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Standardization of level of nitrogen (N) management for maize using Leaf color chart (LCC) in *Hill Zone* of West Bengal

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ABSTRACT

Need based nitrogen (N) fertilizer application in maize (Zea mays L) is beneficial over blanket recommendation, which restrict productivity due field to filed variability. Therefore, a field experiment was conducted during the pre-kharif season of 2017 and 2018 at the Regional Research Station (Hill Zone), Uttar Banga Krishi Viswavidyalaya, Kalimpong to standardize the level of nitrogen application for maize cultivation using leaf color chart in Hill Zone of West Bengal. The analyzed data revealed that the grain yield and yield attributing characters shows better result with leaf color chart over recommend dose of N. Significantly maximum plant height (242 cm), cob length (23.64 cm), cob diameter (6.1 cm), cob fresh weight (434.1 g), 100 grain weight (42.4), grain N content (1.58%) and protein content (9.88%) were achieved when N was applied @ 40 kg/ha at basal and 30 kg/ha when LCC falls below 5. LCC based N application obtained a maximum (7.78 t/ha) maize yield, which much better than our national average as well as it saved 20 kg N per hectare. It has also been found that leaf chlorophyll content increases with N application), and found highest (1.47 mg g-1) with LCC based N application when N was applied @ 40 kg/ha at basal and 30 kg/ha when LCC falls below 5. Therefore, LCC based N application would be the most promising technology to overcome farmers' perception of N over-application.

1. Introduction

The continuous use of high levels of chemical fertilizers is adversely affecting the sustainability of agricultural production and causing environmental pollution. To accomplish the tripartite goal of food security, agricultural profitability and environmental quality, fertilizer nitrogen (N) use efficiency in cereal based agriculture needs to be improved substantially. In most of the cereals crops in India, fertilizer nitrogen has been managed generally following blanket recommendations consists of fixed rate and timing of two or three pre-set split applications of the total nitrogen. Due to large field to field variability of soil nitrogen supply, skilful use of fertilizer N is not possible by following blanket application of fertilizer N. The main reason for low nitrogen use efficiency is inefficient splitting of N applications and use of N in excess to the requirements, which is analogous with uncertainty faced by the farmers in deciding fertilizer N to be applied. Over the last decade, technological development have made it possible for significant improvements are possible by following strategies revolving around feeding the crop nitrogen needs. The strategies for fertilizer N management must be responsive to temporal variation in crop N demand to achieve supply demand synchrony and to minimize N losses. Peng *et al.* (1996) demonstrated that recovery efficiency of top-dressed granular urea during panicle initiation stage could be as high as 78%.

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Thus improvement in the synchrony between crop-N demand and N supply from soil and/ or the applied N fertilizer is likely to be most promising strategy to increase N use efficiency. The crop demand-driven N application have the potential to add farmer's productivity, profits and are crucial for achieving high yield and N-use efficiency (Singh *et al*., 2008; Singh *et al.,* 2010). Leaf color chart (LCC) is a high quality plastic trip on which a series of color based panel embedded based on wavelength characteristic of leaves. The range of green plastic chips ranging from yellowish green to dark green, which follow a continuum from leaf N-deficiency to excessive leaf N content. Thus unlike chlorophyll meter that measure light absorption, LCC measures leaf greenness. This is simple, easy-to-use, and inexpensive alternative to chlorophyll meter and SPAD or optical sensors and are impressive indicator of plant N deficiency. There are two major approaches in the use of LCC. The fixed splitting pattern approach provides a recommendation and planning of splitting/timing of total N application in accordance with growth stage, variety and cropping season. The LCC used at critical growth stages help to adjust upward and/downward of the recommended dose of N rate based on leaf color (Bijay Singh *et al.,* 2012). Need based or crop-driven based N management is well establish using LCC shade 4 of greenness (LCC4) as the threshold value for applying N to rice is well established by several scientists in India (Singh *et al.,* 2002; Maiti *et al.,* 2004; Shukla *et al.,* 2004; Singh *et al.,* 2010). Unlike the extensive use of LCC for need-based N management in rice and wheat, the use of LCC is meager in India. Therefore present investigation was tested demand-driven N management scenarios based on LCC vis-à-vis blanket fixed-time N management schedules on maize in Hill Zone of West Bengal.

