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STUDIES ON THE EFFECT OF IRRIGATION REGIMES AND NITROGEN RATES ON CANOPY TEMPERATURE AND SCMR VALUES (SPAD CHLOROPHYL METER READINGS) OF MAIZE (*Zea mays* L.)

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ABSTRACT

The present research was carried out with the objective of studying the effect of irrigation regimes, nitrogen rates and their functional relationship on morpho-physiological, biochemical parameters and yield attributes in maize at Agricultural Research Institute, PJTSAU, Rajendranagar, Hyderabad. The maize seed variety of Cargill-900 is taken for investigation with main treatment as irrigation regimes at 60% DASM (I_1) (Depletion of available soil moisture), 40% DASM (I_2) and 20% DASM (I_3) and sub treatments as nitrogen rates at 90 kg N ha^{-1} (N_1), 180 kg N ha^{-1} (N_2) and 240 kg N ha^{-1} (N_3). The data was recorded on Physiological parameters like canopy temperature (T_{leaf}-T_{air}) (°c) and SPAD chlorophyll meter readings. Among the irrigation regimes highest chlorophyll meter readings and lowest canopy temperature (T_{leaf}-T_{air}) was recorded at 20% DASM (I_3) and the decreasing trend of chlorophyll meter readings and increasing trend of canopy temperature (T_{leaf}-T_{air}) was recorded with increasing the Depletion of available soil moisture (i.e. from 20% DASM (I_3) to 40% DASM (I_2) and finally to 60% DASM (I_1),which has recorded lowest chlorophyll meter readings and highest canopy temperature (T_{leaf}-T_{air})). Among the nitrogen rates highest chlorophyll meter readings and lowest canopy temperature (T_{leaf}-T_{air}) was recorded at 240 kg N ha^{-1} (N_3) and the decreasing trend of chlorophyll meter readings and increasing trend of canopy temperature (T_{leaf}-T_{air})was recorded with decreasing the nitrogen rates (i.e. from 240 kg N ha^{-1} (N_3) to 180 kg N ha^{-1} (N_2) and finally to 90 kg N ha^{-1} (N_1),which has recorded lowest chlorophyll meter readings and highest canopy temperature (T_{leaf}-T_{air})). Among the interaction of irrigation regimes and nitrogen rates the treatment combination of 20% DASM in conjunction with 240 kg N ha^{-1} (I_3N_3) recorded significantly highest chlorophyll meter readings and lowest canopy temperature (T_{leaf}-T_{air}) compared to all other treatment combinations but remained on par with treatment combination of 20% DASM in conjunction with 180 kg N ha^{-1} (I_3N_2) of canopy temperature, treatment combination of 40% DASM in conjunction with 240 kg N ha^{-1} (I_2N_3) of chlorophyll meter readings and the lowest chlorophyll meter readings and highest canopy temperature (T_{leaf}-T_{air}) was recorded at treatment combination of 60% DASM in conjunction with 240 kg N ha^{-1} (I_1N_3). Data pertaining to before and after irrigation was found that the chlorophyll meter readings decreased after irrigation when compared to before irrigation. At 60% DASM (I_1) irrigation regime the chlorophyll meter readings decreased comparatively more than 40% DASM (I_2) and the negligible amount of decrease in chlorophyll meter readings is found in 20% DASM (I_3) after irrigation..

KEYWORDS:

INTRODUCTION

Maize is less water demanding and gives higher yield per hectare. By growing maize farmers save 90% of water, 70% of power compared to paddy, its yield increased with Compound annual growth rate (CAGR) of 5% and 4% in U.S.A and Brazil respectively in last 4 years. Difference in maize yield between India and world is 130%. Maize consumption growing at a Compound annual growth rate (CAGR) of 11% in last 5 years, Poultry feed accounts for 47% of maize consumption, it acts a source of more than 3,500 products including specialized maize like QPM "Quality Protein Maize". Only 15% of cultivated area of maize is under irrigation. Bihar and Tamil Nadu has almost reached 100% hybridization in maize. Maize contributes 11% to total size of Indian seed industry. Global Maize production reaches 1040 M MT (Million metric tonnes). India stands at 5th rank in maize hybridization. 5-7% of maize produced in India lost due to improper storage. Maize production must grow at 15% Compound annual growth rate (CAGR).

