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EFFECT OF PRECISION NITROGEN MANAGEMENT ON YIELD, NITROGEN AND WATER USE EFFICIENCY OF DRIP IRRIGATED MAIZE (*ZEA MAYS* L.)

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ABSTRACT

A field experiment was conducted during *kharif* 2014 at Zonal Agricultural Research Station, V. C. Farm, Mandya to study the effect of precision nitrogen management on yield,nitrogen and water use efficiency of drip irrigated maize.Excessive use of nitrogen (N) in maize results in low fertilizer N use efficiency. Precise N management in drip irrigated maize using chlorophyll meter (SPAD meter) and leaf color chart (LCC) was investigated compared with state recommendation fixed timing N applications. Experiment consists of 9 treatments replicated thrice in RCBD design. Among the various treatments, drip fertigation of nitrogen through SPAD sufficiency index of 95-100 per cent under paired row (90/30) recorded significantly higher kernel and stover yield (85.73 and 140.43 q ha^{-1}, respectively) as compared to UAS (B) package with surface irrigation and normal spacing of 60 X 30 cm and was being on par with nitrogen management through LCC 6, SPAD sufficiency index of 90-95 per cent and LCC 5. Similar trend was observed with the water use efficiency and nitrogen use efficiency, nitrogen balance in the soil was also high.

INTRODUCTION

Maize is one of the most important and widely grown cereals in the world and it has great significance as human food, animal feed and raw material for large number of industrial products. In India,about 50 to 55 per cent of the total maize production is consumed as food, 30 to 35 per cent goes for poultry, piggeryand fish meal industry and 10 to 12 per cent to wet millingindustry (Singh *et al*., 2003).The productivity of maize in a region is determined by several factors,among which Nitrogen (N) is a key nutrient element for achieving the high yield potential. Application of higher level of N-fertilizer is very common among Indian farmers, who attribute maize crop greenness and quick growth response to N application. Furthermore, large field-to-field variability of soil N supply restricts efficient use of N fertilizer when broad-based blanket fertilizer N recommendations are used (Cassman*et al*., 1996). When N application is not synchronized with crop demand, N losses from the soil-plant system are large leading to low N fertilizer use efficiency (Ashwani*Kumar et al*., 2015). There is a need to synchronize N-fertilizer application with plant growth to optimize nutrient use and minimize environmental pollution. Effective nitrogen management in maize is a major challenge for researchers and producers. To answer the questions of when, where and how much, we require a monitoring technique to evaluate the N status of crops(Peng*et al*., 1996). Ideally the technique needs to be rapid and inexpensive and should allow for immediate decision making. Therefore, there is a need to investigate on N management with tools like LCC and SPAD meter for precision nitrogen management in maize. thus precision agriculture technologies are now available to support N management and increase NUE. Variable rate application technologies and remote sensing are some of the precision agriculture technologies used to better estimate and apply N rates based on temporal and spatial variability within a field resulting in increased NUE. Successful results in assessing N need at mid-season are found in several studies (Kitchen *et al*., 2010).Therefore, the study was conducted for fine-tuning of fertilizer N program to actual needs of plant under field conditions, reducing the risk of yield-limiting N deficiencies or costly over- fertilizing by using a chlorophyll meter and LCC was carried out with an objective to study the effect of precision nitrogen management on yield, nitrogen and water use efficiency of drip irrigated maize.

