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Evaluation of Economic Feasibility for Aonla Production with the Aid of Integrated Nutrient Management

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Abstract

A field experiment was conducted during the year 2018-19 and 2019-2020 to evaluate the effect of integrated nutrient management on economic return for aonla production. The experiment was statistically laid out in Randomized Block Design with 13 treatments which were replicated three times. The treatments vizT1:100% RDF (1:0.5:1+ 10kg per plant),T2:75% RDF+10kgVermicompost,T3:75 % RDF+10kg Vermicompost+ 250g Azotobacter+ 250gPSB, T4 :75 % RDF+20kg Vermicompost,T5:75% RDF + 20kg Vermicompost + 250g Azotobacter +250g PSB,T6:75% RDF + 30kg Vermicompost, T7: 75% RDF + 30 kg Vermicompost+ 250g Azotobacter+250g PSB,T8 :50%RDF + 10kg Vermicompost,T9 : 50 % RDF + 10kg Vermicompost+ 250g Azotobacter+ 250 g PSB,T10:50 % RDF + 20kg Vermicompost,T1:50 % RDF + 20kg Vermicompost+ 250g Azotobacter+ 250g PSB,T12 :50% RDF + 30kg Vermicompost, T13:.50% RDF+ 30 kg Vermicompost+250g Azotobacter+ 250g PSB. The soil application of different organic manure and inorganic fertilizer were found significantly superior for better quality yield which could be a cause of maximum economic return. The maximum yield attributing characters were noted under the treatment T7: 75% RDF + 30 kg Vermicompost+ 250g Azotobacter+250g PSB. Maximum yield gives maximum return and maximum economic return was noted under the same treatment T7. The treatment T1 which comprises 100 % RDF (1:0.5:1: N: P: K + 10kg FYM plant -1) resulted in the lowest yield which was the cause of minimum economic return during both the year of experimentation i.e. 2018-19 and 2019-20.

Keywords: *Vermicompost, Azotobactor, INM, Yield, PSB*

Introduction

Aonla or Indian gooseberry (*Emblica officinalis* Gaertn. Syn. *Phyllanthusemblica*) is one of the important indigenous fruits of the Indian subcontinent, known for its medicinal and therapeutic properties and considered a wonder fruit for the health-conscious population. It has been grown and known in India for last more than 3500 years. It finds a special mention in the ancient Indian text 'Ayurveda' by Sushruta, the father of ancient medicine during 1500 BC-1300 BC. India ranks first in the production of aonla. It occupies an area of 94 thousand hectares with a production of 1098 thousand metric tons **[1]**. In Uttar Pradesh, Aonla cultivation is maximum in nearby belts of the Pratapgarh and Ayodhya districts. The area under the production of Aonla is 15.75 ('000Ha), production is 63.00 ('000MT) and productivity is about 4.0 (MT/Ha). Aonla is one of the most nutritious fruits and the second richest source of vitamin c after Barbados cherry. It is also a fair source of carotene, thiamine, riboflavin, and carbohydrate and minerals like iron, phosphorus, calcium, and magnesium. It is used for Ayurvedic medicine or processed into a quality edible product. Soil type, fertility, and nutrient management play an important role in obtaining higher growth and yields of aonla. Fruit productivity and quality

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can be maintained in subsequent generations by the integrated nutrient management system and contribute to the share in input cost of production [8]. Integrated nutrient supply/management (INM) aims at the maintenance or adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through the optimization of benefits from all possible sources of plant nutrients in an integrated manner [7] is the best approach for sustainable crop production.

