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# Optimization of nitrogen split application in sweet corn (*Zea mays* L. *saccharata*)

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## Abstract

Effective nitrogen management is essential for improving crop development and yield, especially in the cultivation of sweet corn. Conventional basal nitrogen application often leads to nitrogen loss through volatilization and denitrification. To address this issue, split nitrogen application has emerged as a promising strategy to improve nitrogen use efficiency while minimizing losses. In the summer of 2022, this experiment was carried out at the Post Graduate Research Farm of M.S. Swaminathan School of Agriculture, Paralakhemundi, Gajapati, Odisha, India to examine the effects of several nitrogen split application treatments on the growth and productivity of sweet corn. The experiment utilized a randomized complete block design (RCBD) with 10 treatments replicated thrice. Treatments included combinations of nitrogen application timings and amounts, ranging from the basal application to split applications at knee-high and tasseling stages. Results demonstrated that the treatment involving 25 % basal nitrogen, 50 % nitrogen at knee high stage and 25 % nitrogen at tasseling stage significantly maximized growth, yield and income compared to other treatments. Consequently, sweet corn cultivators in southern Odisha seeking to attain maximal development and yield should implement this nitrogen split application strategy. This study underscores the importance of tailored nitrogen management strategies in enhancing crop performance and economic returns in sweet corn cultivation.

## Keywords

split application; nitrogen; sweet corn; growth; yield

## Introduction

Climate change alters agricultural landscapes, causing climatic anomalies and threatening global food security (1). Farmers are under greater pressure to change their techniques and crops as temperatures increase and resources grow scarce. Among them, maize stands out as a staple crop with enormous potential for delivering sustenance and income throughout the globe. Maize (*Zea mays* L.) is one of the most important crops globally, second to wheat and rice in terms of production and is a staple food across continents (2). Maize is called the "Queen of cereals" because of its high genetic yield potential, variability and climate adaptability, which allows maize to become a versatile and resilient crop and suitable for various agricultural systems (3). Worldwide, maize is grown on approximately 182 million hectares, producing 987 million tonnes, with average productivity of 5,423 kg per hectare (4). In India, maize is cultivated on 9.2 million hectares, producing an estimated 27.8 million tonnes with a productivity of 2,965 kg per hectare (5). In Odisha, maize cultivation spans around 254,000 hectares, with an average production of 733,000 tonnes and a productivity of 2,886 kg per hectare (6).

Different types of maize, such as flint corn, dent corn, sweet corn, soft corn, popcorn, waxy corn and pod corn, cater to various dietary and industrial needs. Sweet corn, specifically *Zea mays* L. saccharata, has gained popularity as an alternative for meeting the growing urban demand for fresh and processed vegetable crops. With the highest sugar content among the maize varieties, sweet corn is particularly valued at the milking stage, making it popular for table use, especially as roasted or boiled cobs (7,8). Unlike field corn, harvested in a mature and dry form, sweet corn is harvested at an immature, green stage, which adds value to its tender and sweet flavor profile. This green harvest also provides fodder that can be utilized as animal feed, contributing to farm income diversification (9).

Sweet corn is nutritionally dense, containing about 5-6% sugar, 10-11% starch, 3% water-soluble polysaccharides and 70% water. Its solid parts include carbohydrates (81%), proteins (13%), lipids (3.5%) and other minor components (2.5%) (10). With moderate levels of proteins, vitamins A and C and potassium, it is an excellent choice for fresh and processed consumption, aligning with modern trends in crop diversification. Additionally, as a short-duration crop, sweet corn integrates well into existing cropping systems and can be grown year-round, which helps increase the income of farmers shifting toward high-value crops like sweet corn (11). Effective nutrient management is essential for maximizing growth and yield in sweet corn cultivation. Nitrogen (N) is particularly vital, given its role in plant metabolism and its impact on biomass production. Although nitrogen-based fertilizers are commonly used due to their significant impact and relative affordability, they are also susceptible to loss from leaching, volatilization and denitrification, especially in Indian soils that typically show nitrogen deficiency (12). Sweet corn plants absorb nitrogen primarily in the forms of nitrate ($NO_3^+$) and ammonium ($NH_4^+$). Still, a deficiency in nitrogen availability can impede these forms from being fully utilized by the plant, resulting in reduced yields (13).