MATERIALS AND METHODS

A field experiment was conducted during *kharif*2014 at Zonal Agriculture Research Station V. C. Farm, Mandya (11⁰ 30′ to 13°05′ N latitude and 76°05′to 77°45′ East longitude with an altitude of 695 meters above mean sea level). The experimental soil was red sandy loam in texture having a pH of 6.60 and organic carbon (0.40 %) and available soil nitrogen (230.8 kg ha^{-1}), phosphorus (41.9 kg ha^{-1}) and potassium content (146.2 kg ha^{-1}). The experiment consisted of 9 treatments *viz*.,T_1: Nitrogen management through LCC3, T_2: Nitrogen management through LCC4, T_3: Nitrogen management through LCC5, T_4: Nitrogen management through LCC6, T_5: Nitrogen management through SPAD sufficiency index 85- 90%, T_6: Nitrogen management through SPAD sufficiency index 90-95%, T_7: Nitrogen management through SPAD sufficiency index 95- 100%, T_8: RDF with surface irrigation and paired row planting (30/90 cm), T_9: UAS (B) package with surface irrigation and normal spacing (60 cm X 30 cm) were tested in three replication and RCBD design. Basal 75 kg N ha^{-1} provided for treatment T_8 and T_9 and 75 kg N ha^{-1} at 30 DAS along with surface irrigation, form treatment T_1 to T_7 basal 10 kg N ha^{-1} applied remaining N is top dressed by using LCC and calculating SPAD sufficiency index from 14 DAS to 50 per cent tasseling with drip irrigation. Full dose of P and K applied as basal.

$$\text{SPAD sufficiency index} \quad \frac{\text{Average bulk reading}}{\text{Average reference strip reading}} \quad 100$$

RESULTS AND DISCUSSION

The higher kernel yield of 85.73 was recorded under nitrogen management through SPAD sufficiency index 95-100% as compared to other nitrogen management practices. However, it was on par with LCC 6 (85.27 q ha^{-1}), SPAD sufficiency index 90-95 % (78.23 q ha^{-1}) and LCC 5 (77.92 q ha^{-1}). The extent of increase in the yield in the above treatments was 17.4, 17.0, 9.4 and 9.1 per cent, respectively over UAS (B) package. The increase in the yield in these treatments was attributed due to increase in growth and yield parameters, application of right quantity of N fertilizer as per the crop demand and resulted in reduced losses lead to higher N use efficiency. Similar results were found byGhosh*et al*. (2013) in rice and Banerjee *et al*. (2014) in maize.

Among the various nitrogen management practices, significantly higher nitrogen use efficiency was recorded by nitrogen management through SPAD sufficiency index 95-100% (71.44 kg kg^{-1})and was on par with nitrogen management through SPAD sufficiency index 90-95% (71.12 kg kg^{-1}), LCC 6 (71.05 kg kg^{-1}), LCC 5 (70.83 kg kg^{-1}), LCC 4 (70.54 kg kg^{-1}) and LCC 3 (69.08 kg kg^{-1}). This increase in NUE was mainly due to reduced N application in split doses according to crop demand in turn reduces the losses of N by various means. Hence, increased the NUE. This was in accordance with Ghosh*et al*. (2013) in rice. Whereas, lower NUE was recorded with UAS (B) package with surface irrigation and normal spacing of 60 cm X 30 cm (47.22 kg kg^{-1}). Similar results of lower efficiencies with RDN was observed by Singh *et al*. (2002) and

Table 1: Yield, Nitrogen use efficiency and Water use efficiency of drip irrigated maize as influenced by precision nitrogen management practices

Treatment	Kernel yield (q ha^{-1})	Total nitrogen used (kg)	Nitrogen use efficiency (kg kg^{-1})	Total water used (cm)	Water use efficiency (kg ha-cm^{-1})
T_1: Nitrogen management through LCC3	62.18	90	69.08	64.44	96.48
T_2: Nitrogen management through LCC4	70.54	100	70.54	64.44	109.46
T_3: Nitrogen management through LCC5	77.92	110	70.83	64.44	120.91
T_4: Nitrogen management through LCC6	85.27	120	71.05	64.44	132.32
T_5: Nitrogen management through SPAD sufficiency index 85- 90%	63.39	90	63.39	64.44	98.37
T_6: Nitrogen management through SPAD sufficiency index 90-95%	78.23	110	71.12	64.44	121.40
T_7: Nitrogen management through SPAD sufficiency index 95- 100%	85.73	120	71.44	64.44	133.03
T_8: RDF with surface irrigation and paired row planting (30/90 cm)	72.50	150	52.36	94.42	76.78
T_9: UAS (B) package with surface irrigation and normal spacing (60 cm X 30 cm)	70.83	150	47.22	94.42	75.01
S.Em ±	2.74		2.22		4.16
C.D. (p=0.05)	8.20		6.65		12.49

