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# Nitrogen management in baby corn (*Zea mays*)

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## ABSTRACT

A field experiment was conducted during the rainy season of 2002 and 2003 at Bhubaneshwar, Orissa to study the effect of nitrogen levels (40, 80 and 120 kg N/ha) and timing of nitrogen application [½ basal + ½ at 25 days after sowing (DAS), $^1/_3$ basal + $^2/_3$ at 25 DAS ½ basal + ¼ at 25 days + ¼ at pre-tasselling (40 DAS) and $^1/_3$ basal + $^1/_3$ at 25 DAS + 1/3 at pre-tasselling] along with no-nitrogen (control) on productivity and nitrogen-use efficiency of baby corn (*Zea mays* L.). Growth, yield attributes, baby corn yield, nitrogen content and uptake, protein content and yield, net return and benefit : cost ratio increased significantly up to 120 kg N/ha. The differences between 80 and 40 kg N/ha were also significant. Nitrogen application in 3 equal splits as $^1/_3$ basal + $^1/_3$ at 25 DAS + $^1/_3$ at pre-tasselling (40 DAS) resulted in significantly higher growth, yield attributes, marketable baby corn yield, green fodder yield with lowest discarded baby corn, maximizing net return, benefit : cost ratio, nitrogen content, uptake, protein content and yield than other schedules of N application. The apparent N recovery was the highest at 120 kg N/ha, whereas physiological and agronomic use efficiency progressively decreased with increasing nitrogen levels. Nitrogen applied in 3 equal splits resulted in the highest N recovery and agronomic use efficiency, while physiological efficiency of N was maximum when N was applied in 2 splits.

***Key words :*** Baby corn, N dose, N uptake, N-use efficiency, Productivity

Baby corn cultivation provides tremendous avenues for crop diversification, value addition and revenue generation as this new vegetable is becoming increasingly popular among progressive farmers around big cities. Maize is an exhaustive crop and requires high quantities of nitrogen during the periods of efficient utilization, particularly at 25 days after sowing and pre-tasselling (40 days after sowing) stages for higher productivity. The acidic rainfed upland soils of Orissa are generally low in organic matter, where application of N fertilizer is highly necessary to meet the N requirement of maize to achieve optimum productivity. At the same time, the recovery of applied nitrogen in rainfed maize is very less due to various losses and local crop-management practices. Optimization of applied N at critical growth stages coinciding with periods of efficient utilization are the modern approaches for improving the N-use efficiencies in rainy season maize (Luikhan *et al.*, 2003). Since baby corn is a new crop, not much is known regarding its nitrogen nutrition. Keeping this in view, the experiment was laid out to assess the nitrogen requirement and its best timing of application for higher yield.

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## MATERIALS AND METHODS

A field experiment was conducted in the sub-humid agro-climate of east and south-eastern coastal plain zone of Orissa at Central Research Station of Orissa University of Agriculture and Technology, Bhubaneshwar, during the wet season of 2002 and 2003. The experimental soil was sandy loam, acidic (pH 5.7), low in organic carbon (0.37%) and available N (235 kg/ha) and medium in available P (21.7 kg/ha) and K (203.7 kg/ha). Twelve treatment combinations comprising 3 N levels, viz. 40, 80 and 120 kg N/ha, and 4 schedules of nitrogen application, viz. $T_1$, ½ basal + ½ at 25 days after sowing; $T_2$, $^1/_3$ basal + $^2/_3$ at 25 days after sowing; $T_3$, ½ basal + ¼ at 25 days after sowing + ¼ at pre-taselling (40 days after sowing); $T_4$, $^1/_3$ basal + $^1/_3$ at 25 days after sowing + $^1/_3$ at pre-tasselling along with no-nitrogen (control) were tested in randomized block design with three replications.

Early composite maize 'Navjot' was sown on 16 June 2002 and 18 June 2003 at a spacing of 40 cm × 20 cm. A common basal dose of 26.2 kg P and 33.3 kg K/ha and N as per the treatments were applied. The tassels were pulled out on their emergence to prevent pollination. Baby corn

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was harvested just after emergence of white silk. The crop received 1145.6 and 1,253.8 mm rainfall during 2002 and 2003, respectively, and experienced moisture deficit for a period of 7 and 10 days coinciding with knee–high and pre-tasselling stages in 2002 and 2003, respectively. Biometric observations were recorded at harvest (60 days after sowing). Nitrogen content was determined and uptake was calculated by multiplying the content with the dry-matter yield of fodder and baby corn. Protein content in baby corn was estimated by multiplying the N content with 6.25. The efficiency parameters related to applied nitrogen usages in baby corn were calculated using stand procedures where F, fertilizer plot and C, control plot.

