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Effect of split nitrogen application on growth parameters of maize

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Abstract
A field experiment was designed to study the Effect of split nitrogen application on growth parameters of maize on research field of agricultural development trust, Baramati for two consecutive years during rainy season in 2017and 2018. An experiment was laid out in randomized complete block design with four replications. Four splits application of recommended dose of N were applied as 50% N at basal and 50% N at knee high stage (T1), 50% N at basal, 25% N 30 days after sowing and 25% N at tasseling stage (T2), 50% N at basal and remaining nitrogen as per Leaf Colour Chart (T3) and 30% N at basal, 30% N at 30 days after sowing and 30% N at tasseling stage (T4). Results showed that all studied parameters were significantly affected by application time of nitrogen. Experimental results exhibited that application of 50% N at basal and remaining nitrogen as per Leaf Colour Chart (LCC) has produced maximum plant height, number of leaves per plant and cob length. Results of these studies revealed that, application of N fertilizers based on leaf colour chart, would be more economical to minimize N losses from the soil and efficient use of N at critical growth and development stages of maize.

Keywords: Maize; application time; nitrogen; leaf colour chart

Introduction
Maize (*Zea mays* L.) is the third most important grain crop in the world after wheat and rice. It has a great utility in agro industry. The cultivation of maize has been gaining popularity in recent years. It is now becoming an important cereal crop for its high productivity and diversified use. Maize being an exhaustive crop, its requirement for fertilizers is prominent. The productivity of maize largely depends on its nutrient requirement and management particularly that of nitrogen, phosphorus and potassium (Rasheed *et al.*, 2004) [12]. Nitrogen is essential constituent of chlorophyll, protoplasm, and enzymes and it governs utilization of phosphorus and potassium. Efficient use of nitrogen by maize permits use of appropriate source in an adequate amount, at proper timing and suitable application rates (Rizwan *et al*., 2003) [14]. The utilization efficiency of added nitrogen fertilizer is very low, as applied nitrogen is subjected to various kinds of losses like leaching, volatilization and denitrification. The efficiency of applied N fertilizer not only depends on right quantity but also on right time, method of N application, crops and different genotypes of the same crops. Timing of N application is also deliberated as the best managing strategy and is very crucial for maize production (Walsh *et al*., 2006) [17]. However, split application of N can nourish the crop better through optimum N uptake and thus protects the environment from the adverse effect of these chemical inputs. Application timing of nitrogen in maize has a great importance and considered the best and appropriate for production of maize. In order to get maximum and appropriate vegetative growth and yield, increasing the nitrogen use efficiency by crop could be achieved through best management practices of nitrogen (Rehmati H., 2009) [13]. In recent years many precision tools are being used in the nitrogen management especially in maize. Among these leaf colour chart (LCC) is one of the precision tools. Leaf color charts (LCCs) are high quality a numbered series of plastic stips that range from yellowish green to dark green based on wavelength characteristic of leaves. By visual comparison, the panel value closest in color to a leaf indicates whether N is deficient, sufficient, or in excess (Friedman *et al*., 2016) [8]. 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) [4].

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. Keeping in view the importance of nitrogen application in splits doses on growth performance of maize, the present research studied was planned to study the effects of split N application on growth components of maize.

Materials and methods

Field trial was conducted at Research Farm of Agricultural Developement Trust, Baramati during Kharif seasons of 2017 and 2018 in medium black soil. The trials were laid down in a randomized block design having 4 treatments with 4 replications. The test variety of sweet corn maize was Sugar - 75 a single cross hybrid. Plot size was 4 rows, 6 meters long, with plant spacing of 45×20cm, 1 plant/hill. Recommended practices for disease and insect pest control were followed. Recommended dose of fertilizers for maize crop was 120:60:60 NPK kg/ha. Nitrogen was applied at graded levels as per the treatments in splits i.e.

T1 – 50% N at basal and 50% N at knee high stage,
T2 – 50% N at basal, 25% N 30 days after sowing and 25% N at tasseling stage,
T3 – 50% N at basal and remaining nitrogen as per Leaf Colour Chart (LCC),
T4 – 30% N at basal, 30% at 30 days after sowing and 30% at tasseling stage.

