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Efficient resource conservation technology and foliar fertilization effect on growth, yield attributes and yields of hybrid maize (*Zea mays* L.)

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ABSTRACT

Soil moisture is one of the important factors that manipulates the growth and yield of the maize crop. It will help to supply soil nutrients to the plant to enhance the growth and yield of the crop. Due to the lack of moisture in the soil, foliar nutrition is very much affected and thus it reflects on the growth and yield of the crop. The field experiment was conducted during 2020 – 21 at Annamalai University Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Chidambaram, Tamilnadu, India to maximize the productivity and profitability of maize by adopting various soil moisture conservation techniques and foliar fertilization. The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications. The experiment consists of two factors. In factor I, soil moisture conservation techniques were adopted *viz.*, M_1 – Control, M_2 - Sugarcane trash, M_3 - Water hyacinth and M_4 – Hydrogel. In factor II, foliar nutrient management practice was accommodated such as F_1 - control (without nutrient), F_2 - foliar spray of 1% 19:19:19, F_3 - 1% DAP + 1% MOP, F_4 - 1% PPFM, F_5 - 1% 19:19:19 + 1% PPFM and F_6 - 1% DAP + 1% MOP + 1% PPFM. Foliar nutrients were applied at both Knee high and tasseling stages. Among the soil moisture conservation techniques, the results indicated that mulching with Water hyacinth has registered higher growth parameters, yield parameters and yield than other techniques. While different foliar nutrients, the foliar application of 1% DAP + 1% MOP + 1% PPFM (F_6) have shown higher growth, yield parameters and yield than other treatments. With respect to integration of soil moisture conservation techniques and foliar nutrients, mulching with Water hyacinth andfoliar application of 1% DAP + 1% MOP + 1% PPFM (M_3F_6) recorded higher growth, yield parameters and yield than the rest of the treatment combinations.

Key words: *Maize, Soil Moisture Conservation, Foliar fertilization, PPFM.*

Introduction

Among the cereals, Maize crop has been ranked at the third-place after wheat and rice, globally (Olaniyan, 2015). As a matter of fact, the maize germination rate is reduced under drought stress conditions due to low water absorption and decline in the metabolic enzymatic activation (Ghorbani and Nez-had, 2012). Maize is very sensitive to drought at different growth stages from germination to matu-

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rity. In the development growth stages of maize, moisture stress affects cell division and cell proliferation (Muhammad *et al*., 2015), while in the reproductive stage drought affects tassel, embryo, endosperm development, ear, pollination, fertilization, grain lling and results in loss of crop yield (Du Plessis, 2003). Bhardwaj (2013) reported that mulching has various beneficial effects on crop production in arid and semi-arid regions including increase in soil moisture (4.7-12.5%), reduction in the run off (30- 70.5%), soil erosion (70-85%), weed growth (90-95%), pest control (15.0- 27.35%), maintaining soil temperature (0.5C to 7.0°C higher), increase in the plant growth (12.3-26.9%), development (23-37%) and quality of the produce (7.5-22%) and also promotes earlier harvest of the crop (7-15 days).

In the study area of Cauvery delta zone, during the Kharif season rice crop fits well in the first season of the cropping year and cultivated every year from June onwards by utilizing Cauvery River water and South West monsoon rains. Delay in the onset of monsoon lead to insufficient filling of the reservoir and availability of water that caused uncertainty about the time of water release from Mettur dam (reservoir) and reduced duration of water availability consequently affects the rice cultivation during kharif season. In this grievous situation, cultivation of maize offered assured economic return to the farmers instead of leaving the land as fallows during kharif season due to late receipt of irrigation water in the tail end Cauvery deltaic zone of Tamil Nadu (Thiruppathi, 2017). However, the yield of maize is very low against its potential yield due to low level of available soil moisture during cropping period in the tail end cauvery deltaic regions.

Among the methods of fertilizer application, foliar nutrition is recognized as an important method of fertilization under limited soil moisture condition because foliar nutrients penetrate the leaf cuticle or stomata and enter the cells facilitating easy and rapid utilization of nutrients without much loss. Hence, it is the fastest way to boost crop growth (Latha and Nadanassababady, 2003). It is also an effective method for correcting nutrient deficiencies and overcoming the soil's inability to transfer nutrients to the maize plant under low moisture conditions (Stigler *et al.,* 2010). Supplemental foliar application of major and micronutrients is more advantageous than soil application due to better translocation from the leaves to the developing seeds and efficient utilization of nutrients (Manonmani and Srimathi, 2009).

