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Evaluation of drip irrigation regimes and fertigation levels on yield of maize (*Zea mays* L.)

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Abstract
Field experiments were conducted at Tamil Nadu Agricultural University, during *Kharif* 2008 and *Kharif* 2009 at Coimbatore to study the effect of drip irrigation regimes and fertigation levels on yield of maize. The experiment was laid out in split plot design with three replications. The treatments included two irrigation regimes in main plot and eight fertigation levels in sub plot. In main plot, two irrigation regimes *viz.*, M_1 - Irrigation through drip at 75 per cent PE once in 3 days, M_2 - Irrigation through drip at 100 per cent PE once in 3 days were accommodated. The sub plot treatments consisted of eight fertigation levels *viz.*, S_1 - Drip fertigation with 75 per cent RDF (P as basal), S_2 - Drip fertigation with 100 per cent RDF (P as basal), S_3 - Drip fertigation with 125 per cent RDF (P as basal), S_4 - Drip fertigation with 150 per cent RDF (P as basal), S_5 - Drip fertigation with 75 per cent RDF with P through WSF (17:44:0), S_6 - Drip fertigation with 100 per cent RDF with P through WSF (17:44:0), S_7 - Drip fertigation with 125 per cent RDF with P through WSF (17:44:0) and S_8 - Drip fertigation with 150 per cent RDF with P through WSF (17:44:0). Control plots with surface irrigation at 0.80 IW / CPE ratio for maize with soil application of 100 per cent RDF were maintained separately for comparison. Drip irrigation at 100 % PE once in 3 days resulted in significantly higher grain yield of maize followed by irrigation at 75 % PE. Drip fertigation at 150 per cent RDF (225: 112.5: 112.5) with P through water soluble fertilizer registered significantly higher grain yield. Considering the high cost of water soluble fertilizers, drip irrigation at 100 per cent PE with fertigation level of 125 per cent RDF with P as basal could be an alternative option to realize a reasonably good yields in maize.

Keywords: Drip fertigation, Drip irrigation, Water soluble fertilizer

Introduction
Maize (*Zea mays* L.) is an important cereal crop of India and plays pivotal role in agricultural economy both as staple food for larger section of population, raw materials for industries and feed for animals. With intention of achieving evergreen revolution, intensive research in maize has been started anticipating its importance for food and feed. In India maize is grown in an area of 6.2 m.ha, with a production of 10.57 m.t and the average productivity is 1700 kg ha^{-1}. The present annual requirement of grain maize for different purposes is 12 m.t of which 4.5 m.t for poultry (Sounderarajan, 2002) [7] with a gap of 1.5 m.t. In Tamil Nadu, maize is cultivated in an area of 0.20 m.ha. with a production of 0.24 m.t. with an average productivity of 1189 kg ha^{-1}. By 2020 AD, the requirement of maize for various sectors will be around 100 m.t, of which the poultry sector demand alone will be around 31m.t. (Seshaiah, 2000) [8].
Drip irrigation holds promise in this respect (Narda and Lubana, 1999) [4]. Drip fertigation permits application of nutrients directly at the site of high concentration of active roots (Sivanappan *et al.*, 1987) [9]. Since nutrients are applied to a limited soil volume, the fertilizer use efficiency is also high. On the other hand, conventional fertilization especially on light soils may cause N losses through leaching and volatilization. Drip fertigation also enables accurate adjustment of water and nutrient supplies to meet the crop requirements and thus minimizing the loss of expensive nutrients which ultimately helps in improving productivity and quality of farm produce.

Materials and Methods
Field experiments were conducted during 2007 - 2009 at Tamil Nadu Agricultural University, Coimbatore to study the effect of drip irrigation regimes and fertigation levels on yield of maize. The experiment was laid out in split plot design with three replications. The treatments included two irrigation regimes in main plot and eight fertigation levels in sub plot. In main plot, two irrigation regimes *viz.,* M_1 - Irrigation through drip at 75 per cent PE once in 3 days, M_2 - Irrigation through drip at 100 per cent PE once in 3 days were accommodated. The sub plot treatments consisted of eight fertigation levels *viz.,* S_1 - Drip fertigation with 75 per cent

RDF (P as basal), S_2 - Drip fertigation with 100 per cent RDF (P as basal), S_3 - Drip fertigation with 125 per cent RDF (P as basal), S_4 - Drip fertigation with 150 per cent RDF (P as basal), S_5 - Drip fertigation with 75 per cent RDF with P through WSF (17:44:0), S_6 - Drip fertigation with 100 per cent RDF with P through WSF (17:44:0), S_7 - Drip fertigation with 125 per cent RDF with P through WSF (17:44:0) and S_8 - Drip fertigation with 150 per cent RDF with P through WSF (17:44:0). Control plots with surface irrigation at 0.80 IW / CPE ratio for maize with soil application of 100 per cent RDF were maintained separately for comparison.

