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Studies on fertilizer levels of NPK with split application of nitrogen for maize (*Zea mays* L.) under *rabi* season

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Abstract
A field experiment was conducted during *rabi* season 2015-16 on experimental farm of National Agricultural Research Project, Aurangabad to study the different fertility levels of NPK with split application of nitrogen for maize under *rabi* season. The field experiment was laid in factorial randomized block design with twelve treatments and replicated thrice. The grain yield ha^{-1} as influenced by different fertility levels revealed that the highest grain yield was recorded by F_4 (200:100:100 NPK kg ha^{-1}) (4892 kg ha^{-1}) followed by F_3 (175:87.5:87.5 NPK kg ha^{-1}) and F_2 (150:75:75 NPK kg ha^{-1}) and found to be significantly superior over F_1 (125:62.5:62.5 NPK kg ha^{-1}). The highest grain yield (4705 kg ha^{-1}) was recorded in S_3 (Three splits of N 33% as a basal dose + 33% at 30 DAS + 33% at 60 DAS) followed by S_1 (Two splits of N 50% as a basal dose + 50% at 30 DAS) and significantly superior over S_2 (Three splits of N 25% as a basal dose + 50% at 30 DAS + 25% at 60 DAS). The highest net monetary returns (33431 ha^{-1}) was recorded in F_4 (200:100:100 NPK kg ha^{-1}) followed by F_2 (150:75:75 NPK kg ha^{-1}) and F_3 (175:87.5:87.5 NPK kg ha^{-1}) which was found significantly superior over F_1 and highest B: C ratio (1.98) was recorded in F_2 (150:75:75 NPK kg ha^{-1}). Thus, for securing higher grain yield and net profit, maize crop should be fertilized with 150: 75: 75 NPK kg ha^{-1} with three equal split of nitrogen three splits of N 33% as a basal dose + 33% at 30 DAS + 33% at 60 DAS.

Keywords: NPK, *rabi* maize, split application

Introduction
Maize is an annual crop belongs to family Poaceae and Genus *Zea mays* L. It is cultivated globally being one of the most important cereal crops worldwide. Maize (*Zea mays* L.) is the third most important cereal crop in the world after wheat and rice which is known as "King of grain crops". Maize is an important cereal crop of the world as well as of India.

In cereals, maize is grown throughout the year mainly due to photo-thermo-insensitive character, hence called 'queen of cereal'. There are several factors that affect the productivity of winter maize; however, balanced nutrition is an essential component of nutrient management and plays a significant role in increasing crop production and its quality. For the major processes of plant development and yield formation the presence of nutrient elements like N, P, K, S, Mg etc. Fertilizer play an important role in increasing the maize yield and their contribution is 40-45 per cent. Balanced and optimum use of nitrogen, phosphorus and potassium play pivotal role in increasing the yields of maize. Though the yield potential of our present varieties is high enough, but it has not been explored fully due to some production constraints. Maize is an exhaustive crop and requires high quantities of nitrogen during the period of efficient utilization, particularly at 30 days after sowing and pre-tasseling (40 days after sowing) stages for higher productivity. Nitrogen is indispensable for increasing crop production as a constituent of protoplasm and chlorophyll and is associated with the activity of every living cell. The winter maize crop is highly responsive to fertilizer specially nitrogen and zinc. Thus, by increasing the levels of these nutrients, the yield was increased significantly. Maize has been widely cultivated as a rain fed crop in India. Recent studies have shown that maize can be successfully grown during *rabi* in many part of the country due to evolution of new genotypes. The yield level of maize during *rabi* season is considerably higher than that of *Kharif* due to its timely water availability and higher fertilizer use efficiencies (Singh, 1974). Nitrogen is the key element in crop growth and is the most limiting nutrient in Indian soil. The paramount importance of nitrogen for increasing the yield has been widely accepted. The productivity of maize largely depends upon its nutrient requirement and management particularly that of nitrogen, phosphorus and potassium. Information on fertilizer requirement for *Rabi* maize is scanty.

Hence, there is need to work out a suitable fertilizer dose for *Rabi* maize and there is need to study the effect of nutrient levels and split application of nitrogen on growth and yield attributes of rabi maize. was be carried out at Experiment farm of National Agricultural Research Project, Aurangabad farm during 2015-16 with objectives of find out suitable fertility level of NPK and performance of maize under split application of nitrogen for maize under *rabi* season.

