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Influence of spatial arrangement and nitrogen scheduling on crude protein content and uptake of nitrogen in maize (*Zea mays* L.)

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Abstract
Field experiments were conducted at Department of Agronomy of Tamil Nadu Agricultural University, Coimbatore to study the effect of spatial arrangement and nitrogen scheduling on N uptake and crude protein content in maize. The experiments were laid out in split plot design and replicated thrice. The following spatial arrangements viz., 60 x 25, 30 x 30, 35 x 35, 40 x 40, 45 x 45 and 50 x 50 cm were alloted to main plots. Three nitrogen scheduling approaches were assigned to sub plots. Growth stage based N scheduling approaches were compared with Leaf Colour Chart based (LCC) N management. Based on the experimental results, N uptake was higher under 30 x 30 cm arrangement throughout growth stage and reached maximum at 90 DAS (290.2 and 307.9 kg ha^{-1}). Among N schedling approaches, LCC based N scheduling removed more N (261.6 and 284.2 kg ha) at 90 DAS than conventional approach. Similarly LCC based N management resulted more crude protein (7.68%) content in maize.

Keywords: nutrient uptake, square planting, leaf colour chart, nitrogen, crude protein

Introduction
Maize is a miracle crop called as queen of cereals and is grown in more than 166 countries occupying 168 million hectares with production of 854 million tonnes and productivity of 5120 kg ha^{-1}. Good plant spacing gives the right plant density, which is the number of plants allowed on a given unit of land area for optimum yield (Obi, 1991) [1] and also it decides the amount of nutrient removal by the crop.Higher grain starch and protein content (69.8 and 7.8%) were obtained under 60 × 35 cm crop geometry compared to 60 × 15 cm spacing (Randhawa *et al.*, 2007) [2] The yield increase due to N fertilization was substantial (92%) in maize compared to rice (47%) and wheat (50%) (Prasad, 2011) [3]. Application of higher level of N fertilizer is very common among Indian farmers, who 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 (Cassman *et al.*, 1996) [4]. 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 N fertilizer application with plant to optimize nutrient use and minimize environmental pollution.
The leaf colour chart was developed for rice and is also suitable for maize as indicated by spectral reflectance measurements performed on rice and maize leaves (Witt *et al.*, 2005) [5]. LCC proves to be an effective tool in detecting the maize additional N need, giving higher yields and increased profit compared with fixed rates (Pasuquin *et al*., 2012) [6]. Nitrogen scheduled @ 160 kg ha^{-1} in three splits based on LCC value was superior over other site specific nutrient management practices with respect to growth, yield and nutrient uptake in maize–wheat cropping system (Kumar *et al.*, 2010) [7]. There is need to investigate N management with tools like LCC for site specific nitrogen management in maize. LCC based N management can be an important tool which can answer the questions of when, where and how much to apply nitrogenous fertilizers and its combination with other nutrients, synchronizing it with crop demand, so as to acquire maximum threshold level of yield, reducing environmental harms. Hence, there is a tremendous scope for use of LCC for N management in maize crop.

Materials and Methods

The soil of the experimental site was clay loam in texture belonging to Irugur series and taxonomically known as Typic Ustropepts under USDA classification. Field experiments were laid out in split plot design and treatments were replicated thrice. Maize hybrid, NK 6240 was used as test crop. Main plot treatments were viz., M_1- 60 x 25, M_2- 30 x 30, M_3- 35 x 35, M_4- 40 x 40, 45 x 45 and 50 x 50 cm. Nitrogen scheduling approaches of Recommended dose of nitrogen (RDN) @ 150 kg ha^{-1} in 3 splits as 25, 50 and 25 per cent at basal, 25 and 45 DAS, N_2- RDN @ 150 kg ha^{-1} in 4 splits each 25 per cent at basal, 15, 30 and 45 DAS, Leaf colour chart (LCC) based nitrogen scheduling (whenever LCC critical value falls below 5, top dressing of N @ 30 kg ha^{-1}) were imposed. The recommended entire dose (75 kg ha^{-1}) of P_2O_5 was applied basally. The K_2O (75 kg ha^{-1}) was applied in two equal split doses viz., basal and with first top dressing of nitrogen. The initial analysis of the experimental sites revealed that the soil was slightly alkaline with low soluble salts (EC 0.65 and 0.76 dSm^{-1}), low in organic carbon content (0.41 and 0.39 %), low in available nitrogen (216 and 205 kg ha^{-1}), medium in available phosphorus (15.2 and 16.3 kg ha^{-1}) and high in available potassium (550 and 515 kg ha^{-1}).

Grain samples of maize were taken from each plot and analyzed for total N by Micro-Kjeldahl method (Humphries, 1956) [8]. The N content of the grain was multiplied with 6.25 (Dubez and Wells, 1968) [9] to get the crude protein content and expressed in percentage. Nitrogen content of the plant sample was determined by the Micro-kjeldahl method (Humphries, 1956) [8] and expressed as percentage in dry weight basis and computed to kg ha^{-1}. The uptake of nitrogen was worked out using the following formula.

$$\text{Nitrogen uptake (kg ha}^{-1}) = \frac{\text{Nitrogen concentration (\%)}}{100} \times \text{Biomass yield (kg ha}^{-1})$$

The data obtained from the analysis were statistically analyzed as suggested by Gomez and Gomez (2010) [10].