Keeping these in view, the present field experiment was planned to develop remunerative, productive and cost-effective agronomic approach for hybrid maize grown under limited moisture supply.

Materials and Methods

The field experiment was conducted at Annamalai University Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Chidambaram, Tamilnadu, India during 2020 – 21. Geographically this area is situated at 11° 24' N latitude, 74° 41' E longitude, with an altitude of +5.79 m above mean sea level and 15 km away from the East coast of Bay of Bengal. The mean annual rainfall receives 1541 mm with a distribution of 1061 mm during North-East monsoon (Oct-Dec), 244 mm during South - West monsoon (June-Sep), 53 mm during winter (Jan and Feb) and 183 mm as summer showers (March-May) spreading over 52 rainy days.The mean relative humidity is 87 per cent. The soil of the experimental field is the representative of the Cauvery delta region. The soil is moderately clay with a pH of 7.08. The maize hybrid Dhanvi 166 is used as test crop and dibbled by adopting a spacing of 60 x 20 cm. The treatment was laid out in factorial randomized block design and consisted of two factors with three replications *viz.,* In factor I, soil moisture conservation techniques were adopted *viz.,* M_1 – Control, M_2 - Sugarcane trash at 10 t ha^{-1}, M_3 - Water hyacinth at 12 t ha^{-1} and M_4 – Hydrogel 10 kg ha^{-1}. In factor II, foliar nutrient management practice was accommodated such as F_1 - control (without nutrient), F_2 - foliar spray of 1% 19:19:19, F_3 - 1% DAP + 1% MOP, F_4 - 1% PPFM, F_5 - 1% 19:19:19 + 1% PPFM and F_6 - 1% DAP + 1% MOP + 1% PPFM. The foliar nutrients were applied at knee-high and tasseling stages. N, P_2O_5 and K_2O were supplied through urea, single superphosphate and muriate of potash, respectively. The data on plant height at harvest, dry matter production at harvest, number of cobsplant^{-1}, number of rowscob^{-1}, number of grainscob^{-1}were observed the five tagged plants and the average values of each treatment was calculated and tabulated. The yield was calculated from the net plot area and the produce was cleaned, weighed and expressed in terms of kgha^{-1}. The statistical analysis of the field data was carried out as per the methodology by Gomez and Gomez (2010). The

critical differences were worked out at 5 per cent probability level, wherever the results were significant.

Results and Discussion

Growth parameters

The data on plant height and dry matter production presented in Table 1. Different soil moisture conservation approaches and foliar fertilization exhibited significant effect on plant height and dry matter productionof hybrid maize.

Among the different soil moisture conservation techniques, the plot receiving water hyacinth mulch at 12 t ha^{-1} (M_3) registered the maximum plant height of 207.38cm and dry matter production of 13580kg ha^{-1}. This was followed by application of hydrogel at 10 kg ha^{-1} (M_4). The lower plant height of 165.82 cm and dry matter production 10624 kg ha^{-1} were recorded in control (M_1).

Irrespective of the different foliar nutrition treatments, foliar application of 1% DAP + 1% MOP + 1% PPFM (F_6) recorded maximum plant height of 215.46 cm and dry matter production of 14060kg ha^{-1}. The least plant height of 164.95 cm and dry matter production 10832 kg ha^{-1} were recorded in control (F_1).

Integration of soil moisture conservation techniques and foliar nutrition showed significant effect on plant height and dry matter production. The results revealed that mulching the soil with water hyacinth and foliar application of 1% DAP + 1% MOP + 1% PPFM with RDF (M_3F_6) has recorded maximum plant height of 238.17cm and dry matter production of 15473kg ha^{-1}. The lowerplant height of 152.64cm and dry matter production of 9407kg ha^{-1} recorded in control (M_1F_1). The increased plant height and dry matter production over water hyacinth mulch might be due to availability of soil moisture through its storage and foliar nutrient, which led to the production of higher yield. The parallel results were reported by Dennis *et al*., 2018.