Results and Discussion

Grain yield of maize was found to be significantly influenced by drip irrigation and fertigation levels (Table 1 and 2).Drip irrigated maize at 100 per cent PE recorded significantly higher grain yield of 6439 and 6842 kg ha^{-1} as compared to 75 per cent PE irrigation regime (6087 and 6317 kg ha^{-1}) during *Kharif* 2008 and *Kharif* 2009 respectively. The yield increase observed under 100 per cent PE irrigation regime was 5.8 and 8.3 per cent than 75 per cent PE during *Kharif* 2008 and *Kharif* 2009 respectively.

Drip irrigated maize recorded significantly higher grain yield in both the years of study compared to surface method of irrigation (4250 and 4500 kg ha^{-1}). Among the different fertigation treatments, drip fertigation at 150 per cent RDF with P as WSF (Urea phosphate) registered the highest grain yield of 7154 and 8078 kg ha^{-1} respectively during *Kharif* 2008 and *Kharif* 2009 respectively followed by 125 per cent RDF + P as WSF (6915 and 7118 kg ha^{-1}). The yield increase under drip fertigation at 150 per cent RDF with P as WSF was 24 and 38 per cent in *Kharif* 2007 and *Kharif* 2008 respectively over 100 per cent RDF with P as basal. An yield increase of 68 and 79 per cent was realized under drip fertigation at 150 per cent RDF with P as WSF over surface method of irrigation with 100 per cent RDF as soil application during *Kharif* 2008 and *Kharif* 2009.

The grain yield under drip fertigated maize at 75 per cent RDF with P as WSF (6030 and 6292 kg ha^{-1}) was 5.2 and 7.5 per cent higher than at 100 per cent RDF with P as basal application (5732 and 5852 kg ha^{-1}). It is interesting to note that drip fertigated maize at 125 per cent RDF with P as basal recorded a grain yield of 6125 and 6383 kg ha^{-1}. It was onpar with drip fertigation at 75 per cent RDF with P as 17:44:0 WSF grade (6030 and 6296 kg ha^{-1}) during *Kharif* 2008 and *Kharif* 2009 respectively. Drip irrigation at 75 per cent RDF with P as basal recorded a grain yield of 5588 and 5675 kg ha^{-1} during *Kharif* 2008 and *Kharif* 2009 respectively which was 31.4 and 26.1 per cent higher than surface irrigation with conventional method of fertilizer application. The interaction effect between irrigation regimes and fertigation levels was found significant. Under 100 per cent PE irrigation regime, application of 150 per cent RDF with P as WSF (17 : 44 : 0 grade) significantly recorded higher grain yield (7354 and 7873 kg ha^{-1}) compared to other treatment combinations.

Stover yield

Stover yield of maize was found to be significantly influenced by drip irrigation and fertigation levels (Table 1 and 2).

The stover yield was higher with drip irrigated maize in both the seasons as compared to surface irrigated crop. Drip irrigation at 100 per cent PE recorded significantly higher stover yield (10374 and 10329 kg ha^{-1}) of maize compared to 75 per cent of PE irrigation regime (9790 and 9396 kg ha^{-1}). The stover yield increase observed under 100 per cent irrigation PE regime was 6.0 and 10.0 per cent than 75 per cent PE during *Kharif* 2008 and *Kharif* 2009 respectively.

Among the different fertigation treatments, drip fertigation at 150 per cent RDF with P as WSF registered the highest stover yield of 11113 and 106022 kg ha^{-1} respectively during *Kharif* I year and *Kharif* II followed by 125 per cent RDF + P as WSF (10738 and 10420 kg ha^{-1}). The stover increase under drip fertigation at 150 per cent RDF with P as WSF was 17 and 18 per cent in *Kharif* 2007 and *Kharif* 2008 respectively over 100 per cent RDF with P as basal. A stover yield increase of 23 and 16 was realized under drip fertigation at 150 per cent RDF with P as WSF over surface method of fertigation with conventional method of RDF during *Kharif* I year and *Kharif* II respectively. Drip irrigation at 75 per cent RDF with P as basal stover yield of 9292 and 8958 kg ha^{-1} during *Kharif* 2008 and *Kharif* 2009 respectively.

