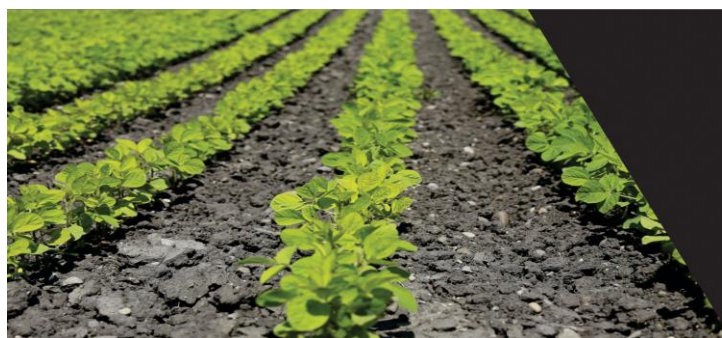




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Vishal B Awasarmal

Professor (CAS), Department of
Agronomy, College of Agriculture,
Parbhani, Vasantao Naik
Marathwada Krishi Vidyapeeth,
Parbhani, Maharashtra, India

Dhanshri M Joshi

M.Sc. Scholar, Department of
Agronomy, College of Agriculture,
Parbhani, Vasantao Naik
Marathwada Krishi Vidyapeeth,
Parbhani, Maharashtra, India

Shruti B Yerawad

M.Sc. Scholar, Department of
Agronomy, College of Agriculture,
Parbhani, Vasantao Naik
Marathwada Krishi Vidyapeeth,
Parbhani, Maharashtra, India

Vivek B Choudhary

M.Sc. Scholar, Department of Seed
Science and Technology, College of
Agriculture, Parbhani, Vasantao
Naik Marathwada Krishi
Vidyapeeth, Parbhani,
Maharashtra, India

Corresponding Author:

Vishal B Awasarmal

Professor (CAS), Department of
Agronomy, College of Agriculture,
Parbhani, Vasantao Naik
Marathwada Krishi Vidyapeeth,
Parbhani, Maharashtra, India

Response of split application of nitrogen on growth and yield of sweet corn (*Zea mays saccharata* L.)

Vishal B Awasarmal, Dhanshri M Joshi, Shruti B Yerawad and Vivek B Choudhary

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Abstract

A field experiment was carried out during *kharif* 2021 at the Agricultural Research Farm, Department of Agronomy, College of Agriculture, Vasantao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani (M.S.), to work out a suitable nitrogen scheduling programme for *kharif* sweet corn (*Zea mays* var. *saccharata* L.). Eight nitrogen split-application schedules, ranging from a single basal dose to four equal splits, were tested in a Randomized Block Design with three replications. Splitting the recommended dose of nitrogen into four equal parts 25% as basal and 25% each at 30, 40 and 50 days after sowing (T8) produced the tallest plants (205.74 cm), the highest number of functional leaves (12.53), the largest leaf area (28.43 dm² plant⁻¹) and the greatest dry matter accumulation (272.23 g plant⁻¹) at harvest, remaining statistically on par with a similar four-split schedule spread over 30, 45 and 60 DAS (T5). The same treatment (T8) also gave the maximum fresh cob yield (22,378.6 kg ha⁻¹), green fodder yield (42,688.2 kg ha⁻¹), biological yield (65,066.8 kg ha⁻¹) and net monetary return (Rs. 1,33,898 ha⁻¹), with the best benefit-cost ratio of 2.36. The untreated control recorded the lowest values for every character studied. The results indicate that dividing the nitrogen dose into four smaller, well-timed applications synchronised with peak crop demand improves nitrogen use efficiency and is agronomically and economically superior to a single or two-split basal application in sweet corn.

