Influence of moisture regimes and nutrient managements on Yield and Quality of *Rabi* maize (*Zea mays L.*)

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Abstract

An experiment on *rabi* maize constituting three moisture regimes *viz.*, Irrigation water / Cumulative Pan Evaporation (IW/CPE) at 0.6 ,0.8 and 1.0 ratio along with ten nutrient management practices *viz.*, application of 100 % RDF only, 125 % STCR-NPK + foliar sprays 2 % NPK (19:19:19)+ 1 % Pink-pigmented facultative methylotrophs (PPFM) + Micronutrient mixture 1 %, 100 % STCR-NPK + foliar sprays 2 % NPK (19:19:19)+ 1 % Pink-pigmented facultative methylotrophs (PPFM) + Micronutrient mixture 1 % and 75 % STCR-NPK + foliar sprays 2 % NPK (19:19:19) + 1 % Pink-pigmented facultative methylotrophs (PPFM) + Micronutrient mixture 1 % was conducted at Research Farm, Agricultural College, and Research Institute, Madurai district, Tamil Nadu during winter seasons of 2020-21 and 2021-22. The results showed that irrigation scheduled at 1.0 IW/CPE ratio recorded significantly higher grain yield of maize over the scheduling of irrigation at 0.8 with 0.6. Moreover, the application of 100 % STCR-NPK + foliar sprays 1 % Micronutrient mixture was at par with the application of 75 % STCR-NPK + foliar sprays 1 % Micronutrient mixture and both of them recorded significantly higher grain yield than other nutrient management practices. As regards quality parameters viz., chlorophyll content, proline content at roasting or milk stage was numerically higher with scheduling of irrigation at 1.0 IW/CPE ratio but did not reach the level of significance during both the year of the experiment. The quality parameters like chlorophyll content, proline content and yield in maize grain at roasting or milk stage were significantly increased with increasing nutrient management practices. The highest values of chlorophyll content, proline content and yield were recorded with the application of 100 % STCR-NPK + foliar sprays 1 % Micronutrient mixture.

Introduction

Maize (*Zea mays L.*) is an ideal crop owing to its quick growing habit, high yielding ability, palatability and nutritiousness. It can be grown in any season and is one of the most important cereal crops in the world for humans and feed for animals. Maize is a very efficient utilizer of solar energy and has immense potential for higher yield. Each climatic zone has its characteristics and as such different hybrids, composites and local varieties maturing in 60 to 150 days are being grown (Jain *et al.,* 2021). It can be fed to cattle at any stage, as there is no problem of poisoning cattle with HCN or oxalic acid in plants unlike sorghum and therefore it is called as Queen of cereals and King of fodder. The father of the green Revolution Renowned Nobel Laureate Dr. Norman E. Borlaug has mentioned maize as the crop of the future. In the future maize can play a vital role in ensuring food security as well as nutritional security by use of quality protein maize for the country as well as the world as a whole. In Tamil Nadu, maize is principally a rainy season crop but the climatic variability and eco-physiological limitations are the major constraints to achieving the potential yield of maize in the traditional rainfed *rabi* season in the state. Recent studies conclusively proved that maize is a potential winter season crop having three times higher yield potential than the *rabi* crop (Desai and Deore, 2010; Nayak *et al.,* 2017; Sawhney *et al.,* 2019). Water and nutrient is the key factor to increase the productivity of this crop. As it is scarce during winter, its efficient utilization is necessary. However, information regarding moisture regimes and the use of STCR sources of nutrients is meager; hence the present experiment was conducted.

Materials and Methods

A field experiment was conducted during the *rabi* season of 2021 at the Research Farm of the Agricultural College and Research Institute, Madurai, Tamil Nadu (95^{o}4' North latitude, 78^{o}0' East longitude, and 147 m above MSL) in sandy clay loam soil *(TypicHaplustalfs)* as per the soil taxonomy, it was observed that the initial characterization of the experimental soil samples results (Table 1). The main plot comprises three moisture regimes *viz.,* I_1 - Irrigation at IW/CPE ratio of 0.6, I_2 - Irrigation at IW/CPE ratio of 0.8, and I_3 - Irrigation at IW/CPE ratio of 1.0.The subplot comprises of ten nutrient management practices *viz.,*N_1 -Control (no foliar application) , N_2 -125 % ;N_3 -100 % and N_4 - 75 % STCR - NPK along with foliar spray of 2 % N:P:K (19:19:19) N_5 -125 % ; N_6 -100 % ; N_7 - 75 % STCR - NPK along with foliar spray of 1 % PPFM, N_8 -125 % ; N_9 -100 % N_{10} -75 % STCR - NPK along with foliar spray of 1 % micronutrient mixture,(N_2-N_{10} based on STCR - NPK). The treatments were imposed in a split-plot design in three replications. Each replication consisted of 30 treatments.

