**Original Research Article**

**Influence of Integrated Nutrient Management on Yield and Economic Returns of Baby Corn (*Zea mays* L.) under South Gujarat Conditions.**

**Abstract**

 A field experiment was conducted at Navsari Agricultural University during the summer seasons of 2022 and 2023 to assess the effect of Integrated Nutrient Management (INM) on growth, yield, quality, and economics of baby corn (*Zea mays* L.) under South Gujarat conditions. The study evaluated twelve treatment combinations involving three nitrogen levels (80, 100, and 120 kg N ha⁻¹), two organic sources (vermicompost and castor cake supplying 25 kg N ha⁻¹), and two liquid organic nutrient treatments (control and 1.5% Novel Organic Liquid Nutrients) using a factorial randomized block design. Results revealed that 120 kg N ha⁻¹ combined with castor cake and 1.5% Novel Organic Liquid Nutrients significantly improved cob yield, both with and without husk. Significant interaction effects confirmed the advantage of combined nutrient strategies. Economically, 120 kg N ha⁻¹ with vermicompost and either control or foliar liquid nutrients produced the highest net returns (₹171531 ha⁻¹) and benefit-cost ratios (0.78-0.79). The study concluded that integrating inorganic nitrogen with organic manures and foliar liquid nutrients enhances yield, profitability, and sustainability of baby corn cultivation under South Gujarat conditions.

**Key words:** Yield, Economics, Net return, Baby corn, INM, Nitrogen levels, Organic sources, Novel Organic Liquid Nutrients, Castor Cake, Vermicompost.

**Introduction:**

 Baby corn (*Zea mays* L.) is gaining popularity as a high-value vegetable crop due to its short growth duration, tender cobs, and multiple harvests. It is harvested at the immature stage, before fertilization, offering both edible young cobs and quality green fodder from its leftover stover. Baby corn is rich in essential nutrients like potassium, folates, and B-complex vitamins, while being low in fat and calories, making it suitable for health-conscious consumers. Its mild flavour and crisp texture make it ideal for salads, stir-fries, and processed food products. The crop’s early maturity allows quick market returns, enhancing its economic potential for farmers (Kumar and Kalloo, 1998; Verma *et al.,* 2013). Baby corn cultivation supports sustainable agriculture through efficient land use, short crop duration, and suitability for diversified cropping systems, contributing to both nutritional security and enhanced farm profitability. However, one of the major constraints limiting baby corn productivity is improper nutrient management. Excessive reliance on chemical fertilizers often results in declining soil health, reduced microbial activity, and long-term fertility issues (Choudhary *et al.,* 2013). Integrated Nutrient Management (INM), which involves the combined application of inorganic fertilizers with organic sources like farmyard manure, vermicompost, castor cake, and bio fertilizers, has been recognized as a sustainable approach to improve soil fertility, nutrient use efficiency, and crop productivity (Kumar *et al.,* 2020). The use of organics enhances soil physical properties, microbial populations, and enzymatic activities, leading to better nutrient availability and uptake. Integration of such practices not only reduces dependency on chemical inputs but also contributes to long-term soil health and environmental sustainability. While studies have demonstrated the potential of INM in various crops, region-specific recommendations for baby corn under South Gujarat’s unique agro-climatic conditions remain scarce. Addressing this gap, the present investigation was undertaken to assess the effect of different nitrogen levels, organic nutrient sources (vermicompost and castor cake), and Novel Organic Liquid Nutrient on yield attributes, productivity, and economic returns of baby corn (*Zea mays* L.). The study aims to develop a balanced and sustainable nutrient management strategy suitable for enhancing yield and profitability of baby corn, while maintaining soil health under South Gujarat conditions.

