Precision Nutrient Management through Use of LCC and Nutrient Expert[®] in Hybrid Maize Under Laterite Soil of India

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Abstract Nutrient management has played a crucial role in achieving self sufficiency in food grain production. Energy crisis resulted in high price index of chemical fertilizers. Coupled with limited production of fertilizer along with escalating fertilizer cost, reduced soil health and the problem of pollution gave rise to interest in precision nutrient management tools. Field experiment was conducted to study the effect of variety and nutrient management on the growth and productivity of maize under lateritic belt of West Bengal during *kharif* season of 2013 at the farmers' field located in Birbhum district of West Bengal, on sandy loam lateritic soil having low fertility status and acidic reaction (pH5.6). The experiment consisted of the five levels of fertilizer i.e, F1 = control, F2 = state recommendation (150:75:75 kg N:P₂O₅:K₂O ha⁻¹), F3= Nutrient Expert[®] (120:34:51 kg N:P₂O₅:K₂O ha⁻¹), F4=farmers practices (80:40:40 kg N:P₂O₅:K₂O ha⁻¹), and F5= Basal application of 50:75:75 kg N:P₂O₅:K₂O ha⁻¹ with split N application on basis of LCC, and two level of varieties viz., V1= Rajkumar, V2= Sona, thus making ten treatment combinations, which were replicated thrice and was laid out in randomized block design (RBD). The "Nutrient Expert[®]" is a Decision support tool developed by IPNI (International Plant Nutrition Institute) & CIMMYT, Mexico. The values for growth parameter like plant height, dry matter, cob characters like length of cob, girth of cob, weight of cob, number of cobs per plant, number of grains per cob, grain yield, stover yield, harvest index were observed. It was found that the growth parameter as well as yield component and yield were significantly affected by different varieties and different levels of fertilizer. Among the two hybrid varieties, Rajkumar proved significantly superior over hybrid variety Sona with regard to growth attributes like plant height, dry matter accumulation. The result indicated that different schedules of fertilizer expressed significant effect on plant height, cob girth and length, grain per cob, grain weight per cob, test weight, Maize grain yield and stover yield at harvest.

It was found that where fertilizer was applied on the basis of "Nutrient expert" recommendation gave highest yield and yield parameter values. The highest values for agronomic efficiency, physiological efficiency and recovery efficiency were also found where fertilizer was applied on the basis of "Nutrient expert[®]" recommendation. Thus, it was observed that the application of nutrient on the basis of recommendation obtained from the decision support system like "Nutrient expert[®]" and LCC based application proved superior over farmer's practice as well as State recommendation where much higher dose of nutrients were applied. So, it may be concluded that the "Nutrient expert" based recommendation and cultivation of Rajkumar hybrid may be helpful in improving productivity and profitability of Maize cultivation in the Laterite soils of West Bengal, India.

Keywords Hybrid Maize, LCC, Nutrient Management, Nutrient Expert, Yield, Economics

1. Introduction

Nutrient management has played a crucial role in achieving self sufficiency in food grain production. The need for precise and responsive management of N fertilizer in Maize is compelling for both economic and environmental reasons. Static fertilizer recommendations based on average response lead to excessive fertilization in some years and inadequate fertilizers in years with high N losses. The uncertainty in optimum N rate poses risks for profit losses which is exacerbating by the asymmetric profit response of maize to N rates. The associated higher cost of under fertilization relative to over fertilization drives farmers to apply imbalanced rates. This uncertainty can be addressed by providing more accurate location and time specific recommendations that increase accuracy and reduce

uncertainty (Clune *et al.*, 2013). The “Nutrient Expert®” a Decision support tool developed by IPNI (International Plant Nutrition Institute) & CIMMYT, Mexico is an easy to use, interactive and computer based decision support tool that can rapidly provide nutrient recommendations for individual farmers’ field in the presence or absence of soil testing data. The precise application of nutrients through the use of these tools can raise the profitability of the production system and may reduce environmental pollution. Very little work has been done to use these improved computer based tools for nutrient management in the laterite soil of West Bengal, India. In this context, an experiment was carried out to study the precision nutrient management through use of LCC and “Nutrient Expert®” in Hybrid maize under laterite soil of West Bengal, India.