Soil Test Crop Response (STCR) approach was applied in each plot to treatments wise in the form of urea, diammonium phosphate, and muriate of potash, respectively. Sowing was done on 08 July 2021 the maize - COH (M) 6 seeds the hybrid matures in 110 days. It is resistant to turcicum leaf blight and downy mildew. Individual plot size: 20 m^2, spacing was 60cm x 30cm; irrigation was given at the time of sowing followed by life irrigation on the fifth to the seventh day. The subsequent irrigations were scheduled based on the moisture regimes of the main plot as per the IW/CPE. All the plots were irrigated at a depth of 50 mm and were measured using the Parshall flume. The other practices of growing maize were properly taken for the management of experimental plots throughout the cropping season. Quality properties were analyzed at the roasting or milk stage and yield was computed at the harvest stage. The statistical analysis was carried out by AGRES software at a 5 % level of significance.

Result and Discussion

Moisture regime

The pooled chlorophyll and proline content increased significantly when irrigation was scheduled at a 0.6 IW/CPE ratio compared with 0.8 and 1.0 during both the years (Table 2). The yield increased significantly with an increase in moisture regime (1.0 IW/CPE ratios) during both the years and in pooled data. The pooled grain yield increased 6.48 % due to irrigation scheduled at 1.0 IW/CPE ratio compared with irrigation scheduled at 0.8 and 0.6, owing to improvement in important quality and yield. Therefore, irrigation to maize with a 1.0 IW/CPE ratio is good for higher grain yield. The results confirm the findings of Narang *et al.,* (2019).

As regards quality parameters viz., chlorophyll and proline content at roasting or milk stage was numerically higher with scheduling of irrigation at 0.6 IW/CPE ratio but did not reach the level of significance during both the year of the experiment.

Nutrient management practices

All the quality and yield were significantly increased with an increase in nutrient management levels. The application of 100 % STCR-NPK + 1% Micronutrient mixture recorded the highest yield of maize and was significantly superior to its lower levels, because of the greater availability of nutrients. (Table 2). The results confirm the findings of Channabasavana *et al.,* (2012) and Hankare *et al.,* (2015).

The quality parameters like chlorophyll, proline content and yield in maize grain at the roasting or milk stage were significantly increased with increasing nutrient management practices (Table 3). The highest values of chlorophyll, proline content and yield were recorded with the application of 100 % STCR-NPK + 1% Micronutrient mixture.

Conclusion

From the present study, it can be concluded that irrigating at an IW/CPE ratio of 0.8 is ideal for obtaining a higher yield at normal conditions and subsequently changes expected to be observed in the rainfall pattern with climate change in India. As regards quality parameters viz., chlorophyll content, proline content at roasting or milk stage was numerically higher with scheduling of irrigation at 1.0 IW/CPE ratio but did not reach the level of significance during both the year of the experiment. The quality parameters like chlorophyll content, proline content and yield in maize grain at roasting or milk stage were significantly increased with increasing nutrient management practices. The highest values of chlorophyll content, proline content and yield were recorded with the application of 100 % STCR-NPK + foliar sprays 1 % Micronutrient mixture.

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Conflicts of Interest: The authors declare no conflict of interest.

References

Channabasavanna, A.S.; Biradar, D.P. and S. G. Velamali. 2012. Effect of poultry manure and N P K on growth and yield of maize. *Karnataka J.Agril. Sci.* 15 (2) 353-355.

Desai, S.N. and D.D.Deore.2010. Performance of maize cultivars in *rabi* season *J. Maharashtra Agric.univ*.5 (2):181-182.

Hankare, R.H.; Jadhav, A.S. Patil, H.T. and P.P. Pawar. 2015. Studies on integrated nitrogen management in the maize-wheat cropping system. *agric. Univ.,*30 (1) :122-124.

Jain, G.L.; Jangir, R.P.; Manohar, R.S. and O.P. Jain. 2021. Agronomic advances in maize research. *Indian soc. Agron.* NT Symp., 196-201.

Narang, R.S.; Singh Nathu and Saudagar Singh. 2019. Response of winter maize (*Zea mays L.)* to different soil moisture regimes and phosphorus levels. *Indian J. Agron.* 34(4):402- 405.

Nayak, R.L.; Chatterjee., B.N. And M. Das. 2017. Production potentiality of maize in mild winter of west Bengal. *Indian J. Agron.* 26(2):175-179.

Sawhney, J.S.; Bhinder, S.S.; Sidhu, M.S. and R.S. Narang. 2019. Agronomic practices for higher productivity in winter maize. *Indian J. Agron.,* 34 (1):24-26.