## RESULTS AND DISCUSSION

### *Nitrogen level*

Nitrogen levels significantly influenced the plant height, dry matter and leaf-area index of baby corn (Table 1). Application of 120 kg/ha resulted in tallest plant with maximum dry matter yield and leaf-area index, which were significantly higher than those at remaining N levels. A significant increase in marketable baby corns/plant, their fresh weight, length and girth were also recorded up to 120 kg N/ha. Application of 120 kg N/ha resulted in the highest baby corn yield, which was 28.6, 52.2 and 178.7% higher than that of 80, 40 kg N/ha and the no-nitrogen (control), respectively, with the corresponding decrease in discarded baby corn yield by 25.4, 38.6 and 73.3%. The green fodder yield followed similar trend as that of baby corn yield. This result confirms the finding of Sunder Singh (2001). Net return and benefit : cost ratio were the highest with 120 kg N/ha, which resulted in significant increase of 289.2, 69.8 and 39.1% in net return and 235.2, 57.7 and 34.1% in benefit : cost ratio compared to that of the no-nitrogen (control), and 40 and 80 kg N/ha respectively. The nitrogen content both in baby corn and green fodder increased significantly with increasing N levels, resulting in increase of 1.48, 1.72 and 2.59% in baby corn, and 0.66, 0.88 and 1.11% in green fodder than that of 40 and 80 kg N/ha and the no-nitrogen (control) respectively. Application of 120 kg N/ha resulted in significantly highest nitrogen uptake in baby corn resulting in increase of 684.6 and 233.3% in baby corn, and 697.9 and 211.7% in green fodder over that of 40 and 80 kg N/ha, respectively, due to increase in both N content and respective yields. The protein content and yield were also maximum at 120 kg N/ha, confirming the results of Lang *et al.* (1996) in corn and of Kar *et al.* (2006) in sweet corn that nitrogen in corn plants is associated with the metabolism of protein. Nitrogen-harvest index, the proportion of nitrogen diverted to baby corn, was not significant with increasing levels of nitrogen application. This trend seems to be due to fact that with increasing levels of nitrogen applications, N uptake increased in baby corn but it was more in green fodder than baby corn. However, the difference between control versus rest of the N effects for nitrogen-harvest

**Table 1.** Effect of nitrogen application on growth, yield and economics of baby corn (pooled over 2002 and 2003)

| Treatment | Plant height (cm) | Dry matter yield (kg/ha) | Leaf-area index | Baby corn length (cm) | Baby corn girth (cm) | Marketable baby corn yield (kg/ha) | Discarded baby corn yield (kg/ha) | Green fodder yield (kg/ha) | Gross returns (Rs/ha) | Net returns (Rs/ha) | Benefit : cost ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Nitrogen level (kg N/ha)* | | | | | | | | | | | |
| 40 | 85.3 | 1,720 | 0.52 | 5.6 | 3.3 | 979 | 220 | 1,659 | 54,014 | 42,636 | 3.74 |
| 80 | 133.5 | 3,335 | 0.58 | 6.4 | 3.6 | 1,159 | 181 | 2,078 | 63,906 | 52,088 | 4.40 |
| 120 | 168.6 | 7,510 | 0.67 | 8.9 | 4.0 | 1,491 | 135 | 3,300 | 84,694 | 72,438 | 5.90 |
| SEm± | 2.5 | 96.1 | 0.008 | 0.20 | 0.11 | 22 | 5 | 103 | | 1,165 | 0.09 |
| CD (P=0.05) | 7.4 | 280.5 | 0.024 | 0.58 | 0.33 | 65 | 15 | 301 | | 3,400 | 0.29 |
| *Timing of N application** | | | | | | | | | | | |
| $T_1$ | 113.1 | 3,222 | 0.56 | 5.9 | 3.2 | 1,115 | 189 | 1,949 | 61,228 | 49,535 | 4.21 |
| $T_2$ | 121.1 | 3,987 | 0.58 | 6.1 | 3.6 | 1,189 | 156 | 2,220 | 66,057 | 54,364 | 4.62 |
| $T_3$ | 134.4 | 4,427 | 0.59 | 6.6 | 3.4 | 1,219 | 172 | 2,400 | 68,512 | 56,569 | 4.71 |
| $T_4$ | 148.0 | 5,116 | 0.62 | 7.6 | 4.2 | 1,317 | 166 | 2,813 | 74,385 | 62,415 | 5.19 |
| SEm± | 2.1 | 111.0 | 0.009 | 0.23 | 0.13 | 26 | 6 | 119 | | 1,345 | 0.19 |
| CD (P=0.05) | 8.4 | 324.0 | 0.028 | 0.67 | 0.39 | 75 | 17 | 348 | | 1,927 | 0.31 |
| Control | 56.8 | 871 | 0.28 | 3.8 | 2.3 | 535 | 231 | 806 | 29,173 | 18,610 | 1.76 |
| Rest | 129.1 | 4,188 | 0.59 | 6.6 | 3.6 | 1,210 | 178 | 2,346 | 67,539 | 55,721 | 4.71 |
| SEd± | 5.2 | 200.1 | 0.017 | 0.42 | 0.24 | 46 | 101 | 215 | | 2,425 | 0.20 |
| CD (P=0.05) | 10.7 | 413.0 | 0.03 | 0.86 | 0.49 | 95 | 22 | 444 | | 5,006 | 0.42 |