The interaction effect between irrigation regimes and fertigation levels was found significant. Under 100 per cent PE irrigation regime with application of 150 per cent RDF with P as WSF significantly recorded higher grain yield (11255 and 11310 kg ha^{-1} respectively) compared to other treatment combinations.

The aim of any applied research is to get maximum income in terms of increased yield. The yield attributing characters of maize (cob length, cob girth, cob weight, number of grain rows cob^{-1}, number of grains cob^{-1} and hundred grain weight) were significantly influenced by drip irrigation regimes and fertigation levels. The yield attributing characters of the two crops in four seasons were higher under drip irrigation at 100 per cent PE with 150 per cent RDF with P as WSF followed by 125 per cent RDF with P as WSF through fertigation because higher rates of nutrients resulted in better translocation of assimilates from source to sink. Better crop growth at higher nutrient levels might have influenced the yield attributes favourably. This finding was in accordance with the findings of Ranjodh Singh (1983) [6] and Narayanasamy *et al.* (1994) [5].

Roots can easily translocate absorbed water from the soil where available soil moisture content was optimum at 100 per cent PE. Required energy for water absorption was less under these treatments and ultimately led to easy energy translocation to the reproductive parts. Also the root growth under these treatments was high which contributed to higher moisture translocation from the soil to the plant parts. Also the nutrients were applied in adequate quantity and were in easily available form which created more conducive environment for the roots to absorb the nutrients more effectively and at higher rate when compared to other treatments. 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.

The increase in yield under 150 and 125 per cent RDF with P as WSF might be due to the fact that fertigation at higher dose obviously resulted in higher availability of all the three (NPK) 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 gherkins under drip fertigation by Sundar Raman *et al.* (2000) [10].

According to Marschner (1983) [3], a balanced supply of nitrogen promotes the translocation of phytohormones to the shoot that probably induces the flower and fruit initiation. The results showed that application of 150 per cent of RDF with P as water soluble fertilizer recorded the highest grain yield in maize. This increase in number might be due to higher production of photosynthates resulting in increased production of fruits and thereby yield per plant. These results were in accordance with the findings of Yadav and Singh (1995) [14], Locascio and Smajstrala (1995) [2] and Salvadore *et al.* (1997) [11]. Prabhakar (1997) [12] also reported that the continuous supply of irrigation water through drip irrigation at the root zone resulted in increased yield under protected cultivation using micro irrigation system.

The low yield at lower levels of fertigation and soil application of normal straight fertilizer might probably be due to the low uptake of nutrients resulting in lower dry matter accumulation. The perusal of the yield data showed the favourable effect of drip fertigation on the yield of maize. The yield per plant and yield per hectare were significantly improved by the application of major nutrients through fertigation as boost the overall vegetative growth and biological efficiency of the plant. The increase in yield might be due to better proportion of air-soil-water which was maintained throughout the life period of crop in drip irrigation as compared to surface irrigation as reported by Kadam and Karthikeyan (2006) [1].

Fertigation with higher rates of fertilizer resulted in higher availability of required nutrients in soil solution which obviously led to increased growth, leaf area, higher uptake of nutrients, better photo assimilation and better translocation of assimilates from source to sink which in turn increased the yield as reported by Prince *et al.* (1988) [13].

Table 1: Effect of drip irrigation regimes and fertigation levels on grain and stover yield (kg ha^{-1}) of maize – *Kharif* 2008

Treatments	Grain yield			Stover yield		
	M_1	M_2	Mean	M_1	M_2	Mean
S_1 – 75 % RDF + P Basal	5450	5726	**5588**	9125	9459	**9292**
S_2 – 100 % RDF + P Basal	5633	5831	**5732**	9200	9759	**9480**
S_3 – 125 % RDF + P Basal	6035	6215	**6125**	9188	9997	**9592**
S_4 – 150 % RDF + P Basal	5954	6460	**6207**	9659	10137	**9898**
S_5 – 75 % RDF + P WSF	5881	6179	**6030**	9899	10510	**10205**
S_6 – 100 % RDF + P WSF	6014	6690	**6352**	9942	10740	**10341**
S_7 – 125 % RDF + P WSF	6771	7059	**6915**	10338	11137	**10738**
S_8 – 150 % RDF + P WSF	6954	7354	**7154**	10972	11255	**11113**
Mean	**6086**	**6439**		**9790**	**10374**	
Surface Irrigation	**4250**			**9010**		

	Grain yield				Stover yield			
	M	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**
SEd	34.71	95.38	130.86	134.88	28.33	102.12	182.81	240.99
CD (p=0.05)	149.36	195.38	288.81	276.30	121.91	235.52	364.96	533.60