Split nitrogen application has proven to be a promising approach to address these challenges. By dividing the total nitrogen dose into multiple applications at critical growth stages, nitrogen use efficiency is improved, reducing losses and synchronizing nutrient availability with the plant's uptake capacity. This strategy aligns with the principles of 4R Nutrient Stewardship (right source, correct rate, right time and place) to optimize nutrient use, ensuring environmental responsibility and enhancing productivity (14). In this context, the present study was conducted in southern Odisha to evaluate the timing and dosage of nitrogen application, aiming to refine nitrogen uptake efficiency, optimize crop performance and minimize the environmental impact associated with nitrogen fertilizer use in sweet corn cultivation.

## Materials and Methods

In the summer of 2022, a field trial was conducted at the Post Graduate Research Farm, M.S. Swaminathan School of Agriculture, situated in the Gajapati district of Odisha, India (latitude 18°48'16" N, longitude 84°10'48" E, altitude approximately 64 m above sea level). The experimental crop was sown in January 2022 and harvested in April 2022. Throughout the growth period, temperatures fluctuated between 37°C and 16°C every week, accompanied by relative humidity levels ranging from 34% to 96%. The soil composition of the experimental site was characterized as sandy clay loam. The experiment was laid out in a randomized complete block design (RCBD) with ten treatments such as $T_1$ (75% Recommended dose of nitrogen (RDN) at knee high stage + 25% RDN at tasseling stage), $T_2$ (100% RDN at knee high stage), $T_3$ (25% Basal RDN + 50% RDN at knee high stage + 25% RDN at tasseling stage), $T_4$ (25% Basal RDN + 75% RDN at knee high stage), $T_5$ (33% Basal RDN + 33% RDN at knee high stage + 33% RDN at tasseling stage), $T_6$ (50% Basal RDN + 25% RDN at knee high stage + 25% RDN at tasseling stage), $T_7$ (50% Basal RDN + 50% RDN at knee high stage), $T_8$ (75% Basal RDN + 25% RDN at knee high stage), $T_9$ (75% Basal RDN + 25% RDN at tasseling stage), $T_{10}$ (100% basal RDN) and three replications. The East-West seed variety, specifically Golden Cob F1, was planted using a spacing of 60 cm x 25 cm, with a seed rate of 25 kg/ha, adhering to recommended agricultural practices to ensure successful crop establishment. The prescribed fertilizer application comprised 120:60:40 kg N, $P_2O_5$, $K_2O$ respectively, with Urea supplying nitrogen (N), Single Super Phosphate (SSP) providing phosphorus (P) and Muriate of Potash (MOP) contributing potassium (K).

### Statistical analysis

Data collected from the field underwent statistical analysis using standard ANOVA techniques. Differences between treatment means were evaluated to determine statistical significance, employing appropriate critical difference (CD) values at a significance level of 5%, as outlined by Gomez and Gomez (15).

## Results and Discussion

### Influence of split application of nitrogen on growth parameters of sweet corn

The parameters such as plant height (cm), dry matter accumulation (g/m$^2$) and leaf area index were found to be significantly influenced by the split application of nitrogen at different crop growth stages (Table 1). The results revealed that the highest plant height in sweet corn (193.8cm) was obtained with the application of 25% RDN as basal + 50% RDN at knee high stage + 25% RDN at tasseling stage, which was statistically at par with the application of 33% RDN as basal + 33% RDN at knee high stage + 33% RDN at tasseling stage (189.5cm) and 50% RDN as basal + 25% RDN at knee high stage + 25% RDN at tasseling stage (190.8 cm). The minimum plant height was recorded with the application of 100% RDN as basal (139.0cm). A similar trend was followed by dry matter accumulation (g/m$^2$) and leaf area index at harvest. Split application of nitrogen helps to improve nitrogen use efficiency by reducing nitrogen loss. An adequate supply of nitrogen influences cell division and elongation, which are necessary for plants to achieve optimal vegetative growth (16). It also helps to increase the

