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EFFECT OF BIO-ENHANCERS AND BIO-FERTILIZERS ON THE ECONOMIC PARAMETERS OF DIFFERENT TREATMENTS OF AONLA (*EMBLICA OFFICINALIS* GAERTN.) CV. NA-7

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ABSTRACT

The present investigation, entitled "Influence of bio-enhancers and bio-fertilizers on economic parameters of different treatments of aonla (*Emblica officinalis* Gaertn.)" cv. NA-7 was carried out over two consecutive years *i.e.*, 2023 and 2024. The experiment was carried out at the Kalyanpur Nursery, Department of Fruit Science, Chandra Shekhar Azad University of Agricultural and Technology, Kanpur, on 22-year-old aonla trees of the cultivar NA-7. A total of ten treatment combinations were evaluated in randomized block design with three replications involving the application of *Azotobacter*, PSB, Amritpani, Jivaamrit and Panchagavya. Significant improvements were observed across all economic traits in the integrated treatments, with T_9- *Azotobacter* (50 g/tree) + PSB (50 g/tree) + Amritpani (10%) + Panchagavya (5%) which is consistently outperforming over the others. Specifically, in economics traits, T_9 recorded the highest cost of cultivation (` 51650.00 $ha^{-1}$), yield (16.48 tonne/ha), gross return (` 164800.00 ha^{-1}), net return (` 113105.00 ha^{-1}) and B: C ratio (2.19) under plains of northern India.

Key words : Bio-enhancers, *Azotobacter*, Vermicompost, Cost of cultivation, Net return and B: C Ratio.

Introduction

Aonla (*Emblica officinalis* Gaertn.) is an important subtropical fruit crop of commercial significance that belongs to the family Euphorbiaceae. Prefers a dry subtropical climate and can successfully be cultivated in a wide range of soil and climatic conditions. Owing to better prospects of aonla in semi-arid regions due to the hardy nature of plants, high medicinal and nutritional values, there is a possibility that it will be one of the most important fruit of the future.

Fruits are commonly used for making preserves (Murabba), pickles, candy, jelly, sauce, and dried chips, among other products. In terms of nutritional values, it is a rich source of vitamin C (500-750 mg/100g), surpassing that of guava and citrus fruits, and also contains phenol, polyphenol, tannins, and alkaloids.(Tiwari *et al*, 2017)

These micro-organisms enhance soil fertility by fixing atmospheric nitrogen, solubilizing insoluble phosphates and producing growth-promoting substances, thereby improving nutrient availability and plant growth. Bioenhancers, on the other hand, are organic formulations derived from natural sources such as cow dung, cow urine and plant extracts. Examples include Panchagavya and Jeevamrit, which are known to enhance soil microbial activity, improve plant immunity and promote overall plant health (Sonkar and Tripathi, 2025).

Nitrogen-fixing bacteria and phosphate-solubilizing bacteria are the main bio-fertilizers for horticultural crops. These micro-organisms are either free-living in the soil or symbiotic with plants and contribute directly or indirectly towards nitrogen and phosphorus nutrition of the plant. They also produce hormones, vitamins and other growth factors required for the growth and development of plants. Mulching protects fruits from soil contact, reduces the number of dirty fruits, prevents the occurrence of fruit rot, reduces the weed population, and improves the physico-chemical properties of the soil. Both

organic and inorganic mulches are used in aonla cultivation, but polythene mulch increases both minimum and maximum temperatures and thus increases soil moisture during summer and autumn (Tripathi *et al*, 2017).

Application of bio-fertilizers and bio-enhancers has been shown to enhance the quality of aonla, including their size and nutritional content, which can fetch higher prices in the market.

Materials and Methods

The present experiment was conducted at the Kalyanpur Nursery, Department of Fruit Science, Chandra Shekhar Azad University of Agricultural and Technology, Kanpur, on a 22-year-old aonla cv. NA-7 during two consecutive years *i.e.,* 2023 and 2024. The Kanpur district is located at an elevation of 135 meters above sea level and situated in a subtropical zone with coordinates between 25.26° and 26.58° North latitude and 79.31° and 80.34° Eastern longitude. A total of ten treatment combinations were evaluated using a randomized block design with three replications involving the application of *Azotobacter* PSB, Amritpani, Jeevamrit, and Panchagavya [T_1- Control (Untreated plant), T_2- Panchagavya (5%) + *Azotobacter* (50 g/ tree.), T_3- Panchagavya (5%) + PSB (50 g/tree), T_4- *Azotobacter* (50 g/tree) + Amritpani (10%), T_5- PSB (50 g/tree) + Amritpani (10%), T_6- *Azotobacter* (50 g/tree) + Jivamrit (20%), T_7- PSB (50 g/tree) + Jivamrit (20%), T_8- Panchagavya (5%) + *Azotobacter* (50 g/tree) + PSB (50 g/tree), T_9- *Azotobacter* (50 g/tree) + PSB (50 g/ tree +Amritpani (10%) + Panchagavya (5%), T_{10}- *Azotobacter* (50 g/tree) + PSB (50 g/tree) + Jivamrit (20%)].

