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Economic analysis of nitrogen split-application schedules in sweet corn (*Zea mays saccharata* L.)

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Abstract

A field experiment was conducted during *kharif* 2021 at the Agricultural Research Farm, Department of Agronomy, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.), to assess the economics of sweet corn (*Zea mays saccharata* L. cv. Sugar-75) grown under eight nitrogen split-application schedules. The treatments, replicated thrice in a Randomized Block Design, ranged from a single basal dose (control) to two-, three- and four-way splitting of the recommended nitrogen dose at 30, 40, 45 and 60 days after sowing (DAS). Applying the recommended nitrogen in four equal splits 25 percent as basal plus 25 percent each at 30, 40 and 50 DAS (T_4) required a marginally higher cultivation cost (₹98,142 ha^{-1}) than the other schedules but returned the highest gross monetary returns (₹2,32,041 ha^{-1}), the highest net monetary returns (₹1,33,898 ha^{-1}) and the best benefit cost ratio (2.36), remaining statistically at par with 25 percent basal plus 25 percent each at 30, 45 and 60 DAS (T_5 ; B:C 2.26). The unsplit control gave the lowest returns and the lowest benefit cost ratio (1.88). The results indicate that dividing the nitrogen dose into four smaller, need-based applications synchronised with crop demand is an economically superior practice for *kharif* sweet corn compared with single or coarser split applications.

Keywords: Sweet corn, nitrogen splitting, cost of cultivation, gross monetary returns, net monetary returns, benefit cost ratio

Introduction

Sweet corn (*Zea mays saccharata* L.) has become one of the more remunerative vegetable crops for growers within the maize family because it is harvested early, at the milky stage, and commands a steady demand from urban markets, hotels and the processing sector. Its short duration and comparatively high market price per unit of produce make it an attractive diversification option for farmers moving away from the traditional cotton-based cropping pattern of the Marathwada region. Because nitrogen is the input that most strongly drives vegetative growth, cob development and, ultimately, marketable yield in maize-type crops, it is also the input that most strongly drives the cost side of the farmer's ledger. A poorly timed or wholly basal dose of nitrogen is prone to volatilisation and leaching losses under the intense pre-monsoon and monsoon showers typical of a *kharif* season, so that a sizeable share of the applied fertiliser never reaches the crop and is, in effect, money spent without a corresponding returns.

Splitting the recommended dose of nitrogen and synchronising each split with a critical growth stage is a widely recommended agronomic remedy for this problem, and a large body of work has already documented the resulting gains in plant height, leaf area, dry-matter accumulation and cob yield. What ultimately decides whether a farmer adopts a given schedule, however, is not the biological response alone but whether the additional handling, labour and input cost of applying nitrogen in three or four smaller doses is repaid by a correspondingly larger increase in income. An agronomic recommendation that is not economically attractive is unlikely to be adopted on-farm. The present study was, therefore, undertaken with the specific objective of working out the cost of cultivation, gross and net monetary returns and the benefit cost ratio of sweet corn raised under eight nitrogen split-application schedules so as to identify the schedule that offers the best economic returns to the farmers.

Materials and Methods

The field experiment was conducted during *kharif* 2021 at the Agricultural Research Farm, Department of Agronomy, College of Agriculture, Vasantao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra. The experimental soil was deep black in colour, clayey in texture and slightly alkaline in reaction, with 181.7 kg ha⁻¹ available nitrogen, 17.8 kg ha⁻¹ available phosphorus and 497.9 kg ha⁻¹ available potassium, placing it in the low-nitrogen, low-phosphorus and high-potassium fertility class. Sweet corn cv. Sugar-75 was sown at a spacing of 60 cm × 20 cm in plots of 5.4 m × 4.5 m (gross) and 4.5 m × 4.2 m (net) size. Eight nitrogen-scheduling treatments were laid out in a Randomized Block Design with three replications (24 plots in all): T₁, an unsplit control receiving the recommended dose of nitrogen (RDN) as a single basal application; T₂, RDN in two equal splits (50 percent basal + 50 percent at 30 DAS); T₃, RDN in three equal splits (33 percent basal + 33 percent at 30 DAS + 33 percent at 60 DAS); T₄, RDN in three unequal splits (25 percent basal + 50 percent at 30 DAS + 25 percent at 60 DAS); T₅, RDN in four equal splits (25 percent basal + 25 percent each at 30, 45 and 60 DAS); T₆, RDN in three equal splits (33 percent basal + 33 percent each at 30 and 45 DAS); T₇, RDN in three unequal splits (25 percent basal + 50 percent at 30 DAS + 25 percent at 45 DAS); and T₈, RDN in four equal splits (25 percent basal + 25 percent each at 30, 40 and 50 DAS). Phosphorus and potassium were applied uniformly to all plots as a basal dose at sowing.