**Table 1**. Influence of split application of nitrogen on growth parameters of sweet corn.

| Treatments | Morphological parameters | | |
|---|---|---|---|
| | Plant height (cm) | Leaf area index | Dry matter accumulation (g/m$^2$) |
| $T_1$ | 160.7 | 3.46 | 933.2 |
| $T_2$ | 158.9 | 3.19 | 754.4 |
| $T_3$ | 193.8 | 4.52 | 1377.7 |
| $T_4$ | 179.0 | 3.96 | 1131.7 |
| $T_5$ | 189.5 | 4.45 | 1366.6 |
| $T_6$ | 190.8 | 4.51 | 1339.1 |
| $T_7$ | 180.2 | 3.27 | 1102.2 |
| $T_8$ | 174.7 | 3.25 | 1164.5 |
| $T_9$ | 168.6 | 3.23 | 961.5 |
| $T_{10}$ | 139.0 | 3.02 | 681.0 |
| S.Em. ± | 4.5 | 0.13 | 33.8 |
| CD at 5% | 13.3 | 0.39 | 100.3 |

**Table 2**. Influence of split application of nitrogen on yield attributes of sweet corn.

| Treatments | Yield attributes | | | |
|---|---|---|---|---|
| | No. of green cobs/plant | Green cob weight (g) | Cob length (cm) | Cob girth (mm) |
| $T_1$ | 1.28 | 152.7 | 17.2 | 7.3 |
| $T_2$ | 1.27 | 164.3 | 16.3 | 7.1 |
| $T_3$ | 1.52 | 202.2 | 21.1 | 11.9 |
| $T_4$ | 1.32 | 172.3 | 17.6 | 8.7 |
| $T_5$ | 1.47 | 192.1 | 20.0 | 10.7 |
| $T_6$ | 1.49 | 198.0 | 19.9 | 10.6 |
| $T_7$ | 1.38 | 175.7 | 17.9 | 8.2 |
| $T_8$ | 1.33 | 176.0 | 17.3 | 7.8 |
| $T_9$ | 1.33 | 167.5 | 17.8 | 7.7 |
| $T_{10}$ | 1.20 | 136.7 | 15.6 | 7.0 |
| S.Em. ± | 0.04 | 7.0 | 0.7 | 0.5 |
| CD at 5% | 0.12 | 20.9 | 2.1 | 1.3 |

length and number of internodes. As a result, plant height has increased. Consequently, the photosynthetic activity, meristematic activity and vegetative growth were also increased. The overall accumulation of photosynthates increased, leading to maximum dry matter accumulation. This result was also reported by Palled and Shenoy (17). Gavhane et al. (18) indicated that the increased leaf area index is likely due to the split application of nitrogen, which provided sufficient nitrogen at optimal times, hence enhancing leaf length and area, ultimately leading to a larger leaf area index. This decrease in LAI can be attributed to nitrogen stress that developed during the later stages of crop growth. Similar findings were reported by (19,20).