Application schedule

Bio-enhancers and bio-fertilizers were applied according to the specific treatment requirements. Foliar application of panchagavya was performed on the plant canopy, and drenching of jivamrit and amritpani on the basal area of the plant was done before flowering, at fruit set (pea stage) and growth stage. To ensure thorough foliar coverage, a 10-litre solution was administered using a pneumatic foot sprayer with a nozzle, targeting the entire foliage between 8:00 am and 10:00 am. A high-legged stool was used to facilitate the complete drenching of the plants, including their upper portions. Paddy straw was spread as a mulch material around the root zone to prevent the spread of excess spray. Biofertilizers are applied according to specific treatment requirements, mixed with farmyard manure (FYM) and incorporated into the soil.

Observation recorded

Cost of cultivation : The prices of all inputs prevailing at the time of their use, the labour cost was considered to work out the cost of cultivation and expressed as rupees per hectare (ha^{-1}).

Yield (tonne/ha) : To calculate the yield per hectare, the yield per tree (kg) was multiplied by the total number of trees per hectare. The result was then divided by 1000 and represented as t/ha.

Selling Price (` /t) : The selling price was calculated by using this formula

Selling price = Cost price + Profit

Gross Return (` /ha) : The gross income per acre was worked out based on the prevailing market price of aonla.

Net Return (` /ha) : The net income per hectare was calculated for each treatment by subtracting the cost of production from the gross income recorded in each treatment.

Net Return (` /ha) = Gross return – Total fixed cost

B: C Ratio : The following method was used to compute the benefit: cost ratio for each treatment, which is stated as a ratio based on the market price of the produce in the local market and the input expenses for cultivation. Benefit: Cost ratio was worked out as follows-

$$\text{Benefit Cost ratio} = \frac{\text{Gross income (Rs./ha)}}{\text{Cost of cultivation (Rs./ha)}}$$

Statistical analysis

The data obtained were statistically analyzed in Randomised Block Design (RBD). The significance of treatment effects was tested using F-test and critical differences (CD) at a 5% probability level were calculated for comparison among treatment means. The experimental data were analysed statistically with the

Table 1 : Method for preparation of nutrient solution.

S. no.	Materials used	Concentrations	Weight of bio-enhancer/bio-fertilizers(per liter of water)
1	Panchgavya	5.0%	30 ml
2	Jivamrit	20.0 %	200 ml
3	Amritpani	10.0 %	200 ml
4	*Azotobacter*	50 g/tree	5 g
5	PSB culture	50 g/tree	5 g

Note : Vermicompost @1 kg/tree/year with organic mulching of paddy straw is used in all treatments.

analysis of variance method given by Panse and Sukhatme (1985).

Results and Discussion

The effects of bio-enhancers and bio-fertilizers significantly influenced the cost of cultivation, yield (tonne/ha), selling price (` /t), gross return (` /ha), net return (` /ha), and B: C ratio over both seasons. The application of *Azotobacter* at 50 g/tree + PSB at 50 g/tree + Amritpani at 10% and Panchagavya at 5% (T_9) consistently outperformed others across all traits.

Cost of cultivation and Fruit yield (tonne/ha) : The perusal of data related to cost of cultivation and fruit yield (Table 2) revealed that the highest cost of cultivation (` 51650.00 ha^{-1}) and fruit yield (16.48 t/ha) was recorded in aonla plants treated with the application of T_9-*Azotobacter* (50 g/tree) + PSB (50 g/tree) + Amritpani (10%) + Panchagavya (5%) followed by the application of T_{10}-*Azotobacter* (50 g/tree) + PSB (50 g/tree) + Jivaamrit (20%) with the value for cost of cultivation ` 51350.00 $ha^{-1}$ and for fruit yield (15.50 t/ha), whereas, the minimum cost of cultivation (` 47655.00 ha^{-1}) and fruit yield (9.21 t/ha) was recorded with the T_1-control (Untreated plant). Additionally, organic treatments may have a slightly higher initial cost, but they reduce dependency on expensive synthetic fertilizers and the need for costly soil amendments in the long run. The results indicate that the bio-enhancers and bio-fertilisers significantly influenced the number of fruits per plant compared to the control. This might be because of the expansion in the number of leaves, which worked as an effective photosynthesis structure and produced a high quantity of carbohydrates in the plant system. Furthermore, the number of blossoms, which resulted in increased fruits per plant due to the vermicompost capacity to produce growth hormones, enzymes, antifungal, and antibacterial compounds, ultimately enhanced the attractive yield compared to other

Table 2 : Influence of bio-enhancers and bio-fertilizers on yield and economic parameters.

