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Influence of leaf colour chart, SPAD and GreenSeeker on productivity and economics in sweet corn (*Zea mays saccharata* L.) during *rabi*

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ABSTRACT: *A field study was conducted during rabi 2014-15 at College of Agriculture, University of Agricultural Sciences, Raichur to study nitrogen management in sweet corn (Zea mays saccharata L.) using Leaf colour chart (LCC), SPAD meter, and GreenSeeker. The hybrid Sugar-75 was selected for the study. Treatment consists of RDN @ 150 kg ha^{-1} in two and three splits, LCC threshold 4 and 5, SPAD threshold 40 and 50 and NDVI 0.6 and 0.8 along with basal 50% followed by foliar spray @ 2 % at 30, 45 and 60 DAS and control as check. Intermittent N application was done by recording LCC, SPAD and NDVI values. Fertilizers applied based on pre fixed threshold levels of each tool. Randomized complete block design was followed with three replications. The fresh cob yield with husk was significantly higher by application of 150 kg N ha^{-1} in three splits (15.6 t ha^{-1}) and LCC threshold 5 (15.2 t ha^{-1}). It also recorded higher fresh cob yield without husk, green fodder and stover yield. Application of nitrogen at 150 kg ha^{-1} in three splits and LCC-5 has resulted in higher gross return, net return and B:C ratio. Based on the economic analysis, it can be inferred that split application of 150 kg N ha^{-1} and LCC threshold 5 and NDVI 0.8 were found to be better for sweet corn nitrogen recommendation.*

Key words: *Sweet corn, LCC, SPAD, GreenSeeker and Nutrient balance*

INTRODUCTION

Sweet corn (*Zea mays saccharata* L.) also known as sugar corn, is a hybridized form of maize, specifically bred to increase the sugar content. It has a sugary rather than a starchy endosperm with a creamy texture. The sweet corn has good amount of calcium (Ca), phosphorus (P), iron (Fe) and potassium (K). Application of huge quantity of Nitrogenous fertilizers is common practice among Indian farmers. It may result in more greenness and quick growth response to N application. 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. There is a need to synchronize time of N fertilizer application and crop demand to optimize nutrient use and minimize environmental pollution. Innovative tool such as chlorophyll meter is faster than tissue testing for N and can help to find when plant need more N [1].

Farmers generally use leaf colour as a visual and subjective indicator of the crop nitrogen status. Leaf colour chart (LCC) can be used as a complementary decision making tool to determine the need for N application. LCC can promote need based variable rate of N application to crops based on soil N supply and crop demand. Under farm situations LCC proved to be as good as the chlorophyll meter method in terms of higher yield and improved nitrogen use efficiency. It is an ideal tool to optimize N use, irrespective of the source of N applied [2]. GreenSeeker emits brief bursts of red and infrared light, and then measures the amount of each type of light that is reflected back from the plant, then sensor continues to sample the scanned area as long as the trigger remains engaged and displays the measured value in terms of an NDVI reading. The strength of the detected light is a direct indicator of the health of the crop, the higher the reading, the healthier the plant. Hence, the experiment conducted with an objective to find out optimum threshold level for LCC, SPAD and NDVI readings in *vertisols* of Karnataka

MATERIAL AND METHODS

A field experiment was conducted at MARS, Raichur Karnataka during *Rabi* 2014-15. The soil of the

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experimental site was sandy loam with pH 7.8, Initial soil available N 280 kg ha^{-1}, P_2O_5 39.5 kg ha^{-1} and K_2O 296 kg ha^{-1}. The hybrid Sugar-75 was selected for the study. Treatments consists of RDN @ 150 kg ha^{-1} in two and three splits, LCC, SPAD and GreenSeeker readings each and subsequent N applications were done by observing the LCC threshold 4 and 5, SPAD threshold at 40 and 50, GreenSeeker values at 0.6 and 0.8. Amount of N applied in different treatments and total quantity is given in Table 1. In addition, basal application of 50% recommended N followed by foliar spray of 2% urea at 30, 45 and 60 DAS and without N application as check. Recommended dose of P and K (75: 37.5 kg P_2O_5 K_2O ha^{-1}) were applied at basal in the form of SSP and MOP. Seeds were hand dibbled at spacing 60 cm × 20 cm. The crop was harvested at milky stage (87 DAS) by removing the fresh cobs from net plot area of 19.2 m^2. The fresh cob weight with husk and without husk, green fodder and stover yield was recorded from net plot area. The LCC values, SPAD chlorophyll meter and GreenSeeker readings were recorded at middle lamina of the third leaf from top at 15 days interval. The third fully expanded leaf from top of sweet corn was selected for leaf colour measurement because this leaf is more related to the nitrogen status of maize [3].

