www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(9): 1643-1646

www.thepharmajournal.com
Received: 27-06-2023
Accepted: 07-08-2023

D Ajith
PG Scholar, Department of Agronomy, AC & RI, TNAU, Coimbatore, Tamil Nadu, India

P Thukkaiyannan
Associate Professor, Department of Agronomy, KVK, Oilseeds Research Station, Tindivanam, Tamil Nadu, India

T Selvakumar
Associate Professor and Head, Department of Agronomy, Maize Research Station, Vagarai, Tamil Nadu, India

K Vanitha
Assistant Professor, Department of Fruit Science, AC & RI, TNAU, Coimbatore, Tamil Nadu, India

PC Prabu
Associate Professor, Department of Environmental Science), AC & RI, TNAU, Coimbatore, Tamil Nadu, Tamil Nadu, India

Corresponding Author:
D Ajith
PG Scholar, Department of Agronomy, AC & RI, TNAU, Coimbatore, Tamil Nadu, India

Enhancing maize profitability through altering split application of nitrogen and potassium at different stages

D Ajith, P Thukkaiyannan, T Selvakumar, K Vanitha and PC Prabu

DOI: https://doi.org/10.22271/tpi.2023.v12.i9Sv.22997

Abstract
The research trial was carried out during summer 2023 at Maize Research station, Vagarai to study the effect of altering split schedule and ratio of nitrogen and potassium application on hybrid maize under irrigated conditions. The research trial was laid out in Randomised block design (RBD) with six treatments and four replications. The trial comprises treatments *viz.*, T_1 – recommended split (25:100:100% NPK as basal, 50% N on 25 DAS, 25% N on 45 DAS),T_2 – Alternate split I (25:100:50% NPK as basal, 50:50:50% N&K on 25 DAS, 25% N on 45 DAS),T_3 – Alternate split II (33.3:100:33.3% NPK as basal, 33.3:0:33.3% N&K on 25 DAS,33.3:0:33.3% N&K on 45 DAS),T_4 – Alternate split III (25:100:25% NPK as basal, 25:0:25% N&K on 25 DAS, 25:0:25% N&K on 45 DAS, 25:0:25% NPK on 60 DAS), T_5 – Alternate split IV (20:100:20% NPK as basal, 20:0:20% NPK on 15 DAS, 20:0:20% NPK on 30 DAS, 20:0:20% NPK on 45 DAS, 20:0:20% NPK on 60 DAS) T_6 – Absolute control. Among treatmental combinations, Alternate split IV (20:100:20% NPK as basal, 20:0:20% NPK on 15 DAS, 20:0:20% NPK on 30 DAS, 20:0:20% NPK on 45 DAS, 20:0:20% NPK on 60 DAS) registered higher grain yield, stover yield as well as economic returns. While the lowest yield parameters and economics were registered in control. Based on the experimental results, it could be concluded that split application has paramount effect on increasing yield and thereby increasing the increasing net returns and thereby preventing the wastage of fertilizers.

Keywords: Nitrogen, potassium, split-dose

1. Introduction

Maize (*Zea mays* L.), is a globally prominent crop which is extensively grown as a cereal grain and was originally domesticated in Central America. Maize is classified within the Maydeae tribe of the Poaceae grass family and the term "Zea" finds its origin in an ancient Greek reference to a type of edible grass. Maize is noted as miracle crop due to its high yielding properties and have to ability to withstand under adverse climatic conditions. Due to its C_4 nature, Maize has higher source-sink relationship which contributes about 39% of world global grain production makes superior among cereals and it is also called as Queen of cereals. Maize is a year around crop which can give optimum yield throughout the entire year but maximum cultivation of maize under area (85%) can be seen in *Kharif* season. India accounted for approximately 2.59% of global production, underscoring its significance in the realm of maize cultivation. Maize is a nutrient demanding crop, relying on both macro and micro nutrients for optimal growth and yield. To unlock its full potential, adopting proper agronomic practices and efficient management becomes a pivotal strategy, enhancing its productivity and ensuring robust growth and development. Among the various essential nutrients, nitrogen stands out as highly limiting in Indian soils, exerting a significant impact on plant growth.