Symbols used	Treatments	Cost of cultivation (Rs /ha)	Yield (t/ha)			Selling Price (`/t)	Gross return (`/ha)	Net return (`/ha)	B: C Ratio
			2023	2024	Pooled				
T_1	Control (Untreated plant)	47655.00	8.93	9.49	9.21	10,000.00	92100.00	44445.00	0.93
T_2	Panchagavya (5%) + *Azotobacter* (50g/tree)	49050.00	10.29	11.11	10.69	10,000.00	106900.00	57850.00	1.17
T_3	Panchagavya (5%) + PSB (50g/tree)	48770.00	9.97	10.46	10.21	10,000.00	102100.00	53330.00	1.09
T_4	*Azotobacter* (50g/tree) + Amritpani (10%)	49950.00	11.87	12.28	12.07	10000.00	120700.00	70750.00	1.41
T_5	PSB (50g/tree) + Amritpani (10%)	49480.00	10.75	11.18	10.96	10000.00	109600.00	60120.00	1.21
T_6	*Azotobacter* (50g/tree) + Jivaamrit (20%)	50650.00	13.31	13.92	13.61	10000.00	136100.00	85450.00	1.68
T_7	PSB (50g/tree) + Jivaamrit (20%)	50250.00	12.53	13.04	12.78	10000.00	127800.00	77550.00	1.54
T_8	Panchagavya (5%) + *Azotobacter* (50g/tree) + PSB (50g/tree)	51070.00	14.31	14.99	14.64	10000.00	146400.00	95330.00	1.86
T_9	*Azotobacter* (50g/tree) + PSB (50g/tree)+ Amritpani (10%) + Panchagavya (5%)	51650.00	15.98	16.99	16.48	10000.00	164800.00	113105.00	2.19
T_{10}	*Azotobacter* (50g/tree) + PSB (50g/tree) + Jivaamrit(20%)	51350.00	15.22	15.73	15.50	10000.00	155000.00	103650.00	2.01

Note: Vermicompost @1 kg/tree/year with organic mulching of paddy straw is used in all treatments.

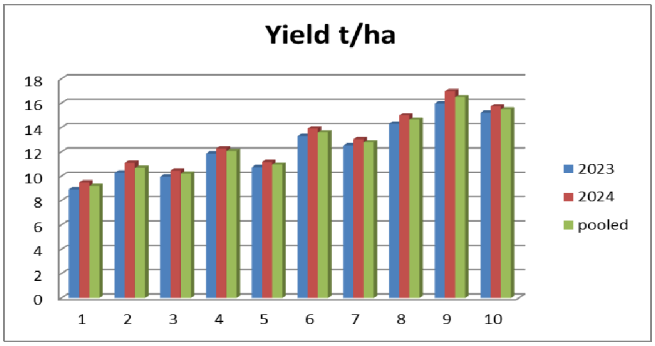

Fig. 1 : Influence of bio-enhancers and bio-fertilizers on yield.

treatments. Similar observations in accordance with the present finding have been reported by Awasthi *et al*. (2009), who observed that the highest cost of cultivation and fruit yield in aonla, Anushi and Tripathi (2024) in strawberry, Bhadauria and Tripathi (2023) in mango, Dubey *et al.* (2015) in aonla, Tripathi *et al*. (2017) and Tripathi *et al.* (2010) observed that the maximum fruit yield in strawberry.

Gross Return (` /ha), net return (` /ha) and B: C ratio : The data in Table 2, related to gross return, net return and B: C ratio, revealed that the highest gross return (` 164800.00 $ha^{-1}$), net return (` 113105.00 ha^{-1}) and B: C ratio (2.19) was recorded with the application of T_9-*Azotobacter* (50 g/tree) + PSB (50 g/tree) + Amritpani (10%) + Panchagavya (5%) followed by the application of T_{10}-*Azotobacter* (50 g/tree) + PSB (50 g/tree) + Jivaamrit (20%) with the value for gross return ` 155000.00 $ha^{-1}$, for net return ` 103650.00 ha^{-1} and for B: C ratio 2.01 was recorded in Aonla plants. However, the minimum gross return (` 92100.00), net return (` 44445.00) and B: C ratio (0.93) were recorded in the T_1-control (Untreated plant). Additionally, Organic aonla fetches premium prices in the market, as consumers prefer chemical-free, eco-friendly products. The lesser net return is due to the reason that returns from the plantings start from the second year onwards, so this will increase in the coming years. These outcomes are consistent with the findings of Singh *et al.* (2022) recored tha the highest gross return, net return and B: C ratio in aonla, Awasthi *et al*. (2009) also observed the maximum gross return, net return and B: C ratio in aonla, Pratap *et al*. (2024), who got highest gross return, net return and B: C ratio in dragon fruit, Chouhan and Tripathi (2025) also found highest gross return, net return and B: C ratio in guava and Mehta *et al.* (2024) recorded highest gross return and B: C ratio in dragon fruit.

Conclusion

The effectiveness of bio-enhancers and biofertilisers on aonla crop economics was significant. Plants treated with the combined application of *Azotobacter* (50 g/tree) + PSB (50 g/tree) + Amritpani (10%) + Panchagavya (5%) gave the highest yield 16.48 t/ha, net return of ` 113105.00 ha^{-1} and Benefit: cost ratio (2.19) that is economical, highly profitable and remunerative of aonla fruits under plains of northern India.

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