2. Materials and Methods

The field experiment was conducted in regional research station (Hill Zone), Uttar Banga Krishi Viswavidyalaya, Kalimpong during pre-kharif season of 2017 and 2018. The experimental sites receives an average annual rainfall of 3000 mm and mean annual summer temperature and mean annual winter temperature are 10^0 C and 29^0 C respectively. Soil pH, electrical conductivity, organic carbon, available N, available P and available K of the composite soil sample of the experimental sites are 5.64, 0.08 µS/cm, 1.06%, 304 kg ha-1, 56 kg ha-1 and 140 kg ha-1 respectively. Total 17 treatments were arranged in randomized block design and replicated thrice. Maize (hero 22 hybrid) was sown in 60 cm × 30 cm spacing in 4 m × 4 m plots. LCC shade 5 was selected for N rate application (Singh *et al.,* 2010). The treatment details were as T1: Control T2: N@0 kg ha-1at basal dose + N@20 if LCC ‹ 5, T3: N@0 kg ha-1at basal dose + N@25 if LCC ‹ 5, T4: N@0 kg ha-1at basal dose + N@30 if LCC ‹ 5, T5: N@25 kg ha-1at basal dose + N@20 if LCC ‹ 5, T6: N@25 kg ha-1at basal dose + N@25 if LCC ‹ 5, T7: N@25 kg ha-1at basal dose + N@30 if LCC ‹ 5, T8: N@30 kg ha-1at basal dose+ N@20 if LCC ‹ 5, T9: N@30 kg ha-1at basal dose+ N@25 if LCC ‹ 5, T10: N@30 kg ha-1at basal dose+ N@30 if LCC ‹ 5, T11: N@40 kg ha-1at basal dose+ N@20 if LCC ‹ 5, T12: N@40 kg ha-1at basal dose+ N@25 if LCC ‹ 5, T13: N@40 kg ha-1at basal dose+ N@30 if LCC ‹ 5, T14: N@50 kg ha-1at basal dose+ N@20 if LCC ‹ 5, T15: N@50 kg ha-1at basal dose+ N@25 if LCC ‹ 5, T16: N@50 kg ha-1at basal dose+ N@30 if LCC ‹ 5, T17: 100% RDF (120:60:60). The LCC reading was started from 6 leaf stage (V2) and continued 15-day interval up to silking stage. Chlorophyll content of leaf sample were determined at 60 DAS (R1 stage). In case of RDF, the fertilizer N (granular urea) was applied at 0, 36 and 50 days of planting. The recommended full dose of P and half dose of recommended K was applied in basal and rest half was applied at pre-silking stage. One week before the harvesting we measured the plant height. At the harvesting, the useful area of every plot had five ears collected at random to measuring the cob length, cob diameter, cob fresh weight, weight of 100 grains using an analytical scale. The grain was dried in a forced air oven at 60°C for 72 hours, ground to pass a 20 mesh screen and analyzed for nitrogen content using the Kjeldahl procedure. For other agricultural operation standard agricultural package of practice were followed during the experiment.

