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Precision Nutrient Management through LCC in *kharif* Maize (*Zea mays* L.)

Amarinder Singh Riar[1], Bikramjit Singh[1], Puneet Kaur[1], Rajanbir Singh[1]

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ABSTRACT

Background: Nitrogenous fertilizers being very expensive, farmers can't come up with the money for them in big and it cannot observe in wasteful way. At the identical time, crop should not suffer from the deficiency of nitrogen. Proper time of N utility is important to limit N loss and increases restoration; it's far commonly determined that farmer tend to apply more nitrogen fertilizer than needed mainly because of its immediately seen effect on plant boom and leaf color.

Methods: Field experiment was conducted to study the effect of methods of sowing and nutrient management on productivity of maize during season of 2018 and 2019 on sandy loam soil at Amritsar. The soil was neutral (pH- 7.6) and it was low in Nitrogen (154 kg N/ha) and medium in phosphorus (24 kg P_2O_5/ha) and high in potassium (328kg K_2O/ha). The experiment consisted three methods of sowing *i.e.* Zero, Flat and Ridge sowing of maize and five levels of fertilizer *i.e.*, No = control, Nrec = recommendation (125:60:30), N_{LCC4} (90:60:30), N_{LCC5} (120:60:30) and N_{LCC6} (150:60:30) with split N application on basis of LCC, thus making fifteen treatment combinations, which were replicated thrice and was laid out in Split pot design (SPD).

Result: Higher grain yield (39.43 q ha^{-1}) was obtained from ridge planting followed by (36.27 q ha^{-1}) in planting method Zero tillage.The result indicated that different schedules of fertilizer expressed significant effect on maize grain yield and quality. It was found that the application of split N on the basis of LCC gave highest yield. The application of nutrient nitrogen used more efficiently by the N_{LCC4} in maize it may be due to less losses of nitrogen by application through leaf color chart shade 4. The gross return, net return and Benefit: cost ratio indicated that the application of nutrients on basis of LCC5 proved economically more remunerative.

Key words: LCC, Maize, Methods of sowing, Nitrogen, Precision.

INTRODUCTION

Rice-wheat cropping system has led to a number of unfavourable effects together with deterioration of soil fitness and extreme ground water depletion. To triumph over these consequences there's a want to update the rice crop with relatively low water requiring, brief period and hybrid sorts of maize crop. It has attained a status of slogan in nowadays with suitability for diversification and a couple of cropping.

Maize occupied 114.6 thousand hectare with production of 410.5 thousand tonnes in Punjab during 2019-20. The productivity of maize is 35.82 quintal per hectare (Annonymus, 2021). To accelerate production in Punjab, adoption of cutting-edge agro-management practices seems imperative and one of the predominant strategies is the usage of proper method of sowing. Planting approach has good sized importance among all agronomic practices, as right adjustment of plant inside the field not only guarantees effective plant population, but additionally allows the flora to utilize the land and different input sources greater correctly and resolutely toward boom and development and yield of maize. Maize may be planted in specific approaches i.e. Ridge planting, furrow planting, line planting and broadcast. All these technique have superiority over each other with admire to crop stand, irrigation control, drainage of excess water, utilization of herbal moisture within the soil, root balance in check to lodging and weed control and many others.

Nitrogenous fertilizers being very expensive, farmers can't come up with the money for them in big and it cannot observe in wasteful way. At the identical time, crop should not suffer from the deficiency of nitrogen. Proper time of N utility is important to limit N loss and increases restoration; it's far commonly determined that farmer tend to apply greater nitrogen fertilizer than needed mainly because of its immediately seen effect on plant boom and leaf color. So, in maize also there is scope to modify nitrogen fertilizer application with timing of plant requirement to decorate nitrogen use performance due to the fact nitrogen requirement of maize plant is not identical in the course of the growth period. This adjustment ought to be primarily based on leaf colour depth of crop because it's miles at once related to leaf chlorophyll content and leaf nitrogen popularity. This real time nitrogen control can be completed through leaf coloration chart which assist in increasing nitrogen use performance.

[1]Department of Agriculture, Guru Nanak Dev University, Amritsar-143 005, Punjab, india.