**Materials and methods**

 **Result and discussion**

The results indicated that cob yield per hectare, both with and without husk, was significantly affected by different nitrogen levels, organic treatments, and foliar applications of novel organic liquid nutrients, which is in line with earlier findings emphasizing the importance of integrated nutrient strategies for enhancing crop productivity and nutrient use efficiency (Kumar *et al.,* 2020; Patel *et al.,* 2022). Among the nitrogen levels, application of 120 kg N ha⁻¹ (N₃) consistently recorded the highest cob yields across both years and in pooled data, which agrees with previous reports highlighting the critical role of optimum nitrogen application in maximizing baby corn yield (Sharma *et al.,* 2014). Specifically, for cob yield with husk, treatment N₃ produced 14388.89 kg ha⁻¹ in 2022, 15138.89 kg ha⁻¹ in 2023, and 14763.89 kg ha⁻¹ in pooled analysis. Similarly, for cob yield without husk, N₃ achieved 2416.67 kg ha⁻¹, 2694.44 kg ha⁻¹, and 2555.56 kg ha⁻¹ in 2022, 2023, and pooled analysis, respectively.

Organic treatments also exerted a significant effect on cob yield. Application of 25 kg N ha⁻¹ through castor cake (O₂) recorded significantly higher yields in both years and in pooled analysis, Under O₂, cob yield with husk was 13462.96 kg ha⁻¹ in 2022, 14259.26 kg ha⁻¹ in 2023, and 13861.11 kg ha⁻¹ in pooled data. Cob yield without husk recorded 2240.74 kg ha⁻¹, 2462.96 kg ha⁻¹, and 2351.85 kg ha⁻¹ in 2022, 2023, and pooled data, respectively.

Furthermore, foliar application of novel nrganic niquid nutrients at 1.5% (L₂) significantly improved cob yield compared to control, by the findings of Meena *et al.* (2007), who reported that liquid organic formulations enhance nutrient absorption and crop yield. Under treatment L₂, cob yield with husk reached 13329.81 kg ha⁻¹ in 2022, 14056.05 kg ha⁻¹ in 2023, and 13692.93 kg ha⁻¹ in pooled data. For cob yield without husk, L₂ registered 2179.82 kg ha⁻¹, 2446.16 kg ha⁻¹, and 2312.99 kg ha⁻¹ across 2022, 2023, and pooled analysis, respectively. Overall, these results demonstrate the effectiveness of integrated nutrient management involving optimal nitrogen fertilization, organic manures, and liquid organic nutrients in enhancing cob yield and economic returns of baby corn under South Gujarat conditions.

**Interaction Effects**

 The interaction effects of nitrogen levels, organic sources, and Novel Organic Liquid Nutrients on baby corn cob yield (kg ha⁻¹) with husk were statistically significant in both 2022 and 2023, as well as in pooled analysis, as reflected in Tables 2 to 5, 7 to 10, and Figures 1 and 2. Application of 120 kg N ha⁻¹ combined with 25 kg nitrogen ha⁻¹ via castor cake (N₃O₂) consistently produced the highest cob yields with husk, recording 14646.65 kg ha⁻¹ in 2022, 15415.69 kg ha⁻¹ in 2023, and 15031.17 kg ha⁻¹ in pooled results.

 Significant differences were also observed in the interaction between nitrogen levels and Novel Organic Liquid Nutrients. Treatment with 120 kg N ha⁻¹ and control (N₃L₁) achieved the highest cob yield with husk during both years (14661.99 kg ha⁻¹ in 2022 and 15376.00 kg ha⁻¹ in 2023), with a pooled average of 15018.99 kg ha⁻¹.

 Similarly, the interaction between organic sources and Novel Organic Liquid Nutrients was significant. Application of 25 kg nitrogen ha⁻¹ through castor cake combined with 1.5% Novel Organic Liquid Nutrients (O₂L₂) resulted in higher yields with husk, reaching 14403.31 kg ha⁻¹ in 2022, 15037.29 kg ha⁻¹ in 2023, and 14720.30 kg ha⁻¹ in pooled analysis. Across nitrogen, organics, and Novel Organic Liquid Nutrients interactions, treatment N₃O₂L₂ (120 kg N ha⁻¹ + castor cake + Novel Organic Liquid Nutrients 1.5%) recorded the highest yields during 2023 and in pooled analysis, while N₃O₁L₁ achieved the highest in 2022. For cob yield without husk, significant interaction effects were also recorded. Application of 120 kg N ha⁻¹ with 25 kg nitrogen ha⁻¹ via castor cake (N₃O₂) resulted in higher yields: 2494.96 kg ha⁻¹ in 2022, 2718.45 kg ha⁻¹ in 2023, and 2606.70 kg ha⁻¹ in pooled data.