2. Materials and Methods

A field experiment was conducted to study the precision nutrient management through use of LCC and “Nutrient Expert®” in Hybrid maize under laterite soil of West Bengal, India during the *kharif* season of 2013 at the farmer’s field in Chella Kamarpara village, Chella G.P, Chella Mouza of Illambazar Block, Birbhum, West Bengal which is situated at 23° 37.374’ latitude and 87° 37.170’E longitudes with an average altitude of 58.9 m above mean sea level under sub-humid, sub-tropical belt of West Bengal. Composite surface soils were collected for determination of available N, available P₂O₅ and available K₂O in soil following the standard methods of Alkaline permanganate method (Subiah & Asija, 1956), Brays method No.1 (Bray and

Kurtz, 1945) and Flame photometer method (Hanway and Heidel, 1952) respectively. The soil was slightly acidic (pH-5.6) and it was low in Nitrogen (200 kg N/ha) and medium in phosphorus (20 kg P₂O₅/ha) and potassium (112 kg K₂O/ha).

The experiment was conducted with Hybrid Maize varieties. The experimental area comes under Red and Lateritic zone of West Bengal. The experiment consisted of the five levels of fertilizer i.e., F1 = control, F2 = state recommendation (150:75:75 kg N:P₂O₅:K₂O ha⁻¹), F3 = farmers practices (80:40:40 kg N:P₂O₅:K₂O ha⁻¹), F4 = Nutrient expert® (120:34:51 kg N:P₂O₅:K₂O ha⁻¹), and F5 = Basal application of 50:75:75 kg N:P₂O₅:K₂O ha⁻¹ with split N application on basis of LCC, and two level of varieties viz., V1 = Rajkumar, V2 = Sona, thus making ten treatment combinations, which were replicated thrice and was laid out in factorial randomized block design (FRBD). In F5, three splits of nitrogen were applied @ 25 kg N/ha in each split thus the total dose of nitrogen applied was @ 125 kg N/ha. The crop was raised following standard package of practices for water management, weed management and plant protection. Agronomic efficiency (AE), physiological efficiency (PE) and recovery efficiency (RE) of N was calculated as per the following formula given by Cassman *et al.*, 1998 :

$$AE = \Delta \text{ kg grain/kg N applied}$$

$$RE = (\Delta \text{ kg uptake/Fertilizer N applied}) \times 100$$

$$PE = \Delta \text{ kg grain}/\Delta \text{ kg N uptake}$$

Where, Δ = Difference between treatment plot and control plot

3. Result and Discussion

Table 1. Effect of precise nutrient Management on the Growth and Yield of Maize

Treatment	Plant height (cm) at 60 DAS	Dry matter at harvest (gm /plant) at 60 DAS	SPAD Chlorophyll Meter Reading at 60 DAS	Grain yield (t/ha)	Stover yield (t/ha)
Nutrient management					
Control	166.5	70.30	15.8	1.14	4.29
State Recommendation	180.05	79.12	24.6	3.52	5.69
Farmer’s practice	175.6	79.20	19.4	2.67	4.63
Nutrient expert®	180.4	81.75	26.2	4.64	6.59
LCC based application	180.5	76.31	29.8	4.47	6.49
SEm (±)	4.3	3.1	2.3	0.42	0.53
CD (p=0.05)	11.8	9.3	7.4	1.3	1.6
Variety					
Sona	173.08	76.5	24.9	4.16	6.24
Rajkumar	180.08	79.3	27.5	3.39	6.38
SEm (±)	3.6	2.7	3.33	0.7	0.72
CD (p=0.05)	10.4 (NS)	9.0 (NS)	10.6 (NS)	2.3 (NS)	2.9 (NS)

The data presented in Table 1 suggested that among nutrient management practices, the LCC and Nutrient Expert® based application of fertilizer produced higher plant height compared to the state recommendation and the values were significantly higher than farmer practices treatment at 60 DAS. The highest dry matter accumulation per plant was recorded in state recommendation. The lowest dry matter accumulation per plant was observed when there was no fertilizer application.

The SPAD chlorophyll meter reading was highest in LCC based application and it was statistically at par with that of all treatments except farmers' practice and control.

