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EFFECT OF IRRIGATION AND MULCHING PRACTICES ON THE GROWTH AND YIELD OF HYBRID MAIZE (*Zea mays* L.)

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ABSTRACT

Field investigation was carried out during Feb- June 2013 at Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai nagar to study the effect of irrigation and mulching practices on the growth and yield of hybrid maize. The experiment was laid out in split-plot design with three replications and nine treatments. The experiment consisted of three levels as main treatments viz., M_1- 0.6 IW/CPE ratio, M_2 – 0.8 IW/CPE ratio, M_3 – 1.0 IW/CPE ratio and three mulching treatments as sub treatments viz., S_1 – Sugarcane trash mulching (10cm thickness), S_2 – water hyacinth mulching (10cm thickness), S_3 – polythene mulching.Among the irrigation treatments, irrigation at 0.8 IW/CPE ratio significantly influenced the growth and yield components such as plant height, leaf area index, dry matter production, cob length, number of grains cob^{-1}, cob diameter and test weight. This was on par with 1.0 IW/CPE ratio. The least values were recorded at 0.6IW/CPE ratio.Among the mulching treatments, sugarcane trash mulching at 10cm thickness increased the growth and yield components of maize as compared to other treatments.Irrigation at an IW/CPE ratio of 0.8 along with sugarcane trash mulching at 10cm thickness recorded the highest grain yield. This was on par with 1.0 IW/CPE ratio along with sugarcane trash mulching at 10cm thickness. The uptake of N, P_2O_5 and K_2O by crop was significantly influenced by irrigation regimes. The uptake of nutrients was significantly increased at 0.8 IW/CPE ratio and it is on par with 1.0 IW/CPE ratio. Among the mulching treatments, sugarcane trash mulching at 10cm thickness registered the highest N, P_2O_5 and K_2O uptake by crop.Irrigation at an N, P_2O_5 and K_2O by crop of 0.8 along with the sugarcane trash mulching at 10cm thickness required 6 irrigations and it recorded the highest return per rupee invested of Rs.3.46 as compared to other treatments.

Keywords: Sugarcane trash mulching, water hyacinth mulching, polythene mulching,Irrigation, water use efficiency, plant height, leaf area index, dry matter production, cob length, number of grains cob^{-1}, cob diameter and test weight.

1.INTRODUCTION

Maize (*Zea mays* L.) is the third important cereal crop next to rice and wheat in the World, because of its high production potential compared to any other cereal crop and adaptability to wide range of environments.

In the world maize is grown in about 166 countries occupying 165 million hectare area with production of more than 800 million tonnes with a productivity of 5.1 tonnes ha^{-1}. In India, maize occupies an area of 8.38 million hectares with a production of 22.23 million tonnes and the productivity is 2.36 t h^{-1}(Agriculture statistics 2013). In Tamil Nadu, it is cultivated in an area of 0.12 million ha with an annual production of 0.19 million tonnes (Anonymous, 2010).Water is the key factor in deciding the yield of crops. At present water for irrigation is becoming expensive for crop production due to depletion of surface underground water resources by erratic and uneven distribution of rainfall. Due to the serious water shortages the great challenge for the coming decade is the task of increasing food production with less water, particularly in countries with limited water, land resources (FAO, 2002). The yield of maize can be enhanced by proper irrigation scheduling.

Among several recognized criteria for irrigation scheduling climatological approach was found to be useful.Irrigation scheduling to crops based on relatively more practical meteorological approach of IW/CPE ratio which is a relation between a fixed amount of irrigation (IW) and cumulative pan evaporation (CPE). Prihar*et al.* (1976) reported that suitable method of scheduling irrigation by modified meteorological approach based on the ratio of amount of irrigation water (IW) to cumulative pan evaporation (CPE) has been found to be reliable and economical. Among different approaches of scheduling irrigation, use ofcumulative pan evaporation (CPE) and water sensitive critical crop growth stages are simple and feasible (Shinde *et al.,* 2009).Mulching is a practice carried out to conserve soil moisture. In recent years, with the adoption of intensive agriculture, naturally available inputs are becoming a scarce and synthetic materials such as plastic films are replacing conventional mulching. Polythene mulch increases the soil temperature and prevents the loss of nutrients and develop soil micro climate favorable for growth, development and early maturity of the crop.Polythene mulch creates better micro environment, better

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retention of soil moisture and increasing temperature leading ultimately to higher yield. Better germination, early corn initiation and flowering were also observed under polythene mulch (Mahale*et al*., 2002).Keeping these in view, an investigation was carried out to study the effect of irrigation and mulching practices on the growth and yield of hybrid maize.