Yield parameters

The data on number of cobs plant^{-1}, number of rows

Table 1. Effect of soil moisture conservation and foliar fertilization techniques on number of plant height (cm) and dry matter production (kg ha^{-1}) of hybrid maize

Treatments	Plant height (cm)							Dry matter production (kg ha^{-1})						
	F1	F2	F3	F4	F5	F6	Mean	F1	F2	F3	F4	F5	F6	Mean
M1	152.64	166.86	166.91	166.21	170.09	172.19	165.82	9407	10481	10558	10418	11423	11459	10624
M2	167.01	184.21	196.85	168.03	211.28	224.85	192.04	11135	12081	12849	11278	13751	14595	12615
M3	171.11	198.95	212.32	197.91	225.84	238.17	207.38	11451	13144	13832	12978	14602	15473	13580
M4	169.05	185.21	210.31	183.21	213.51	226.61	197.98	11337	12159	13703	12018	13954	14713	12981
Mean	164.95	183.81	196.60	178.84	205.18	215.46		10832	11966	12735	11673	13432	14060	
		SEd			CD (p=0.05)				SEd			CD (p=0.05)		
M		2.20			4.42				143.22			288.30		
F		2.69			5.41				175.41			353.10		
M x F		5.38			10.82				350.83			706.20		

Table 2. Effect of soil moisture conservation and foliar fertilization techniques on number of cobs plant^{-1} and Number of rows cob^{-1} of hybrid maize

Treatments	Number of cobs plant^{-1}							Number of rows cob^{-1}						
	F1	F2	F3	F4	F5	F6	Mean	F1	F2	F3	F4	F5	F6	Mean
M1	1.00	1.00	1.02	1.02	1.02	1.01	1.01	15.01	15.14	15.21	15.14	15.35	15.11	15.16
M2	1.00	1.02	1.00	1.01	1.00	1.01	1.01	15.58	15.51	15.99	15.51	17.05	17.89	16.25
M3	1.02	1.00	1.03	1.01	1.02	1.03	1.02	15.21	16.05	17.33	15.98	18.11	18.72	16.90
M4	1.01	1.00	1.01	1.02	1.02	1.02	1.02	15.26	15.64	16.65	15.45	17.54	18.44	16.50
Mean	1.01	1.01	1.02	1.02	1.02	1.02		15.27	15.59	16.30	15.52	17.01	17.54	
		SEd			CD (p=0.05)				SEd			CD (p=0.05)		
M		NS			NS				0.19			0.37		
F		NS			NS				0.23			0.46		
M x F		NS			NS				0.46			0.92		

cob^{-1}, number of grains row^{-1}, test weight furnished in table 2and 3. Different soil moisture conservation approaches and foliar fertilization exhibited significant effect on number of rows cobs^{-1} and number of grains row^{-1} in hybrid maize. However, number of cobs plant^{-1} and test weight were not significantly affected by soil moisture conservation approaches and foliar fertilization.

Among the different soil moisture conservation techniques, the plot receiving water hyacinth mulchat 12 t ha^{-1} (M_3) registered the maximum row number of 16.90 cob^{-1}and grain number of 20.22 row^{-1}. This was followed by application of hydrogel at 10 kg ha^{-1} (M_4). The least number of rows cob^{-1}(15.16) and grain number row^{-1} (17.63) were recorded in control (M_1).

Irrespective of the different foliar nutrition treatments, foliar application of 1% DAP + 1% MOP + 1% PPFM (F_6)recorded maximum row number of 17.54 cob^{-1} and grain number of 20.17 row^{-1}. The least number of rows cob^{-1}of 15.27 and grain number row^{-1}17.92 were recorded in control (F_1).

Integration of soil moisture conservation techniques and foliar nutrition showed significant effect on number of rows cob^{-1} and grain number row^{-1}. The results revealed that mulching the soil with water hyacinth and foliar application of 1% DAP + 1% MOP + 1% PPFM with RDF (M_3F_6) has recorded maximum row number of 18.72 cob^{-1} and grain number of 20.82 row^{-1}. The least number of rows cob^{-1}were 15.01 and grains row^{-1} were 16.06 recorded in control (M_1F_1). The increased number of rows cob^{-1} and grains row^{-1} over water hyacinth mulch was probably due to supply of soil moisture through its conservation mechanism and foliar nutrient, which led to the production of higher yield. Foliar spray of 1% of DAP, MOP and PPFMB at knee high and tasseling stages have helped in contribution of more quantum of assimilates to reproductive organs to produce higher number of rows cob^{-1} and grains row^{-1}. The parallel results were reported by Parvin Akter Bithy*et al.* (2020).