The grain yield was highest when fertilizer application was done based on Nutrient Expert recommendation and it was statistically at par with LCC based application and State recommendation. The percentage increase in grain yield from Nutrient Expert® based recommendation over farmers practices, state recommendation and LCC based application of fertilizer were approximately 74 %, 32 %, and 4 % respectively. Similar result was observed by Nottidge, *et al.* (2011). When fertilizer application was done based on Nutrient Expert® based recommendation, the stover yield

was highest (65.90 q/ha) and it was statistically at par with LCC based application of fertilizer and State recommendation. Similar superior results in Nutrient expert were reported by Wang *et al.*, 2014. Similar result was observed by Tatarwal *et al.* (2011).

The effect of nutrient management was found non-significant in case of varieties. The two varieties gave similar response to the different nutrient management practices.

The data reported in Table 2 indicated that the treatment Nutrient Expert® based recommendation produced highest average wt of cob. The length of cob and shelling percentage was highest in LCC based application. The highest value for girth of cob and number of grains per cob was recorded in State recommendation and Nutrient Expert® based recommendation. The number of rows per cob and number of columns per cob were not significantly affected by the nutrient management treatments.

The two varieties did not varied much among each other in case of various yield attributes. However, the variety Rajkumar proved superior over that of Sona variety and recorded significantly higher number of rows per cob.

Table 2. Effect of Precise Nutrient Management on the Yield Attributes of Maize

Treatment details	Yield attributes						
	Average wt of cob(gm)	Length of cob (cm)	Girth of cob (cm)	No of row/cob	No of Column/cob	No of grain/cob	Shelling %
Nutrient management							
Control	152.23	22.2	11.33	23	13	311	83.04
State Recommendation	173.67	26.8	15.92	28	15	365	84.87
Farmer's practice	159.00	23.67	13.6	26	14	340	85.69
Nutrient expert®	178.87	27.34	15.92	28	16	363	86.38
LCC based application	177.34	28.5	15.83	26	16	351	87.16
SEm (±)	4.2	1.1	1.5	0.7	0.8	7.67	1.8
CD (p=0.05)	12.6	3.3	4.2	NS	NS	23	5.4
Variety							
Sona	167.34	25.83	16.08	27	15	391	83.95
Rajkumar	176	26.67	14.83	29	13	381	83.26
SEm (±)	5.8	0.9	1.0	0.5	0.8	9.2	1.2
CD (p=0.05)	NS	NS	NS	1.5	NS	NS	NS

Table 3. Effect of Precise Nutrient Management On The Agronomic Efficiency (AE), Recovery Efficiency (RE In %), Physiological Efficiency(PE) Of Hybrid Maize

Treatment details	Agronomic efficiency (AE)	Recovery efficiency (RE)	Physiological efficiency (PE)
Nutrient management			
Control			
State Recommendation	15.86	37.07	42.79
Farmer's practice	19.12	41.21	46.40
Nutrient expert®	29.16	53.59	54.42
LCC based application	26.64	49.98	53.30
SEm (±)	0.40	0.96	0.74
CD (p=0.05)	1.3	2.4	2.1

Agronomic efficiency (AE), recovery efficiency (RE), physiological efficiency (PE) of applied N significantly differed due to different nutrient management (Table 3). The treatment Nutrient Expert® based application of fertilizer produced highest Agronomic efficiency (AE) and recovery efficiency (RE) of applied N which was significantly greater than all other treatments. The highest physiological efficiency (PE) of applied N was recorded in Nutrient Expert® based application of fertilizer which was statistically at par with LCC based application and significantly greater than all other treatments. Similar response was observed by Maiti and Das, 2006 in Rice and Kumar et al, 2013 in Maize.

4. Conclusions

There were temporal differences in various agronomic parameters. The result indicated that different schedules of fertilizer expressed significant effect on plant height, cob girth and length, grain per cob, Maize grain yield and stover yield at harvest. It was found that the application of nutrient on the basis of recommendation obtained from the decision support system like “Nutrient expert” gave highest yield and yield parameter values. The application of nutrient on the basis of LCC also proved satisfactory. The AE and RE of applied N was also highest in Nutrient expert treated plot and it was significantly higher than all other treatments. The PE was also highest in Nutrient expert treated plot and it was statistically at par with LCC based application.

This indicates that production and use efficiency of nutrients can be increased with the use of nutrient expert tool and LCC based application in Maize.

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