 Nitrogen combined with Novel Organic Liquid Nutrients showed similar trends. Treatment N₃L₂ (120 kg N ha⁻¹ + Novel Organic Liquid Nutrients 1.5%) recorded higher yields in 2022 (2439.23 kg ha⁻¹), while N₃L₁ (control) recorded higher yields during 2023 (2741.28 kg ha⁻¹) and in pooled results (2567.69 kg ha⁻¹), remaining statistically comparable to N₃L₂.

 Interaction of organic sources and Novel Organic Liquid Nutrients also showed significant results for yield without husk. Application of 25 kg nitrogen ha⁻¹ through castor cake with 1.5% Novel Organic Liquid Nutrients (O₂L₂) recorded higher yields: 2410.61 kg ha⁻¹ in 2022, 2630.87 kg ha⁻¹ in 2023, and 2520.74 kg ha⁻¹ in pooled analysis. Treatment N₃O₂L₂ consistently achieved the highest yields without husk, ranging from 2648.81 to 2872.89 kg ha⁻¹, with a pooled average of 2760.85 kg ha⁻¹. These findings confirm that higher nitrogen application combined with castor cake and 1.5% Novel Organic Liquid Nutrients significantly enhances baby corn cob yield, both with and without husk. This is consistent with previous research emphasizing integrated nutrient management for optimized crop productivity (Patel *et al.,* 2022 and Singh *et al.,* 2007)

**ECONOMICS**

 The economic analysis over two years identified the most profitable nutrient management strategies for baby corn, as presented in Table 11 and Figure 3. The highest net income of ₹171531 ha⁻¹ and benefit-cost ratios (BCR) of 0.78 and 0.79 were recorded with treatments N₃O₁L₁ (120 kg N ha⁻¹ + vermicompost + control) and N₃O₁L₂ (120 kg N ha⁻¹ + vermicompost + 1.5% Novel Organic Liquid Nutrients), making them the most economically viable options. A slightly lower yet profitable treatment, N₂O₁L₂ (100 kg N ha⁻¹ + vermicompost + 1.5% Novel Organic Liquid Nutrients), provided ₹135781 ha⁻¹ net income and 0.72 BCR. The integration of vermicompost with inorganic nitrogen improved soil health, nutrient efficiency, and crop yields, while Novel Organic Liquid Nutrients enhanced plant growth and profitability. These results align with findings of Nawaz *et al.* (2017) and Kadari *et al.* (2019), confirming the economic benefits of combined organic and inorganic nutrient use.

**Table 1: Effect of various nitrogen levels, organics and Novel Organic Liquid Nutrients on cob yield (kg ha-1)with husk of baby corn**

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| **Treatments** | **Cob yield (kg ha-1) with husk** |
| **2022** | **2023** | **Pooled** |
| **Nitrogen levels** |
| N1 - 80 kg N ha-1 | 11722.22 | 12583.33 | 12152.78 |
| N2 - 100 kg N ha-1 | 12277.78 | 13138.89 | 12708.33 |
| N3 - 120 kg N ha-1 | 14388.89 | 15138.89 | 14763.89 |
| S.Em. (±) | 191.92 | 169.94 | 131.43 |
| CD at 5 % | 562.88 | 498.43 | 374.59 |
| **Organics**  |
| O1 - 25 kg Nitrogen ha-1 through Vermicompost | 12129.63 | 12981.48 | 12555.55 |
| O2 - 25 kg Nitrogen ha-1 through Castor Cake | 13462.96 | 14259.26 | 13861.11 |
| S.Em. (±) | 156.70 | 138.76 | 107.31 |
| CD at 5 % | 459.59 | 406.96 | 305.85 |
| **Novel Organic Liquid Nutrients**  |
| L1 – Control | 12262.79 | 13184.69 | 12723.74 |
| L2 - Novel Organic Liquid Nutrients 1.5 % | 13329.81 | 14056.05 | 13692.93 |
| S.Em. (±) | 156.70 | 138.76 | 107.31 |
| CD at 5 % | 459.59 | 406.96 | 305.85 |
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**Table 2: Interaction effect of nitrogen levels and organics on cob yield (kg ha-1)with husk of baby corn**