2.MATERIALS AND METHODS

The experiment was conducted at Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University during Feb 2013 at plot number GL12B. The Experimental Farm is geographically situated at 11° 24' North latitude and 79° 41' East longitudes with an altitude of + 5.79 m above mean sea level. The topography of the Experimental field was levelled and about 1.0m in depth with good drainage. The soil was clay loam in texture with 234.5, 22.5 and 327.5 Kg of available N, P and K respectively.The experiment was laid out by split-plot design with three main plot treatments - Irrigation *viz.,* (M_1 – irrigation at 0.6 IW/CPE ratio, M_2 – irrigation at 0.8 IW/CPE ratio, M_3- irrigation at 1.0 IW/CPE ratio) and three sub plot treatments - Mulching *viz.,* (S_1 – Sugarcane trash [10cm thickness], S_2 – Water hyacinth [10cm thickness], S_3 – Polythene mulching).Irrigation was given to each plot as per treatment schedule. Two common irrigations *viz.,* first at sowing and second at 7 DAS were given uniformly to all plots. Irrigation treatments were imposed to the plots at 20 DAS and the depth of irrigation was fixed as 50mm. the water was let into the plot through a Parshall flume with throat width of 15cm placed at the main field channels. The mulching was practiced at 20 DAS. The mulch materials used were Sugarcane trash at 10cm thickness (12 t ha^{-1}) and Water hyacinth at 10 cm thickness (10 t ha^{-1}) and Polythene mulching.

3.RESULTS AND DISCUSSION

Growth components

Adoption of different treatments significantly influenced the growth components of Maize. Among the irrigation treatments, irrigation at an IW/CPE ratio of 0.8 increased the growth components *viz.,* plant height, LAI and DMP. This was on par with 1.0 IW/CPE ratio. The growth components were significantly reduced under irrigation at 0.6 IW/CPE ratio.Mulching with Sugarcane trash at 10cm thickness was favorable in increasing the growth components. This was on par with polythene mulching. The least growth components were recorded with the water hyacinth mulching 10cm thickness. The interaction effect between irrigation and mulching was found to be significant. The treatment combination of irrigation at an IW/CPE ratio 0.8 and sugarcane trash mulching at 10cm thickness was found to be par with irrigation at 1.0 IW/CPE ratio and sugarcane trash mulching at 10cm thickness. These two combinations were significantly superior over irrigation at 0.6 IW/CPE ratio and water hyacinth mulching 10cm thickness.

Increased in plant height, LAI and DMP under mulching treatments might be due to reduced evaporation losses, thereby better conservation of soil moisture leading to increased plant height. Morandibi*et al.,* (2005) reported higher moisture contents upto 45cm depth in soils under trash mulching. Similar observations were reported by Singh and Singh (1995) and Elumalai (1997).

Yield components

Yield components *viz.,* cob length, cob diameter, number of grains cob^{-1} and 100seed weight were increased under irrigation regimes of 0.8 IW/CPE ratio and it was on par with 1.0 IW/CPE ratio. The least value was recorded under at IW/CPE ratio of 0.6.Among the mulching treatments, sugarcane trash mulching at 10cm thickness favorably increase the yield components, while these components were significantly reduced under water hyacinth mulching at 10cm thickness.The treatment combination of 0.8 ad 1.0 IW/CPE ratios along with sugarcane trash mulching at 10cm thickness were found to be on par with each other and these two combination were significantly superior over the combination of irrigation at 0.6IW/CPE ratio and water hyacinth mulching 10cm thickness.Elumalai (1997) reported that mulching with sugarcane trash at 10 cm thickness increased the growth and yield components of maize. This might be due to the favorable influence of irrigation as well as mulching materials in influencing the growth of the crop which reflected on yield components. The results are in agreement with the results of Elumalai(1997) and Pinjari (2007).