Materials and method

The experiment was conducted during *rabi*, 2015-16 at the experimental farms of National Agriculture Research Project, Aurangabad (Maharashtra). The soil of experimental plot was clay in texture and medium black in colour with good drainage. The topography of experimental plot was uniform and fairly leveled. The chemical composition of experimental plots indicated that the soil was low in available nitrogen (236 kg ha^{-1}), low in available phosphorus (24 kg ha^{-1}), very high in available potassium (548 kg ha^{-1}) and alkaline in reaction having pH 8.1. The total rainfall received during experiment is 32.5 mm and distribute in two days. The experiment was laid out in a Factorial Randomized Block Design with 12 treatments replicated thrice. Fertility levels the treatment was F_1: 125:62.5:62.5 NPK kg ha$^{-1,}$ F_2: 150:75:75 NPK kg ha$^{-1,}$ F_3: 175:87.5:87.5 NPK kg ha^{-1}, $F_{4:}$ 200:100:100 NPK kg ha^{-1} and Split application of nitrogen S_1: Two splits of N-50% basal + 50% at 30 DAS, S_2: Three splits of N-25% basal +50% at 30 DAS + 25% at 60 DAS, $S_{3:}$ Three splits of N-33% basal +33% at 30 DAS + 33% at 60 DAS. The gross and net plot size of each experimental unit was 5.4 × 6.0 m and 4.2 × 4.8 m respectively. Sowing was done by dibbling method on 10th Nov 2015. Recommended cultural practices and plant protection measures were under taken as per recommendation. Data on various variables were analyzed by analysis of variance (Panse and Sukhatme, 1967)

Result and Discussion

Growth attributes

The data pertaining to growth parameters have been presented in Table 1. The important growth parameters *viz*., plant height (cm), number of branches per plant, leaf area (dm^2), numbers of leaves, total dry matter per plant (g) were influenced by application of NPK and split application of nitrogen.

Application of 200:100:100 NPK kg ha^{-1} and S_3: Three splits of N- 33% basal+33% at 30 DAS+ 33% at 60DAS recorded significantly plant height (cm), number of functional leaves plant^{-1} and Mean leaf area plant^{-1} (dm^2) which was significantly superior over F_1 (125:62.5:62.5 NPK kg ha^{-1}) and at pat with F_3 (175:87.5:87.5 kg ha^{-1}) and F_2 (150:75:75 NPK kg ha^{-1}) The mean plant height was significantly influenced due to different NPK levels and split application of nitrogen at all the crop growth stages. Similar kind of observations were recorded by Mathukia *et al.* (2014) [10] and Kumar and Dhar (2010) [10].

Leaf area index (LAI) was influenced by various NPK levels. The F_4 was found to be effective in increasing LAI based on leaf area as compared to F_3, F_2 and F_1 value at 61-75 days F_4 was recorded the highest (4.51). F_1 recorded minimum LAI values for leaf area at all the growth stages of crop growth the present findings are in close agreement with the results obtained by Massey and Gaur (2006) [9] and Khazaei *et al*. (2010) [7]. Profound influence of NPK levels on crop growth seem to be due to maintaining congenial nutritional environment of plant system on account of their greater availability from soil media which might have resulted in greater synthesis of amino acids, proteins and growth promoting substances which seems to have enhanced the meristematic activity and increased cell division and their elongation.

Table 1: Growth attributes of soybean as influenced by different treatment at various crop growth stages

Treatment	Plant height (cm) at harvest	Leaf area (dm^2) Plant^{-1} at 75 DAS	Leaf area Index (LAI)	Total dry matter (kg ha^{-1})
F_1:125:62.5:62.5 NPK kg ha^{-1}	57.9	73.8	4.10	4626
F_2:150:75:75 NPK kg ha^{-1}	63.6	81.1	4.50	5895
F_3:175:87.5:87.5 NPK kg ha^{-1}	66.7	84.7	4.70	6098
F_4: 200:100:100 NPK kg ha^{-1}	67.2	85.4	4.74	6364
S.Em ±	1.77	1.79	-	176.6
C.D. at 5%	5.20	5.25	-	518.1
S_1:Two splits of N- 50% basal+50% at 30 DAS	65.4	81.7	4.53	5820
S_2: Three splits of N- 25% basal+50% at 30 DAS+ 25% at 60 DAS	59.8	78.1	4.33	5407
S_3: Three splits of N- 33% basal+33% at 30 DAS+ 33% at 60 DAS	66.3	84.0	4.66	6010
S.Em ±	1.53	1.55	-	152.9
C.D. at 5%	4.50	4.55	-	448.7
S.Em ±	3.07	3.10	-	305.9
C.D. at 5%	NS	NS	-	NS
General Mean	63.8	81.32	4.51	5746