Method and Material

The investigation carried out at the main experiment station Horticulture, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during the year 2018-19 and 2019-20 on 28year old plants of aonla uniformly healthy and well-maintained square system of an orchard with 39 number of plants. The experiment was laid out in Randomized Block Design with 13 treatments *viz* $T_{1:}$100 % RDF (1:0.5:1: N: P: K + 10kg FYM plant^{-1}),$T_{2:}$ 75 % RDF+10kgVermicompost,$T_{3:}$75 % RDF+10kg Vermicompost+ 250g Azotobacter+ 250gPSB, T_4 :75 % RDF+20kg Vermicompost,$T_{5:}$75% RDF + 20kg Vermicompost + 250g Azotobacter +250g PSB,$T_{6:}$75% RDF + 30kg Vermicompost ,$T_{7:}$ 75% RDF + 30 kg Vermicompost+ 250g Azotobacter+250g PSB,T_8 :50%RDF + 10kg Vermicompost,T_9 : 50 % RDF + 10kg Vermicompost+ 250g Azotobacter+ 250 g PSB,T_{10} :50 % RDF + 20kg Vermicompost,T_{11} :50 % RDF + 20kg Vermicompost+ 250g Azotobacter+ 250g PSB,T_{12} :50% RDF + 30kg Vermicompost, T_{13}: 50% RDF+ 30 kg Vermicompost+250g Azotobacter+ 250g PSB. All the treatments were replicated three times. The experiment was conducted to evaluate the different yield attributing characteristics like fruit weight, fruit size, fruit volume, pulp: stone ratio, fruit yield, and economics *viz* total cost, gross return, the net return, and benefit: cost ratio. Geographically the experimental site lies between the course of the Gomti and Saryu rivers (Gangetic alluvium) and lies between a latitude of 81.12° and 83.89° at an elevation of 113.0 m above mean sea level. The climatic condition of the experimental site comes under semi-arid comprising three district seasons viz rainy or wet, winter and summer or hot with an average rainfall of 1200 mm. The relative humidity during summer varies from 35 to 60 percent. Severe drought occurs quite frequently accompanied by very low relative humidity, sensitivity, and wind velocity. The soil condition of the experimental field was good in texture and medium in fertility status with available nitrogen (220.00 kg ha^{-1}), phosphorus (14.55 kg ha^{-1}), Potassium (250.80kg ha^{-1}), pH (8.62), EC (4.41) and Organic carbon (0.31%). The two-year data obtained were statistically analyzed using the F-test with the method suggested by Panse and Sukhatme, 1985 [5] and conclusions were drawn at a 5% probability level.

Result and Discussion

Yield attributing characters

Data recorded for fruit length of aonla is presented in table-1 (a). The maximum fruit length of aonla fruit was recorded (4.62cm and 4.79cm) under the treatment T_7 (75% RDF + 30 kg Vermicompost+ 250g Azotobacter+250g PSB) followed by T_6: 75% RDF + 30kg *Vermicompost* during both the year of experimentation (2018-19 and 2019-2020). All the treatments were found significantly superior while the treatment T_1:100 % RDF (1:0.5:1: N: P: K + 10kg FYM plant^{-1}) recorded minimum (3.56cm and 3.70cm) fruit length of aonla fruit.

The effect of Integrated Nutrient Management on the width of aonla fruit was found significantly superior while the maximum width of aonla fruit (4.48cm and 4.64cm) was noted under the treatment T_7 (75% RDF + 30 kg Vermicompost+ 250g Azotobacter+250g PSB) followed by T_6: 75% RDF + 30kg *Vermicompost.* Treatment T_5: 75% RDF + 20kg *Vermicompost* + 250g *Azotobacter* + 250g PSB, T_{13}: 50% RDF+ 30 kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB, T_{11}: 50 % RDF + 20kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB, T_3: 75 % RDF + 10kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB and T_9 : 50 % RDF + 10kg *Vermicompost*+ 250g *Azotobacter*+ 250 g PSB were found statistically at par with the treatment T_7. Among all the treatments T_1:100 % RDF (1:0.5:1: N: P: K + 10kg FYM plant^{-1}) gives minimum (3.46cm and 3.59cm) width of anola fruit.

The data presented in table-1 (a) regarding the fruit weight of aonla. The maximum fruit weight (46.51g and 48.34g) was recorded under the treatment T_7 (75% RDF + 30 kg Vermicompost+ 250g Azotobacter+250g PSB). It was found statistically at par with the treatment T_5: 75% RDF + 20kg *Vermicompost* + 250g *Azotobacter* + 250g PSB, T_{13} : 50% RDF+ 30 kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB, T_{11}: 50 % RDF + 20kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB, T_3 : 75 % RDF + 10kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB and T_9: 50 % RDF + 10kg *Vermicompost*+ 250g *Azotobacter*+

Table 1(a): Effect of Integrated Nutrient Management on yield and yield attributes

