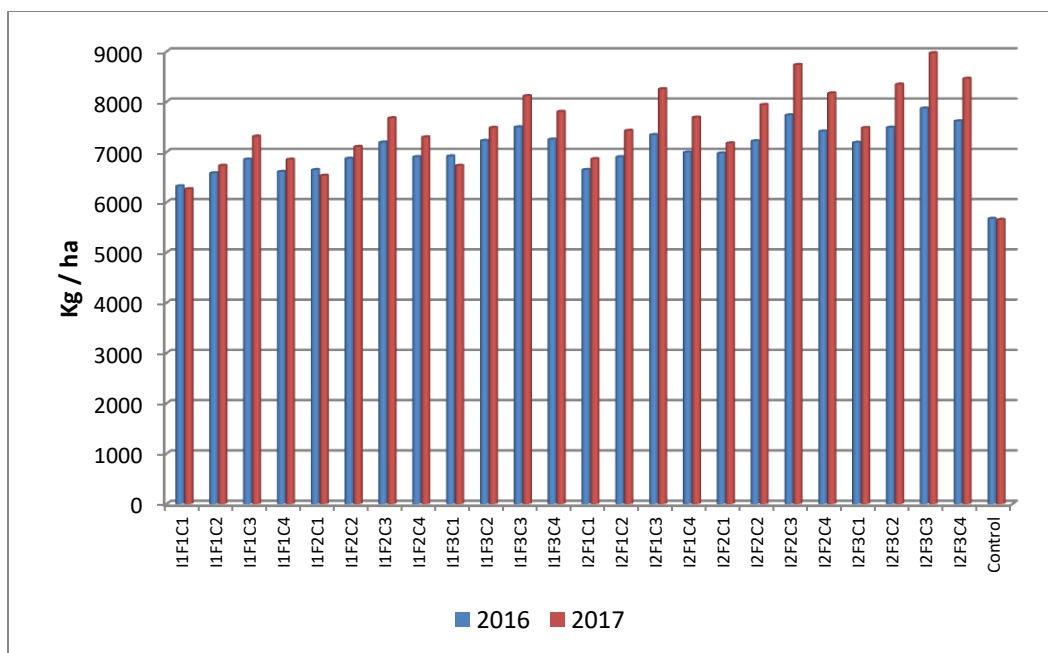
Treatments	Grain yield (kg/ha)	Stover yield (kg / ha)
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<b>Irrigation regimes</b>	<b>2016</b>	<b>2017</b>	<b>Pooled mean</b>	<b>2016</b>	<b>2017</b>	<b>Pooled mean</b>
I1 – 75 % PE	6521	6385	6453	14663	14080	14372
I2 – 100 % PE	6873	7008	6941	15096	15498	15297
S.Ed	<b>139.7</b>	<b>141.0</b>		<b>304</b>	<b>304.4</b>	
CD (0.05%)	<b>NS</b>	<b>606.6</b>		<b>NS</b>	<b>1309.7</b>	
<b>Fertigation levels</b>						
F1 – 75 % RDF	6425	6419	6422	14062	13855	13959
F2 – 100 % RDF	6719	6703	6711	14872	14789	14831
F3 – 125 % RDF	6946	6967	6957	15705	15723	15714
S.Ed	<b>143.5</b>	<b>144.3</b>		<b>317.1</b>	<b>318.4</b>	
CD (0.05%)	<b>330.9</b>	<b>332.8</b>		<b>731.2</b>	<b>734.3</b>	
<b>Intercrops</b>						
C1- Maize	6785	6860	6823	14960	15024	14992
C2 -Maize + Cow pea	6704	6580	6642	14890	14554	14722
C3 -Maize + black gram	6687	6724	6706	14857	14870	14864
C4-Maize +Cluster bean	6612	6622	6617	14811	14708	14760
S.Ed	<b>166.5</b>	<b>165.7</b>		<b>370.1</b>	<b>364.8</b>	
CD (0.05%)	<b>NS</b>	<b>NS</b>		<b>NS</b>	<b>NS</b>	
<b>Control (surface irrigation)</b>	5678	5656	5667	12347	12571	12459