Keywords: Sweet corn, split nitrogen application, growth, yield, economics, nitrogen use efficiency

Introduction

Maize (*Zea mays* L.) is one of the world's leading cereals after rice and wheat and is known as the "Queen of cereals" because of its wide genetic diversity, climatic adaptability and diverse uses. It is cultivated from tropical to temperate regions for grain, fodder, food and industrial products. Among its types, sweet corn (*Zea mays* var. *saccharata* L.) has gained considerable commercial importance due to its sweet, tender kernels, resulting from a recessive gene that restricts the conversion of sugar into starch in the endosperm. Harvested at the milk stage, it is consumed fresh, boiled, roasted or canned and is widely used in soups, salads and confectionery. Thus, sweet corn offers good opportunities for crop diversification and improved farm income, particularly near urban markets.

Nitrogen is a key nutrient influencing sweet corn productivity as it forms an essential component of chlorophyll, amino acids and nucleic acids and promotes leaf growth, photosynthesis and cob development. However, nitrogen is highly mobile and can be lost through leaching, volatilization and denitrification. Therefore, efficient scheduling of nitrogen applications is as important as the total quantity applied. Farmers commonly apply nitrogen as a basal dose or in two splits at sowing and the knee-high stage, which may cause excessive availability during early growth and deficiency during later stages of high crop demand. Splitting nitrogen into smaller applications according to critical crop growth stages, such as vegetative growth, tasseling and cob development, can improve nutrient availability, reduce losses and enhance nitrogen-use efficiency, fresh cob yield and fodder yield. Therefore, the present investigation was undertaken to evaluate eight nitrogen split-application schedules and their effects on growth, yield attributes, yield and economics of *kharif* sweet corn.

Materials and Methods

The experiment was conducted during *kharif* 2021 at the Agricultural Research Farm, Department of Agronomy, College of Agriculture, VNMKV, Parbhani, Maharashtra. The experimental soil was deep, clayey in texture, slightly alkaline in reaction, and well drained, with low available nitrogen, low available phosphorus and high available potassium. The site lies at about 19°16' N latitude and 76°47' E longitude at an elevation of roughly 409 m above mean sea level, and falls in the assured-rainfall zone of the South-West monsoon belt; the mean maximum and minimum temperatures during the crop season were 30.95 °C and 22.25 °C respectively, with a mean relative

humidity of about 65-90%.

The sweet corn variety Sugar-75 was sown by dibbling on 7 July 2021 at a spacing of 60 cm × 20 cm in a Randomized Block Design comprising eight nitrogen scheduling treatments replicated three times (24 plots in all), with a gross plot size of 5.4 m × 4.5 m and a net plot size of 4.5 m × 4.2 m. A uniform, recommended dose of nitrogen was applied to all treatments except the control, but the timing and number of splits differed as summarized in Table 1. Phosphorus and potassium were applied uniformly as a basal dose at sowing in all treatments, and recommended package of practices was followed for the rest of the crop management.

Table 1: Nitrogen split-application treatments

Treat.	Nitrogen scheduling
T1	Control (no nitrogen applied)
T2	Two equal splits: 50% N as basal + 50% N at 30 DAS
T3	Three equal splits: 33% N basal + 33% N at 30 DAS + 33% N at 60 DAS
T4	Three splits: 25% N basal + 50% N at 30 DAS + 25% N at 60 DAS
T5	Four equal splits: 25% N basal + 25% N at 30 DAS + 25% N at 45 DAS + 25% N at 60 DAS
T6	Three equal splits: 33% N basal + 33% N at 30 DAS + 33% N at 45 DAS
T7	Three splits: 25% N basal + 50% N at 30 DAS + 25% N at 45 DAS
T8	Four equal splits: 25% N basal + 25% N at 30 DAS + 25% N at 40 DAS + 25% N at 50 DAS

Data on growth parameters (plant height, number of functional leaves, leaf area, and total dry matter accumulation) were recorded periodically, and yield-attributing characters, fresh cob yield, green fodder yield, biological yield, harvest index and post-harvest soil nutrient status were recorded at harvest. Economic indices gross monetary return, net monetary return and benefit-cost ratio were worked out using prevailing input costs and produce prices. All data were statistically analyzed by the analysis of variance technique appropriate for a Randomized Block Design (Panse and Sukhatme, 1967) [9], and treatment means were compared using the critical difference at 5% probability.