Treatments		Fruit length (cm)		Fruit width (cm)		Fruit weight (g)	
		2018	2019	2018	2019	2018	2019
T_1	100 % RDF (1:0.5:1: N: P: K + 10kg FYM plant $^{-1}$)	3.56	3.70	3.46	3.59	35.90	37.31
T_2	75 % RDF + 10kg Vermicompost	3.69	3.80	3.57	3.71	37.13	38.58
T_3	75 % RDF + 10kg Vermicompost+ 250g Azotobacter + 250g PSB	4.21	4.37	4.09	4.24	42.43	44.10
T_4	75 % RDF + 20kg Vermicompost	3.93	4.07	3.81	3.95	39.58	41.13
T_5	75% RDF + 20kg Vermicompost + 250g Azotobacter + 250g PSB	4.50	4.66	4.36	4.52	45.29	47.06
T_6	75% RDF + 30kg Vermicompost	4.05	4.20	3.93	4.07	40.80	42.40
T_7	75% RDF + 30 kg Vermicompost+ 250g Azotobacter+ 250g PSB	4.62	4.79	4.48	4.64	46.51	48.34
T_8	50 % RDF + 10kg Vermicompost	3.65	3.78	3.54	3.67	36.72	38.16
T_9	50% RDF + 10kg Vermicompost+ 250g Azotobacter+ 250 g PSB	4.13	4.28	4.01	4.16	41.62	43.25
T_{10}	50 % RDF + 20kg Vermicompost	3.77	3.91	3.65	3.79	37.94	39.43
T_{11}	50 % RDF + 20kg Vermicompost+ 250g Azotobacter+ 250g PSB	4.29	4.45	4.16	4.32	43.25	44.94
T_{12}	50% RDF + 30kg Vermicompost	3.85	3.99	3.73	3.87	38.76	40.28
T_{13}	50% RDF+ 30 kg Vermicompost+ 250g Azotobacter+ 250g PSB	4.41	4.58	4.28	4.44	44.47	46.22
	SEm ±	0.19	0.17	0.15	0.17	1.76	1.89
	CD	0.56	0.49	0.45	0.50	5.14	5.52

Table 1 (b): Effect of Integrated Nutrient Management on yield and yield attributes

Treatments		Fruit volume (cm^3)		Pulp: Stone ratio	Fruit yield (kg/plant)	Pulp: Stone ratio	Fruit yield (kg/plant)
		2018	2019	2018	2019	2018	2019
T_1	100 % RDF (1:0.5:1: N: P: K + 10kg FYM plant $^{-1}$)	36.96	37.22	10.12	10.25	64.80	66.72
T_2	75 % RDF + 10kg Vermicompost	38.22	38.49	10.47	10.60	66.96	69.00
T_3	75 % RDF + 10kg Vermicompost+ 250g Azotobacter+ 250g PSB	43.68	43.99	11.96	12.12	75.28	76.92
T_4	75 % RDF + 20kg Vermicompost	40.74	41.03	11.16	11.30	71.40	73.52
T_5	75% RDF + 20kg Vermicompost + 250g Azotobacter + 250g PSB	46.62	46.95	12.77	12.93	79.20	80.95
T_6	75% RDF + 30kg Vermicompost	42.00	42.30	11.50	11.65	73.16	75.84
T_7	75% RDF + 30 kg Vermicompost+ 250g Azotobacter+ 250g PSB	47.88	48.22	13.11:1	13.28:1	85.00	90.89
T_8	50 % RDF + 10kg Vermicompost	37.80	38.07	10.35	10.49	66.24	68.24
T_9	50% RDF + 10kg Vermicompost+ 250g Azotobacter+ 250 g PSB	42.84	43.15	11.73	11.88	73.76	77.32
T_{10}	50 % RDF + 20kg Vermicompost	39.06	39.34	10.70	10.83	68.40	70.56
T_{11}	50 % RDF + 20kg Vermicompost+ 250g Azotobacter+ 250g PSB	44.52	44.84	12.19	12.35	76.90	77.76
T_{12}	50% RDF + 30kg Vermicompost	39.90	40.19	10.93	11.07	69.92	72.00
T_{13}	50% RDF+ 30 kg Vermicompost+ 250g Azotobacter+ 250g PSB	45.78	46.11	12.54	12.70	77.03	80.72
	SEm ±	1.81	1.89	0.23	0.46	1.28	1.27
	CD	5.29	5.50	0.67	1.35	3.74	3.71