Table -1 Physicochemical and biological properties of initial soil characters

	Experiment values
A. Mechanical analysis	**Values**
Coarse sand fraction (%)	21.27
Fine sand fraction (%)	16.12
Silt fraction (%)	27.18
Clay fraction (%)	34.03
Textural class	Sandy clay loam
B. Soil Physical properties	
Bulk density (Mg m^{-3})	1.30
Particle density (Mg m^{-3})	2.59
Pore space (%)	48.50
C. Electro-chemical properties	
pH	7.42
EC (dS m^{-1})	0.28
CEC (cmol (p^+) kg^{-1})	15.30
D. Chemical properties	
Available N (kg ha^{-1})	200
Available P (kg ha^{-1})	18.80
Available K (kg ha^{-1})	317
Available S (mg kg^{-1})	8.42
Available Fe (mg kg^{-1})	14.20
Available Zn (mg kg^{-1})	1.23
Available Mn (mg kg^{-1})	5.30
Available Cu (mg kg^{-1})	2.37
Exchangeable Ca^{2+} (cmol (p+) kg^{-1}	11.30
Exchangeable Mg^{2+} (cmol (p+) kg^{-1}	7.20
Exchangeable Na^{+} (cmol (p+) kg^{-1}	2.00
Exchangeable K^{+} (cmol (p+) kg^{-1}	1.40
Organic Carbon (g kg^{-1})	6.23
$CaCO_3$ (%)	2.30
Total N (%)	0.03
Total P (%)	0.05
Total K (%)	0.62
E. Biological properties	
Bacterial count (x 10^6 CFU)	10.20
Fungal count (x 10^4 CFU)	3.68
Actinomycetes count (x 10^3 CFU)	8.63

Table 2 Effect of deficit and excess water on chlorophyll content, proline content (µg g-1) at roasting or milk stage of maize.

Moisture Regimes	Nutrient management practices (kg ha^{-1})										
	N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8	N_9	N_{10}	Mean
	Chlorophyll content (%)										
$I_{1.0}$	54.80	57.29	55.50	54.10	55.50	55.29	53.09	59.70	53.80	53.40	**55.24**
$I_{0.8}$	50.20	55.30	53.40	52.00	53.50	53.25	50.20	54.09	54.50	53.00	**52.94**
$I_{0.6}$	44.50	49.30	48.50	46.31	49.39	48.30	47.00	49.39	49.60	47.10	**47.94**
Mean	**49.83**	**53.96**	**52.46**	**50.80**	**52.80**	**52.28**	**50.09**	**54.39**	**52.63**	**51.16**	
	Proline content (µg g^{-1})										
$I_{1.0}$	77.00	77.83	75.50	74.09	76.20	76.40	72.80	78.55	76.31	75.31	**76.00**
$I_{0.8}$	65.70	76.60	72.69	69.34	73.52	71.70	66.37	76.20	72.40	70.00	**71.45**
$I_{0.6}$	61.50	69.50	65.77	65.42	67.48	65.60	65.23	70.40	66.96	65.79	**66.36**
Mean	**68.06**	**74.64**	**71.32**	**69.62**	**72.40**	**71.23**	**68.13**	**75.05**	**71.89**	**70.37**	

	Chlorophyll content (%)				Proline content (µg g^{-1})			
	I	N	I at N	N at I	I	N	I at N	N at I
SEd	0.67	0.23	1.16	1.13	0.94	0.37	1.62	1.59
LSD (0.05)	1.35	0.66	2.38	2.31	1.89	1.07	3.35	3.27

Table 3 Effect of deficit and excess water on yield (kg ha^{-1}) of maize

Moisture Regimes	Nutrient management practices										
	N_1	N_2	N_3	N_4	N_5	N_6	N_7	N_8	N_9	N_{10}	Mean
	Yield (kg ha^{-1})										
$I_{1.0}$	6,537	8,690	8,179	7,640	8,541	8,037	6,765	8,541	8,790	7,856	**7,979**

$I_{0.8}$	6,477	8,464	7,945	6,684	8,198	7,713	6,628	8,198	8,462	7,618	**7,689**
$I_{0.6}$	5,445	8,311	7,357	6,081	7,937	6,311	6,043	7,937	8,312	5,628	**6,973**
Mean	**6,153**	**8,421**	**7,827**	**6,801**	**8,425**	**7,420**	**6,478**	**8,225**	**8,521**	**7,034**	

	Yield (kg ha^{-1})			
	I	**N**	**I at N**	**N at I**
SEd	94.69	37.70	164.01	160.09
LSD (0.05)	190.37	107.48	337.37	329.32