

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(10): 926-928
www.biochemjournal.com
Received: 02-08-2024
Accepted: 10-09-2024

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Optimizing maize productivity through split nitrogen application strategies

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DOI: <https://doi.org/10.33545/26174693.2024.v8.i10Sk.2588>

Abstract

A field experiment was conducted at Agricultural Research Station, Karimnagar for two years during Kharif & Rabi 2014-15 & 2015-16 in red sandy loam soils. The initial soil status indicated of high available N (614 kg ha⁻¹), P (63 kg ha⁻¹) and K (436 kg ha⁻¹), respectively. The experiment was carried out in Randomized block design with following treatments nitrogen (N) in 3 splits (33% at basal: 33% at knee height: 33% at tasseling), N in 3 splits (10% at basal: 50% at knee height: 40% at tasseling), N in 3 splits (20% at basal: 50% at knee height: 30% at tasseling), N in 4 splits (25% at basal: 25% at 30 DAS: 25% at knee height: 25% at tasseling), N in 4 splits (10% at basal: 35% at 30 DAS: 35% at knee height: 20% at tasseling), N in 4 splits (20% at basal: 30% at 30 DAS: 30% at knee height: 20% at tasseling), N in 5 splits (20% at basal: 20% at 30 DAS: 20% at knee height: 20% at tasseling: 20% at grain filling) and N in 5 splits (15% at basal: 25% at 30 DAS: 25% at knee height: 25% at tasseling: 10% at grain filling). Recommended dose of nitrogen @ 240 kg ha⁻¹ applied as per the treatments, phosphorus (80 kg ha⁻¹) applied as a basal and potash (80 kg ha⁻¹) applied as a two splits half at basal and remaining half at flowering stage. Among the different treatments there was no significant difference was observed.

Keywords: Maize, split nitrogen, yield and yield attributes

1. Introduction

Maize (*Zea mays* L.) is one of the important food grain crops in India and in world after wheat and rice due to its high value as staple food as well as straw demand for animal feed and also known as corn belongs to family Poaceae. It is one of the most versatile crops having wider adaptability and grown under varied agro-climatic conditions, diverse seasons and ecologies for various purposes. Globally, maize is known as “queen of cereals” because of its highest genetic yield potential among the cereals. Maize being an important cereal crop meets about 60% of the world dietary needs along with wheat and rice. Maize is known as “Miracle crop” in view of its several uses. Therefore, improvement in maize yields is an important task for food security. Nitrogen (N) nutrient plays a key role in several physiological and metabolic processes in plant. The most important role of Nitrogen in the plant is its presence in the structure of the protein and nucleic acids and is essential for enzymatic, biochemical and physiological reactions in plant metabolism (Sharma *et al.*, 2017) [8]. Therefore, adequate supply of Nitrogen is necessary to achieve higher yield and the time of Nitrogen application plays a very important role in maize yield. Among the agronomic management practices for improved nitrogen use efficiency (NUE), rational use of N fertilizer is a key factor to increase maize production reducing environmental pollution. Improving NUE enhance utilization rate of chemical fertilizers (mainly N). Through enormous research, N uptake, transport and distribution pattern in maize plants are fully understood. For systematic discovery of maize potential to maximize N utilization, biological means are vital to identify genetic, physiological and molecular basis. Nitrogen is often the most limiting nutrient in reducing crop yields. Often times, farmers tend to apply over dose of this nutrient. Due to an increase in its cost, environmental pollution, concerns and demand for mandatory nutrient management, planning and a comprehensive knowledge on N management strategies for optimal nitrogen use is essential. Nitrogen is the major input for corn production and also rate and time application is main factor for proper utilization. Nitrogen (N) fertilizer is an important measure to ensure maize yields, but excessive N inputs make it a difficult problem for optimum N utilization.

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In modern agricultural production, N fertilizer application is an important measure or necessary condition to ensure high and stable crop yields. N is the key element for grain formation in maize (Evenson & Gollin, 2003 and Hirel *et al.*, 2001)^[1, 2]. Maize being a C4 plant, physiologically more efficient in utilizing N than other crops. But paradoxically, maize production systems as a whole generally have low fertilizer N uptake efficiency or recovery efficiency (RE), which is the proportion of applied fertilizer that is being taken up by the plant. Therefore, it is necessary to give optimum dose of nitrogen for improving yield of maize (Li *et al.*, 2010)^[3]. Hence, to identify the effect of Nitrogen management on maize yield, the present experiment was planned.