Grain yield

The grain yield of maize exhibited significant variation due to irrigation treatments. The highest grain yield (5127.14 Kg ha^{-1}) was recorded at 0.8 IW/CPE ratio and this was followed by the treatments receiving irrigations at 1.0IW/CPE ratio. The least grain yield (4524.4 Kg ha^{-1}) was registered at 0.6 IW/CPE ratio.Among the mulching treatments, sugarcane trash mulching at 10 cm thickness registered the highest grain yield (5521.26 Kg ha^{-1}). It was followed by polythene mulching. The least grain yield (4078.67 Kg ha^{-1}) was recorded with water hyacinth 10cm thickness.With regard to the interaction effect, combination of irrigation at 0.8IW/CPE ratio and sugarcane trash mulching at 10cm thickness registered highest grain yield (5840.07Kg ha^{-1}). The reduction in the yield of maize might be ascribed to moisture stress that prevailed during grand growth stage and lower leaf area and the leaf indices which might have led to lesser absorption of photosynthetically active radiation (Maiti*et al.,* 2004). The results are in line with Reddy *et al*., (1999) and Mallikarjunaswamy*et al.,* (1999)

The reason for increased seed yield observed under 0.8 IW/CPE ratio along with sugarcane trash mulching might be due to better availability of soil moisture to the crop which enhanced the nutrient availability resulting in more translocation of photosynthates to the crop ultimately reflected on the final yield of crop. Similar findings were reported by Elumalai (1997) and Sangakkara *et al.* (2010)

Nutrient uptake

Among the irrigation treatments, irrigation at 0.8IW/CPE ratio recorded highest uptake of nutrient *viz.,* N, P_2O_5 and K_2O and the lowest uptake of nutrients was recorded under irrigation at 0.6IW/CPE ratio.With regard to various mulching practices, the highest nutrient uptake of nutrients was noticed with sugarcane trash mulching at 10cm thickness. This was followed by polythene mulching. While the least nutrients uptake was observed with water hyacinth mulching at 10cm thickness.With respect to interaction effect, the highest uptake of nutrients was registered under at 0.8 IW/CPE ratio and sugarcane trash mulching at 10cm thickness while the lowest uptake of nutrients was observed with the treatments receiving 0.6 IW/CPE ratio and water hyacinth mulching at 10cm thickness.

Yadav (1985) pointed out that mulching reduced the rate of nitrate formation and decreased losses of N thereby availability of N was increased. Increased uptake of N was due to increased mobilization of nutrients along with the enhanced transport of soil water through the plant system under higher moisture. The results are in agreement with the result of Shinde *et al.* (2009). Under favorable soil moisture level, the solubility and availability of nutrients was more leading to better uptake of P_2O_5. The present findings are in accordance with Mallikarjunaswamy*et al.* (1999).Decreased uptake of K_2O under lower irrigation treatment might be due to restricted potassium diffusion. Saren and Jana (1999) reported that increased K uptake in plant was mainly due to greater K_2 uptake in stover owing to higher stover yield with irrigation.

Irrigation requirement

The IW/CPE ratio of 1.0 consumed more water through irrigation 350mm. The irrigation water consumed under 0.8 IW/CPE ratio was 300mm. Least water was consumed under irrigation at 0.6 IW/CPE ratio was 250mm. The WUE increased with decrease in the level of irrigation.

Irrigation WUE was higher under lower moisture with 0.6 IW/CPE ratio. The irrigation WUE decreased under 1.0 IW/CPE ratio due to

more number of irrigations given to this treatment. Sunil and Idani (2012) stated that WUE was increased with decrease in number of irrigations.