Entire quantity of P2O5 and K2O was applied as a basal dose. The sources of nitrogen, phosphorus and potassium were urea, single super phosphate and muriate of potash respectively. The split dose of nitrogen fertilizer was applied by placement at 5 cm away and 5 cm below the seed rows. Data collection started two weeks after the treatments were applied. Growth parameters recorded at 15, 30, 45, 60, 75 days after sowing and at harvest stage. Five plants were randomly selected per plot for determination of growth parameters. The growth parameters assessed included plant height (cm) and number of leaves. The data recorded on hybrid maize for plant height and no. of leaves was statistically analyzed following the method of analysis of variance. The recorded data were statistically analyzed by SPSS version 20. Means were compared using LSD test at 0.05 level of probability, if the F-values are significant. Treatment differences that were non significant are denoted as NS.

Result and discussion

Plant height (cm)

The time of N application significantly affected plant height. It increased with increasing split application of nitrogen. So, the maximum plant height was obtained with the T3 treatment (50% N at basal and remaining nitrogen as per Leaf Colour Chart (LCC) for all observations recorded at 15, 30, 45, 60, 75 days after sowing and at harvest stage, while the least values was recorded in plots of T4 (30% N at basal, 30% at 30 days after sowing and 30% at tasseling stage) treatment application (Table 1). Split nitrogen application had significantly ($P \leq 0.05$) affected plant height of maize crop measured at different times except 30 days after sowing (Table 1). Anjum *et al*. (2018) [3] reported maximum plant height from treatment of nitrogen application in three split 60 kg ha-1 before sowing + 60 kg ha-1 at knee height stage + 60 kg ha-1 before tasseling stage in comparison with two split, 90 kg ha-1 at sowing + 90 kg ha-1 at knee height stage and single application of nitrogen 180 kg ha-1 before sowing. The plant height increased with more nitrogen splits application. It may be due to supply of proper amount of N at different growth stages of maize. The N promotes plant growth, increase the number and length of internodes which resulted in taller plants of maize crop (Adhikari *et al*., 2016) [1]. Similarly, almost similar results were found with more N splits as compared to lesser no. of N splits (OSU, 2016) [11]. Jat *et al*., (2013) [9] reported that sequential applications of N just prior to planting with starter fertilizer at a rate of 30 kg N ha-1 and split applications at knee height stage, and at the time of flowering stage can be an effective N delivery system. Thakur *et al*. (1997) [16] suggested that higher N application increased cell division, cell elongation, nucleus formation as well as green foliage. Increase in plant height may also be due to prolonged vegetative growth which increased the plant height. Castro *et al*. (2008) [5] reported that plant height is influenced by the availability of N in the soil since this nutrient participates directly in photosynthetic process and cell division and expansion. Gross *et al*. (2006) [7] recommended that N should be applied in one or two application during the season only, due to the positive effects on plant height. However, it is worth noting that plant height does not always correlate with productivity since modern hybrids with high productive potential are mostly of lower height (Cruz *et al*., 2008) [6].

Table 1: Effect of different nitrogen application timings on plant height of maize

Treatments	Plant Height (cm)					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	Harvest Stage
T1 = 50% N basal + 50% N knee high stage	16.59^{ab}	66.70	160.00^{a}	189.75^{a}	201.25^{a}	205.25^{a}
T2 = 50% N basal + 25% N 30 DAS + 25% N tasseling	18.02^{a}	68.40	156.50^{a}	186.25^{a}	197.20^{a}	201.20^{a}
T3 = 50% N basal + Remaining N as per LCC	18.02^{a}	70.30	172.35^{b}	202.10^{b}	213.75^{b}	217.75^{b}
T4 = 30% N basal + 30% N 30 DAS + 30% N tasseling	15.25^{b}	65.10	141.60^{c}	171.35^{c}	182.65^{c}	186.65^{c}
Mean	16.97	67.63	157.61	187.36	198.71	202.71
SD	3.67	9.07	21.20	21.34	21.46	21.46
SE of mean	0.41	1.01	2.37	2.39	2.40	2.40
P - value	0.045	0.306	0.000	0.000	0.000	0.000
LSD at 5%	Significant	NS	Significant	Significant	Significant	Significant

Data within columns followed by different letters are significantly different at $P < 0.05$.