2. Methodology

This experiment was conducted at Agricultural Research Station, Karimnagar during *Kharif* & *Rabi* 2014-15 & 2015-16 in red sandy loam soils. The initial soil status of this experimental site is indicated of high available N (614 kg ha⁻¹), P (63 kg ha⁻¹) and K (436 kg ha⁻¹), respectively. The experiment was carried out in Randomized block design in three replications with 8 treatments *i.e.*, T₁. Application of N in 3 splits (33% at basal: 33% at knee height: 33% at tasseling), T₂. Application of Nitrogen (N) in 3 splits (10% at basal: 50% at knee height: 40% at tasseling), T₃. Application of N in 3 splits (20% at basal: 50% at knee height: 30% at tasseling), T₄. Application of N in 4 splits (25% at basal: 25% at 30 DAS: 25% at knee height: 25% at tasseling), T₅. Application of N in 4 splits (10% at basal: 35% at 30 DAS: 35% at knee height: 20% at tasseling), T₆. Application of N in 4 splits (20% at basal: 30% at 30 DAS: 30% at knee height: 20% at tasseling), T₇. Application of N in 5 splits (20% at basal: 20% at 30 DAS: 20% at knee height: 20% at tasseling: 20% at grain filling), T₈. Application of N in 5 splits (15% at basal: 25% at 30 DAS: 25% at knee height: 25% at tasseling: 10% at grain filling). Entire Phosphorus (80 kg ha⁻¹) applied as a basal and Potash (80 kg ha⁻¹) in two splits *i.e.* half at basal and remaining half at flowering stage. The recommended dose of NPK use for

kharif maize is 200:60:50 kg ha⁻¹ and for *rabi* 240:80:80 kg ha⁻¹. 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. Timely management practices like weed management by inter cultivation *via* bullock drawn cultivator and pest management by recommended pesticides was done. Need based irrigations were given with 7-10 days interval. Observations were recorded on grain yield and its attributes.

3. Results

The results indicated that among all treatments highest grain yield (8574 kg ha⁻¹ & 7689 kg ha⁻¹) was noticed in application of Nitrogen in 4 splits (10% at basal: 35% at 30 DAS: 35% at knee height: 20% at tasseling) in both *Kharif* seasons and was on par to all other treatments. Non-significant differences were observed among all the treatments. Lowest grain yield was observed with application of Nitrogen (N) in 3 splits (10% at basal: 50% at knee height: 40% at tasseling). But in *Rabi* season highest grain yield (8258 kg ha⁻¹ & 7873 kg ha⁻¹) was observed with application of Nitrogen in 3 splits (33% at basal: 33% at knee height: 33% at tasseling) in both the years, but it was on par with all other treatments. And also recorded lowest grain yield with application of N in 5 splits (15% at basal: 25% at 30 DAS: 25% at knee height: 25% at tasseling: 10% at grain filling). For yield attributes like cob length, cob girth, number of kernel rows per cob and number of kernels per row of cob, non-significant differences were observed in both the seasons. Pooled data reveal that there was no significant difference of observed among the treatments in terms of yield and yield attributes.

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)^[6]. Rahman *et al.* (2016)^[5] reported that N fertilisation at booting and silking stages caused significant increments in grain yield

Table 1: Effect of nitrogen management on yield of maize crop.

