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Field Performance of Maize (*Zea mays* L.) for Precision Nitrogen Management using LCC and SPAD Meter

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Abstract Field experiment was conducted during *kharif*, 2014 to study the effect of precision nitrogen management on yield attributes, yield and economics of drip irrigated maize. The experiment consists of nine treatments replicated thrice in RCBD design. Among the various treatments imposed, drip fertigation of nitrogen through SPAD sufficiency index of 95—100% under paired row (90/30) recorded significantly higher yield parameters. In addition, this treatment also recorded significantly higher kernel and stover yield (85.73 and 140.43 q ha^{-1}, respectively) and also net returns (Rs 69,634 ha^{-1}) as compared to UAS (B) package with surface irrigation and normal spacing of 60 × 30 cm.

Keywords Maize, Drip irrigation, Precision N Management, LCC, SPAD sufficiency index.

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Introduction

Maize (*Zea mays* L.) is one of the economically important cereal crops used us food, feed and other products. It is third most important cereal crop in India after rice and wheat that occupied about 8.67 million hectares producing 22.25 million tons with an average productivity of 2,566 kg ha^{-1} during 2013-2014 (Anonymous [1]). The productivity of maize in a region is determined by several factors including nitrogen as one of the important factor. Application of higher level of N-fertilizer is very common among Indian farmers, which attribute maize crop greenness and 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. When N application is not synchronized with crop demand, N losses from the soil-plant system are large leading to low N use efficiency (Ashwani Kumar et al. [2]). There is a need to synchronize N-fertilizer application with plant need to optimize the nutrient use and minimize environmental pollution. Successful results in assessing N need at mid-season are found in several studies Kitchen et al. [3]. Effective management of fertilizer, particularly N is a major challenge for researchers and as well as for producers. Hence, there is need for precision nitrogen management in maize by using tools like LCC (Leaf Color Chart) and SPAD (Soil Plant Analysis Development) meter for better utilization of nitrogen and also to obtain optimum yield. Consider-

Table 1. Yield parameters and yield of drip irrigated maize as influenced by precision nitrogen management practices. (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}) and NS : Non-Significant.

Treatments	Coblength (cm)	No. of rows per-cob	No. of kernels per cob	Cob weight per plant (g)	100 kernel weight (g)	Kernel yield (q ha^{-1})	Stover yield (q ha^{-1})	Hervest index
T_1 : Nitrogen management through LCC3	10.11	11.00	180.13	80.79	41.13	62.18	99.27	0.38
T_2 : Nitrogen management through LCC4	11.08	12.77	291.20	112.44	41.73	70.54	110.40	0.39
T_3 : Nitrogen management through LCC5	14.42	16.07	492.23	213.44	42.67	77.92	121.93	0.39
T_4 : Nitrogen management through LCC6	15.37	16.50	517.27	226.56	42.87	85.27	139.32	0.38
T_5 : Nitrogen management through SPAD sufficiency index 85–90%	10.31	11.40	206.97	82.51	41.33	63.39	100.97	0.38
T_6 : Nitrogen management through SPAD sufficiency index 90–95%	14.72	16.17	495.40	214.85	42.73	78.23	127.52	0.38
T_7 : Nitrogen management through SPAD sufficiency index 95–100%	15.54	16.73	522.27	227.97	42.93	85.73	140.43	0.38
T_8 : RDF with surface irrigation and paired row planting (30/90 cm)	12.14	14.53	446.40	196.45	41.83	72.50	116.16	0.38
T_9 : UAS (B) package with surface irrigation and normal spacing (60 cm × 30 cm)	12.05	14.47	433.00	195.36	41.70	70.83	110.81	0.39
SEm±	0.42	0.54	15.78	5.87	0.41	2.74	3.62	0.02
CD (p=0.05)	1.25	1.63	47.30	17.61	NS	8.20	10.84	NS

ing the benefits of these tools, a field experiment was laid out consisting of N management in maize using LCC and SPAD meter to 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 parameters, yield and economics drip irrigated maize.

Materials and Methods

A study was conducted during *kharif* 2014 at Zonal Agricultural Research Station, VC Farm, Mandya (11°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 soil of the experimental site is red sandy loam in texture with a pH of 6.60, 0.40% organic carbon, 230.8 kg ha^{-1} available soil nitrogen, 41.9 kg ha^{-1} phosphorus and 146.2 kg ha^{-1} potassium content.The experiment consists 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 × 30

Table 2. Economics of drip irrigated maize as influenced by precision nitrogen management practices. 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}).