Results and Discussion

Nitrogen uptake

The statistical analysis at different stages indicated that the crop geometry and nitrogen scheduling exerted significant influence on N uptake of maize. Higher N uptake (70.6, 219.7 and 290.2 kg ha^{-1}) at 30, 60 and 90 DAS, respectively during 2011 was recorded under 30 × 30 cm (Tables 1 and 2). Simiar results were reported during 2012 also. The increased N uptake might be due to higher biomass gain and total ratio of total above ground N content to leaf area index are the driving factor for N uptake. The results are in confirmity with the findings of Misra *et al.* (1994) [11] and Kumar (2009) [12] in maize.

Table 1: Effect of spatial arrangement and nitrogen scheduling on nitrogen uptake (kg ha^{-1}) at various growth stages of maize during 2011.

Treatments	30 DAS				60 DAS				90 DAS			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
M_1- 60 × 25 cm	49.5	56.0	54.7	53.4	175.3	176.1	203.4	184.9	247.2	249.7	291.8	262.9
M_2- 30 × 30 cm	60.6	72.4	78.7	70.6	207.0	207.6	244.5	219.7	270.6	274.6	325.4	290.2
M_3- 35 × 35 cm	64.1	46.5	56.4	55.6	181.2	178.0	217.8	192.3	261.3	259.6	321.1	280.7
M_4- 40 × 40 cm	37.8	45.2	47.7	43.6	136.0	138.2	165.1	146.4	201.5	206.0	248.7	218.7
M_5- 45 × 45 cm	36.8	37.3	37.6	37.2	111.8	116.4	135.3	121.1	171.9	170.7	206.0	182.9
M_6- 50 × 50 cm	32.7	31.7	30.6	31.7	98.4	100.6	114.8	104.6	151.6	150.5	176.5	159.5
Mean	46.9	48.2	50.9		151.6	152.8	180.2		217.4	218.5	261.6	
	M	N	M at N	N at M	M	N	M at N	N at M	M	N	M at N	N at M
SEm (±)	1.8	1.1	2.8	2.7	8.2	2.0	9.1	4.9	13.3	4.5	16.1	11.1
CD (0.05)	4.0	2.2	6.0	5.5	18.3	4.1	20.0	10.1	29.5	9.3	NS	NS

N_1- Recommended dose of nitrogen (RDN) @ 150 kg ha^{-1} in 3 splits
N_2 - RDN @ 150 kg ha^{-1} in 4 splits
N_3 - LCC based N application

Different N scheduling practices also significantly influenced the N uptake during course of experimentation at all the stages of observations. Maize crop supplied with LCC based N (N_3) resulted in higher values for N uptake (50.9, 180.2 and 261.6 kg ha^{-1}) at 30, 60 and 90 DAS, respectively during 2011 and it was significantly superior from the other treatments. Similar results were obtained during 2012. The judicious supply of N under LCC treatment (180 kg ha^{-1} in 6 splits) significantly increased biomass throughout the growth stages which might have resulted in higher N accumulation and N uptake.

Table 2: Effect of crop geometry and nitrogen scheduling on nitrogen uptake (kg ha^{-1}) at various growth stages of maize during 2012.

Treatments	30 DAS				60 DAS				90 DAS			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
M_1- 60 × 25 cm	52.7	60.6	56.0	56.4	174.7	179.4	209.3	187.8	255.1	263.5	310.8	276.5
M_2- 30 × 30 cm	63.3	73.0	79.8	72.0	199.1	222.5	253.7	225.1	269.4	304.8	349.6	307.9
M_3- 35 × 35 cm	61.5	54.9	59.6	58.7	187.2	190.1	222.0	199.7	279.5	286.9	338.0	301.7
M_4- 40 × 40 cm	41.9	49.5	51.4	47.6	131.1	136.9	165.7	144.6	201.2	211.3	258.4	223.6
M_5- 45 × 45 cm	42.0	42.8	42.9	42.5	118.6	114.7	148.4	127.2	183.9	185.7	233.9	201.2
M_6- 50 × 50 cm	37.4	35.8	35.3	36.2	105.3	110.7	134.2	116.7	164.1	175.3	213.7	184.4
Mean	49.8	52.8	54.2		152.6	159.1	188.9		225.5	237.9	284.2	
	M	N	M at N	N at M	M	N	M at N	N at M	M	N	M at N	N at M
SEm (±)	1.8	1.1	2.9	2.8	6.8	2.1	8.1	5.2	9.9	4.4	13.3	10.8
CD (0.05)	4.1	2.3	6.2	5.7	15.3	4.4	17.6	10.7	22.1	9.1	NS	NS

N_1- Recommended dose of nitrogen (RDN) @ 150 kg ha^{-1} in 3 splits
N_2 - RDN @ 150 kg ha^{-1} in 4 splits
N_3 - LCC based N application

A significant interaction effect was found between crop geometry and N scheduling practices for N uptake at 30 and 60 DAS. Maize crop planted at 30 × 30 cm with LCC based N application registered higher N uptake (78.7 and 244.5 kg ha^{-1}) during 2011 and it was significantly superior from other treatment combinations.