## Influence of split application of nitrogen on yield attributes of sweet corn

Nitrogen split application significantly affects all the yield attributes (Table 2). Among all the treatments, the application of 25% RDN as basal + 50% RDN at the knee-high stage + 25% RDN at the tasseling stage performed superiorly over all the other treatments. The maximum number of green cobs/plant (1.52) was obtained with the application of 25% RDN as basal + 50% RDN at knee high stage + 25% RDN at tasseling stage, which was statistically at par with the application of 33% RDN as basal + 33% RDN at knee high stage + 33% RDN at tasseling stage (1.47) and 50% RDN as basal + 25% RDN at knee high stage + 25% RDN at tasseling stage (1.49). The minimum number of green cobs/plants was recorded using 100% RDN as basal (1.20). A similar trend was obtained in green cob weight (g), cob length (cm), cob girth (mm). Split application of nitrogen helped to reduce the loss of nitrogen by applying it at the right time and at the right stage. Application of nitrogen helped to increase the leaf area index, which consequently increased the photosynthetic activity, which led to the increased number of green cobs plant$^{-1}$. A similar result was reported by Mollah et al. (21). Increasing the assimilation of photosynthates in a sink increased the number of grains per cob, which in turn increased the weight of the cob. The similar results are in close conformity with the findings of Tilahun et al. (22) and Pandey and Chaudhary (23). An adequate supply of nitrogen helped to increase photosynthetic activity, which led to the increased supply of assimilates to the sink. As a result, the length of the cob was increased. Ogoke et al. (24), Amanullah et al. (25), and Suraj et al. (26) also reported similar findings. The probable reason might be that increased splits of nitrogen led to the adequate supply of the photosynthates to the sink, and in turn, the girth of the cob was increased. A similar opinion was also forwarded by Harikrishna et al. (27), Saha and Mondal (28) and Verma et al. (29).

## Influence of split application of nitrogen on the yield (t/ha) of sweet corn

The study of data on yield parameters differed significantly from the split application of nitrogen presented in Table 3. The highest green cob yield (12.9 t/ha) was recorded with the application of 25% RDN as basal + 50% RDN at knee high stage + 25% RDN at tasseling stage, which was statistically at par with the application of 33% RDN as basal + 33% RDN at knee high stage + 33% RDN at tasseling stage (12.2 t/ha) and 50% RDN as basal + 25% RDN at knee high stage + 25% RDN at tasseling stage (12.1 t/ha). The minimum number of green cobs / plants was recorded using 100% RDN as basal (3.1 t/ha). A similar trend was observed in green fodder yield and biological yield. The maximum harvest index (46.4%) was obtained with the application of 25% RDN as basal+50% RDN at the knee-high stage + 25% RDN at the tasseling stage and the minimum harvest index was noted with the application of 100% RDN as basal (33.3%). The yield of a crop is determined by various factors, including yield-attributing characteristics. One of the crucial factors influencing yield is the relationship between the source (photosynthesis) and the sink (grain), which is directly associated with nitrogen. In other words, nitrogen plays a significant role in determining crop yield by influencing the efficiency of photosynthesis and grain development. The application of nitrogen in different splits increases the nitrogen availability, which might have contributed to the maximum grain yield. The accumulation of photosynthates helps increase the straw yield, ultimately leading to a higher

**Table 3**. Influence of split application of nitrogen on the yield (t/ha) of sweetcorn.

| Treatments | Yield | | | |
|---|---|---|---|---|
| | Green cob yield (t/ha) | Green fodder yield (t/ha) | Biological yield (t/ha) | Harvest index (%) |
| $T_1$ | 5.5 | 8.4 | 13.9 | 39.6 |
| $T_2$ | 5.2 | 7.7 | 12.9 | 40.4 |
| $T_3$ | 12.9 | 14.9 | 27.8 | 46.4 |
| $T_4$ | 10.5 | 12.2 | 22.7 | 46.3 |
| $T_5$ | 12.2 | 14.6 | 26.8 | 45.5 |
| $T_6$ | 12.1 | 14.1 | 26.2 | 46.2 |
| $T_7$ | 10.0 | 12.0 | 22.0 | 45.5 |
| $T_8$ | 9.1 | 10.5 | 19.6 | 46.4 |
| $T_9$ | 8.4 | 10.0 | 18.4 | 45.7 |
| $T_{10}$ | 3.1 | 6.2 | 9.3 | 33.3 |
| S.Em. ± | 0.5 | 0.6 | 0.7 | 1.8 |
| CD at 5% | 1.4 | 1.8 | 2.0 | 5.5 |

biological yield. Similar findings were reported by (30,31).