Application of nitrogen in split doses during various stages of maize plant growth leads to enhanced grain yield in hybrids. This increase is attributed to higher numbers of grains per cob, as observed by Cooke, (1954) [5], along with a greater thousand-grain weight, as noted by Abbas *et al.*, (2009) [1]. This practice also extends the time taken for maturity, as indicated by Archana *et al.*, (2012) [2]. Nitrogen holds the distinction of being the most crucial element, as it assumes a pivotal role in numerous physiological and metabolic functions. Potassium plays a multifaceted role in plant development and health. It contributes to robust early growth, enhances grain quality (including factors like fruit size, colour and flavour), optimizes water and nutrient utilization, enhances stress tolerance, mitigates pest and disease susceptibility, prevents lodging, regulates water and nutrient transport, aids in translocation and storage of photosynthates facilitates protein and starch synthesis. Additionally, potassium facilitates the formation and conversion of energy and sugars crucial for crop development through the photosynthetic process. Developed countries are actively advocating for the adoption of balanced fertilizer application with precise quantities and ratios. Potassium stands out as a pivotal element for enhancing crop productivity. Particularly in semi-arid climatic conditions, applying potassium not only enhances crop resilience to drought stress but also enhance the overall crop growth, optimal distribution of dry matter and substantial yield improvements.

2. Materials and Methods

The impact of split application of N and K on maize was studied at Maize research station, Vagarai with geo-coordinates (latitude 10.57 °N, longitude 77.56 °E and altitude of about 254.45 MSL). The experimental field consists of soil type clay loamy in texture, pH (7.20), EC (0.13 dsm^{-1}) and initial soil sample contains nitrogen (195.0 kg/ha), phosphorous (15.2 kg/ha) and potassium (720 kg/ha). TNAU COH(M)8 seeds were used for conducting the experimental study. The research trial was laid out in Randomised block design (RBD) with six treatments and four replications. The trial comprises treatments *viz.*, T_1 – recommended split (25:100:100% NPK as basal, 50% N on 25 DAS, 25% N on 45 DAS), T_2 – Alternate split I (25:100:50% NPK as basal, 50:50:50% N&K on 25 DAS, 25% N on 45 DAS), T_3 – Alternate split II (33.3:100:33.3% NPK as basal, 33.3:0:33.3% N&K on 25 DAS, 33.3:0:33.3% N&K on 45 DAS), T_4 – Alternate split III (25:100:25% NPK as basal, 25:0:25% N&K on 25 DAS, 25:0:25% N&K on 45 DAS,25:0:25% NPK on 60 DAS), T_5– Alternate split IV (20:100:20% NPK as basal, 20:0:20% NPK on 15 DAS, 20:0:20% NPK on 30 DAS, 20:0:20% NPK on 45 DAS, 20:0:20% NPK on 60 DAS), T_6 – Absolute control. The observations on yield attributing characters such as cob length, cob girth, Number of rows/cobs, Number of grains/rows, Number of cobs/plants, Average cob weight(g), cob yield, grain yield, stover yield are taken to ensure the economics of different treatments.

Table 1: Effect of application of Nitrogen and Potash on yield attributes by Altering of split schedule and ratio of maize hybrid

Treatments	Yield attributes			
	Cob length	Cob girth	No of rows/cob	No of grains/row
T_1-Recommended Split (25: 100: 100% NPK @ basal + 50% N @ 25 DAS + 25% N @ 45 DAS	15.14	13.43	13.3	27.33
T_2-Alternate Split I (25: 100: 50% NPK @ basal + 50: 0: 50% N&K @ 25 DAS + 25% N at 45 DAS)	16.27	13.87	14.0	27.67
T_3-Alternate split II (33.3: 100: 33.3% NPK @ basal + 33.3: 0: 33.3% N&K @ 25 DAS + 33.3: 0: 33.3% N&K at 45 DAS)	17.07	14.17	14.0	27.33
T_4-Alternate Split III (25: 100: 25% NPK @ basal + 25: 0: 25% NPK @ 20 DAS + 25: 0: 25% NPK @ 40 DAS + 25: 0: 25% NPK @ 60 DAS	19.17	14.73	14.0	29.67
T_5-Alternate Split IV (20: 100: 20% NPK @ basal + 20: 0: 20% NPK @ 15 DAS + 20: 0: 20% NPK @ 30 DAS + 20: 0: 20% NPK @ 45 DAS + 20: 0: 20% NPK @ 60 DAS	19.37	15.37	15.3	30.67
T_6-Absolute control (no fertilizer application)	12.56	10.93	13.3	21.67
S.Ed	0.42	0.23	0.65	1.43
CD (P=0.05)	0.89	0.48	NS	3.04