Table- 2: Effect of Integrated Nutrient Management on economic feasibility

Treatments		Total cost		Gross return		Net return		B: C ratio	
		2018	2019	2018	2019	2018	2019	2018	2019
T_1	100 % RDF (1:0.5:1: N: P: K + 10kg FYM plant $^{-1}$)	30080.36	31715.19	121305.60	130728.50	91225.24	99013.31	3.03	3.12
T_2	75 % RDF + 10kg Vermicompost	30552.77	32204.64	125349.12	135195.84	94796.35	102991.20	3.10	3.20
T_3	75 % RDF + 10kg Vermicompost+ 250g Azotobacter+ 250g PSB	30584.02	32237.14	140920.32	150707.94	110336.30	118470.80	3.61	3.67
T_4	75 % RDF + 20kg Vermicompost	31052.77	32724.64	133660.80	144052.15	102608.03	111327.50	3.30	3.40
T_5	75% RDF + 20kg Vermicompost + 250g Azotobacter + 250g PSB	31084.02	32757.14	148254.72	158619.74	117170.70	125862.60	3.77	3.84
T_6	75% RDF + 30kg Vermicompost	31552.77	33244.64	137779.20	148597.86	106226.43	115353.22	3.37	3.47
T_7	75% RDF + 30 kg Vermicompost+ 250g Azotobacter+ 250g PSB	31584.02	33277.14	159498.24	178080.70	127914.22	144803.56	4.05	4.35
T_8	50 % RDF + 10kg Vermicompost	30535.18	32184.10	124001.28	133706.73	93466.10	101522.63	3.06	3.15
T_9	50% RDF + 10kg Vermicompost+ 250g Azotobacter+ 250 g PSB	30566.43	32216.60	138074.88	151497.72	107508.45	119281.12	3.52	3.70
T_{10}	50 % RDF + 20kg Vermicompost	31035.18	32704.10	128044.80	138252.44	97009.62	105548.35	3.13	3.23
T_{11}	50 % RDF + 20kg Vermicompost+ 250g Azotobacter+ 250g PSB	31066.43	32736.60	143961.60	152351.80	112895.17	119615.20	3.63	3.65
T_{12}	50% RDF + 30kg Vermicompost	31535.18	33224.10	130890.24	141073.92	99355.06	107849.83	3.15	3.25
T_{13}	50% RDF+ 30 kg Vermicompost+ 250g Azotobacter+ 250g PSB	31566.43	33256.60	144209.28	158153.51	112642.85	124896.92	3.57	3.76

250 g PSB while the treatment T_1 which consist 100 % RDF (1:0.5:1: N: P: K + 10kg FYM plant^{-1}) gave minimum (35.90g and 37.31g) fruit weight.

The volume of aonla fruit was recorded and represented in table-1 (a). The increment in fruit volume was recorded in every treatment whereas the maximum fruit volume (47.88cm^3 and 48.22cm^3) was noted under the treatment T_7 (75% RDF + 30 kg Vermicompost+ 250g Azotobacter+250g PSB) which was almost equal with the treatment T_5: 75% RDF + 20kg *Vermicompost* + 250g *Azotobacter* + 250g PSB, T_{13}: 50% RDF+ 30 kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB, T_{11}: 50 % RDF + 20kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB. The minimum (36.96cm^3 and 37.22cm^3) fruit volume was noted under the treatment T_1:100 % RDF (1:0.5:1: N: P: K + 10kg FYM plant^{-1}).

The data regarding the pulp: stone ratio is presented in table-1 (b). The maximum pulp: stone ratio (13.11:1 and 13.28:1) was recorded under the treatment T_7 (75% RDF + 30 kg Vermicompost+ 250g Azotobacter+250g PSB) followed by T_{11}: 50 % RDF + 20kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB during both the year of experimentation (2018-19 and 2019-20). The treatment: 100 % RDF (1:0.5:1: N: P: K + 10kg FYM plant^{-1}) noted minimum (10.12:1 and 10.25:1) ratio of pulp: stone.

The yield of fruit depends upon the different yield-attributing characteristics of aonla fruits which all were significantly influenced by different soil applications of organic manure and inorganic fertilizers during both the years of experimentation (2018-19 and 2019-2020). It is clear from the data presented in the table-1 (b) that the treatment T_7 (75% RDF + 30 kg Vermicompost+ 250g Azotobacter+250g

PSB) recorded maximum (85.0 kg/plant and 90.89 kg/plant) yield followed by treatment T_5: 75% RDF + 20kg *Vermicompost* + 250g *Azotobacter* + 250g PSB. The treatment T_1: 100 % RDF (1:0.5:1: N: P: K + 10kg FYM plant⁻¹) noted minimum (64.80 kg/plant and 66.72 kg/plant) fruit yield of aonla fruit.