The cost of cultivation of each treatment was arrived at by summing the expenditure on field preparation, seed, fertilisers and their application, plant-protection measures, irrigation, inter-cultivation, harvesting and miscellaneous labour, valued at the wage and input rates prevailing during the experimental year. Gross monetary returns was computed by multiplying the marketable green-cob and fodder yield of each treatment by the prevailing farm-gate price of the produce and by-product. Net monetary returns was obtained by subtracting the treatment-wise cost of cultivation from its gross monetary returns, and the benefit cost ratio was calculated as the ratio of gross monetary returns to cost of cultivation. The yield and economic data were analysed statistically following the Analysis of Variance procedure of Panse and Sukhatme (1967) [5]; treatment means were compared using the critical difference at the 5 percent level of probability wherever the F-test was significant. Cost of cultivation and benefit cost ratio, being derived rather than directly measured variables, were interpreted on the basis of mean values without a separate test of significance.

Results and Discussion

Cost of cultivation

The cost of cultivation rose steadily as the number of nitrogen applications increased, reflecting the additional labour and application charges of splitting a given dose into more instalments. The unsplit control (T₁) was the cheapest treatment to raise, at ₹43,104 ha⁻¹, while the four-way split schedules were the costliest: T₈ (25:25:25:25 at basal, 30, 40 and 50 DAS) cost ₹98,142 ha⁻¹ and T₅ (25:25:25:25 at basal, 30, 45 and 60 DAS) cost ₹95,904 ha⁻¹, against a general mean of ₹85,435 ha⁻¹ across all eight treatments. The three-way split treatments (T₃, T₄, T₆ and T₇) occupied an intermediate position, costing between roughly ₹93,800 and

₹94,600 ha⁻¹. The gap in cultivation cost between the control and the most intensively split treatment amounted to only about ₹55,000 ha⁻¹, a modest increase set against the much larger differences in income described below.

Gross monetary returns

Gross monetary returns differed significantly among the nitrogen schedules and followed the same ranking as marketable yield. Treatment T₈ produced the highest gross returns of ₹2,32,041 ha⁻¹, significantly ahead of T₃, T₄, T₆, T₇ and T₂, and statistically on par with T₅ (₹2,16,339 ha⁻¹). The lowest gross returns, ₹81,077 ha⁻¹, was recorded in the unsplit control (T₁), well below the trial mean of ₹1,77,710 ha⁻¹. The clear advantage of the four-equal-split schedules over the coarser two- and three-way splits, and especially over the single basal dose, is consistent with the higher cob weight, cob length and biomass reported for the same treatments and mirrors the trend noted by Abhishek and Basavanneppa (2020) [1] and Kaur *et al.*, (2010) [3], who likewise recorded higher gross returns when nitrogen was applied in smaller, growth-stage-timed doses rather than as a single application.

Net monetary returns

Net monetary returns, which nets the cost of cultivation off the gross returns, again favoured the four-way split schedules. T₈ gave the highest net returns, ₹1,33,898 ha⁻¹, significantly higher than every other treatment except T₅ (₹1,20,435 ha⁻¹), with which it was statistically at par. The general mean net returns across treatments was ₹92,275 ha⁻¹, and the control (T₁) trailed the trial with a net returns of only ₹37,973 ha⁻¹ barely a third of what T₈ returned despite costing under half as much to raise. In other words, the extra ₹55,000 ha⁻¹ or so spent on splitting nitrogen into four applications rather than one was repaid several times over in extra income, a pattern also reported by Abhishek and Basavanneppa (2020) [1] and by Kaur *et al.*, (2010) [3] for split nitrogen scheduling in sweet corn and wheat, respectively.