Water stress at any stage of development shows impact on physiological parameters and yield attributes in maize such as plant height, leaf area index, grain yield per hectare, as well as number of ears per plant, grain yield per cob and 1000 kernels weight, water stress occurring during vegetative and tasseling stages reduced plant height and leaf area development. Short-duration water deficits during the rapid vegetative growth period caused 28–32% loss of final dry matter weight. Much greater losses of 66–93% could be expected as a result of prolonged water stress during tasseling and ear formation stages (Cakir *et al.,* 2004).

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Nitrogen is very important and essential element for plant growth and development. It shows impact on morphological characteristics like increasing rates of nitrogen, reduced the number of days for silking and tasseling, but increased the number of days to physiological maturity. Plants were remained green for longer period with increased nitrogen rates. Increased nitrogen rates also show impact on yield attributes like increase in number of cobs per plant, cob length, cob diameter and increased number of grains per cob (Shrestha *et al.,* 2018).

The interactive effects of water and nitrogen shows impact on many morphological, physiological parameters and yield attributes on maize plant like enhanced net assimilation rate, increased leaf area duration, chlorophyll content at anthesis, biomass yield, kernel yield when supplied with optimal nitrogen (160 kg N ha^{-1}) and well-watered conditions. In contrast, supra-optimal (320 kg N ha^{-1}), zero nitrogen and water stress had detrimental effects on these parameters except chlorophyll content at anthesis. The optimal nitrogen level improved drought resistance (Molla *et al*., 2014).

MATERIAL AND METHODS

Location of the experimental site

The experiment was carried out in the research farm of Agro Climate Research Centre, Agricultural Research Institute, Professor Jayashankar Telanagana State Agricultural University, Rajendranagar, Hyderabad. It is situated at 17°32'N latitude, 78°39'E longitude and at an altitude of 542.3m above MSL in the Southern Telangana Agro- Climatic Zone in Telangana State. According to troll's classification, it falls under semi-arid tropics.

Treatment Details

Mainplots	**Subplots**
Irrigation-Scheduling	Nitrogen-levels
I1: 60%DASM	**N1**: 90 kg N ha^{-1}
I2: 40%DASM	**N2**: 180 kg N ha^{-1}
I3:20%DASM	**N3**: 240 kg N ha^{-1}

P_2O_5: 60 kg ha^{-1}applied as basal; K_20: 50 kg ha^{-1} applied in two equal splits(common to all treatments), each at six leaf and tasselling stage of maize.

Canopy temperature (°C) (T_{leaf}-T_{air}).

The canopy temperature of maize was measured using Portable photosynthesis system LI-6800) hand held Infrared Thermometer (IRT) (Blad and Rosenberg, 1976) and the mean value of five observations in each plot was expressed as °C.

SCMR values (SPAD Chlorophyll meter readings).

The leaf chlorophyll meter readings was measured by using MC-100 Chlorophyll content meter.

RESULTS AND DISCUSSIONS

SCMR values (SPAD Chlorophyll meter readings)

The effect of irrigation scheduling and nitrogen levels on Chlorophyll meter readings (spad meter) measured at different phenophases were summarized (Table 1).

Irrigation scheduling

The influence of irrigation scheduling on Chlorophyll meter readings was found to be significant at all crop stages. Increase in moisture levels from I_1 to I_3 (20% DASM) increased the Chlorophyll meter readings respectively. Highest Chlorophyll meter readings was recorded at silking stage. The crop irrigated at I_3 (20% DASM) maintained more Chlorophyll meter readings of 61.28 and 52.11% at silking and dough stages, respectively as compared to other irrigation treatments.

Data recorded at before and after irrigation was found that the Chlorophyll meter readings decreased after irrigation when compared to before irrigation. Pertaining to before and after irrigation indicates that at 60% DASM (I_1) irrigation regime the Chlorophyll meter readings decreased comparatively more than 40% DASM (I_2) and the negligible amount of decrease in Chlorophyll meter readings is found in 20% DASM (I_3) after irrigation. Similar results were shown by Szeles *et al.* (2012).

The influence of irrigation levels on Chlorophyll meter readings has shown that the lower Chlorophyll meter readings was recorded at poorly irrigated conditions compared to moderate and highly irrigated conditions this may be due decrease in Chlorophyll meter readings from water stressed plants provided evidence that water deficiency degraded the photosynthetic pigments and changed the leaf morphology in corn canopies. Similar results were shown by Genc *et al*. (2013).