Treatment	Grain yield (kg ha ⁻¹)						Cob yield (kg ha ⁻¹)						1000 grain weight (g)					
	<i>Kharif</i>			<i>Rabi</i>			<i>Kharif</i>			<i>Rabi</i>			<i>Kharif</i>			<i>Rabi</i>		
	2014	2015	Mean	2014-15	2015-16	Mean	2014	2015	Mean	2014-15	2015-16	Pooled	2014	2015	Pooled	2014-15	2015-16	Pooled
T ₁	6404	7062	6733	8258	7873	8066	10856	11884	11370	9276	11199	10238	314	221	268	369	277	323
T ₂	6253	6351	6302	7462	7321	7392	11179	11273	11226	9154	11719	10437	303	213	258	370	309	340
T ₃	7486	6285	6886	7909	7654	7782	11696	11468	11582	9503	11676	10590	306	211	259	349	308	329
T ₄	6805	6601	6703	7825	7596	7711	12117	12023	12070	9583	11710	10647	308	213	261	354	303	329
T ₅	8574	7689	8132	7178	7700	7439	12414	11995	12205	8776	11754	10265	325	216	271	362	277	320
T ₆	6864	6394	6629	8117	7638	7878	11573	11523	11548	9879	11465	10672	295	215	255	358	306	332
T ₇	8412	7250	7831	8054	7456	7755	12069	11190	11630	9758	11143	10451	320	223	272	344	274	309
T ₈	7404	6706	7055	7131	7043	7087	12441	11606	12024	8889	11410	10150	303	223	263	349	288	319
C.D.	NS	NS	NS	NS	NS	NS	NS	NS	NS	527	NS	NS	NS	NS	NS	7	NS	7
SE(m)±	709	307	508	597	409	503	700	260	480	NS	569.6	569.6	8.5	9	8.75	NS	7.2	7.2

Table 2: Effect of nitrogen management on cob length (cm) and cob girth (cm) of maize crop.

Treatment	Cob length (cm)						Cob girth (cm)					
	Kharif			Rabi			Kharif			Rabi		
	2014	2015	Pooled	2014-15	2015-16	Pooled	2014	2015	Pooled	2014-15	2015-16	Pooled
T ₁	16.1	17.5	16.8	19.6	18.2	18.9	14.8	15.7	15.3	17.3	15.7	16.5
T ₂	15.1	18.3	16.7	20.2	19.5	19.8	14.5	15.8	15.2	17.6	17.0	17.3
T ₃	15.7	18.2	17.0	19.0	19.4	19.2	14.9	16.0	15.5	17.2	16.4	16.8
T ₄	15.9	18.1	17.0	19.5	19.9	19.7	14.7	16.2	15.5	17.4	16.2	16.8
T ₅	17.6	17.8	17.7	19.5	19.7	19.6	15.5	16.1	15.8	17.5	16.4	17.0
T ₆	16.8	17.8	17.3	19.6	20.5	20.1	14.8	15.8	15.3	16.9	69.1	43.0
T ₇	15.6	18.5	17.1	19.7	20.1	19.9	14.1	15.9	15.0	16.7	16.7	16.7
T ₈	15.5	19.0	17.3	18.5	19.5	19.0	14.6	16.2	15.4	16.9	16.0	16.5
C.D.	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SE(m) _±	0.8	0.5	0.6	0.6	0.5	0.6	0.4	0.3	0.3	0.3	18.5	9.4

Table 3: Effect of nitrogen management on cob length (cm) and cob girth (cm) of maize crop.

Treatment	No. of Kernel rows						No. of kernels row ⁻¹					
	Kharif			Rabi			Kharif			Rabi		
	2014	2015	Pooled	2014-15	2015-16	Pooled	2014	2015	Pooled	2014-15	2015-16	Pooled
T ₁	14	15	14	14	14	14	29	33	31	39	32	35
T ₂	14	16	15	16	14	15	27	37	32	39	33	36
T ₃	14	15	14	16	14	15	28	35	31	38	34	36
T ₄	14	15	15	16	14	15	25	33	29	39	33	36
T ₅	14	15	14	16	16	16	29	34	31	40	33	37
T ₆	14	15	14	14	14	14	28	34	31	39	33	36
T ₇	14	15	15	14	14	14	30	36	33	39	32	35
T ₈	14	15	14	14	16	15	28	37	33	37	32	34
C.D.	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SE(m) _±	0.3	0.5	0.4	0.8	0.4	0.6	1.6	1.4	1	2.9	1.3	2.1

4. Conclusion

In our study it was observed that in *Kharif & Rabi* seasons, the effect of split application of nitrogen in maize indicated that application of nitrogen in 3 or 4 or 5 splits makes no significant difference for yield and yield attributes.

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