Table 2: Effect of application of Nitrogen and Potash on yield attributes by Altering of split schedule and ratio of maize hybrid

Treatments	Yield attributes				
	No of cobs/plant	Average cob weight (g)	Cob yield(kg/ha)	Grain yield(kg/ha)	Stover yield (kg/ha)
T_1-Recommended Split (25: 100: 100% NPK @ basal + 50% N @ 25 DAS + 25% N @ 45 DAS	1.00	146.00	7350	5879	8231
T_2-Alternate Split I (25: 100: 50% NPK @ basal + 50: 0: 50% N&K @ 25 DAS + 25% N at 45 DAS)	1.00	155.00	7851	6360	8840
T_3-Alternate split II (33.3: 100: 33.3% NPK @ basal + 33.3: 0: 33.3% N&K @ 25 DAS + 33.3: 0: 33.3% N&K at 45 DAS)	1.00	167.33	8409	6808	9382
T_4-Alternate Split III (25: 100: 25% NPK @ basal + 25: 0: 25% NPK @ 20 DAS + 25: 0: 25% NPK @ 40 DAS + 25: 0: 25% NPK @ 60 DAS	1.25	174.00	8854	7170	9752
T_5-Alternate Split IV (20: 100: 20% NPK @ basal + 20: 0: 20% NPK @ 15 DAS + 20: 0: 20% NPK @ 30 DAS + 20: 0: 20% NPK @ 45 DAS + 20: 0: 20% NPK @ 60 DAS	1.50	185.33	9190	7535	10157
T_6-Absolute control (no fertilizer application)	1.00	88.00	4766	3763	6739
S.Ed	0.23	7.01	448.82	357.75	559.13
CD (P=0.05)	NS	14.94	956.63	762.54	1191.76

Table 3: Effect of application of Nitrogen and Potash on NPK content(kg/ha) on economics by Altering of split schedule and ratio of maize hybrid

Treatments	Yield attributes				
	No of cobs/plant	Average cob weight (g)	Cob yield(kg/ha)	Grain yield(kg/ha)	Stover yield (kg/ha)
T_1-Recommended Split (25: 100: 100% NPK @ basal + 50% N @ 25 DAS + 25% N @ 45 DAS	1.00	146.00	7350	5879	8231
T_2-Alternate Split I (25: 100: 50% NPK @ basal + 50: 0: 50% N&K @ 25 DAS + 25% N at 45 DAS)	1.00	155.00	7851	6360	8840
T_3-Alternate split II (33.3: 100: 33.3% NPK @ basal + 33.3: 0: 33.3% N&K @ 25 DAS + 33.3: 0: 33.3% N&K at 45 DAS)	1.00	167.33	8409	6808	9382
T_4-Alternate Split III (25: 100: 25% NPK @ basal + 25: 0: 25% NPK @ 20 DAS + 25: 0: 25% NPK @ 40 DAS + 25: 0: 25% NPK @ 60 DAS	1.25	174.00	8854	7170	9752
T_5-Alternate Split IV (20: 100: 20% NPK @ basal + 20: 0: 20% NPK @ 15 DAS + 20: 0: 20% NPK @ 30 DAS + 20: 0: 20% NPK @ 45 DAS + 20: 0: 20% NPK @ 60 DAS	1.50	185.33	9190	7535	10157
T_6-Absolute control (no fertilizer application)	1.00	88.00	4766	3763	6739
S.Ed	0.23	7.01	448.82	357.75	559.13
CD (P=0.05)	NS	14.94	956.63	762.54	1191.76

3. Results and Discussion

3.1 Impact on yield attributing characters

The effect of altering split application of Nitrogen and potash was highly significant on cob length. The highest cob length (19.37 cm) was observed in T_5 (20: 100: 20% NPK @ basal + 20: 0: 20% NPK @ 15 DAS + 20: 0: 20% NPK @ 30 DAS + 20: 0: 20% NPK @ 45 DAS + 20: 0: 20% NPK @ 60 DAS) which is statistically at par with cob length (19.17 cm) seen on T_4 (25: 100: 25% NPK @ basal + 25: 0: 25% NPK @ 20 DAS + 25: 0: 25% NPK @ 40 DAS + 25: 0: 25% NPK @ 60 DAS). The shortest cob length (12.56 cm) was noticed on T_6(Absolute control). It was also line with the results of Verma *et al.*, (2022) [12].