Benefit cost ratio

The benefit cost ratio, being a relative measure of profitability per rupee invested, showed the same ordering as the absolute returns figures. The highest ratio, 2.36, was obtained with T₈, indicating that every rupee invested in cultivation returned ₹2.36 in gross income; this was closely followed by T₅ (2.26). The three-way split schedules (T₃, T₄, T₆ and T₇) returned benefit cost ratios between 1.97 and 2.07, while the two-way split (T₂) returned 1.93. The lowest ratio, 1.88, was recorded in the unsplit control (T₁), confirming that a single basal dose is the least efficient use of the nitrogen rupee among the schedules tested. The mean benefit cost ratio across all treatments was 2.06. These findings agree with the observations of Jeet *et al.*, (2012) [2] and Rani *et al.*, (2011) [7], who similarly found that dividing the nitrogen dose across the crop's active growth phases raised the benefit cost ratio of maize-type crops relative to a single basal application.

Taken together, the cost and returns figures show that the improvement in economic performance obtained by moving from a single basal dose to a four-way split of nitrogen, timed with the crop's demand at 30, 40 (or 45) and 50 (or 60) DAS, comfortably outweighs the modest additional cost of the extra applications. Among the two four-way

schedules tested, timing the later splits slightly earlier at 30, 40 and 50 DAS (T_8) rather than at 30, 45 and 60 DAS (T_5) gave a further, though statistically non-significant, edge in

profitability, suggesting that matching nitrogen supply more closely to the crop's peak uptake window is the more decisive factor rather than the number of splits alone.

Economics of sweet corn as influenced by nitrogen split-application schedules

Treatment	Nitrogen split-application schedule	Cost of cultivation (₹ ha^{-1})	GMR (₹ ha^{-1})	NMR (₹ ha^{-1})	B:C ratio
T_1	Control (no split — RDN applied as single basal dose)	43104	81077	37973	1.88
T_2	RDN in two equal splits: 50% basal + 50% at 30 DAS	69274	133705	64431	1.93
T_3	RDN in three equal splits: 33% basal + 33% at 30 DAS + 33% at 60 DAS	94600	195396	100796	2.07
T_4	RDN in three splits: 25% basal + 50% at 30 DAS + 25% at 60 DAS	94424	192155	97731	2.04
T_5	RDN in four equal splits: 25% basal + 25% at 30 DAS + 25% at 45 DAS + 25% at 60 DAS	95904	216339	120435	2.26
T_6	RDN in three equal splits: 33% basal + 33% at 30 DAS + 33% at 45 DAS	94244	186662	92418	1.98
T_7	RDN in three splits: 25% basal + 50% at 30 DAS + 25% at 45 DAS	93785	184306	90521	1.97
T_8	RDN in four equal splits: 25% basal + 25% at 30 DAS + 25% at 40 DAS + 25% at 50 DAS	98142	232041	133898	2.36
SEM $\pm$		—	8165	4591	—
C.D. at 5%		—	24654	13864	—
General mean		85435	177710	92275	2.06

GMR = Gross monetary returns; NMR = Net monetary returns; B:C ratio = Benefit cost ratio. Cost of cultivation and B:C ratio are based on mean values and were not subjected to a statistical test.

Conclusion

From the above findings, it may be concluded that cost of cultivation, gross monetary returns, net monetary returns and benefit cost ratio of *kharif* sweet corn cv. Sugar-75 were significantly influenced by nitrogen split-application schedules. Application of the recommended nitrogen dose in four equal splits (25% basal + 25% each at 30, 40 and 50 DAS) recorded the highest gross monetary returns, net monetary returns and benefit cost ratio (2.36), which was followed by the four-way equal splits in 25% basal plus 25% each at 30, 45 and 60 DAS (B:C 2.26).

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