Corresponding Author: Rajanbir Singh, Department of Agriculture, Guru Nanak Dev University, Amritsar-143 005, Punjab, india. Email: rajanbir51@gmail.com

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Leaf colour chart is basically a guide to supply the necessary nitrogen fertilizer for the optimal nitrogen content which is very necessary in achieving maximum yield. In maize by using threshold LCC shade 5 saved 25-50% fertilizer nitrogen. Leaf color chart is technique for real time nitrogen management (Singh *et al*. 2002) which can be used for rapid and reliable monitoring of relative green color of the leaf as an indicator of leaf nitrogen status. In this context, an experiment was carried out to study the precision nutrient management through use of LCC and "Nutrient Expert" in maize under sandy loamy soil of Amritsar, India.

MATERIALS AND METHODS

A field experiment was conducted to study the precision nutrient management through use of LCC and different methods of sowing in *kharif* maize during season of 2018 and 2019 at the research farm of Khalsa College Amritsar which is situated at 31°-38′N latitude and 74°-52′E longitudes with an average altitude of 236 m above mean sea level under semi-arid of Punjab. The soil was neutral (pH-7.6) and it was low in Nitrogen (154 kg N/ha) and medium in phosphorus (24 kg P_2O_5/ha) and high in potassium (328kg K_2O/ha). The experiment was conducted with *kharif* Maize cv PMH-1. The experiment consisted three methods of sowing *i.e*. zero, flat and ridge sowing of maize and five levels of fertilizer *i.e*, No = control, Nrec = recommendation (125:60:30), N_{LCC4} (90:60:30), N_{LCC5}(120:60:30) and N_{LCC6} (150:60:30) with split N application on basis of LCC, thus making fifteen treatment combinations, which were replicated thrice and was laid out in Split pot design (SPD). In N_{LCC4} three splits, N_{LCC5} four splits and $_{NLCC6}$ five splits of nitrogen were applied @ 30 kg N/ha in each split.

Nitrogen content of grain

The nitrogen content in seeds was determined by modified Kjeldahls method as described by Piper (1966).

Nitrogen content of straw

The nitrogen content in straw was determined by modified Kjeldahls method as described by Piper (1966).

Protein content

Nitrogen percentage was determined in grains and protein content was worked out by multiplying by the factor 6.25.

Efficiencies

Partial factor productivity

$$PFP = \frac{\text{N uptake in fertilized plot (kg ha}^{-1}\text{) -N uptake in control plot (kg ha}^{-1}\text{)}}{\text{Fertilizer N applied (kg ha}^{-1}\text{)}}$$

Agronomic efficiency

$$AE = \frac{\text{Grain yield (kg}^{-1}\text{)}}{\text{Fertilizer N applied (kg}^{-1}\text{)}}$$

Benefit cost ratio

Cost of cultivation was calculated by taking into account the prevailing prices of inputs like tillage operations, seed, irrigation, fertilization, weeding, harvesting, transportation charges, management charges, rental value of land and depreciation.

Additional cost involved and returns obtained with different treatments was worked out on the basis of market rate of all the applied inputs during experimentation on per hectare basis. The benefit cost ratio is computed on the basis of the formula given below:

$$B:C = \frac{\text{Total income}}{\text{Total cost of cultivation}}$$

RESULTS AND DISCUSSION

Grain yield

The data with respect to grain yield presented in Table 1 showed that different methods had significant effect on grain yield of maize. Higher grain yield (39.43 q ha^{-1}) was obtained from ridge planting followed by Zero tillage (36.27 q ha^{-1}). The planting method ridge and Zero tillage statistically at par with each other but were significantly superior over Flat planting method. The higher grain yield of ridge might be due to vigor growth. Similar results were observed by Lashkari *et al* (2011). Appropriate approach of sowing has several advantages in agronomic measures consisting of intercultural, weeding, insect-pest control and so on. Ridge sowing is taken into consideration to be the approach that have the above advantages as opposed to different techniques of sowing supported with the aid of the findings of Vogal *et al*. (1994) located that grain yield of maize changed into better with ridging plots. While Vedove *et al*. (1996) pronounced that grain yield of maize changed into greater with ridging which changed into attributed to the more quantity of N under this device.