The treatment T_5 (20: 100: 20% NPK @ basal + 20: 0: 20% NPK @ 15 DAS + 20: 0: 20% NPK @ 30 DAS + 20: 0: 20% NPK @ 45 DAS + 20: 0: 20% NPK @ 60 DAS) registered the highest cob girth (15.37 cm) on giving high splits, while the reduced cob length was seen in T_6(Absolute control). The similar results are attained on split applications by Hassan *et al.*, (2010) [7].

From the above collected data, it is noticed that split application of nitrogen and potash does not have any effect on all treatments and it is considered as non-significant. Application of (20: 100: 20% NPK @ basal + 20: 0: 20% NPK @ 15 DAS + 20: 0: 20% NPK @ 30 DAS + 20: 0: 20% NPK @ 45 DAS + 20: 0: 20% NPK @ 60 DAS) influenced more number of grains per row (30.67) which was found to be on par with T_4 (25: 100: 25% NPK @ basal + 25: 0: 25% NPK @ 20 DAS + 25: 0: 25% NPK @ 40 DAS + 25: 0: 25% NPK @ 60 DAS) recording (29.67) which implies that split application of fertilizers have the ability to increase the number of grains per row of cob. The results agree with the findings of Sarafraz *et al.*, (2015). The split application strategies don't produce any impact on number of cobs/plant because the number of cobs per plant is a genetic trait, and the treatment shows non-significant when it is analysed. This was in consonance with the remarks of Nemati *et al.*, (2012) [8].

The weight of cob was found to be maximum (185.33 g) on applying split application of nitrogen and potash (20: 100: 20% NPK @ basal + 20: 0: 20% NPK @ 15 DAS + 20: 0: 20% NPK @ 30 DAS + 20: 0: 20% NPK @ 45 DAS + 20: 0: 20% NPK @ 60 DAS) which was found to be significantly on par with T_4 (25: 100: 25% NPK @ basal + 25: 0: 25% NPK @ 20 DAS + 25: 0: 25% NPK @ 40 DAS + 25: 0: 25% NPK @ 60 DAS) weighs about 174 g. The increase in cob weight is due to the increased photosynthate accumulation and transfer from source to sink, increasing cob weight. Similar results were observed by Stesi *et al.*, (2020) [11].

The effect of split nitrogen and potash management on cob yield was shown to be statistically significant, and the higher the cob yield (9910 kg/ha), was noticed in higher split application of nitrogen and potash, while the control plot recorded the lowest cob yield (4766 kg/ha) where there is no fertilizer application. The results are in accordance with the findings of Begam *et al.*, (2018) [4].

Nitrogen supplied as splits had a significant impact on hybrid maize grain production. In general, yield is the final reflection of yield indicating characters. The paramount amount of grain yield (7535 kg/ha) was observed on applying split application of nitrogen and potash(20: 100: 20% NPK @ basal + 20: 0: 20% NPK @ 15 DAS + 20: 0: 20% NPK @ 30 DAS + 20: 0: 20% NPK @ 45 DAS + 20: 0: 20% NPK @ 60 DAS) which was found to be on par with T_4(25: 100: 25% NPK @ basal + 25: 0: 25% NPK @ 20 DAS + 25: 0: 25% NPK @ 40 DAS + 25: 0: 25% NPK @ 60 DAS) achieved a grain yield of about 7170 kg/ha. These results were found to be in-line with the findings of Deng *et al.*, (2023) [6].

The stover yield was found to be higher (10157 kg/ha) on implying T_5(100% P as basal, 20% of nitrogen and potash applied as even splits at five different stages (basal,15 DAS, 30 DAS, 45 DAS and 60 DAS). This was found to be on par with T_4 application of 25: 100: 25% NPK @ basal + 25: 0: 25% NPK @ 20 DAS + 25: 0: 25% NPK @ 40 DAS + 25: 0: 25% NPK @ 60 DAS attaining a stover yield of about 9752 kg/ha. From the above treatments it is confirmed that control plot recorded the lowest stover yield. These pertaining results correlate with the findings by Ngosong *et al.*, (2022) [9].