Nitrogen levels

Chlorophyll meter readings was significantly influenced by different levels of Nitrogen. Increase in nitrogen levels increased Chlorophyll meter readings respectively. The crop received with N_3 (240 kg N ha^{-1}) recorded significantly more chlorophyll of (62.6, 48.3) which was on par with N_2 (180 kg N ha^{-1}) and remained comparatively higher than N_1 (90 kg N ha^{-1})

Table 1. Effect of irrigation and nitrogen levels on SCMR values (SPAD Chlorophyll meter readings)

SCMR values (SPAD Chlorophyll meter readings)																
	6 Leaf stage				Silking stage				Dough stage				Physiological maturity stage			
Treatments	**N_1**	**N_2**	**N_3**	**Mean**	**N_1**	**N_2**	**N_3**	**Mean**	**N_1**	**N_2**	**N_3**	**Mean**	**N_1**	**N_2**	**N_3**	**Mean**
I_1	45.94	50.39	54.79	50.37	55.03	58.00	59.83	57.62	40.23	38.47	37.77	38.82	28.67	27.90	24.97	27.18
I_2	48.08	52.69	55.64	52.14	56.07	61.20	63.90	60.39	43.63	46.57	51.13	47.11	27.53	29.10	31.33	29.32
I_3	48.46	54.94	56.40	53.27	57.43	62.30	64.10	61.28	48.93	51.47	55.93	52.11	28.37	31.47	31.60	30.48
Mean	47.50	52.67	55.61	51.93	56.18	60.50	62.61	59.76	44.27	45.50	48.28	46.01	28.19	29.49	29.30	28.99
Factors	**SEm ±**	**SEd**	**C.D.**		**SEm ±**	**SEd**	**C.D.**		**SEm ±**	**SEd**	**C.D.**		**SEm ±**	**SEd**	**C.D.**	
I	0.26	0.36	1.00		0.48	0.68	1.90		1.13	1.60	4.45		0.40	0.56	1.56	
N	0.29	0.40	0.88		0.52	0.74	1.61		0.25	0.35	0.76		0.31	0.44	0.96	
IiNi-IiNj	0.50	0.70	1.53		0.90	1.28	NS		0.43	0.61	1.32		0.54	0.76	1.66	
IiNi-IjNi	0.48	0.68	1.59		0.88	1.25	NS		1.19	1.68	4.57		0.59	0.84	2.05	

Irrigation : I_1 - 60% DASM, I_2 - 40% DASM, I_3 - 20% DASM
Nitrogen : N_1 – 90 kg N ha^{-1}, N_2 – 180 kg N ha^{-1}, N_3 – 240 kg N ha^{-1}

The influence of nitrogen levels on Chlorophyll meter readings has shown that the lower Chlorophyll meter readings was recorded at lower nitrogen application conditions compared to moderate and higher nitrogen rates this is due to decrease in Chlorophyll meter readings as nitrogen is considered an essential constituent of chlorophyll. Similar findings were also observed by Singh (2010).

Interaction effect

The interaction effect of irrigation scheduling and nitrogen levels was found significant at six leaf, dough and physiological maturity stages and increased with increase in irrigation and nitrogen levels. Among the different treatment combinations, the crop irrigation scheduled at 20% DASM in conjunction with 240 kg N ha^{-1}(I_3N_3) recorded significantly more Chlorophyll meter readings of 56.40, 55.93 and 31.60 at six leaf, dough and physiological maturity stages, respectively. The interaction effect of irrigation scheduling and nitrogen levels was not significant at silking stage of the crop growth.

The influence of irrigation and nitrogen levels has shown that Chlorophyll meter readings decreased with decreased irrigation and nitrogen levels as water deficiency degraded the photosynthetic pigments and changed the leaf morphology in corn canopies and nitrogen which is considered an essential constituent of chlorophyll. These findings are in line with Dinh *et al.* (2017).

Canopy temperature (Tleaf -Tair)

The data pertaining to Canopy temperature (Tleaf -Tair) recorded at different phenophases was presented in (Table 2).