The reason behind the increment in the different yield attributing characters of aonla fruits might be due to the supply of all the plant nutrients and growth hormones in optimum amounts and proportion right from starting of the experimentation to the harvest of the crop, which induces more flowering and retention of fruit due to production and supply of photosynthesis at critical requirement. The results are in conformation with the findings of [6] and [2]. Among the treatments, the maximum fruit yields were recorded with the soil application of treatment T_7 (75% RDF + 30 kg Vermicompost+ 250g Azotobacter+250g PSB) and both are significantly superior (Table-1a and 1b). The enhancement in the yield of fruits is mainly because of the proper supply of nutrients and induction of growth hormones, which stimulated cell division, cell elongation, increase in the number of fruit and weight, ultimately increasing fruit yield. Similar findings were also reported by [9] [3] [10] [12] [13].

Economic feasibility

The data recorded for different economic estimations are presented in the table-2. The soil application of different organic manure and inorganic fertilizers was found very effective to improve the different yield and yield attributing characteristics which become the reason to gain a maximum economic return from produced yield. It is clear from the table-2 that the maximum (₹31584.02 and ₹33277.14) total cost was utilized under the treatment T_7 (75% RDF + 30 kg Vermicompost+ 250g Azotobacter+250g PSB) during both the year of experimentation (2018-19 and 2019-2020) while the maximum (₹159498.24 and ₹178080.70) gross return was estimated under the same treatment as well. The treatment T_7 (75% RDF + 30 kg Vermicompost+ 250g Azotobacter+250g PSB) recorded the highest (₹127914.22 and ₹144803.56) net return during both years and got maximum (4.05:1 and 4.35:1) benefit: cost ratio. The treatment T_5: 75% RDF + 20kg *Vermicompost* + 250g *Azotobacter* + 250g PSB was noted second richest treatment in terms of gross return (₹148254.72 and ₹158619.74), net return (₹117170.70 and ₹125862.60) and benefit: cost ratio (3.77:1 and 3.84:1) followed by the treatment T_{13}: 50% RDF+ 30 kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB and T_{11}: 50 % RDF + 20kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB. The treatment T_1: 100 % RDF (1:0.5:1: N: P: K + 10kg FYM plant⁻¹) which does not respond much effect on total yield and noted lowest in terms of gross return (₹121305.60 and ₹130728.50), net return (₹91225.24 and ₹99013.31) and benefit: cost ratio (3.03: and 3.12:1) during both the years of experimentation (2018-19 and 2019-20) Treatments comprising organic manures and bio-fertilizers in combination with inorganic fertilizers had a higher cost of cultivation but higher yields obtained maximized the benefit resulting in a higher benefit: cost ratio. Similar results were reported by [4] [11] in strawberries with the combined application with organic manures.

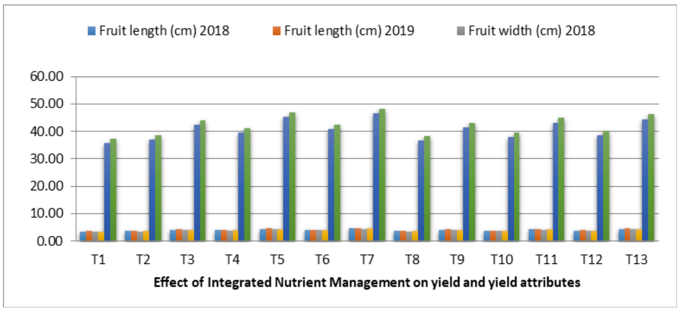

Figure 1(a): Effect of Integrated Nutrient Management on yield and yield attributes

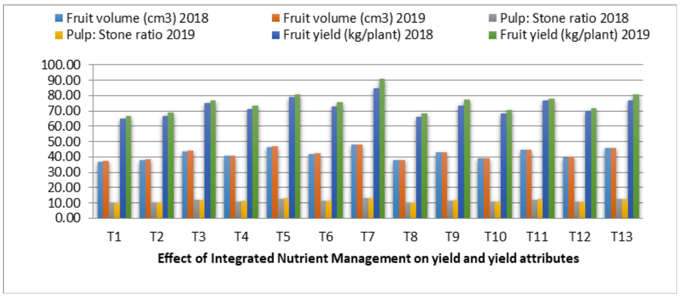

Figure 1(b): Effect of Integrated Nutrient Management on yield and yield attributes

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