No. of leaves per plant

It can be inferred from the data showed that time of application of nitrogen at different growth stages had significant effect on number of leaves plant per plant of maize at 30, 45, 60, 75 days after sowing. However, time of application of nitrogen found non-significant with number of leaves per plant at 15 days after sowing. Maximum number of leaves plant per plant was recorded from T3 treatment which is statistically at par with T1, T2 and T4 treatment (Table 2). Split application of N had significant effects on the leaf

number per plant (Amanullah *et al*., 2009) [2]. The increase in the number of leaves per plant could possibly be ascribed to the fact that nitrogen often increases plant growth and plant height and this resulted in more nodes and internodes and subsequently more production of leaves. Number of leaves per plant was recorded as 13.9 with application at the rate of 150 kg ha-1 and 12.3 with no N application after 90 DAS (Kaur *et al*. 2015) [10]. The increase in number of leaves per plant with each increment of nitrogen level might be attributed to increase in plant height and better crop growth.

Table 2: Effect of different nitrogen application timings on number of leaves per plant and cob length (cm) of maize

Treatments	No. of Leaves per plant					Cob length (cm)
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	
T1 = 50% N basal + 50% N knee high stage	6.45	9.90^{ab}	12.10^{a}	14.80^{a}	17.80^{a}	13.70^{a}
T2 = 50% N basal + 25%N 30 DAS + 25% N tasseling	6.30	9.80^{ab}	11.85^{a}	14.60^{a}	17.60^{a}	13.81^{a}
T3 = 50% N basal + Remaining N as per LCC	6.30	10.40^{a}	13.95^{b}	18.70^{b}	23.45^{b}	18.70^{b}
T4 = 30% N basal + 30% N 30 DAS + 30% N tasseling	6.20	9.40^{b}	11.55^{a}	13.80^{c}	16.55^{c}	16.09^{c}
Mean	6.31	9.88	12.36	15.48	18.85	15.58
SD	0.52	1.08	1.34	2.18	2.92	2.37
SE of mean	0.06	0.12	0.15	0.24	0.33	0.26
P - value	0.505	0.031	0.000	0.000	0.000	0.000
LSD at 5%	NS	Significant	Significant	Significant	Significant	Significant

Data within columns followed by different letters are significantly different at $P < 0.05$.

Cob length (cm)

Nitrogen applications in split have significant ($P \leq 0.05$) effect on cob length. Maximum cob length was observed from T3 treatment application (50% N at basal and remaining nitrogen as per Leaf Colour Chart (LCC)) followed by T4 treatment (30% N at basal, 30% at 30 days after sowing and 30% at tasseling stage). Lowest cob length was recorded from T1 and T2 treatment (Table 2). Maximum cob length at more split application of nitrogen has decreased nitrogen loses and provided an adequate amount of nitrogen to the plant which showed more increase in vegetative growth and hence increased length of cob. Our results were strongly in agreement with Anjum *et al*. (2018) [3], who reported that highest cob length was observed from treatment of nitrogen in three split application (60 kg ha-1 before sowing + 60 kg ha-1at knee height stage + 60 kg ha-1 before tasseling stage) followed by two splits. Similarly, highest cob length in nitrogen fertilizer plots and smallest cob length in the plots where nitrogen was not applied reported by Sharifi SR & Taghizadeh (2009) [15].

Conclusion

In our study it was observed that split application of N rates led to increased N availability, which possibly increased the plant height, number of leaves per plant and cob length. Timing of N application is also deliberated as the best managing strategy and is very crucial for maize production. Time of application significantly enhances N absorption, particularly at the time of critical N requirement for the crop. It was concluded from the research that nitrogen application in split as per requirement of crop i.e. 50% N at basal and remaining nitrogen as per Leaf Colour Chart (LCC) gave better results.

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