Results and Discussion

Growth attributes

The mean initial and final plant stand of sweet corn (78.35 and

75.52 per plot, respectively) did not differ significantly among treatments, confirming that crop establishment was uniform and that the differences recorded later were attributable to nitrogen scheduling rather than uneven germination.

Growth characters recorded at harvest are summarized in Table 2. Plant height, number of functional leaves, leaf area and total dry matter accumulation increased steadily up to about 60 days after sowing and then more slowly toward harvest. At 30 DAS none of these characters differed significantly among treatments, indicating that the early nitrogen dose had not yet produced a measurable growth response; from 45 DAS onward, however, treatment differences became significant and remained so up to harvest.

Table 2: Plant height, functional leaves, leaf area and dry matter accumulation of sweet corn at harvest as influenced by split nitrogen application

Treat.	Plant height (cm)	Leaves plant ⁻¹	Leaf area (dm ² plant ⁻¹)	Dry matter (g plant ⁻¹)
T1 - Control	135.11	7.80	13.64	117.45
T2	156.21	9.29	15.45	215.71
T3	182.01	10.63	24.34	258.54
T4	181.74	10.47	24.19	256.56
T5	203.96	12.23	27.62	271.45
T6	178.99	10.23	24.09	255.45
T7	176.74	10.03	23.86	254.98
T8	205.74	12.53	28.43	272.23
SEm±	7.25	0.59	0.92	10.41
CD at 5%	21.89	1.80	2.77	31.44
General mean	177.56	10.40	22.66	237.80

Across all four growth characters, the four-split schedule of 25% nitrogen as basal followed by 25% each at 30, 40 and 50 DAS (T8) consistently produced the best performance, remaining statistically on par with the alternative four-split schedule spread over 30, 45 and 60 DAS (T5), and significantly ahead of every other treatment. The lowest values throughout were recorded in the unfertilized control (T1). Because nitrogen is a building block of chlorophyll and protoplasm and drives cell division and elongation, supplying it in smaller, more frequent doses appears to keep the crop's nitrogen supply better matched to demand across the vegetative and early reproductive phases than a single

basal dose or a two-way split, where a large initial pulse is prone to loss before the crop can use it. These findings agree with earlier reports of improved vegetative growth under split nitrogen scheduling in maize and sweet corn (Amanullah *et al.*, 2009; Verma *et al.*, 2012; Pradhan and Sahoo, 2021) [2, 10, 14].

Yield-attributing characters

The number of cobs per plant was largely a varietal trait and did not vary significantly with nitrogen scheduling, but cob length, cob weight (with and without husk), number of grains per cob and grain weight per cob were all significantly influenced by

treatment (Table 3), while test weight remained statistically unaffected. Treatment T8 again gave the highest values for every significant character, on par with T5 and significantly superior to the remaining schedules; the control produced the smallest, lightest cobs with the fewest grains. The build-up of cob size and

grain number under frequent nitrogen splitting is consistent with better assimilate supply during the cob-formation and grain-filling window, in line with the observations of Pandey and Chaudhary (2014) ^[8] and Shah (2010) ^[12].

Table 3: Yield-attributing characters of sweet corn as influenced by split nitrogen application

Treat.	Cob length w/ husk (cm)	Cob wt. w/ husk (g)	Cob wt. w/o husk (g)	Grains cob ⁻¹	Grain wt. cob ⁻¹ (g)	Test wt. (g)
T1 - Control	17.81	165.11	111.88	346.88	110.54	19.39
T2	19.33	179.52	137.99	380.67	118.14	20.54
T3	23.11	275.43	186.45	452.76	143.32	21.83
T4	23.00	253.34	164.23	448.65	140.76	21.79
T5	26.33	306.67	228.65	510.98	160.23	22.00
T6	22.78	221.18	157.32	446.34	138.54	21.32
T7	22.49	208.98	148.11	442.56	136.54	21.08
T8	26.89	316.97	240.23	514.34	162.17	22.10
SEm±	1.28	10.54	7.12	18.09	5.70	0.85
CD at 5%	3.75	30.91	20.91	53.07	16.75	NS
General mean	22.72	240.90	171.86	442.90	138.78	21.25