RESULT AND DISCUSSION

Fresh cob and fodder yield

Application of Nitrogen different recommendation techniques had significant influence on fresh cob yield fodder yield (Table 2) The fresh cob yield with husk was significantly higher with application of 150 kg ha^{-1} in three splits (15.6 t ha^{-1}). LCC threshold 5 (15.21 t ha^{-1}), GreenSeeker based NDVI-0.8 (14.0 t ha^{-1}). The magnitude of improvement in fresh cob yield was 8 to 15 per cent across different N recommendations. Over significant reduction in fresh cob yield of sweet corn was observed in treatment without receiving nitrogen. Among different nitrogen recommendation techniques LCC-5 out yielded over LCC-4, SPAD-50 over SPAD-40 and NDVI-0.8 over NDVI-0.6. Further, foliar spray of 2 per cent urea at 30, 45, 60 DAS resulted in lower cob yield of sweet corn. Use of LCC for N recommendation was also reported by [4].

Among different N levels, green fodder yield significantly higher with application of 150 kg N ha^{-1} in three splits (19.84 t ha^{-1}), LCC threshold 5 (19.03 t ha^{-1}) and NDVI at 0.8 (18.33 t ha^{-1}). Lower green fodder yield was recorded in treatment which receives no fertilizers (7.53 t ha^{-1}). Similar results were also reported by [5]. Higher harvest index was recorded with application of nitrogen based on LCC threshold 4 (45.1 %) and lower in without N fertilizers (35.7%).

LCC, SPAD and GreenSeeker values

Application of nitrogen based on different management techniques recorded varied LCC, SPAD and NDVI values (Table 3) at different growth stages. The LCC values were increased from 15 DAS up to 75 DAS in both LCC threshold 4 and 5, based on these values fertilizers were applied up to 60 DAS. The SPAD values also varied in SPAD -40 and SPAD-50. At 45 DAS, the SPAD threshold 40 is exceeded, in SPAD threshold 50 it was exceeded after 60 DAS. NDVI threshold at 0.6 was reached at 45 DAS (0.69) where as NDVI threshold 0.8 reached at 75 DAS (0.82).

Table 1
Quantity of N applied for different treatments (kg ha^{-1}) based on LCC, SPAD and GreenSeeker values

Treatment	*Basal*	*15 DAS*	*30 DAS*	*45 DAS*	*60 DAS*	*Total*	*Saving 'N' fertilizer-over RDF*
T_1: 150 kg N ha^{-1} in 2 splits (30, 45 DAS)	75	-	37.5	37.5	-	150	-
T_2: 150 kg N ha^{-1} in 3 splits (30, 45 and 60 DAS)	75	-	25	25	25	150	-
T_3: LCC based 'N' at threshold 4	-	30	30	30		90	60
T_4: LCC based 'N' at threshold 5	-	30	30	30	30	120	30
T_5: SPAD based 'N' at threshold 40	-	30	30	-	-	60	90
T_6: SPAD based 'N' at threshold 50	-	30	30	30	-	90	60
T_7: GreenSeeker based NDVI at 0.6	-	30	30	-	-	60	90
T_8: GreenSeeker based NDVI at 0.8	-	30	30	30	30	120	30
T_9: Basal application of 50 % recommended N and urea foliar spray @ 2 % at 30, 45 and 60 DAS	75	-	-	-	-	75	75
T_{10}: Control (without N application)	-	-	-	-	-	-	-

LCC: Leaf colour chart; **SPAD:** Soil plant analysis development; **NDVI:** Normalized difference vegetation index

Table 2
Fresh cob yield with husk and fresh cob yield without husk, green fodder yield, stover yield and harvest index of sweet corn as influenced by application of N based on LCC, SPAD and GreenSeeker values

Treatment	*Fresh cob yield with husk (t ha^{-1})*	*Fresh cob yield without husk (t ha^{-1})*	*Green fodder yield (t ha^{-1})*	*Stover yield (t ha^{-1})*	*Harvest index (%)*
T_1: 150 kg N ha^{-1} in 2 splits (30, 45 DAS)	13.95	8.28	17.25	8.84	44.7
T_2: 150 kg N ha^{-1} in 3 splits (30, 45 and 60 DAS)	15.65	9.48	19.84	9.51	44.1
T_3: LCC based 'N' at threshold 4	13.26	7.93	16.23	8.14	45.1
T_4: LCC based 'N' at threshold 5	15.21	8.13	19.03	9.01	44.4
T_5: SPAD based 'N' at threshold 40	12.48	7.81	16.72	7.62	42.8
T_6: SPAD based 'N' at threshold 50	13.62	8.95	17.27	7.87	44.0
T_7: GreenSeeker based NDVI at 0.6	11.84	6.17	16.12	7.57	42.1
T_8: GreenSeeker based NDVI at 0.8	14.4	8.15	18.33	8.88	44.0
T_9: 50 % N at basal and urea spray @ 2 % at 30, 45 and 60 DAS	8.18	3.01	13.94	6.68	37.2
T_{10}: Control (without N application)	4.21	1.38	7.53	3.85	35.7
S.Em.±	0.58	0.47	0.75	0.39	2.0
C.D. (p=0.05)	1.73	1.41	2.24	1.08	5.9