3. Results and Discussion

The plant height, cob length, cob diameter, cob fresh weight, 100 Seed weight and yield of maize (cv. hero 22) were observed at the time of harvesting and grain total N percentage was also analyzed (Table 1). The variation of dose of N (granular urea) application had a significant effect on yield attributing characters and yield. Generally the plant height of maize was increased significantly with increasing amount N rate from zero N level (control) to a certain N level. Significantly highest plant height was obtained with N @ 40 kg ha-1 at basal dose + N @ 30 (T13) *i.e.* 242 cm. It was also been observed that plant height (242 cm) was achieved with T13 is greater than the plant height (238.4 cm) achieved with recommended dose of fertilizer. Souza *et al.* (2016) observed that the plant height had no influence from the N sources, but they were different as to the time of fertilizer application. Likely, this fact was the result of the higher availability of the nutrient in the crucial stages of the plants development. Cob length and cob diameter plays pivotal role for increased productivity as it increased bearing capacity of grains per cob. It has been found that the cob length and diameter were increased significantly with increased N rate application upto a certain maximum level and thereafter those remained constant even after further increasing the rate of N. Significantly highest cob length and cob diameter were achieved with treatment T13 *i.e.* 23.64 cm and 6.1 cm respectively. This was conformity with the findings of Singh *et al.* 2010. Fresh weight of maize cob is the one the most important parameters that resembles the yield. It has been found that cob fresh was increased with increasing amount of N application and was obtained significantly highest cob fresh weight (434.1 g) with treatment T13. The 100-grain weight and grain yields of maize were attained more when the crop received increasing amount of N level upto a certain maximum point. The significantly highest 100-grain weight was achieved with treatment T13. The N content of grains resembles the protein percentage which may help in bio-fortification, worth serious attention of most of the 3rd world countries. The lowest N content (1.38 %) was found in control treatment (T1) *i.e.* no fertilizer application. A significantly highest grain-N content (1.58 %) was obtained with treatment T13. The findings of grain-N content are in agreement with the report of Boone *et al.* 1984. As the yield attributing characters were responsive with rate and time of N application, the yield varies and increased with increasing rate of N application and attained a maximum yield (7.78 t ha-1) with the treatment T13. This may be due to application of demand-driven N application and result shown above were in agreement with the findings of Singh *et al.* 2010; Roy *et al.* 2018.

4. Conclusion

Crop demand-driven fertilizer N management was superior over blanket dose of recommended fertilizer. Demand specific fertilizer N can be easily managed by the use of leaf color chart (LCC), as it is less time consuming and cheap as well as ecofriendly. In hill region West Bengal, it can recommended for application of 40 kg/ha N at basal and apply 30 kg/ha N in maize when LCC falls below 5. This recommendation can vary place to place, as it is location specific, soil fertility specific as well as genotype specific. This study was the evidence of using LCC based N management for improving yield 5.85% over blanket dose and saved 20 kg/ha N. Therefore, blanket application of fertilizer N must be replaced with need-based N fertilizer application using LCC.

Table 1. Influence on yield attributing characters and quality parameters of maize as affected by level of N application through leaf color chart (LCC).

Treatments	Plant height (cm)	Cob length (cm)	Cob diameter (cm)	Cob fresh weight (g)	100 Seed weight (g)	Total N (%) in grain	Chlorophyll content (mg g^{-1})	Protein (%)	Yield (t/ha)
T_1	180.1	17.88	5.3	305.1	39.4	1.38	0.60	8.63	6.03
T_2	185.1	17.84	5.3	307.1	39.6	1.42	0.75	8.88	6.91
T_3	186.1	20.53	5.5	310.1	38.3	1.41	0.85	8.81	6.92
T_4	189.2	19.51	5.5	332.4	41.1	1.43	0.88	8.94	7.08
T_5	194.0	20.33	5.7	331.0	39.8	1.43	1.02	8.94	7.11
T_6	192.1	20.96	5.9	340.1	38.6	1.44	1.05	9.00	6.95
T_7	193.1	20.18	5.8	353.2	38.4	1.45	1.08	9.06	6.88
T_8	196.1	20.85	5.8	357.1	38.5	1.44	1.18	9.00	7.26
T_9	210.3	21.33	5.9	367.5	39.7	1.43	1.24	8.94	7.26
T_{10}	212.2	22.38	5.8	386.4	40.4	1.47	1.29	9.19	7.42
T_{11}	224.4	21.65	5.9	376.7	41.0	1.50	1.33	9.38	7.43
T_{12}	225.0	21.65	5.9	395.0	40.8	1.53	1.35	9.56	7.53
T_{13}	242.0	23.64	6.1	434.1	42.4	1.58	1.47	9.88	7.78
T_{14}	243.0	23.59	6.0	436.1	43.1	1.56	1.46	9.75	7.54
T_{15}	241.1	22.55	6.1	431.2	42.3	1.58	1.45	9.88	7.76
T_{16}	242.1	24.23	6.1	436.1	42.4	1.59	1.48	9.94	7.72
T_{17}	238.4	22.88	5.9	431.8	41.0	1.55	1.38	9.69	7.35
SEm (±)	3.290	0.276	0.096	5.756	0.623	0.023	0.019	0.142	0.149
CD	9.478	0.796	0.276	16.580	1.794	0.066	0.054	0.409	0.430

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