### 3.5. Maize equivalent yield

The maize equivalent yield was worked out for two different years, among the treatment combinations irrigation given at 100 per cent based PE and fertigation with 125 per cent RDF and intercropped with blackgram recorded higher maize equivalent yield of 7872 and 8974 kg ha<sup>-1</sup> in 2016 and 2017, respectively (Figure 2). This may be assigned to the synergetic effect of maize and blackgram in utilization of natural resources. Addition of dry matter to the soil and nitrogen fixation by pulse intercrops with maize were also the cause for higher maize equivalent yield in these treatments. Similarly, Shivay *et al.* (1999) have observed higher maize equivalent yield with maize + urdbean/soybean intercropping system over sole maize.

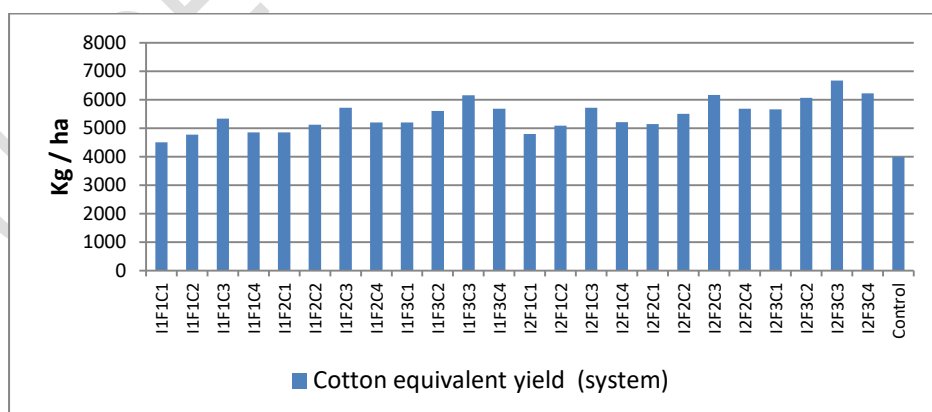
**Figure 2. Effect of irrigation regimes and fertigation levels on the Maize equivalent yield under sub surface drip irrigation in cotton-maize cropping sequence**



### 3.6. Cotton equivalent yield (system)

The cotton equivalent yield was worked out for two different years, among the treatment combinations irrigation given at 100 per cent PE and fertigation with 125 per cent RDF and intercropped with blackgram recorded higher cotton equivalent yield of 6668 kg ha<sup>-1</sup> (Figure 3). Generally, the production of a system depends not on the efficiency of individual component crop of the system but also how well these crops compliment with each other in time and space. Therefore the overall productivity of maize based system depends partly on the efficiency of crop itself and partly on how well maize fits in with other intercrops and vice versa.

**Figure 3. Effect of irrigation regimes and fertigation levels on the cotton equivalent yield (system) under sub surface drip irrigation in cotton-maize cropping sequence**



## 4. CONCLUSION

In cotton based intercropping, cotton + blackgram intercropping would be the ideal Irrigation at 100 % PE with 125 % RDF (150:75:75 kgs NPK/ha) resulted in higher cotton yield (3860

kg/ha cotton equivalent yield) and with water saving of 24 per cent. 75 % PE - yield increase in cotton 18.9 % with water saving of 40.6 %. In maize based intercropping system, maize + black gram intercropping would be the best system. Irrigation at 100 % PE irrigation regime with 100 % RDF (250: 75: 75 Kgs NPK) gave higher maize yield (7735kg/ha maize equivalent yield). In cotton – maize sequence, intercropping of black gram found to be best suitable system with the irrigation level of 100 % PE and 125 % RDF (150:75:75 kg NPK/ha) for cotton and 100 % PE irrigation regime with 100 % RDF (250: 75: 75 kg NPK/ha) for maize is recommended to get higher yield in the system.

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