Table 3
Leaf colour chart (LCC), SPAD and NDVI values of sweet corn recorded at different for nitrogen application

Treatment	*15 DAS*	*30 DAS*	*45 DAS*	*60 DAS*	*75 DAS*
			LCC values		
T_3: LCC threshold 4	2.1	3.2	3.8	4.5	4.5
T_4: LCC threshold 5	2.1	3.3	3.9	4.7	5.0
			SPAD values		
T_5: SPAD threshold 40	24.6	37.7	49.4	46.3	44.2
T_6: SPAD threshold 50	24.8	39.4	49.4	56.8	55.1
			NDVI values		
T_7: NDVI at 0.6	0.27	0.46	0.69	0.65	0.63
T_8: NDVI at 0.8	0.25	0.44	0.51	0.73	0.82

Table 4
Cost of cultivation, gross returns, net returns and B: C ratio of sweet corn as influenced by nitrogen recommendation techniques

Treatment	*Cost of cultivation (Rs. ha^{-1})*	*Gross returns (Rs. ha^{-1})*	*Net returns (Rs. ha^{-1})*	*B:C ratio*
T_1: 150 kg N ha^{-1} in 2 splits (30, 45 DAS)	32301	111632	79331	3.46
T_2: 150 kg N ha^{-1} in 3 splits (30, 45 and 60 DAS)	32301	125174	92873	3.88
T_3: LCC threshold 4	31518	98056	66538	3.11
T_4: LCC threshold 5	31907	121667	89760	3.81
T_5: SPAD threshold 40	31126	83854	52728	2.69
T_6: SPAD threshold 50	31518	97743	66225	3.10
T_7: NDVI at 0.6	31126	83507	52381	2.68
T_8: NDVI at 0.8	31907	117591	85684	3.69
T_9: 50 % N at basal and urea spray @ 2% at 30, 45 and 60 DAS	31321	65451	34130	2.09
T_{10}: Control (without N application)	28200	33681	5481	1.19
S.Em.±	-	4563	4563	0.15
C.D. (p=0.05)	-	13321	13321	0.43

Economic returns

The higher gross returns, net returns and B:C ratio was recorded by application of 150 kg N ha^{-1} in three splits (T_2) as compared to 150 kg N ha^{-1} in two splits (T_1). Nitrogen application based on LCC threshold 5 and NDVI-0.8 recorded higher gross returns, net returns and B:C ratio over both SPAD-40 and GreenSeeker based NDVI at 0.6. Application of

nitrogen at 150 kg ha^{-1} in three splits has resulted in 12.1 per cent gross returns, 17.07 per cent net returns and 12.1 per cent B:C ratio over 150 kg N ha^{-1} in two splits. Whereas, LCC-5 based N application has resulted in 24.07 per cent gross returns, 34.9 per cent net returns and 22.50 per cent B:C ratio increased over LCC-4. Further, NDVI-0.8 and SPAD 50 based nitrogen application better over NDVI at 0.6 and SPAD-40 respectively. Based on the economic analysis, it can be inferred that for sweet corn split application of N at the rate of 120 kg ha^{-1} whenever LCC threshold -5 and GreenSeeker based NDVI-0.8 was helped to realize higher profit (Table 6). Hence, the LCC and GreenSeeker based NDVI will be a better tools for N management over blanket or recommended N practices in sweet corn. A higher economic return was realized by use of LCC for nutrient management reported by [2] and [6] Biradar *et al.* (2005). The results of the study concluded that LCC threshold 5 based nutrient application is comparable with 150 kg N ha^{-1} in three splits. It can be used as tool for Nitrogen recommendation to sweet corn in *Vertisols* during *Rabi*.

CONCLUSION

Based on the yield attributes and economics it can be inferred that split application of 150 kg N ha^{-1} and LCC threshold 5 and NDVI 0.8 were found to be better for sweet corn helps to increase the yield of sweet corn and economically feasible.

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