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S Thenmozhi
Krishi Vigyan Kendra, Tamil Nadu Agricultural University, Pongalur, Tiruppur, Tamil Nadu, India

G Thiyagarajan
Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

M Manikandan
Agricultural Research Station, Tamil Nadu Agricultural University, Kovilpatti, Tamil Nadu, India

J Bhuvaneswari
Agricultural College and Research Institute, Tamil Nadu Agricultural University, Killikulam, Tamil Nadu, India

Corresponding Author:
G Thiyagarajan
Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Studies on growth, yield and water use efficiency of maize as influenced by irrigation methods and fertilizer application

S Thenmozhi, G Thiyagarajan, M Manikandan and J Bhuvaneswari

Abstract
An experiment was laid out in strip plot design with three replications. Each replication consist of eighteen treatment combinations with six irrigation methods *viz*., I_1 – Drip irrigation, I_2 – Drip fertigation, I_3 – Sub surface drip irrigation, I_4 – Sub surface drip fertigation, I_5 – Sprinkler irrigation and I_6 – Conventional method of irrigation as main plot and three fertilizer levels *viz*., S_1 – Absolute control (No fertilizer), S_2 – Recommended dose of NPK fertilizers through normal fertilizers / Recommended dose of NPK fertilizers through water soluble fertilizers (According to the irrigation treatment) and S_3 - S_2 + Vermicompost @ 5 t ha^{-1} in sub plot. The growth and yield parameters *viz.*, the plant height, cob length, cob girth and hundred seed weight were recorded during harvest. The growth and yield attributes, yield, economics and water use efficiency recorded higher values in sub surface drip fertigation (I_4). Similarly, application of fertilizer *i.e*., 100% of recommended dose (250: 75: 75 kg NPK ha^{-1}) of NPK fertilizers + vermicompost @ 5 t ha^{-1} recorded significantly higher values of above mentioned growth and yield attributes as well as yield, economic and water use efficiency than the other treatments.

Keywords: Maize, irrigation methods, fertilizer application, growth and yield parameters, yield, economics, water use efficiency

Introduction
Maize (*Zea mays* L.) also called corn, is one of the most crucial and strategic crop in the world. Its origin is Mexico (Central America) and it is also called as queen of cereals due to its great importance in human and animal diet with high yield potential. It is ranked third after wheat and rice in area and production in the world, but in productivity, it surpasses all cereals. In India, area and production of maize is about 9.43 million hectares and 24.35 million tones, respectively, having average productivity of about 2337 kg ha-1 (Anonymous, 2014) [1].
Generally, irrigation frequency and water application methods play an important role to achieve the full yield potential of food, fiber and vegetable crop. Hence, it becomes an essential to give more concern over scheduling of irrigation, which will help to achieve the higher productivity, optimum use of water with better irrigation efficiency particularly for crop like maize. Normally many soils in India are with low organic matter content and are inherently low in fertility. Such soils often require replenishment of nutrient deficiency by application of manures and fertilizers to increase crop yield. Now a day's micro irrigation technique such as the drip and micro sprinkler irrigation systems are gaining momentum and popularity amongst the farmers. Conventional method of applying fertilizers by broadcasting uniformly on the surface or by drilling a continuous band of fertilizers alongside the row crop are not compatible with drip irrigation system, because in drip irrigation system water is applied only to a fraction of soil volume (near the root zone). In this wetted zone only, we have to apply fertilizers with nutrients, which are essential for plant growth. Surface application of dry fertilizers may not ensure optimum placement, moreover, requires lot of man power and time consuming compared to fertigation through drip system. Drip irrigation is more desirable than any other irrigation methods for several reasons. Two major advantages are (1) water conservation (drip requires about half as much water over the growing season as surface irrigation) and (2) the potential for significantly improving fertilizer management (Bibe *et al.*, 2016) [2]. Reddy and Reddy (2016) [8] reported that drip irrigation can save water up to 40-70 per cent as well as increasing the crop production to the extent of 20-100 per cent. Fertigation is timely application of small amount of fertilizer through drip tubes directly to the root zone. Compared to conventional soil application, fertigation improves fertilizer use efficiency.

Subsequently, comparable or better yields and quality can be produced with 20-50 per cent less fertilizers.