Note: T_1 to T_7 Paired row planting of 30 cm b/w row and 90 cm b/w pair with drip irrigation adopted, RDF = Recommended dose of Fertilizer (150: 75: 40 kg NPK ha^{-1})

Table 2: Nitrogen balance as influenced by precision nitrogen management practices

Treatments	Nitrogen Initial 1	Applied 2	Crop uptake 3	Expected balance 4=1+2-3	Actual balance 5	Net gain(+) or Loss (-) 6=5-4
T_1: Nitrogen management through LCC3	230.8	90	131.7	189.1	181.23	-7.87
T_2: Nitrogen management through LCC4	230.8	100	160.06	170.74	176.63	5.89
T_3: Nitrogen management through LCC5	230.8	110	189.07	151.73	165	13.27
T_4: Nitrogen management through LCC6	230.8	120	207.5	143.3	163.8	20.5
T_5: Nitrogen management through SPAD sufficiency index 85- 90%	230.8	100	142.53	188.27	179.67	-8.6
T_6: Nitrogen management through SPAD sufficiency index 90-95%	230.8	110	189.23	151.57	163.6	12.03
T_7: Nitrogen management through SPAD sufficiency index 95- 100%	230.8	120	208.9	141.9	164.3	22.4
T_8: RDF with surface irrigation and paired row planting (30/90 cm)	230.8	150	168.13	212.67	162	-50.67
T_9: UAS (B) package with surface irrigation and normal spacing (60 cm X 30 cm)	230.8	150	162.1	218.7	154.13	-64.57

Note: T_1 to T_7 Paired row planting of 30 cm between rows and 90 cm between pairs with drip irrigation, RDF = Recommended dose of fertilizer (150: 75: 40 kg NPK ha^{-1})

Jagdeep Singh and C. S. Khind (2015)in rice, due to more N losses from soil-plant system leading to low NUE, when N application is not synchronized with crop demand.

Nitrogen management through SPAD sufficiency index 95 - 100% with drip irrigation, recorded the significantly higher water use efficiency (133.03 kg ha-cm^{-1}) compared with the UAS (B) package with surface irrigation (75.01 kg ha-cm^{-1}). However, it was on par with LCC 6 (132.32 kg ha-cm^{-1}), SPAD sufficiency index 90-95 % (121.40 kg ha-cm^{-1}) and LCC 5 (120.91 kg ha-cm^{-1}). This increase in water use efficiency in drip-irrigated treatments was mainly due to considerable saving of irrigation water with drip, greater increase in yield of crop and higher nutrient use efficiency along with reduced loss of irrigation water. This was in accordance with Kharrou*et al.* (2011) in wheat.

The analysis on nitrogen balance in soil is presented in Table 2. The initial soil available nitrogen was 230.8kg ha^{-1} while, the added nitrogen various with different treatments.A higher quantity of nitrogen was added to the UAS (B) package and RDF in paired rows (150 kg ha^{-1}) followed by nitrogen management through SPAD sufficiency index 95-100% and LCC 6 (120 kg ha^{-1}) and lowest was in LCC 3 (90 kg ha^{-1}).The expected nitrogen balance between initial and crop uptake was positive in all treatments over actual nitrogen balance. It was more in UAS (B) package (218.7 kg ha^{-1}) and lowest in nitrogen management through SPAD sufficiency index 95-100% (141.9 kg ha^{-1}). The actual nitrogen balance after harvest of crop was higher in nitrogen management through LCC 3 (181.23 kg ha^{-1}).The overall balance of nitrogen in soil (net loss or gain) indicated a net gain by nitrogen management through SPAD sufficiency index 95-100%, LCC 6, SPAD sufficiency index 90-95%, LCC 5 and LCC 4, whereas, other treatments recorded negative of N in soil.

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