### Influence of split application of nitrogen on the nitrogen content (%) and uptake (kg/ha) of sweet corn

Nitrogen content and plant uptake were highly influenced by the split application of nitrogen presented in Table 4. The maximum content and uptake of nitrogen were found in sweet corn with the application of 25% RDN as basal + 50% RDN at knee high stage + 25% RDN at tasseling stage, which was statistically at par with the application of 33% RDN as basal + 33% RDN at knee high stage + 33% RDN at tasseling stage and 50% RDN as basal + 25% RDN at knee high stage + 25% RDN at tasseling stage. The minimum nitrogen content and uptake were recorded using 100% RDN as basal. Nitrogen content was obtained maximum in split application of nitrogen because split application facilitated the synchronization between nitrogen requirement and supply to the plant. It also reduced nitrogen loss, enhancing the nitrogen content in grain and straw. Uptake is a function of yield and nitrogen content in grain and straw. Timely application of. The adequate amount of nitrogen in different split doses helped increase the yield and nitrogen content in both grain and straw, resulting in higher nitrogen uptake by both grain and straw.

**Table 4.** Influence of split application of nitrogen on the nitrogen content (%) and uptake (kg/ha) of sweetcorn.

| Treatments | Total Nitrogen content (%) in plant | Total Nitrogen uptake (kg/ha) in plant |
|---|---|---|
| **$T_1$** | 1.11 | 69.7 |
| **$T_2$** | 1.10 | 83.0 |
| **$T_3$** | 1.28 | 158.5 |
| **$T_4$** | 1.12 | 124.4 |
| **$T_5$** | 1.18 | 155.6 |
| **$T_6$** | 1.20 | 150.0 |
| **$T_7$** | 1.14 | 121.2 |
| **$T_8$** | 1.12 | 106.1 |
| **$T_9$** | 1.10 | 101.4 |
| **$T_{10}$** | 1.06 | 58.1 |
| **S.Em. ±** | 0.04 | 4.1 |
| **CD at 5%** | 0.11 | 12.1 |

This result conformed with findings of Singh (32) and Chaudhary et al. (33).

## Conclusion

Based on the experimental findings, it may be concluded that applying 25% nitrogen as basal + 50% at knee high stage + 25% at tasseling stage promotes sweet corn growth and productivity and helps achieve a maximum net return and benefit-cost ratio. Additionally, it improves the nitrogen use efficiency. Furthermore, it has been observed that three equal splits of 120 kg N/ha are preferable for producing sweet corn economically. For future research, it would be valuable to explore the effects of varying nitrogen application rates and timings across different soil types and environmental conditions to determine optimal nitrogen management practices for diverse regions. Additionally, studies examining the interactions between nitrogen application and other essential nutrients could provide insights into further optimizing nutrient use efficiency. Investigating sustainable nitrogen sources, such as organic amendments or controlled-release fertilizers, could also offer alternatives to improve yield and environmental sustainability in sweet corn production.

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## Authors' contributions

TS conceptualized the study and provided overall guidance for the research. LY performed the experiment, while SM curated the data and prepared the original draft in collaboration with SKP. SR contributed to editing and corrections.

## Compliance with ethical standards

**Conflict of interest:** The authors of this paper declare that they have no conflicts of interest associated with this paper.