Yield and economics

Fresh cob yield, green fodder yield and biological yield followed the same trend as growth and yield-attributing characters (Table 4). Treatment T8 gave the highest fresh cob yield (22,378.6 kg ha⁻¹), green fodder yield (42,688.2 kg ha⁻¹) and biological yield (65,066.8 kg ha⁻¹), remaining statistically at par with T5 but significantly better than the rest; the control yielded the least on every count. Harvest index also improved modestly with splitting,

from 30.84% in the control to a maximum of 34.39% under T8, suggesting that frequent nitrogen application not only increased total biomass but also shifted a somewhat greater share of that biomass into the economic (cob) fraction. These trends corroborate earlier findings of yield gains from split nitrogen scheduling in sweet corn and maize (Harikrishna *et al.*, 2010; Amanullah *et al.*, 2009) ^[2, 6].

Table 4: Fresh cob yield, green fodder yield, biological yield and harvest index of sweet corn as influenced by split nitrogen application

Treat.	Fresh cob yield (kg ha ⁻¹)	Green fodder yield (kg ha ⁻¹)	Biological yield (kg ha ⁻¹)	Harvest index (%)
T1 - Control	7,235.6	16,223.1	23,458.7	30.84
T2	12,879.5	24,632.0	37,511.5	34.33
T3	18,832.2	35,974.4	54,806.6	34.36
T4	18,435.2	35,567.2	54,002.4	34.14
T5	20,823.2	39,891.6	60,714.8	34.30
T6	17,745.3	34,915.4	52,660.7	33.70
T7	17,389.2	34,770.7	52,159.9	33.34
T8	22,378.6	42,688.2	65,066.8	34.39
General mean	-	-	-	32.98

The improved biomass and yield under frequent splitting translated directly into better economics (Table 5). The highest gross monetary return (Rs. 2,32,041 ha⁻¹) and net monetary return (Rs. 1,33,898 ha⁻¹) were realized under T8, on par with T5, giving the most favourable benefit-cost ratio of 2.36 among all treatments compared with 1.88 for the untreated control. Even though the cost of cultivation rose slightly with additional split

applications, largely on account of extra labour for fertilizer application, the yield gains more than compensated for this added cost, making the four-split schedule the most remunerative option among those tested. Similar economic advantages of split nitrogen application in sweet corn have been reported by Abhishek *et al.*, (2020) ^[1] and Rani *et al.*, (2011) ^[11].

Table 5: Gross monetary returns, net monetary returns, cost of cultivation and benefit-cost ratio of sweet corn as influenced by split nitrogen application

Treat.	GMR (Rs. ha ⁻¹)	NMR (Rs. ha ⁻¹)	Cost of cultivation (Rs. ha ⁻¹)	B:C ratio
T1 - Control	81,077	37,973	43,104	1.88
T2	1,33,705	64,431	69,274	1.93
T3	1,95,396	1,00,796	94,600	2.07
T4	1,92,155	97,731	94,424	2.04
T5	2,16,339	1,20,435	95,904	2.26
T6	1,86,662	92,418	94,244	1.98
T7	1,84,306	90,521	93,785	1.97
T8	2,32,041	1,33,898	98,142	2.36
SEm±	8,165	4,591	-	-
CD at 5%	24,654	13,864	-	-
General mean	1,77,710	92,275	85,435	2.06

Post-harvest soil analysis showed a broadly similar pattern of nutrient depletion across treatments, with available nitrogen, phosphorus and potassium status declining somewhat more where crop uptake and yield were higher, indicating efficient utilisation of applied nitrogen by the higher-yielding split-application treatments rather than nutrient carry-over.

Conclusion

Among the different treatments, dividing nitrogen into four equal parts 25% as basal and 25% each at 30, 40 and 50 days after sowing gave the tallest, most leafy plants with the largest leaf area and dry matter accumulation, translated into the heaviest, longest cobs with the most grains, and produced the highest fresh cob yield, green fodder yield, biological yield and harvest index.

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