3.2 Impact on economics

The current study enhanced split application of nitrogen and potash for the same level, although the cost of cultivation increased somewhat owing to higher manpower charges. On concerning cultivation cost, the cost of cultivation may be little bit higher (₹ 52,034/ha) for application of fertilizers in split schedules, whereas for control the cost of cultivation is lower (₹43688/ha). The cultivation cost variation includes purchasing of fertilizers and application charges.

The gross return (₹118107/ha) and net return (₹66073/ha) attained in T_5 (20: 100: 20% NPK @ basal + 20: 0: 20% NPK @ 15 DAS + 20: 0: 20% NPK @ 30 DAS + 20: 0: 20% NPK

@ 45 DAS + 20: 0: 20% NPK @ 60 DAS) was found to be more profitable than other treatments. The lowest gross returns (₹59807) and net returns (₹16119) was attained in T_6 with no fertilizer application. From the above data we could presume that split application has higher cost of cultivation but it plays a major role in attaining more economic returns than other treatments. Increased crop productivity with lower cultivation costs may result in improved economic parameters such as higher net profit and B:C ratio. Similar views were reported by Batool, (2023) [3].

4. Conclusion

From the above experimental research we found that maize is a highly nutrient demanding crop which requires large amount of fertilizers, rather than applying all nutrients at the same time splitting of fertilizers into five even splits (20: 100: 20% NPK @ basal + 20: 0: 20% NPK @ 15 DAS + 20: 0: 20% NPK @ 30 DAS + 20: 0: 20% NPK @ 45 DAS + 20: 0: 20% NPK @ 60 DAS) helps to attain more yield and it also can enhance the livelihood of farmers by giving more returns. Other than split application can reduce the fertilizer losses and also protects the environment by preventing the voltailization of fertilizers.

5. References

1. Abbas G, Khan M, Khan M, Hussain F, Hussain I. Effect of iron on the growth and yield contributing parameters of wheat (*Triticum aestivum* L.). J Anim. Plant Sci. 2009;19(3):135-139.
2. Archana J, Amanullah MM, Manoharan S, Subramanian K. Influence of iron and arbuscular mycorrhiza inoculation on growth and yield of hybrid maize in calcareous soil. Madras Agricultural Journal. 2012;99:1.
3. Batool M. Nutrient Management of Maize; c2023.
4. Begam A, Adhikary S, Roy D, Ray M. Grain Yield of Kharif Maize Hybrid (*Zea mays* L) as Influenced by Doses and Split Application of Nitrogen. Int. J Curr. Microbiol. App. Sci. 2018;7(7):2121-2129.
5. Cooke G. Recent advances in fertilizer placement. II.—Fertilizer placement in England. Journal of the Science of Food and Agriculture. 1954;5(9):429-440.
6. Deng T, Wang JH, Gao Z, Shen S, Liang XG, Zhao X, et al. Late split-application with reduced nitrogen fertilizer increases yield by mediating source–sink relations during the grain filling stage in summer maize. Plants. 2023;12(3):625.
7. Hassan S, Oad F, Shamasuddin T, Gandahi A, Siddiqui M, Oad S, *et al*. Effect of N applicaton and N spliting strategy on maize N uptake, biomass production and physio-agronomic characterstics. Sarhad Journal of Agriculture. 2010;26(4):551-558.
8. Nemati AR, Sharifi RS. Effects of rates and nitrogen application timing on yield, agronomic characteristics and nitrogen use efficiency in corn. International Journal of Agriculture and Crop Sciences (IJACS). 2012;4(9):534-539.
9. Ngosong CN, Enow ATDVV, Olougou MNE, Tening AS. Optimising potassium fertilizer rates for sustainable maize (*Zea mays* L.) production on the volcanic soils of Buea, Cameroon. Fundamental and Applied Agriculture. 2022;7(1):11-20.
10. Sarafra R, Marashi S. Effect of split application of nitrogen fertilizer on quantitative and qualitative characteristics of maize (SC 704) under water deficit condition. Indian Journal of Fundamental and Applied Life Sciences. 2015;5(1):172-178.
11. Stesi S, Karthikeyan R, Sivakumar R, Maragatham N. Response of enhanced dose and differential time of nitrogen application on growth, yield and economics of irrigated hybrid maize (*Zea mays* L.). Journal of Pharmacognosy and Phytochemistry. 2020;9(1):196-199.
12. Verma L, Kumar P, Shinde S. Effect of split application of nitrogen on economics of different treatments in kharif maize; c2022.