Grain and Stover yield

The data on grain yield and stover yield furnished in Table 4. Different soil moisture conservation ap-

Table 3. Effect of soil moisture conservation and foliar fertilization techniques on Number of grains row^{-1} and Test weight of hybrid maize

Treatments	Number of grains row^{-1}							Test weight(100 grain weight)						
	F1	F2	F3	F4	F5	F6	Mean	F1	F2	F3	F4	F5	F6	Mean
M1	16.06	17.31	17.51	17.29	18.58	19.04	17.63	19.21	21.15	20.85	20.65	21.01	21.49	20.73
M2	18.29	19.63	20.54	18.32	20.31	20.61	19.62	21.25	21.78	22.31	21.36	23.05	23.15	22.15
M3	18.75	20.65	20.12	20.78	20.21	20.82	20.22	21.21	22.81	22.35	22.19	23.13	23.65	22.56
M4	18.58	19.85	21.05	19.41	20.05	20.21	19.86	21.55	21.95	22.59	21.58	22.98	23.15	22.30
Mean	17.92	19.36	19.81	18.95	19.79	20.17		20.81	21.92	22.03	21.45	22.54	22.86	
		SEd			CD (p=0.05)				SEd			CD (p=0.05)		
M		0.22			0.45				NS			NS		
F		0.27			0.55				NS			NS		
M x F		0.55			1.10				NS			NS		

Table 4. Effect of soil moisture conservation and foliar fertilization techniques on Grain yield (kg ha^{-1}) and Stover yield (kg ha^{-1}) of hybrid maize

Treatments	Grain yield (kg ha^{-1})							Stover yield(kg ha^{-1})						
	F1	F2	F3	F4	F5	F6	Mean	F1	F2	F3	F4	F5	F6	Mean
M1	3412	4001	4038	3956	4467	4512	4038	7033	7647	7690	7622	8161	8230	7757
M2	4326	4865	5251	4403	5761	6181	5132	8099	8676	9121	8121	9620	10054	8948
M3	4507	5386	5821	5318	6251	6618	5644	8164	9186	9634	9153	10064	10479	9453
M4	4461	4875	5695	4812	5879	6312	5339	8135	8711	9590	8646	9646	10079	9134
Mean	4130	4782	5202	4623	5588	5905		7905	8555	9008	8385	9375	9711	
		SEd			CD (p=0.05)				SEd			CD (p=0.05)		
M		57.97			116.69				101.50			204.31		
F		70.99			142.91				124.30			250.23		
M x F		141.99			285.83				248.61			500.45		

proaches and foliar fertilization exhibited significant effect on grain yield and stover yield.

Among the different soil moisture conservation techniques, the plot receiving water hyacinth mulch at 12 t ha^{-1} (M_3) registered the grain yield of 5650 kg ha^{-1} and stover yield of 9447 kg ha^{-1} This was followed by application of hydrogel at 10 kg ha^{-1} (M_4). The least grain yield (4064 kg ha^{-1}) and stover yield (7731 kg ha^{-1}) were recorded in control (M_1).

Irrespective of the different foliar nutrition treatments, foliar application of 1% DAP + 1% MOP + 1% PPFM (F_6) recorded the grain yield of 5906 kg ha^{-1} and stover yield of 9711. The least grain yield of 4176 kg ha^{-1} and stover yield of 7858 were recorded in control (F_1).

Integration of soil moisture conservation techniques and foliar nutrition showed significant effect on grain yield and stover yield. The results revealed that mulching the soil with water hyacinth and foliar application of 1% DAP + 1% MOP + 1% PPFM with RDF (M_3F_6) has recorded higher grain yield of 6618kg ha^{-1}and stover yield of 10479 kg ha^{-1}. The least grain yield recorded was 3412 kg ha^{-1} and stover yield was 7033 kg ha^{-1}were recorded in control (M_1F_1). The use of water hyacinth mulch leads to increased moisture retention capacity of soil due to lesser evaporation, reduced the soil temperature, improved microclimate above and below the soil surface and timely application of foliar nutrients thus helped to attain higher yield. The similar findings were concorded with Sharda and Lakshmi (2014).

Conclusion

From the present field experiment it can be concluded that mulching the soil with water hyacinth and application of 1% DAP plus 1% MOP plus 1% PPFM with RDF (M_3F_6) has found to be effective practice for getting higher yield and economic benefit to the maize farmers during kharif season.

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