Yield attributes

Yield attributes *viz*., Mean number of cob plant^{-1}, mean length of cob (cm) and mean girth of cob (cm), Mean number of grains cob^{-1}, test weight (100 seed wt.) (g) The maximum length of cob plant^{-1}, Mean grain yield cob^{-1}(g), mean weight of spindle plant^{-1}(g), mean husk yield plant^{-1} (g) and mean cob weight plant^{-1} (g) as influenced by various treatments. (Table 2)

Mean number of cob plant^{-1} and length of cob plant^{-1} was recorded with treatment S_3 (Three splits of N- 33% basal+33% at 30 DAS+ 33% at 60 DAS) and with straight fertilizer application recorded with treatment F_4(200:100:100 NPK kg ha^{-1}) which was significantly superior over F_1 (125:62.5:62.5 NPK kg ha^{-1}) and at par with F_3 (175:87.5:87.5 NPK kg ha^{-1}) and F_2 (150:75:75 NPK kg ha^{-1}). These results are agreement with those reported by, Khadtare *et al*. (2006) [6] and Patil *et al.* (1972) [11].

Table 2: Number of cob plant^{-1}, Length of cob plant^{-1}, number of grains plant^{-1}, grain yield cob^{-1} (g), grain yield kg ha^{-1} of maize influence by various treatment at harvest

Treatment	Number of cob plant^{-1}	Length of cob plant^{-1}	Number of grains plant^{-1}	Grain yield cob^{-1} (g)	Grain yield kg ha^{-1}
NPK level (F)					
F_1:125:62.5:62.5 NPK kg ha^{-1}	1.0	16.8	307.0	91.08	3801
F_2:150:75:75 NPK kg ha^{-1}	1.0	18.7	345.6	103.83	4492
F_3:175:87.5:87.5 NPK kg ha^{-1}	1.1	18.9	353.3	108.11	4626
F_4: 200:100:100 NPK kg ha^{-1}	1.0	19.9	368.7	112.28	4892
S.Em ±	0.03	0.44	9.42	3.15	150.86
C.D. at 5%	NS	1.30	27.63	9.26	442.50
Split application of nitrogen (S)					
S_1:Two splits of N- 50% basal+50% at 30 DAS	1.0	18.9	350.4	105.71	4514
S_2: Three splits of N- 25% basal+50% at 30 DAS+ 25% at 60 DAS	1.1	17.8	320.9	97.85	4139
S_3: Three splits of N- 33% basal+33% at 30 DAS+ 33% at 60 DAS	1.0	19.1	359.6	107.92	4705
S.Em ±	0.03	0.38	8.16	2.73	130.65
C.D. at 5%	NS	1.12	23.93	8.02	383.21
Interaction (F×S)					
S.Em ±	0.06	0.76	16.32	5.46	261.30
C.D. at 5%	NS	NS	NS	NS	NS
General Mean	1.0	18.6	343.6	103.83	4453

The highest length of cob plant^{-1} and girth of cob plant^{-1} was recorded in NPK levels F_4 (200:100:100 NPK kg ha^{-1}) and the lowest in F_1 (125:62.5:62.5 NPK kg ha^{-1}) as compared to rest of treatment. This might be due to adequate supply of nutrients resulted favorable growth of the plants. These results are agreement with those reported by, Khadtare *et al*. (2006) [6] and Patil *et al.* (1972) [11].

The highest number of grains cob^{-1} were observed in S_3 (three splits 33% N as a basal dose + 33% N 30 DAS + 33% at 60 DAS) than rest of the treatments. Treatment (S_3) played a major role in furnishing the needs of maize crop to attain its maximum yield potential. The results of present investigation indicating positive response of various yield parameters to balanced and higher level of fertilization collaborates findings of several researchers Rizwan *et al.* (2003) [12], Saleem *et al.* (2009) [13] and Ceretta *et al.* (2002) [2].

Number of cobs plant^{-1} was not-significantly influenced by split application of nitrogen. 100 seed weight (test weight) (g) of with treatment of (S_3).

The split application of N had significant influence on grain yield of maize. Significantly, higher grain yield was recorded under treatment (S_3) which was significantly superior to (S_2). This might be due to better use of nitrogen which helps to enhance plant growth. The results are in close agreements with the findings of Saleem *et al*. (2009) [13], Ali and Sharifi (2012) [1], Chaudhary and Prihar (2002) [3]. Cooke (2006) [5] and Lehrsch *et al.* (2000) [4] reported that application of N fertilizer in splits was better than its full application at the time of sowing.

Conclusions

From the above findings we conclude that, for securing higher grain yield and net profit of maize crop should be fertilized with 150: 75: 75 NPK kg ha^{-1} with three equal split of nitrogen i.e. N 33% as a basal dose + 33% at 30 DAS + 33% at 60 DAS.

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