*Treatment details are given in Materials & Methods index was found significant. Physiological efficiency and agronomic use efficiency of nitrogen by baby corn were also highest with 40 kg N/ha and progressively decreased with increasing levels of N application. This is because of low proportion of N was taken up and used by baby corn (20%) compared to that in succulent green fodder. So, a sizeable portion of N taken up by the crop largely utilized for green fodder production than that of the young unfertilized baby corn harvested 1–2 days after silking. However, the apparent N recovery increased with increasing levels of N up to 120 kg N/ha because a sizeable proportion of applied fertilizer N is not lost but largely taken up by the plant for both baby corn and green fodder production.

### *Timing of N application*

Application of N in 3 equal splits, viz. basal, 25days after sowing and pre-tasselling (40 days after sowing) stages, resulted in significantly tallest plants, maximum dry matter yield, leaf-area index, baby corns/plant, their fresh weight, length and girth compared to the other schedules of N application (Table 1). Nitrogen applied in 3 equal splits (1/3 basal + 1/3 at 25 days after sowing + 1/3 at pre-tasselling) recorded significantly highest baby corn yield and green fodder yield, resulting in 18.1, 10.7, 8.0%; and 44.3, 26.7 and 17.2% increase over the other N schedules of ½ basal + ½ at knee-high, 1/3 basal + 2/3 at 25 days after sowing, and ½ basal + ¼ at 25 days after sowing + ¼ at pre tasselling stages respectively. The discarded baby corn yield was maximum when nitrogen was applied in 2 splits. Net return and benefit : cost were also maximum with the application of N in 3 equal splits. Net return increased significantly by 26.0, 14.8 and 10.3% and benefit : cost ratio by 23.8, 13.0 and 10.6% compared to ½ basal + ½ at 25 days after sowing, 1/3 basal + 2/3 at 25 days after sowing and ½ basal + ¼ at 25 days after sowing + ¼ at pre tasselling schedules of N application respectively. Nitrogen applied in 3 equal splits significantly increased N content and uptake both in baby corn and green fodder respectively (Table 2). The protein content and protein yield also followed the similar trend as that of nitrogen content and uptake. However, the different schedules of N application could not influence the nitrogen harvest index in baby corn, as the nitrogen uptake was more in favour of green fodder due to shift in N absorption as young baby cobs were harvested 1-2 days after silking just before fertilization. The apparent N recovery and agronomic use efficiency were the highest, while the physiological efficiency of nitrogen was the lowest when N was applied in 3 equal splits at basal, 25 days after sowing and pre-tasselling stages compared to other schedules of N application during rainy season in baby corn.

### *Interaction effect*

The interaction effect (Table 3) between nitrogen level and timing of N application revealed that the dry-matter

**Table 2.** Effect of level and timing of N application on N content, uptake and use efficiency of applied N (pooled mean of 2002 and 2003)