Nitrogen has paramount area in figuring out sustainable soil fertility control. The crop elimination, real stability and internet benefit have been higher with LCC-5 practices. The effect of different nitrogen levels on grain yield of maize was significant. The treatment N_{LCC6} recorded highest grain yield (46.50 q ha^{-1}). It was significantly higher than N_0 (25.27 q ha^{-1}) but statistically at par with N_{LCC5} (43.05 q ha^{-1}).Where maximum grain yieldwas observed with N_{LCC6} (46.50 q ha^{-1}) followed byN_{LCC5} (43.05 q ha^{-1}), N_{REC} (40.36q ha^{-1}), N_{LCC4} (34.50 q ha^{-1}) and N_0 (25.27 q ha^{-1}). Greater grain yield at

higher nitrogen application was probably due to better vegetative growth of crop plant. These results are in line with finding of Ahmad *et al* (2009) who also found that grain yield increased by increasing nitrogen levels. Higher to be had NPK repute after harvest of maize with graded tiers of NPK software become also pronounced by Jayaprakash *et al*. (2006). Varinderpaul-Singh *et al*. (2011) also opined that fertilizer N can be greater correctly managed by applying fertilizer N dose primarily based on leaf color as measured by LCC than blanket recommendation. Ravi *et al*. (2007) reported that utility and fertilizer primarily based LCC-five mixed with in experienced manure expanded grain yield and nutrient uptake in hybrid rice.

Nitrogenand protein content in grain

Nitrogen content of maize grain as indication of potential yield response to applied nitrogen. Data presented in Table 1 illustrated that nitrogen content of grains in planting methods is non-significant but significantly higher in ridge as compare to zero and flat sowing of maize.

In sub plots treatments different N levels has significant effect on nitrogen content of grain. The highest N content found in N_{lcc6} and lowest found in $N_{0.}$ But N_{LCC5} and N_{Rec} remained at par with each other during both years.

The protein content is a very important quality parameter of maize. This ultimately depends on the uptake of nitrogen by the crop. The data regarding protein content has been presented in Table 1 showed that varieties could not show any significant influence on grain protein content during both 2018 and 2019. But higher grain protein content found inridge planting method.During both years, the highest grain protein content found in N_{LCC6} and lowest found in N_0. $N_{LCC6,}$ N_{LCC5}, N_{LCC4} remained at par with $N_{Rec.}$ Higher protein content inN_{LCC6}, N_{Rec} and N_{LCC} may be due to higher nitrogen application. This results were in lines with the finding of Amanullah*et al* (2009) who reported that Quality character in maize, such as protein content in seed were improved with optimum N levels. The higher internet benefits with these treatments become related to higher split doses of nitrogen and uptake through crop. Higher harvest index turned into recorded with utility of nitrogen primarily based on LCC threshold four (45.1%) and lower in whilst N fertilizer became now not carried out (35.7%). Arvind *et al*. (2004) additionally pronounced extended nitrogen uptake in ordinary sown rice based totally on LCC < five.0 as compared to decrease threshold tiers. Based at the monetary returns, it can be inferred that for maize break up software of N at the charge of a hundred and twenty kg ha^{-1} every time LCC threshold -5 and Green Seeker based totally NDVI-zero.8 has found out better profit. These are better gear for N control over fixed N charge in sweet corn.

Efficiencies

Nitrogen use efficiency (PFP and AE) has been presented in Table 2. From this highest nitrogen use efficiency PFP40.30 percent for 2018 and 42.33 per cent for 2019 found in the treatment N_{LCC4} whereas Agronomic efficiency observed more under N_{LCC5} as compared to other treatments.

Table 1: Precision nutrient management through use of LCC under different methods of sowing in *kharif* maize during season of 2018 and 2019.

Treatments	Grain yield (q ha^{-1})		Spad chlorophyll meter reading		Nitrogen content		Protein content	
	2018	2019	2018	2019	2018	2019	2018	2019
Methods of planting								
Zero	36.27	38.66	25.2	24.9	1.64	1.58	10.25	9.87
Flat	35.25	34.78	24.7	24.5	1.63	1.56	10.18	9.75
Ridge	39.43	40.19	25.1	25.3	1.60	1.55	10.00	9.68
CD (p=0.05)	3.43	3.21	NS	NS	NS	NS	NS	NS
Nitrogen levels								
N_0	27.27	26.10	16.8	17.5	1.51	1.47	9.43	9.18
N rec	40.36	41.65	24.5	24.1	1.70	1.67	10.62	10.43
NLCC4 (3 splits)	36.27	38.10	26.7	25.9	1.59	1.52	10.12	9.50
NLCC5 (4 splits)	43.05	43.38	27.8	27.6	1.67	1.62	10.43	10.12
NLCC6 (5 splits)	4514	45.97	29.2	29.5	1.74	1.68	10.81	10.50
CD (p=0.05)	3.88	3.39	4.36	5.36	0.14	0.12	0.15	0.21

Table 2: Nitrogen use efficiency-partial factor productivity and Agronomic efficiency influenced by precision nutrient management through use of LCC.