Crude protein

Crude protein content was not affected significantly by crop geometry treatments. Nitrogen scheduling treatments exerted positive influence on crude protein content only during 2012. Among different N scheduling approaches evaluated, scheduling of N based on LCC value recorded more crude protein content (7.68%) and it was significantly differed from conventional approach (Table 3).

Table 3: Effect of crop geometry and nitrogen scheduling on crude protein content (%) of maize during 2011 and 2012.

Treatments	2011				2012			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
M_1- 60 × 25 cm	7.31	6.85	6.47	6.87	7.40	7.42	7.55	7.45
M_2- 30 × 30 cm	7.78	7.60	7.55	7.64	6.89	7.10	7.32	7.10
M_3- 35 × 35 cm	6.85	6.82	6.85	6.84	7.40	7.34	7.50	7.41
M_4- 40 × 40 cm	7.10	7.31	7.08	7.16	7.63	7.64	7.80	7.69
M_5- 45 × 45 cm	6.70	7.23	6.70	6.87	7.62	7.69	7.92	7.74
M_6- 50 × 50 cm	7.73	7.55	7.59	7.62	7.77	7.81	8.01	7.86
Mean	7.24	7.22	7.04		7.45	7.50	7.68	
	M	N	M at N	N at M	M	N	M at N	N at M
SEm (±)	0.32	0.23	0.57	0.57	0.31	0.05	0.33	0.14
CD (0.05)	NS	NS	NS	NS	NS	0.12	NS	NS

N_1- Recommended dose of nitrogen (RDN) @ 150 kg ha^{-1} in 3 splits
N_2 - RDN @ 150 kg ha^{-1} in 4 splits
N_3 - LCC based N application

The lack of significant difference during 2011 might be due to fluctuation of rainfall occurred during grain filling. Maize crop nourished through LCC based N application recorded significantly higher protein content over others. Increase in N application under LCC treatment and consequent absorption by the plant resulted in enhanced protein content of the sink. Similar view is also expressed by Ramesh *et al.* (2008) [13].

Conclusion

Based on the experimental results it was concluded that closer planting at 30 x 30 cm removed more amount of nitrogen from the soil throughout growth stages. The LCC based N application showed higher N uptake than growth stage based N scheduling at all the growth stages.

References

1. Obi IU. Maize its agronomy, diseases, pests and food values. Optional computer solutions ltd. Enugu. 1991, 207.
2. Randhawa MA, Javed Khan MA, Hussain Khan N. Studies into the effect of plant spacing on quality and yield of maize crop. International Journal of Agriculture and Biology. 2007; 9(2):370-371.
3. Prasad R. Nitrogen and food grain production in India**.** Indian Journal of Fertilizers. 2011; 7(12):66-76.
4. Cassman KG, Gines DC, Dizon MA, Samon MI, Alcantara JM. Nitrogen use efficiency in tropical low land rice systems: contributions from indigenous and applied nitrogen. Field Crops Research. 1996; 47:1-12.
5. Witt C, Pasuquin JMCA, Mutters R, Buresh RJ. New leaf color chart for effective nitrogen management in rice. Better Crops-Southeast Asia. 2005; 89(1):36-39.
6. Pasuquin JM, Saenong S, Tan PS, Witt C, Fisher MJ. Evaluating N management strategies for hybrid maize in Southeast Asia. Field Crops Research. 2012; 134:153-157.
7. Kumar R, Sarkar AK, Karmakar S, Mazumdar K. Site specific nutrient management in maize-wheat cropping system in Jharkhand. In: IPNI research cooperators meet and national symposium on future strategies for nutrient management research. Birsa Agricultural University, Ranchi, Jharkhand, India, 2010; 17-19:18-19.
8. Humphries EC. Mineral components and ash analysis in modern methods of plant analysis. Springer Verlag. Berlin. 1956; 1:468-502.
9. Dubez S, Wells A. Reaction of barley varieties to nitrogen fertilizers. Journal of Agriculture Science. 1968; 70:253-256.
10. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. 2nd Edn. John Wiley and Sons, New York, USA. 2010, 680.
11. Misra BN, Yadav RS, Rajput AL, Pandey SM. Effect of plant geometry and nitrogen application on yield and quality of winter maize (*Zea mays*). Indian Journal of Agronomy. 1994; 39(3):468-469.
12. Kumar A. Influence of varying plant population and nitrogen levels on growth, yield, economics and nitrogen use efficiency of pop corn (*Zea mays everta* Sturt). Crop Research. 2009; 37(1, 2, 3):19-23.
13. Ramesh S, Chandrasekaran B, Muthukrishnan P, Ravi S. Leaf nitrogen concentration, nitrogen use efficiency and quality of rice (*Oryza sativa* L.) CoRH-2 as influenced by establishment methods and nitrogen management. International Journal of Agricultural Science. 2008; 4(1):257-265.