| Treatment | Nitrogen content (%) | | Total nitrogen uptake (kg/ha) | Nitrogen harvest index (%) | Protein content in baby corn (%) | Protein yield (kg/ha) | Physiological efficiency (kg/kg N uptake) | Apparent N recovery (%) | Agronomic use efficiency (kg/kg N applied) |
|---|---|---|---|---|---|---|---|---|---|
| | Baby corn | Green fodder | | | | | | | |
| *Nitrogen level (kg N/ha)* | | | | | | | | | |
| 40 | 1.48 | 0.60 | 12.75 | 20.44 | 8.73 | 16.22 | 207.3 | 5.50 | 11.1 |
| 80 | 1.72 | 0.88 | 32.10 | 19.61 | 10.77 | 38.27 | 113.0 | 7.26 | 7.8 |
| 120 | 2.59 | 1.16 | 101.39 | 20.18 | 16.19 | 127.47 | 55.9 | 16.70 | 8.0 |
| SEm± | 0.04 | 0.05 | 3.36 | 1.27 | 0.24 | 1.75 | | | |
| CD (P=0.05) | 0.11 | 0.15 | 9.70 | NS | 0.72 | 5.25 | | | |
| *Timing of N application** | | | | | | | | | |
| $T_1$ | 1.70 | 0.75 | 28.85 | 21.07 | 10.60 | 36.06 | 138.7 | 6.00 | 7.5 |
| $T_2$ | 1.87 | 0.76 | 39.39 | 20.30 | 11.31 | 46.47 | 143.0 | 7.50 | 8.7 |
| $T_3$ | 2.00 | 0.95 | 52.21 | 19.26 | 12.37 | 65.20 | 123.4 | 10.47 | 9.1 |
| $T_4$ | 2.14 | 1.12 | 74.53 | 20.33 | 13.31 | 94.87 | 96.9 | 15.20 | 10.4 |
| SEm± | 0.04 | 0.06 | 3.83 | 1.47 | 0.28 | 2.07 | | | |
| CD (P=0.05) | 0.13 | 0.17 | 11.20 | NS | 0.83 | 6.06 | | | |
| Control | 0.78 | 0.36 | 3.35 | 11.97 | 4.85 | 2.51 | | | |
| Rest | 1.93 | 0.90 | 48.75 | 20.24 | 11.90 | 60.65 | | | |
| SEd± | 0.08 | 0.11 | 6.92 | 2.65 | 0.51 | 3.74 | | | |
| CD (P=0.05) | 1.17 | 0.22 | 14.28 | 5.47 | 1.05 | 7.72 | | | |

*Details are given in Materials and Methods

**Table 3.** Interaction effect of nitrogen levels and timing of its application on dry-matter yield, length, nitrogen content, uptake and protein content of baby corn (pooled data of 2002 and 2003)

| Timing of N application* | N level (kg N/ha) | | |
|---|---|---|---|
| | 40 | 80 | 120 |
| | | *Dry-matter yield (kg/ha)* | |
| $T_1$ | 1,577 | 2,152 | 5,937 |
| $T_2$ | 1,645 | 3,205 | 7,111 |
| $T_3$ | 1,767 | 3,476 | 8,035 |
| $T_4$ | 1,888 | 4,505 | 8,954 |
| SEm± | | 192 | |
| CD (P=0.05) | | 561 | |
| | | *N content in baby corn (%)* | |
| $T_1$ | 1.35 | 1.54 | 2.22 |
| $T_2$ | 1.54 | 1.63 | 2.45 |
| $T_3$ | 1.46 | 1.73 | 2.82 |
| $T_4$ | 1.55 | 1.99 | 2.88 |
| SEm± | | 0.08 | |
| CD (P=0.05) | | 0.23 | |
| | | *N uptake in baby corn (kg/ha)* | |
| $T_1$ | 2.09 | 4.70 | 10.52 |
| $T_2$ | 2.32 | 4.79 | 15.20 |
| $T_3$ | 2.48 | 6.30 | 22.52 |
| $T_4$ | 3.50 | 8.71 | 33.34 |
| SEm± | | 0.57 | |
| CD (P=0.05) | | 1.68 | |
| | | *N uptake in green fodder (kg/ha)* | |
| $T_1$ | 7.81 | 16.19 | 45.25 |
| $T_2$ | 7.80 | 22.21 | 65.85 |
| $T_3$ | 11.36 | 29.71 | 84.25 |
| $T_4$ | 13.65 | 35.79 | 128.62 |
| SEm± | | 6.35 | |
| CD (P=0.05) | | 18.52 | |
| | | *Protein content in baby corn (%)* | |
| $T_1$ | 8.29 | 9.65 | 13.88 |
| $T_2$ | 8.44 | 10.19 | 15.29 |
| $T_3$ | 8.69 | 10.83 | 17.60 |
| $T_4$ | 9.50 | 12.42 | 18.00 |
| SEm± | | 0.49 | |
| CD (P=0.05) | | 1.43 | |

*Treatment details given in material and methods

yield, length of baby corn, both N content and uptake, and protein content in baby corn were maximum with N levels of 120 kg N/ha applied in 3 equal splits ($^1/_3$ basal + $^1/_3$ at 25 days after sowing + $^1/_3$ at pre-tasselling) and were significantly higher than those of other N levels at same and different timings of N application except 120 kg N/ha applied at ½ basal + ¼ at 25 days after sowing + ¼ at pre-tasselling stages only for protein content in baby corn and remained statistically at par with each other.

It was concluded that baby corn should be fertilized with 120 kg N/ha in 3 equal splits at basal, 25 days after sowing and at pre-tasselling (40 days fter sowing) stages to obtain higher marketable yield and net return from baby corn in rainy season in east and south eastern coastal plain agro-climatic zone of Orissa.

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