Material and Methods

The field experiment was conducted at Agricultural Research Station, Bhavanisagar, Erode district, Tamil Nadu. The soil in the experimental plot was red sandy loam. The experiment was laid out in strip plot design with three replications. Each replication consist of 18 treatment combinations with six irrigation methods *viz*., I_1 – Drip irrigation, I_2 – Drip fertigation, I_3 – Sub surface drip irrigation, I_4 – Sub surface drip fertigation, I_5 – Sprinkler irrigation and I_6 – Conventional method of irrigation as main plot and three fertilizer levels *viz*., S_1 – Absolute control (No fertilizer), S_2 – Recommended dose of NPK fertilizers through normal fertilizers / Recommended dose of NPK fertilizers through water soluble fertilizers (According to the irrigation treatment) and S_3 - S_2 + Vermicompost @ 5 t ha^{-1} in sub plot. The gross plot size was 15 M^2. Irrigations and fertilizers were applied as per treatment schedule. The volume of water to be applied was calculated as per the treatment of irrigation level. The recommended dose of fertilizer for maize was 250: 75: 75 kg NPK ha^{-1}. The growth and yield parameters *viz*., the plant height, cob length, cob girth and hundred seed weight and yield were recorded during harvest.

Result and Discussion

Growth and yield attributes

The growth and yield attributes *viz*., the plant height, cob length, cob girth and hundred seed weight were recorded and reported in table 1. The data indicated that, among the main plot treatments I_4 (sub surface drip fertigation) recorded the highest plant height (200.8 cm), and there was no significant difference between the main plot treatments. The subplot treatments significantly influenced the plant height. Among the subplot treatments the highest plant height of 212.0 cm was recorded by S_3 (recommended dose of NPK fertilizers + vermicompost @ 5 t ha^{-1}) followed by S_2 and S_1. Among the interactions, sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha^{-1} (I_4S_3) recorded the highest plant height.

The data on cob length and cob girth of maize indicated that, among the main plot treatments I_4 (sub surface drip fertigation) recorded the highest cob length (16.6 cm) and cob girth (15.1 cm) and the parameters were significantly influenced by the main plot treatments. Among the subplot treatments the highest cob length (17.1cm) and cob girth (15.4 cm) were recorded by S_3 (recommended dose of NPK fertilizers + vermicompost @ 5 t ha^{-1}). The cob length was not significantly influenced by subplot treatments. Among the interactions, sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha^{-1} (I_4S_3) recorded the highest cob length and cob girth.

With respect to hundred grain weight of maize, the main plot treatments were significantly influenced the parameter. Among the main plot treatments the highest value of 45.0 gm was recorded by I_4 (sub surface drip fertigation) and the treatments I_2, I_3, and I_4 were on par with each other. Among the subplot treatments the highest hundred grain weight (44.3 gm) was recorded by S_3 (recommended dose of NPK fertilizers + vermicompost @ 5 t ha^{-1}) and the treatments S_2 and S_3 were on par with each other. Among the interactions, sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha^{-1} (I_4S_3) recorded the highest hundred grain weight. Better growth of maize under subsurface drip fertigation might be attributed to better moisture availability, soil aeration and also crop did not experience stress during the crop growth period. This ultimately reflected better physiological activity in plant and there by increased the plant height, cob length, cob girth and hundred seed weight (Bibe *et al*., 2016) [2]. Similar findings were reported by Leta Tulu (1998). Better growth attributes under 100 per cent RDF through drip + vermicompost @ 5 t ha^{-1} as compared to lower dose of fertilizer through soil application indicated that maize crop showed better response to increased fertilization of NPK and also better performance of water soluble fertilizers over application of fertilizers through soil. This might be attributed to better availability of nutrients under application of water soluble fertilizer which resulted in better or on par growth attributes with low fertigation levels. Similar results were reported by Sampatkumar and Pandian (2010) [9] and Muthurakrishnan and Anitta Fanish (2011) [6].

Table 1: Growth and yield attributes of maize as influenced by treatments

Treatments	Plant height (cm)				Cob length (cm)				Cob girth (cm)				100 grain weight (g)			
	S_1	S_2	S_3	**Mean**	S_1	S_2	S_3	**Mean**	S_1	S_2	S_3	**Mean**	S_1	S_2	S_3	**Mean**
I_1	165.0	188.3	212.3	188.6	13.8	15.4	16.6	15.3	12.7	14.3	14.9	14.0	33.9	41.2	42.5	39.0
I_2	166.7	193.3	216.7	192.2	14.2	15.8	17.1	15.7	12.2	14.2	16.0	14.1	34.6	39.8	45.7	40.0
I_3	166.7	193.3	207.3	189.1	14.5	16.4	18.1	16.3	13.0	14.4	16.0	14.5	35.5	45.0	47.8	42.8
I_4	184.3	198.3	220.0	200.8	14.6	16.9	18.4	16.6	13.6	14.7	16.9	15.1	36.8	46.9	51.3	45.0
I_5	167.3	182.3	208.3	186.0	13.7	15.5	16.2	15.1	12.0	12.8	14.4	13.0	32.0	39.2	40.4	37.2
I_6	151.6	176.7	207.3	178.6	13.6	12.9	16.1	14.2	11.5	12.8	14.4	12.9	30.5	37.2	38.0	35.2
Mean	166.9	188.7	212.0		14.1	15.5	17.1		12.5	13.9	15.4		33.9	43.2	44.3	
	SED		CD (0.05)		SED		CD (0.05)		SED		CD (0.05)		SED		CD (0.05)	
I	6.0		NS		0.51		1.13		1.00		2.23		2.5		5.6	
S	17.8		39.6		0.32		0.65		0.25		NS		0.83		1.7	
I at S	21.4		46.6		0.81		1.73		1.12		2.45		3.0		6.6	
S at I	14.7		NS		0.77		NS		0.61		1.25		2.03		NS	