Irrigation scheduling

The Canopy temperature (Tleaf -Tair) was influenced by irrigation scheduling at all crop phenological stages. The crop irrigation scheduled at 20% DASM (I_3) showed significantly lower Canopy temperature (Tleaf -Tair) of -0.47, -0.87, -0.62 and -0.32 when compared to irrigation scheduled at 40% DASM (I_2) and 60% DASM (I_1) at 6^{th} leaf, tasseling, dough and physiological maturity stages, respectively. The Canopy temperature (Tleaf -Tair) recorded under I_1 (60% DASM) remained significantly higher to I_2 (40% DASM) and I_3 (20% DASM) at all crop stages.

Data recorded at before and after irrigation was found that the Canopy temperature (Tleaf -Tair) decreased after irrigation when compared to before irrigation. Pertaining to before and after irrigation indicates that at 60% DASM (I_1) irrigation regime the Canopy temperature (Tleaf -Tair) decreased comparatively more than 40% DASM (I_2) and the negligible amount of decrease in Canopy temperature (Tleaf -Tair) is found in 20% DASM (I_3) after irrigation.

The influence of irrigation levels on canopy temperature has shown that with increase in irrigation levels the canopy temperature gradually decreased this is due to increase in soil moisture uptake which finally increased transpiration rate. Similar results were shown by Majumder (2015).

Nitrogen levels

The effect of nitrogen dose on Canopy temperature (Tleaf -Tair) was found to be significant only at 6^{th} leaf stage and remained non-significant at silking, dough and physiological maturity stages. The crop supplied with 240 kg N ha^{-1} (N_3) recorded significantly lowest Canopy temperature (Tleaf -Tair) of -0.488 compared to other nitrogen treatments at 6^{th} leaf stage.

The influence of nitrogen rates has shown that with increase in nitrogen levels the canopy temperature gradually decreased this is due to nitrogen application might have promoted the absorption of soil moisture which ultimately increased the transpiration rate and decreased the canopy temperature. Similar results were shown by Yan *et al*. (2010).

Interaction effect

The interaction effect of irrigation scheduling and nitrogen levels on Canopy temperature (Tleaf -Tair) was significant at silking, dough and physiological maturity stages and remained non significant at 6 leaf stage. The treatment combination 20% DASM in conjunction with 240 kg N ha^{-1} (I_3N_3) recorded significantly lower Canopy temperature (Tleaf -Tair) of -0.923, -0.65 and 0.437 when compared to all treatment combinations at silking, dough and physiological maturity stages respectively but remained on par with treatment combination 20% DASM in conjunction with 180 kg N ha^{-1} (I_3N_2) at silking, dough and physiological maturity stages. The treatment combination 60% DASM in conjunction with 240 kg N ha^{-1} (I_1N_3) recorded significantly higher Canopy temperature (Tleaf -Tair) when compared to all treatment combinations at silking, dough and physiological maturity stages.

Interaction effect of irrigation scheduling and nitrogen levels on canopy temperature has shown that with increase in irrigation and nitrogen levels canopy temperature gradually decreased this is due to increased transpiration rate. These findings are in line with Zien *et al.* (2004).

Table 2. Effect of irrigation and nitrogen levels on canopy temperature (T_{leaf}-T_{air}) (^oC)

	Canopy temperature															
	6 Leaf stage				Silking stage				Dough stage				Physiological maturity stage			
Treatments	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
I_1	-0.38	-0.41	-0.46	-0.42	-0.59	-0.52	-0.36	-0.49	-0.27	-0.25	-0.17	-0.23	0.07	0.10	0.23	0.13
I_2	-0.42	-0.45	-0.49	-0.45	-0.67	-0.67	-0.75	-0.69	-0.38	-0.42	-0.43	-0.41	-0.13	-0.18	-0.25	-0.19
I_3	-0.43	-0.46	-0.51	-0.47	-0.79	-0.89	-0.92	-0.87	-0.55	-0.64	-0.65	-0.62	-0.34	-0.40	-0.44	-0.39
Mean	-0.41	-0.44	-0.49	-0.45	-0.68	-0.69	-0.68	-0.68	-0.40	-0.44	-0.42	-0.42	-0.13	-0.16	-0.15	-0.15
Factors	SEm ±	SEd	C.D.		SEm ±	SEd	C.D.		SEm ±	SEd	C.D.		SEm ±	SEd	C.D.	
I	0.002	0.003	0.008		0.012	0.017	0.049		0.011	0.015	0.044		0.003	0.005	0.014	
N	0.005	0.006	0.014		0.008	0.011	NS		0.012	0.016	NS		0.007	0.009	NS	
IiNi-IiNj	0.004	0.011	NS		0.021	0.019	0.048		0.019	0.028	0.068		0.006	0.016	0.037	
IiNi-IjNi	0.007	0.010	NS		0.016	0.023	0.059		0.020	0.028	0.066		0.010	0.014	0.032	