**Ethical issues:** None

## References

1. Ray S, Maitra S, Sairam M, Sravya M, et al. An unravelled potential of foliar application of micro and beneficial nutrients in cereals for ensuring food and nutritional security. Int J Exp Res Rev 2024;41:19-42. https://doi.org/10.52756/ijerr.2024.v41spl.003
2. Edmeades GO, Trevisan W, Prasanna BM, Campos H. Tropical maize (*Zea mays* L.). In: Campos H, Caligari PDS (Eds). Genetic improvement of tropical crops. Springer, Cham. 2017;57-109. https://doi.org/10.1007/978-3-319-59819-2
3. Sairam M, Maitra S, Sahoo U, Sagar L, Krishna TG. Evaluation of precision nutrient tools and nutrient optimization in maize (*Zea mays* L.) for enhancement of growth, productivity and nutrient use efficiency. Res Crop. 2023;24:666-67.https://

doi.org/10.31830/2348-7542.2023.ROC-1016 .

4. FAOSTAT, 2022. FAOSTAT Production Database, Crops Processed.
5. Rani JSS, Sreedevi B, Vani KP, Latha PC, et al. Effect of organic and inorganic sources of nutrients on yield attributes and yield of maize in aerobic rice-zero till maize cropping system under sandy clay loam soils in southern Telangana agro-climatic zone. Int J Environ Clim Chang. 2022;12(10):449-61. https://doi.org/10.9734/ijecc/2022/v12i1030818
6. Odisha Agricultural Statistics. 2020. Department of Agriculture and Farmers' Empowerment, Government of Odisha.
7. Kumar RS, Kumar B, Kaul J, Karjagi CG, Jat SL, Parihar CM, et al. Maize research in India-historical prospective and future challenges. Maize Journal. 2012;1(1):1-6.
8. Usman SM, Khan RS, Shikari AB, Yousuf N, Waza SA, Wani SH, et al. Unveiling the sweetness: evaluating yield and quality attributes of early generation sweet corn (*Zea mays* subsp. *sachharata*) inbred lines through morphological, biochemical and marker-based approaches. Mol Biol Rep. 2024;51:307. https://doi.org/10.1007/s11033-024-09229-7
9. Meena A, Solanki RM, Malam KV, Palanjiya RR. Effect of spacing and nitrogen levels on quality parameters and nitrogen uptake of fodder maize (*Zea mays* L.). Int J Chem Stud. 2019;7(5):2355-357.
10. Fekonja M, Bavec F, Grobelnik-Mlakar S, Turinek M, et al. Growth performance of sweet maize under non-typical maize growing conditions. Biol Agric Hortic. 2011;27(2):147-64. https://doi.org/10.1080/01448765.2011.9756644
11. Massey JX, Gaur BL. Response of sweet corn cultivars to plant population and fertility levels on yield, NPK uptake and quality characters. Int J Agric. Sci. 2013;9(2):713-15.
12. Chander S. Nitrogen in Indian Agriculture: Frank Notes. Indian Journal of Fertilizers. 2016; 12-13.
13. Thornton B, Robinson D. Uptake and assimilation of nitrogen from solutions containing multiple N sources. Plant Cell Environ. 2005;28(6):813-21. https://doi.org/10.1111/j.1365-3040.2005.01332.x.
14. Thorup JT, Stewart JWB. Optimum fertilizer uses with differing management practices and changing government practices. In: Proc. 25th Anniversary Symposium of Division S-8 of the Soil Society of America: Advances in Fertilizer Technology and Use. 1988; 86-101.
15. Gomez KA, Gomez AA. Statistical procedures for agricultural research, John wiley and sons. 1984.
16. Majumder S, Shankar T, Maitra S, Adhikary R, Sairam M. Effect of nutrient omission on growth and productivity of *rabi* rice. Crop Res. 2023;58(3&4):129-35. https://doi.org/10.31830/2454-1761.2023.cr-11166
17. Palled YB, Shenoy H. Effect of nitrification inhibitors and time of nitrogen application on hybrid maize. Current-Research-University of Agricultural Science Bangalore. 2006;29(1/2):19-20.