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| **Levels of Nitrogen**  | **Cob yield (kg ha-1) with husk** |
| **Organics** |
| **2022** | **2023** | **Pooled** |
| **O1** | **O2** | **O1** | **O2** | **O1** | **O2** |
| **N1** | 10810.21 | 12634.23 | 11799.61 | 13367.05 | 11304.91 | 13000.64 |
| **N2** | 11447.55 | 13108.01 | 12282.75 | 13995.03 | 11865.15 | 13551.52 |
| **N3** | 14131.12 | 14646.65 | 14862.08 | 15415.69 | 14496.60 | 15031.17 |
| **S.Em. (±)** | 271.41 | 240.34 | 185.87 |
| **CD at 5 %** | 796.03 | 704.88 | 529.75 |
| **CV %** | 5.20 | 4.32 | 4.87 |

**Table 3: Interaction effect of nitrogen levels and Novel Organic Liquid Nutrients on cob yield (kg ha-1)with husk of baby corn**

|  |  |
| --- | --- |
| **Levels of Nitrogen** | **Cob yield (kg ha-1) with husk** |
| **Novel Organic Liquid Nutrients** |
| **2022** | **2023** | **Pooled** |
| **L1** | **L2** | **L1** | **L2** | **L1** | **L2** |
| **N1** | 10785.41 | 12659.04 | 11912.17 | 13254.49 | 11348.79 | 12956.76 |
| **N2** | 11340.96 | 13214.59 | 12265.89 | 14011.88 | 11803.43 | 13613.24 |
| **N3** | 14661.99 | 14115.79 | 15376.00 | 14901.77 | 15018.99 | 14508.78 |
| **S.Em. (±)** | 271.41 | 240.34 | 185.87 |
| **CD at 5 %** | 796.03 | 704.88 | 529.75 |
| **CV %** | 5.20 | 4.32 | 4.87 |

**Table 4: Interaction effect of organics and Novel Organic Liquid Nutrients on cob yield (kg ha-1)with husk of baby corn**

|  |  |
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| **Organics** | **Cob yield (kg ha-1) with husk** |
| **Novel Organic Liquid Nutrients** |
| **2022** | **2023** | **Pooled** |
| **L1** | **L2** | **L1** | **L2** | **L1** | **L2** |
| **O1** | 12002.95 | 12256.30 | 12888.16 | 13074.80 | 12445.56 | 12665.55 |
| **O2** | 12522.62 | 14403.31 | 13481.22 | 15037.29 | 13001.92 | 14720.30 |
| **S.Em. (±)** | 156.70 | 138.76 | 107.31 |
| **CD at 5 %** | 459.59 | 406.96 | 305.85 |
| **CV %** | 5.20 | 4.32 | 4.87 |