Irrigation : I_1 - 60% DASM, I_2 - 40% DASM, I_3 - 20% DASM
Nitrogen : N_1 – 90 kg N ha^{-1}, N_2 – 180 kg N ha^{-1}, N_3 – 240 kg N ha^{-1}

The crop response to added nitrogen depends on soil moisture status. As degree of water stress increases the response to nitrogen at higher dose was nullified and negative impact was observed. Under severe water stress situation at 60% DASM the crop growth was adjusted to lower dose of 90 kg N ha^{-1}. The plant has exhibited moisture stress symptoms like leaf rolling early in treatment at 60% DASM in conjunction with 240 kg N ha^{-1}(I_1N_3) plots when compared to treatment at 60% DASM in conjunction with 90 kg N ha^{-1} (I_1N_1) plots. These results are in line with the findings of Pandey *et al* (2000) who reported that, under deficit irrigated condition the maize crop responded positively up 120 kg N ha^{-1} and further increase in nitrogen dose from 120 kg to 160 kg, negative results were observed.

LITERATURE CITED

Cakir, R. 2004. Effect of water stress at different development stages on vegetative and reproductive growth of corn. *Field Crops Research*. 89(1): 1-16.

Dinh, T.H., Watanabe, K., Takaragawa, H., Nakabaru, M and Kawamitsu, Y. 2017. Photosynthetic response and nitrogen use efficiency of sugarcane under drought stress conditions with different nitrogen application levels. *Plant Production Science*. 20(4): 412-422.

Genc, L., Inalpulat, M., Kizil, U., Mirik, M., Smith, S.E and Mendes, M. 2013. Determination of water stress with spectral reflectance on sweet corn (*Zea mays* L.) using classification tree (CT) analysis. *Zemdirbyste-Agriculture*. 100(1): 81-90.

Majumder, D. 2015. Modification of soil micro-climate to mitigate climate change impacts and improve water productivity of spring maize (Doctoral dissertation, *Punjab agricultural university,* ludhiana).

Molla, M.S.H., Nakasathien, S., Sarobol, E and Vichukit, V. 2014. Effects of nitrogen and water on maize varieties under short and prolonged drought. *Journal of Developments in Sustainable Agriculture*. 9(2): 97-110.

Pandey, R.K., Maranville J.W and Adamou, A. 2000. Deficit irrigation and nitrogen effects on maize in a Sahelian environment: I. Grain yield and yield components. *Agricultural Water Management.* 46(1): 1-13.

Sarma, J.P., Burman, R.R., Gills, R and Bhowmik, A. 2018. Developing Value Chain Map for Maize in Samastipur district Bihar-Methodological Approach. *Journal of Community Mobilization and Sustainable Development*. 13(3): 606-612.

Singh V, Singh B, Singh Y, Thind HS and Gupta R K. 2010. Need based nitrogen management using the chlorophyll meter and leaf colour chart in rice and wheat in South Asia: a review. *Nutrient Cycling Agroecosyst*. 88: 361-380.

Shrestha, J., Yadav, D.N., Amgain, L.P and Sharma, J.P. 2018. Effects of nitrogen and plant density on maize (*Zea mays* L.) phenology and grain yield. *Current Agriculture Research Journal*. 6(2): 175-182.

Yan, C., Ding, Y., Wang, Q., Liu, Z., Li, G., Muhammad, I and Wang, S. 2010. The impact of relative humidity, genotypes and fertilizer application rates on panicle, leaf temperature, fertility and seed setting of rice. *The Journal of Agricultural Science*. 148(3): 329-339.

Zi-Zien, L., W. D. Li and W. L. Li. 2004. Dry period irrigation and fertilizer application affect water use and yield of spring wheat in semi-arid regions. *Agriculture Water Management*. 65: 133-143.