The grain and stalk yield (Table 2) of maize was significantly influenced by irrigation and fertilizer treatments. The grain yield of maize indicated that, sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha^{-1} (I_4S_3) recorded the highest grain yield of 6558 kg ha^{-1}, followed by sub surface drip irrigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha^{-1} (I_3S_3). The lowest yield was recorded with conventional method of irrigation with no fertilizer (I_6S_1). The stalk yield of maize showed similar trend as that of grain yield. Sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha^{-1} (I_4S_3) registered the highest stalk

yield of 11300 kg ha^{-1} which was followed by sub surface drip irrigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha^{-1} (I_3S_3) as 10665 kg ha^{-1} and the lowest yield of 7640 kg ha^{-1} was noticed with conventional method of irrigation with no fertilizer (I_6S_1).

Significantly higher grain and stock yield was observed with sub surface drip fertigation (I_4) than other methods of irrigation. This might be attributed due to better growth and yield attributes under sub surface drip fertigation compared to other irrigation methods. These findings are in conformity with the findings of Gautam *et al*. (2000) [4], Tariq *et al*. (2003) [10] and Ponnuswamy and Santhi (2008) [7]. Under moisture stress condition all the growth factors were affected adversely to a greater extent. This was evident from the significantly reduced growth and yield parameters in rest of the irrigation methods. This resulted in the reduction in grain and stalk yield due to low moisture availability and was also shown by Classen and Show (1970). Thus, revealing the significance of growth and yield parameters in enhancing the grain and stalk yield. These results are in line with those of reported by Thorat and Ramteke (1988) [11] and Vijayalakshmi *et al*. (1994) [12].

Table 2: Yield of maize as influenced by treatments

Treatments	Grain yield (Kg ha^{-1})				Stover yield (Kg ha^{-1})			
	S_1	S_2	S_3	**Mean**	S_1	S_2	S_3	**Mean**
I_1	4330	5096	5567	4998	8100	9192	9840	9076
I_2	4456	5232	5952	5213	8196	9646	10030	9105
I_3	4870	5560	6364	5598	8826	9858	10665	9783
I_4	5032	5868	6558	5819	9125	10354	11300	10260
I_5	4260	4715	5368	4781	7782	9067	9527	8898
I_6	3500	4109	4600	4070	7640	8895	9520	8732
Mean	4908	5097	5735		8278	9502	10147	
	S.Ed		CD (0.05)		S.Ed		CD (0.05)	
I	104		289		97		274	
S	124		250		101		250	
I at S	226		492		191		426	
S at I	214		433		173		350	

Economics

Irrigation regimes and fertilizer treatments increased the net returns. Sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha^{-1} (I_4S_3) recorded the highest B: C ratio of 2.37 followed by sub surface drip fertigation with recommended dose of NPK fertilizers (I_4S_2) as 2.24. The lowest B: C ratio of 1.80 was recorded with conventional method of irrigation with no fertilizer (I_6S_1).

Table 3: Show the Maize

Treatments	Grain Yield (kg ha^{-1})	Income (Rs.)	Stover yield (kg ha^{-1})	Income (Rs.)	Total income (Rs.)	Cost of cultivation (Rs.)	Net returns (Rs.)	B: C ratio
I_1S_1	4330	56290	8100	6075	62365	32500	29865	1.92
I_1S_2	5096	66248	9192	6894	73142	35000	38142	2.09
I_1S_3	5567	72371	9840	7380	79751	37500	42251	2.13
I_2S_1	4456	57928	8196	6147	64075	32500	31575	1.97
I_2S_2	5232	68016	9646	7235	75251	35000	40251	2.15
I_2S_3	5952	77376	10030	7523	84899	37500	47399	2.26
I_3S_1	4870	63310	8826	6620	69930	34500	35430	2.03
I_3S_2	5560	72280	9858	7394	79674	37000	42674	2.15
I_3S_3	6364	82732	10665	7999	90731	39500	51231	2.30
I_4S_1	5032	65416	9125	6844	72260	34500	37760	2.09
I_4S_2	5868	76284	10354	7766	84050	37000	47050	2.24
I_4S_3	6558	85254	11300	8475	93729	39500	54229	2.37
I_5S_1	4260	55380	7782	5837	61217	32500	28717	1.88
I_5S_2	4715	61295	9067	6800	68095	35000	33095	1.95
I_5S_3	5368	69784	9527	7145	76929	37500	39429	2.05
I_6S_1	3500	45500	7640	5730	51230	28500	22730	1.80
I_6S_2	4109	53417	8895	6671	60080	31000	29080	1.94
I_6S_3	4600	59800	9520	7140	66940	33500	33440	2.00