**Table 5.: Interaction effect of nitrogen, organics and Novel Organic Liquid Nutrients on cob yield (kg ha-1) with husk of baby corn**

|  |  |
| --- | --- |
| **Treatment combinations**  | **Cob yield (kg ha-1) with husk** |
| **2022** | **2023** | **Pooled** |
| N1O1L1 | 9826.6 | 11158.1 | 10492.3 |
| N1O1L2 | 11793.8 | 12441.2 | 12117.5 |
| N1O2L1 | 11744.2 | 12666.3 | 12205.2 |
| N1O2L2 | 13524.3 | 14067.8 | 13796.0 |
| N2O1L1 | 10755.6 | 11511.5 | 11133.5 |
| N2O1L2 | 12139.5 | 13054.0 | 12596.8 |
| N2O2L1 | 11926.4 | 13020.3 | 12473.3 |
| N2O2L2 | 14289.6 | 14969.8 | 14629.7 |
| N3O1L1 | 15426.7 | 15994.9 | 15710.8 |
| N3O1L2 | 12835.6 | 13729.3 | 13282.4 |
| N3O2L1 | 13897.3 | 14757.1 | 14327.2 |
| N3O2L2 | 15396.0 | 16074.3 | 15735.1 |
| S.Em.± (N X O X L) | 383.8 | 339.9 | 262.9 |
| CD at 5 % (N X O X L) | 1125.8 | 996.9 | 749.2 |
| CV % | 5.20 | 4.32 | 4.87 |

**Table 6: Effect of various nitrogen levels, organics and Novel Organic Liquid Nutrients on cob yield (kg ha-1) without husk of baby corn**

|  |  |
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| **Treatments** | **Cob yield (kg ha-1) without husk** |
| **2022** | **2023** | **Pooled** |
| **Nitrogen levels** |
| N1 - 80 kg N ha-1 | 1861.11 | 2111.11 | 1986.11 |
| N2 - 100 kg N ha-1 | 1972.22 | 2250.00 | 2111.11 |
| N3 - 120 kg N ha-1 | 2416.67 | 2694.44 | 2555.56 |
| S.Em. (±) | 36.83 | 41.18 | 28.61 |
| CD at 5 % | 108.03 | 120.78 | 81.55 |
| **Organics**  |
| O1 - 25 kg Nitrogen ha-1 through Vermicompost | 1925.93 | 2240.74 | 2083.33 |
| O2 - 25 kg Nitrogen ha-1 through Castor Cake | 2240.74 | 2462.96 | 2351.85 |
| S.Em. (±) | 30.07 | 33.62 | 23.36 |
| CD at 5 % | 88.20 | 98.62 | 66.59 |
| **Novel Organic Liquid Nutrients**  |
| L1 - Control | 1986.84 | 2257.54 | 2122.19 |
| L2 - Novel Organic Liquid Nutrients 1.5 % | 2179.82 | 2446.16 | 2312.99 |
| S.Em. (±) | 30.07 | 33.62 | 23.36 |
| CD at 5 % | 88.20 | 98.62 | 66.59 |
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**Table 7: Interaction effect of nitrogen levels and organics on cob yield (kg ha-1) without husk of baby corn**

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| **Levels of Nitrogen** | **Cob yield (kg ha-1) without husk** |
| **Organics** |
| **2022** | **2023** | **Pooled** |
| **O1** | **O2** | **O1** | **O2** | **O1** | **O2** |
| **N1** | 1664.15 | 2058.07 | 1941.93 | 2280.30 | 1803.04 | 2169.19 |
| **N2** | 1775.26 | 2169.19 | 2109.85 | 2390.15 | 1942.56 | 2279.67 |
| **N3** | 2338.37 | 2494.96 | 2670.44 | 2718.45 | 2504.41 | 2606.70 |
| **S.Em. (±)** | 52.09 | 58.24 | 1941.93 |
| **CD at 5 %** | 152.77 | 170.81 | 115.33 |
| **CV %** | 6.12 | 6.07 | 6.32 |

**Table 8: Interaction effect of nitrogen levels and Novel Organic Liquid Nutrients on cob yield (kg ha-1) without husk of baby corn**