Parameters	Grain yield	SPAD (Chlorophyll content)	Agronomic efficiency	Partial factor productivity
Grain yield	1	0.94	0.79	0.94
SPAD (Chlorophyll content)		1	0.86	0.95
Agronomic efficiency			1	0.95
Partial factor productivity				1

*Correlation is significant at the 0.05 level (2-tailed).

Table 3: Correlation between grain yield and efficiencies.

Treatment Nitrogen levels	N Applied (kg ha^{-1})	Grain yield(kg ha^{-1})		NUE(PFP)		NUE (AE)	
		2018	2019	2018	2019	2018	2019
N_0	0	2779	2610	0	0	0	0
N_{Rec}	125	4036	4165	32.28	33.32	10.05	12.44
N_{LCC4}	90	3627	3810	40.30	42.33	9.42	13.33
N_{LCC5}	120	4305	4338	35.87	36.15	12.71	14.4
N_{LCC6}	150	4514	4597	30.09	30.6	11.56	13.24

Table 4: Economics of *kharif* maize during season of 2018 and 2019 (pooled data).

Treatments	Benefit cost ratio			
Method of planting	Total cost (Rs ha^{-1})	Total income (Rs ha^{-1})	Net profit (Rs ha^{-1})	B:C
Zero	35780	59145	23365	1.65
Flat	37580	52815	15775	1.40
Ridge	38810	62040	23230	1.59
Nitrogen levels				
N_0	35730	39541	3811	1.10
N_{Rec}	39250	58522	19272	1.49
N_{LCC4}	38215	48241	10026	1.26
N_{LCC5}	39500	64597	25097	1.63
N_{LCC6}	40550	65453	24903	1.61

This mean the nitrogen used more efficiently by the N_{LCC4} in maize it may be due to less losses of nitrogen by application through leaf color chart shade 4. Our results are in line with Rehman *et al* (2011) who reported that nutrient use efficiency increased but up to a certain level of fertilizer application and then it curved with further increase in fertilizer application probably due to fact that higher rates of fertilizer could lead to relatively more losses of nutrient. The positive correlation observed in Table 3 between the grain yield and nitrogen use efficiencies.

Economics

The pooled data of two years in Table 4 shows that among all the sowing methods maximum income was obtained with ridge planting method (Rs 62040 ha^{-1}) followed by zero tillage planting (Rs 59145 ha^{-1}) and flat planting (Rs 52815 ha^{-1}) methods. The data also revealed that all the nitrogen management treatments gave higher income over control (no nitrogen). Maximum income obtained with LCC_6 (Rs 65453 ha^{-1}) and minimum was obtained with N_0 (Rs 39541).

Benefit cost is the ratio of gross returns to cost of cultivation. According to the data given in Table 4 it was observed that among planting methods highest benefit cost ratio was recorded in zero tillage planting. Zero tillage gave more benefit cost ratio due to less cost of cultivation in zero tillage method. The data in Table further depicted that maximum BC ratio (1.63) was recorded in N_{LCC5} followed N_{LCC6} (1.61), N_{REC} (1.49) and N_{LCC4} (1.26). Minimum BC ratio (1.10) was recorded in control plots where no nitrogen was applied. A higher monetary go back was realized by use of LCC for nutrient control mentioned by using Balasubramanian *et al*. (2000) and Biradar *et al*. (2005). Among this equipment, LCC being a cost powerful, easy and farmer's pleasant machine can be effortlessly used even by using small and illiterate farmers. Thus the blanket guidelines of making use of constant N dose at constant time durations need to get replaced with want based fertilizer N management generation the usage of LCC in maize.

CONCLUSION

The outcomes of this study showed that Ridge method of sowing produced higher grain yield whereas as Zero tillage method of sowing is more economical. Amongst the application of nutrient nitrogen, more efficient utilization of nitrogen was under N_{LCC5}which proved economically more remunerative.

Authors contributions statement

The authors declare that they have contributed to the article at a similar rate.

Conflict of interest

The authors declare no conflicts of interest.

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