18. Gavhane KN, Pawar SB, Dhakne SB. Studies on fertilizer levels of NPK withsplit application of nitrogen for maize (*Zea mays* L.) under *rabi* season. Pharma Innovation. 2021;10(12):1646-1448.
19. Sharifi RS, Namvar A. Effects of time and rate of nitrogen application on phenology and some agronomical traits of maize (*Zea mays* L.). Biologija. 2016;62(1):35-45 https://doi.org/10.6001/biologija.v62i1.3288.
20. Patel Upasana J, Deshmukh SP, Khadadiya MB, Desai NB. Effect of different levels, split and foliar application of nitrogen on growth and yield of sweetcorn (*Zea mays var. saccharate*). Int J Chem Stud. 2021;9(1):918-22. https://doi.org/10.22271/chemi.2021.v9.i1m.11344
21. Mollah MRA, Asaduzzaman M, Akther MA, Khalequzzaman KM. Synchronization of Nitrogen Application with Growth Stages of Maize. Int J Sustain Crop Prod. 2007:2(3): 53-55.
22. Pandey B, Chaudhary NK. Response of tillage system, nitrogen level and split application of nitrogen on spring maize in chitwan, Nepal. International Journal Applied Science Biotechnology. 2014;2(3):298-301. https://doi.org/10.3126/ijasbt.v2i3.11007.
23. Tilahun T, Alemayehu A, Minale L, Zelalem T. Effect of nitrogen split application on productivity, nitrogen use efficiency and economic benefits of maize production in Ethiopia. International Journal of Agricultural Policy and Research. 2013; 1(4): 109-15.
24. Ogoke I, Igwe CS, Tom CT, Ofoh MC. Effects of nitrogen fertilizer split- treatments on maize yield in a humid tropical environment. International Journal of Agriculture and Rural Development. 2006;7(1):133-37. https://doi.org/10.4314/ijard.v7i1.2630.
25. Amanullah H, Marwat KB, Shah P, Maula N, Arifullah S. Nitrogen levels and its time of application influence leaf area, height and biomass of maize planted at low and high density. Pak J Bot. 2009;41(2):761-68.
26. Suraj M, Somangouda G, Salakinkop SR. Yield and yield attributes of sweet corn (*Zea mays* L. *saccharate*) as influenced by the split application of nitrogen and potassium during kharif under protective irrigation. J Entomol Zool Stud. 2020;8(4):361-64.
27. Harikrishna BL, Dasog GS, Patil PL. Effect of soil depth and nitrogen application on yield attributes of maize and its economic analysis. Karnataka J Agric Sci. 2005;18(2):370-74.
28. Saha M, Mondal SS. Influence of integrated plant nutrient supply on growth, productivity and quality of baby corn (*Zea mays* L.) in Indo Gangetic plains. Indian J Agron. 2006;51:202-05. https://doi.org/10.59797/ija.v51i3.5008
29. Verma L, Kumar V. Effect of split application of nitrogen on the different growth stages of *Kharif* Maize. Pharma Innovation. 2022;11(2):1249-1253.
30. Varshini SV, Babu R. Effect of graded levels and split application of nitrogen inyield, yield attributes and economics of hybrid maize. J Pharmacogn Phytochem.2019;8(6):882-87.
31. Verma L, Kumar V, Shinde SS, Asewar BV. Yield response of *kharif* maizefor split application of nitrogen. J Pharmacogn Phytochem. 2018;7(2):1097-099.
32. Singh D. Impact of scheduling nitrogen on productivity of single cross maize (Zea mays) hybrids. Indian J Agric Sci. 2010;80(7): 649-51.
33. Chaudhary R, Singh D, Nepalia V. Productivity and economics of quality protein maize (*Zea mays* L.) as influenced by nitrogen levels, its scheduling and sulphur application. Indian J Agron. 2013;58(3):340-43. https://doi.org/10.59797/ija.v58i3.4196