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| --- | --- |
| **Nitrogen** | **Cob yield (kg ha-1) without husk** |
| **Novel Organic Liquid Nutrients** |
| **2022** | **2023** | **Pooled** |
| **L1** | **L2** | **L1** | **L2** | **L1** | **L2** |
| **N1** | 1838.55 | 1883.67 | 1903.89 | 2318.33 | 1871.22 | 2101.00 |
| **N2** | 1727.88 | 2216.56 | 2127.47 | 2372.53 | 1927.67 | 2294.55 |
| **N3** | 2394.10 | 2439.23 | 2741.28 | 2647.61 | 2567.69 | 2543.42 |
| **S.Em. (±)** | 52.09 | 58.24 | 40.46 |
| **CD at 5 %** | 152.77 | 170.81 | 115.33 |
| **CV %** | 6.12 | 6.07 | 6.32 |

**Table 9: Interaction effect of organics and Novel Organic Liquid Nutrients on cob yield (kg ha-1) without husk of baby corn**

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| **Organics** | **Cob yield (kg ha-1) without husk** |
| **Novel Organic Liquid Nutrients** |
| **2022** | **2023** | **Pooled** |
| **L1** | **L2** | **L1** | **L2** | **L1** | **L2** |
| **O1** | 1902.81 | 1949.04 | 2220.04 | 2261.44 | 2061.43 | 2105.24 |
| **O2** | 2070.87 | 2410.61 | 2295.05 | 2630.87 | 2182.96 | 2520.74 |
| **S.Em. (±)** | 42.53 | 47.55 | 33.04 |
| **CD at 5 %** | 124.74 | 139.47 | 94.17 |
| **CV %** | 6.12 | 6.07 | 6.32 |

**Table 10: Interaction effect of nitrogen, organics and Novel Organic Liquid Nutrients on cob yield (kg ha-1) without husk of baby corn**

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| --- | --- |
| **Treatment combinations**  | **Cob yield (kg ha-1) without husk** |
| **2022** | **2023** | **Pooled** |
| N1O1L1 | 1772.87 | 1729.75 | 1751.31 |
| N1O1L2 | 1555.42 | 2154.11 | 1854.76 |
| N1O2L1 | 1904.22 | 2078.04 | 1991.13 |
| N1O2L2 | 2211.93 | 2482.55 | 2347.24 |
| N2O1L1 | 1488.47 | 2011.82 | 1750.15 |
| N2O1L2 | 2062.04 | 2207.89 | 2134.97 |
| N2O2L1 | 1967.29 | 2243.11 | 2105.20 |
| N2O2L2 | 2371.09 | 2537.18 | 2454.13 |
| N3O1L1 | 2447.10 | 2918.55 | 2682.82 |
| N3O1L2 | 2229.65 | 2422.34 | 2325.99 |
| N3O2L1 | 2341.11 | 2564.00 | 2452.56 |
| N3O2L2 | 2648.81 | 2872.89 | 2760.85 |
| S.Em.± (N X O X L) | 73.67 | 82.36 | 57.23 |
| CD at 5 % (N X O X L) | 216.06 | 241.56 | 163.10 |
| CV % | 6.12 | 6.07 | 6.32 |

**Fig. 1: Interaction effect of nitrogen, organics and Novel Organic Liquid Nutrients on cob yield (kg ha-1) with husk during 2022, 2023 and pooled basis of baby corn**

**Fig. 2: Interaction effect of nitrogen, organics and Novel Organic Liquid Nutrients on cob yield (kg ha-1) without husk during 2022, 2023 and pooled basis of baby corn**

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**Fig. 3: Effect of various nitrogen levels, organics and Novel Organic Liquid Nutrients on economics of baby corn cultivation (₹ ha-1)**

**Summary and conclusions:**

 Integrated nutrient management combining 120 kg N ha⁻¹, 25 kg N ha⁻¹ through castor cake or vermicompost, and 1.5% Novel Organic Liquid Nutrients significantly improved baby corn cob yield with and without husk across both years and pooled data. Significant interaction effects confirmed the benefit of combined nutrient strategies. Economically, 120 kg N ha⁻¹ with vermicompost and either control or 1.5% Novel Organic Liquid Nutrients provided the highest net income (₹171531 ha⁻¹) and benefit cost ratios (0.78-0.79), making these treatments most suitable for profitable and sustainable baby corn production.

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