Economics

Irrigation at an IW/CPE ratio of 0.8 along with the sugarcane trash mulching at 10cm thickness recorded highest return of Rs.3.46. This was followed by irrigation at IW/CPE ratio of 1.0 along with the polythene mulching. The least return of Rs.2.46 was recorded under irrigation at 0.6 IW/CPE ratio along with the water hyacinth mulching.

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Table 1: Effect of irrigation and mulching on the growth and yield of hybrid maize

Treatments	Plant height (cm)			LAI		DMP (Kg ha^{-1})			Cob length (cm)	Cob diameter (cm)	Number of grains cob^{-1}
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	30 DAS	60 DAS	90 DAS			
M_1S_1	90.30	132.63	144.46	2.50	4.51	4154	6724	11872	17.30	7.33	391.00
M_1S_2	71.73	99.16	120.86	1.96	3.05	3315	5165	8026	12.04	5.23	261.33
M_1S_3	82.63	110.36	136.46	2.32	4.36	3406	6087	9668	14.50	6.53	317.33
M_2S_1	98.87	147.00	169.70	3.75	7.82	4389	7012	13951	22.33	7.80	482.33
M_2S_2	78.30	126.20	138.86	3.15	7.12	3687	5763	9318	14.10	5.80	300.00
M_2S_3	90.00	129.20	143.23	3.49	7.47	4013	6671	11410	16.73	6.86	381.33
M_3S_1	96.46	138.50	148.76	2.71	6.77	4205	6886	12468	19.80	7.43	462.00
M_3S_2	76.06	105.30	125.56	2.15	6.02	3561	5534	8821	12.53	5.46	288.66
M_3S_3	87.10	113.60	138.43	2.41	5.44	3817	6318	10163	14.90	6.75	321.66

M_1- Irrigation at 0.6 IW/CPE ratio, **M_2 -** Irrigation at 0.8 IW/CPE ratio, **M_3-**Irrigation at 1.0 IW/CPE ratio;
S_1 - Sugarcane trash mulching at 10cm thickness, **S_2 -** Water hyacinth mulching at 10cm thickness, **S_3 -** Polythene mulching
LAI-Leaf area index; **DMP -**Dry matter production; **DAS-**Days after sowing

Table 2: Effect of irrigation and mulching on hundred grain weight (gm), grain yield (Kg ha $^{-1}$), stover yield (Kg ha $^{-1}$), and nutrient uptake of hybrid maize

Treatments	Hundred grain weight (gm)	Grain yield (Kg ha $^{-1}$)	Stover yield (Kg ha $^{-1}$)	Nutrient uptake (Kg ha $^{-1}$)			Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	Rupee per rupee invested
				N	P	K				
M_1S_1	28.49	5303	6564	147.50	39.81	148.29	21000	68944.72	47644.72	3.26
M_1S_2	27.53	3794	5568	101.32	16.75	84.32	20040	49326.29	29286.29	2.46
M_1S_3	28.10	4475	6493	133.48	27.68	126.39	22250	58180.46	35930.46	2.61
M_2S_1	29.53	5840	9809	158.61	51.07	181.24	21900	75923.51	54023.51	3.46
M_2S_2	27.83	4314	6186	128.88	23.59	120.30	20600	56083.04	35483.04	2.72
M_2S_3	28.12	5227	7768	140.47	35.50	144.78	22890	67951.78	45061.78	2.96
M_3S_1	28.40	5420	8944	150.12	44.97	160.39	22200	70460.91	48260.91	3.17
M_3S_2	27.72	4127	5862	109.16	19.70	109.17	21000	53659.06	32659.06	2.55
M_3S_3	28.12	4785	6832	135.81	31.38	132.78	23110	62215.14	39105.14	2.69

M_1- Irrigation at 0.6 IW/CPE ratio, **M_2 -** Irrigation at 0.8 IW/CPE ratio, **M_3-**Irrigation at 1.0 IW/CPE ratio;
S_1 - Sugarcane trash mulching at 10cm thickness, **S_2 -** Water hyacinth mulching at 10cm thickness, **S_3 -** Polythene mulching
N -Nitrogen; **P -**Phosphorus; **K -**Potassium