Table 2: Effect of drip irrigation regimes and fertigation levels on grain and stover yield (kg ha^{-1}) of maize – *Kharif* 2009

Treatments	Grain yield			Stover yield		
	M_1	M_2	Mean	M_1	M_2	Mean
S_1 – 75 % RDF + P Basal	5433	5917	**5675**	8550	9367	**8958**
S_2 – 100 % RDF + P Basal	5621	6083	**5852**	8567	9483	**9025**
S_3 – 125 % RDF + P Basal	6150	6617	**6383**	9300	9967	**9633**
S_4 – 150 % RDF + P Basal	6307	6985	**6646**	10133	10300	**10217**
S_5 – 75 % RDF + P WSF	5975	6617	**6296**	9420	10550	**9985**
S_6 – 100 % RDF + P WSF	6083	7093	**6588**	9533	10550	**10042**
S_7 – 125 % RDF + P WSF	6687	7550	**7118**	9733	11107	**10420**
S_8 – 150 % RDF + P WSF	8283	7873	**8078**	9933	11310	**10622**
Mean	**6317**	**6842**		**9396**	**10329**	
Surface Irrigation	**4500**			**9120**		

	Grain yield				Stover yield			
	M	**S**	**M at S**	**S at M**	**M**	**S**	**M at S**	**S at M**
SEd	120.68	154.82	218.95	237.72	136.37	159.83	192.81	240.99
CD (p=0.05)	250.15	395.25	448.51	625.06	279.28	387.72	394.96	732.62

Reference

1. Kadam JR, Karthikeyan S. Effect of soluble NPK fertilizers on the nutrient balance, water use efficiency, fertilizer use efficiency of drip system in a Tomato. *Internat. J Plant. Sci.* 2006; 1:92-94.
2. Locascio SJ, Smajstrla AG. Water and N-K application timing for drip irrigation tomato 38th Annual Meeting of the international Soc. for Tropical. Hort. 1995; 36:104-111.
3. Marschner H. Introduction to the mineral nutrition of plants. In: Handb. *Plt physiol.* 1983; 154:31-38.
4. Narda NK, Lubana SP. Growth dynamics studies of tomatoes under sub-surface drip irrigation. J Res. Punjab Agric. Univ. 1999; 36(3-4):222-233.
5. Narayanaswamy MR, Veerabadran V, Jayanthi C, Chinnuswamy C. Plant density and nutrient management for rainfed maize in red soils. Madras Agric. J. 1994; 81(5):248-251.

6. Ranjodh Singh. Integrated fertilizer use in drylands. In: Dryland Agricultural Research in India: Thrust in the eighties. Singh, R.P. and V. Balasubramanian. (Eds.). All India Co-ordinated Research Project on Dry land Agriculture, Hyderabad, 1983.
7. Sounderarajan B. Duty free import of maize sought. The Hindu, 31st May, 2002. Prentice Hall. Inc. Englewood Cliff NJ, 2002.
8. Seshaiah MP. Sorghum grain in poultry feed. In. Technical and Institutional options for sorghum grain mould management. *Proc. In H. Consultation.* Chandhrasekaran, A., R. Bandyopadhyay and H.I. Hall (Eds.). ICRISAT, Patencheru, Andhra Pradesh, India. 18 – 19 May, 2000, 240-241.
9. Sivanappan RK, Padmakumari O, Kumar V. *Drip Irrigation*. Keerthi Publishing House, Coimbatore, India, 1987, 75-80.
10. Sundar Raman S, Dakshina Murthy KM, Ramesh G, Palaniappan SP, Chelliah S. Effect of fertigation on growth and yield of Gherkin. *Veg. Sci.* 2000; 27(1):64-66.
11. Salvadore JL, Hochmuth GJ, Fred MR, Olson SM, Smajstrala AG, Honlon Ed. A. Nitrogen and potassium application scheduling effects on drip irrigated tomato yield and leaf tissue analysis. Hort. Sci. 1997; 3:230-235.
12. Prabhakar M. Yield performance of hybrid tomato under micro irrigation. In: Advances in Microirrigation and fertigation, 1997, 120.
13. Prince CA, Sanders DC, Cambell CR. Response of bell pepper to N fertilizer and N/K ratios. In: Proc. Fourth International micro irrigation congress, October 23-28, Australia, 1988, 7-10.
14. Yadav AC, Singh. Water stress in vegetable production – a review. Agric. Rev. 1995; 12:177-184.