	Treatments	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
T_1 :	Nitrogen management through LCC3	38015	78388	40373	2.06
T_2 :	Nitrogen management through LCC4	38187	88821	50634	2.33
T_3 :	Nitrogen management through LCC5	38258	98108	59850	2.56
T_4 :	Nitrogen management through LCC6	38580	107653	69073	2.79
T_5 :	Nitrogen management through SPAD sufficiency index 85—90%	38137	79576	41439	2.09
T_6 :	Nitrogen management through SPAD sufficiency index 90—95%	38258	98747	60489	2.58
T_7 :	Nitrogen management through SPAD sufficiency index 95—100%	38630	108264	69634	2.82
T_8 :	RDF with surface irrigation and paired row planting (30/90 cm)	36581	91419	54838	2.50
T_9 :	UAS (B) package with surface irrigation and normal spacing (60 cm × 30 cm)	36581	89183	52601	2.44

cm) laid out in randomized complete block design and replicated thrice. For T_1 to T_7 treatments, basal dose of 10 kg N ha^{-1} was applied and remaining N was top dressed by using LCC and SPAD sufficiency index from 14 DAS to 50% tasseling. In addition, for these treatments full dose of P and K was applied as basal. But for the T_8 and T_9 treatments 75 kg N ha^{-1} was applied as basal dose at 30 DAS. SPAD sufficiency index is calculated using the below formula.

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

Economics is calculated by considering the prices in the market and also by depreciation over the drip irrigation system.

Results and Discussion

The yield parameters and yield of maize presented in Table 1. Kernel yield of maize were significantly different among the various nitrogen management practices. Nitrogen management through SPAD sufficiency index 95—100% recorded significantly higher kernels yield (85.73 q ha^{-1}) as compared to UAS (B) package (70.83 q ha^{-1}). However, it was on par with nitrogen management through 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}). While, lower kernel yield was recorded in LCC 3 (62.18 q ha^{-1}). Among the various nitrogen management practices applying nitrogen based on SPAD sufficiency index 95—100% recorded significantly higher stover yield (140.43 q ha^{-1}) compared to UAS (B) package (110.81 q ha^{-1}). However, it was on par with nitrogen management through LCC 6 (139.32 q ha^{-1}), SPAD sufficiency index 90—95% (127.52 q ha^{-1}) and LCC 5 (121.93 q ha^{-1}). While, lower stover yield was recorded in LCC 3 (99.27 q ha^{-1}). Similar results are obtained in case of other yield parameters like cob length, number of rows per cob, number of kernels per cob and cob weight. The variation in the harvest index and 100 seed weight of maize as influenced by precision nitrogen management practices was not significant.

The higher kernel and stover yield of 85.73 and 140.43 q ha^{-1}, respectively 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 (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%, respectively over UAS (B) package. The increase in the yield in these treatments was attributed due to application of right quantity of N fertilizer as per the crop demand and resulted in reduced losses lead to higher N use efficiency. The results are in agreement with the findings of Banerjee et al. [4] in maize ; Ghosh et al. [5] in rice and El-habbal et al. [6] in wheat. The yield ability of the crop is the reflection of growth and yield attributing characters. The increase in kernel yield of maize could be traced back to increase in growth and yield attributes viz., plant height (202.13 cm), number of leaves per plant (15.37), leaf area (7259.63 cm^2 $plant^{-1}$), leaf area index (8.06), total dry weight (296.05 g $plant^{-1}$), cob length (15.54 cm), number of rows per cob (16.73), number of kernels per cob (522.27) and cob weight per plant (227.97 g $plant^{-1}$). Nitrogen management through LCC 6, SPAD sufficiency index 90—95% and LCC5 also produced at par yield attributes as that of SPAD sufficiency index 95—100% (Table 1).

Economics is the ultimate criteria for acceptance and wider adoption of any technology. Among different indicators of economics efficiency in any production system, net returns and B : C ratio have greater impact on the practical utility and acceptance of the technology by the farmers (Table 2). In the present study, comparative economics of precision nitrogen management practices are indicated. The economics of maize varied with respect to gross returns, which was a result of prices and yield of marketable produce, cost of cultivation which varies in relation to different inputs used, and in turn net returns and B:C ratio. Among the various nitrogen management treatments nitrogen management through SPAD sufficiency index 95—100% recorded higher gross returns (Rs 1,08,264 ha^{-1}) followed by nitrogen management through LCC 6 (Rs 1,07,653 ha^{-1}). Same trend was followed by former treatments with respect to net returns (Rs 69,634 and 69,073 ha^{-1}, respectively) and benefit cost ratio (2.82 and 2.79, respectively) in comparison with other precision nitrogen management practices. The consequence of higher yield and lower cost on N fertilizer resulted in higher B:C ratio. This increased net returns and B:C ratio in SPAD sufficiency index 95—100% and LCC 6 was mainly due to increase in yield as well as reduction in the application of N fertilizer. These results are in agreement with the findings of Maiti and Das [7] ; El-Habbal et al. [6] in wheat.

Conclusion

From the present study it is clear that nitrogen management through SPAD sufficiency index 90—100% and LCC 5 and 6 helps in achieving higher yield of maize that UAS (B) package under drip irrigated condition along with higher economic returns.

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