

Liquid Bioinoculant of Endophytic (*Azotobacter chroococcum*) Nitrogen Fixing Bacteria (NRRI-EndoN) for Vegetable Crops

Upendra Kumar, P. Panneerselvam, Laxmipriya Dash,
Sai Krishna Repalli, Rashmita Rani Rath

Nitrogen is lacking in most soils around the world, which affects crop production. In rice fields, more than half of the chemical nitrogen fertilizer is lost. This harms soil health and reduces crop yield and nitrogen use efficiency. Nitrogen-fixing microbes can be a good alternative to chemical fertilizers. One such microbe, *Azotobacter chroococcum* Avi2, is a native endophyte and is less affected by environmental conditions. It has been studied for use in rice crops. A formulation called NRRI-EndoN was developed from it, which can reduce nitrogen fertilizer use by about 25% and increase yield by about 10%. Its dosage has also been tested in vegetables like tomato, brinjal, chilli, okra and cauliflower to show its effectiveness. The product was verified according to Fertilizer Control Guidelines by a third-party laboratory in the SBC, Bhubaneswar. It can be stored for more than twelve months under normal conditions.

Technology Description

- The microbial strain used is *Azotobacter chroococcum* Avi2, preserved at NCMR (Pune, India) under accession MCC 3432, with NCBI accession number KP099933.
- The liquid formulation contains several components: an osmo-protectant or preservative (2–5%), adhesive (4%), disinfectant (0.7–0.8%), lubricator (1.5%), and inoculum (2–5%) prepared in nitrogen-free medium.
- The product remains effective for up to 12 months when stored under normal ambient conditions.
- It is recommended for crops such as tomato, brinjal, chilli, okra and cauliflower, with an application rate of 250 ml per hectare (Fig. 1).
- The application method involves dipping the roots of seedlings for 2–3 hours prior to transplanting.
- This technology is primarily suited for agro-ecological regions of Eastern India, particularly Odisha.
- Its effectiveness has been tested and confirmed at 30 different sites across 10 districts in Odisha.
- The product has been commercialized through ATIC and is also documented by AgrInovate, India.

Salient Features

- Used as a root dip treatment for seedlings.
- Can save about 25% nitrogen without reducing vegetable yield.
- Improves seedling vigor and promotes plant growth.
- Enhances photosynthesis efficiency in plants.
- Maintains yield with the recommended fertilizer dose.
- Reduces harmful effects of chemical nitrogen fertilizers on soil, animals, and human health.
- Could be applied as seed treatment.



Fig. 1. Effect of endophytic N-fixing liquid bioinoculant for vegetables.

Technology Validation

- The liquid bioinoculant technology was validated in farmers' fields in different districts of Odisha.
- It was evaluated in 30 locations across 10 districts of Odisha for two consecutive seasons (Table 1 and Fig. 2).
- An impact study was done on 25 beneficiary and 25 non-beneficiary farmers. Two doses (250 ml/acre and 500 ml/acre) of NRRRI Endo N were used on different vegetables. The results showed that the 250 ml/acre dose gave the best growth.

Impacts of Technology

- Could save approximately 25% of N without compromising the vegetable yield.
- The developed liquid bioinoculant technology has been widely spread through awareness and hands-on training cum demonstration programme in 10 districts of Odisha, and feedback was collected from the farmers (Fig. 3 & 4).
- Increases the seedling vigor and plant-growth promotion in tested vegetables.
- Endophytic liquid bioinoculant technology has been promoted through entrepreneurial developmental programs and a series of lecture courses conducted by Agribusiness Incubation Centre, ICAR-CRRI, Cuttack.



Fig. 2. Farmers field validation of endophytic nitrogen-fixing liquid bioinoculant for vegetables at Puri and Cuttack, Odisha, during 2024-25.

Table 1 Farmer's Field validation details at different districts of Odisha.

Formulation Name	Target Vegetables	Number of Locations	Increase in Yield (over farmer practice)	Benefits (Saving N-fertilizer)
<i>Azotobacter chroococcum</i> Avi2 (Endophytic bacteria)	Tomato (Pusa)	9	5-10%	~ 25%
	Brinjal (Akhita)	5	5-10%	~ 25%
	Chilly (Arka)	7	5-10%	~ 25%
	Okra (Shubhadra)	5	5-10%	~ 25%
	Cauliflower (Barkha)	4	5-10%	~ 25%



Fig. 3 Farmer's awareness cum demonstration programme on endophytic nitrogen fixing liquid bioinoculant for rice at Puri and Cuttack districts, Odisha, during 2025-26.

Monetary benefits

Results of on farm validation showed that by application of NRRI-EndoN, yield advantage of 5-10% achieved besides saving of about 25% nitrogen which could lead to a monetary benefit of Rs. 5000 to 8000/- per hectare in tomato, brinjal, chilli, okra and cauliflower.

Other Benefits

- NRRI-EndoN fixes about 15–20 kg nitrogen per hectare per year.
- Produces plant growth hormones like auxin, cytokinin, and gibberellin.
- Improves seed germination and speeds up crop growth.
- Helps control harmful plant bacteria.
- Increases nutrient availability and improves soil fertility.

Precautions

- Do not mix bioinoculants with chemical insecticides, fungicides, herbicides, or fertilizers.
- Wear protective gear (goggles, mask, gloves etc).
- Keep the product out of reach of children.
- Avoid breathing in or touching the product during mixing.
- Do not eat, drink, or smoke while mixing.
- If it gets in your eyes, rinse with water for 20 minutes.
- Wash hands with soap and water after use.



Fig. 4 Feedback moments from benefitted farmers at Puri and Cuttack, Odisha.

Economics of Technology

NRRI-EndoN may enter inside the vegetable crops like tomato, brinjal, chilli, okra, and cauliflower and fix atmospheric nitrogen and provide nitrogen to the plants. Only about 250 ml is needed for one hectare of land, and it costs around ₹100. This small amount can help add about 15–20 kg of nitrogen per hectare, which improves soil fertility and reduces the need for chemical fertilizers.

Entrepreneurial opportunities

The total yearly operational expenses to produce 50,000 litres of NRRI--EndoN in a 5000 square feet area is Rs. 31.75 lakhs. If the product is sold at Rs. 200 per liter, it can generate a net profit of about Rs. 68.25 lakhs per year (excluding capital investment). This shows that large-scale production of liquid bioinoculants is profitable, with a benefit-cost ratio of 2.15 (Table 2).

Table 2. Cost analysis of mass production and upscaling of liquid bioinoculant technology

Sl. No.	Particulars	Amount (Rs. in lakhs)
A.	Capital Investment	
i.	Building including cost of site (App. 5000 sq. ft.)	36.00
ii.	Equipment and apparatus	125.00
	Total Capital Investment	161.00
B.	Operational cost (variable cost)	
i.	Working capital (Raw materials)	15.00
ii.	Staff salary and labour	13.00
iii.	Electricity	1.00
iv.	Travelling expenses	2.00
v.	Administrative expenses	0.50
vi.	Miscellaneous expenses	0.25
vii.	Total operational cost	31.75
viii.	Total investment	192.75
A	Liquid biofertilizer productions= 50,000 L/annum @ Rs. 200/L	100.00
B	Net profit (Excluding capital investment)	68.25
C	Benefit-Cost Ratio	2.15

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