Cost of maize grain = Rs. 13.00/ kg, cost of maize stover = Rs. 750/ ton

Water use efficiency

The water use efficiency was worked out and furnished Table 4. The results showed that, the highest total water used was noticed in conventional method of irrigation as 667.9 mm and 839.1mm for maize and groundnut respectively. The water use efficiency of treatments indicated that, the highest water use efficiency values was noted with sub surface drip fertigation as 15.163 kg / ha.mm 6.176 kg / ha.mm for maize and groundnut respectively and the lowest value was noted with conventional method of irrigation as 5.240 kg / ha. mm and 1.251 kg / ha. mm for maize and groundnut respectively.

Table 4: Total water used and water use efficiency

Particu. / Treat.	Maize		
	Yield (kg/ha)	**Total water used (mm)**	**WUE (kg/ha.mm)**
I_1S_1	4330	432.5	10.012
I_1S_2	5096	432.5	11.783
I_1S_3	5567	432.5	12.872
I_2S_1	4456	432.5	10.303
I_2S_2	5232	432.5	12.097
I_2S_3	5952	432.5	13.762
I_3S_1	4870	432.5	11.260
I_3S_2	5560	432.5	12.855
I_3S_3	6364	432.5	14.714
I_4S_1	5032	432.5	11.635
I_4S_2	5868	432.5	13.568
I_4S_3	6558	432.5	15.163
I_5S_1	4260	432.5	9.850
I_5S_2	4715	432.5	10.902
I_5S_3	5368	432.5	12.412
I_6S_1	3500	667.9	5.240
I_6S_2	4109	667.9	6.152
I_6S_3	4600	667.9	6.887

Conclusion

It can be concluded from the results that sub surface drip fertigation with recommended dose of NPK fertilizers + vermicompost @ 5 t ha^{-1} (I_4S_3) is superior in enhancing the growth and yield attributes, yield, economics and water use efficiency in maize under maize and groundnut cropping system when compared to other treatment combinations.

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References

1. Anonymous. 2014. The current status published on website – http://www.indiastat.in.
2. Bibe SM, Jadhav KT, Gite RV. Studies on Growth and Yield of Post Kharif Maize as Influenced by Irrigation and Fertigation Management, J Agric. Res. Technol. 2016;41(3):396-402.
3. Claassen MM and Shaw RH. Water deficit effect on corn I (vegetative component). Agron. J. 1970;62:649-652.
4. Gautam RC, Pachuri P, Singh V and Gaur NS. Response of winter maize (*Zea mays*) to irrigation schedule and tassel removal. Indian J. Agril. Sci. 2000;70(12):859-860.
5. Leta Tulu. Response of maize (*Zea mays* L.) to moisture stress at different growth stages: A modelling approach. M.Sc. (Agri.) thesis, Univ. of Agril. Sciences, Bangalore. 1998.
6. Muthurakrishnan P, Anitta Fanish S. Influence of drip Fertigation on yield water saving and WUE in maize. Madras Agric. J. 2011;98(7-9):243-247.
7. Ponnuswamy K and Santhi P. Drip fertigation for enhancing productivity in maize (*Zea mays* L.). Green farming. 2008;2(3):148-149.
8. Reddy Yelmenda T and Reddy Sankara GH. Principles of agronomy. Fifth revised edition. Kalyani Publishers. New Delhi. 2016, 374-375.
9. Sampatkumar T and Pandian BJ. Effect fertigation frequencies and levels on growth and yield of maize. Madras Agric. J. 2010;97(7-9):245-248.
10. Tariq JA, Khan MJ and Usman K. Irrigation scheduling of maize crop by pan evaporation method. Pakistan J of water resources. 2003;7(2):29-36
11. Thorat ST, Ramteke JR. Dry matter accumulation in forage maize as influenced by irrigation and nitrogen levels. J. Maharashtra Agric. Univ. 1988;13(2):211-212.
12. Vijayalakshmi R, Ramamoorthy K, Rajagopala A. Effect of irrigation and coir waste on green gram and succeeding fodder maize. Indian J Agron. 1994;39(3): 470-471.