Effect of Integrated Nutrient Management on Productivity and Qualityof Aonla

Abstract:

The field experiment was conducted at the Horticulture Research CRC Farm – 1 of the Department of Horticulture, School of Agriculture, ITM University Gwalior (M.P.) during the year 2019 and 2020 to study the effect of Integrated Nutrient Management on fruit yield and quality of aonl. The experiment was laid out in the randomized block design with three replications andeleven treatments viz. (control) - RDF (1000: 500:1000 g/ tree), 3/4thof RDF + FYM, 3/4thof RDF + FYM + Azotobacter (100g), 3/4thof RDF + FYM+ Azospirillum (100g), 3/4thof RDF + FYM+ PSB (100g), 3/4thof RDF + FYM+ Azotobacter + Azospirillum + PSB(100g/tree each), ½ of RDF + FYM, 1/2 of RDF + FYM+ Azotobacter (100g), 1/2 of RDF + FYM + Azospirillum(100g), ½ of RDF + FYM + PSB(100g),½ of RDF + FYM + Azotobacter + Azospirillum + PSB (100g/tree, each. The results revealed that among different treatments, application of ½ of RDF + FYM + Azotobacter + Azospirillum + PSB recorded higherfruit yield, TSS, Total sugar, Ascorbicacid which was followed by application of ¾thofRDF+FYM +*Azotobacter* +*Azospirillum* +PSB except acidity.Thus, application of ½ of RDF + FYM + Azotobacter + Azospirillum + PSB was found to best for improving the soil nutrient status which will in turn help in improving the yield of Aonla.

Keywords: *Farmyard manures, Biofertilizers, Yield, TSS, Total sugar*

Introduction

The Indian gooseberry (*Emblica officinalis* Gaertn.), belonging to *Euphorbiaceae* family and is called as Aonla, Amlika, Amali, Ambala, Amalakamuis a native to tropical South – East Asia, is grown in India since its origin (Singh *et al.*, 2019). It is widely grown as backyard fruit in India, due to its hardness and wasteland compatibility, high productivity (15-20 tonnes/ha), high nutritive and therapeutic value, it has been considered as an important fruit tree in our country (Chadha, 2001). Itisalsoknownas‘AmritPhal’ or ‘wonder drug’ because of its great medicinal and nutritional utilization. In respect of nutritional values, it is rich source of vitamin C (650-900 mg/100g) which is more than that of guava,citrusandtomatofruitsandalsocontainscarbohydrates(14.10-21.89%),minerals(1.2% Iron), phenol, polyphenol and tannins, alkaloid and ellagic acid. It is a necessary componentof Triphala, Chavanprash and other aurvedic preparations (Kulkarani *et al*., 2017).

The nutritional value of aonla fruits is also influenced by the fertilization process, soil fertility and sources of nutrition (Korwar*et al*., 2006). Tropical soils are deficient in phosphorus and when a farmer adds phosphatic fertilizers, nearly 75% of it is converted to a formunavailableforplantgrowth.Manyfungi andbacterialike *Aspergillus,Penicillium,andBacillus etc.* solublize these bound phosphates by producing organic acids and convert them to a form available to a plant growth. Indiscriminate use of inorganic sources of nutrient to provide better nutrition to plantsand achieve high yield, made the soil and water quality degraded and brought stagnation in productivity of crops (Kalloo, 2003). Integrated use of chemical fertilizers with biofertilizers markedly increases fertilizer use efficiency, minimizes their losses and leakage and improves fertility status of soil (Ramamurthy *et al.,* 2005). Integrated nutrient management system consists of effective and judicious utilization of all available sources of nutrients to the plants *viz*., chemical fertilizers, plant and animal sources, organic sources and microbial sources for sustaibale soil fertility and productivity. The increase in crop productivity results from their combined effects, the synergistic effect, that helps to improve chemical, physical and biological properties of soil andconsequently the soil organic matter and nutrient status; to a large extent balanced nutrientsupply to crops in cropping system and with no or minimal deleterious effect on environment if any. Considering the role of microbial consortium in soil and as component of INM, study was conducted to evaluate the response of integrated nutrient management practices on productivity and Quality of Aonla cv. NA-7.

Materials and Method:

The field experiment was conducted during 2019 and 2020 by selecting thirty-three plants of uniform size (canopy volume) and vigour from ten-year-old Aonla cultivar ‘NA-7’ planted with a spacing of 8.0 x 8.0 meter in ten-year-old orchard of aonla cv. NA-7located at the Department of Horticulture, ITM, University Gwalior, MP (India). The experiment was laid out in randomized block design with eleven treatments and three replications. The treatments are: Full dose of NPK (1000:500:1000 g/tree) control; three-fourth dose of NPK/tree + 100kg FYM; three-fourth dose of NPK/tree + 100kg FYM + Azotobacter; three-fourth dose of NPK/tree +

100kg FYM + Azospirillum; three-fourth dose of NPK/tree + 100kg FYM + PSB; three-fourth dose of NPK/tree + 100kg FYM +Azotobacter Azospirillum+ PSB; half dose of NPK/tree +100kg FYM; half dose of NPK/tree +100kg FYM + Azotobacter; half dose of NPK/tree +100kg FYM + Azospirillum; half dose of NPK/tree +100kg FYM + PSB; half dose of NPK/tree +100kg FYM + Azotobacter + Azospirillum + PSB. The treatments include recommended dose of fertilizer (RDF) as 1.0kg of nitrogen, 0.5kg of phosphorus and 1.0kg of potassium per tree. Farm yard manure (FYM) @ 100 kg/plant along with bio fertilizers was applied around each tree in the second week of January. The Bio fertilizers *viz*. *Azotobacter*, *Azospirillum* and PSB (100g/tree each) were applied in the rhizosphere zone of Aonla around the tree at a depth of 15 cm leaving 50 cm from the main trunk. The NPK fertilizers were applied in form of Urea, SSP, and MOP, respectively. Two third of the total nitrogen and whole of the phosphorus and potassium were applied during last week of February. Rest one third dose of N was applied in the first week of august. The fertilizers were applied in trenches of 20-25 cm width and 10-15 cm depth made beneath the tree canopy leaving 50 cm distance from the main trunk. The fertilizer was well mixed with the soil in the trenches and then levelled. The observation on the fruit yield was estimated after picking in the second week of December during the year, 2019 and 2020. All the fruits from the individual trees were picked manually and were collected in the baskets. The total weight of the fruits per tree was estimated and expressed in kilogram. Further, the total soluble solids (TSS) of the fruit pulp were estimated by using Erma hand refractometer (0-32^{o} B) as per the procedure of A.O.A.C (1995) and was expressed in Brix (^{o}B). Acidity of the fruit was calculated by titrating the pulp extract with 0.1 N NaOH as per themethoddescribedinA.O.A.C.,(1970) a n d total sugar of aonla fruits was estimated by using Lane and Eynon method given by Ranganna (1986). Ascorbicacidcontentofthefruitswasestimatedasperthemethodsuggestedby A.O.A.C. (1980) using standardized 2, 6- dichlorophenol indophenols dye. The data were analyzed as per the method suggested by Gomez and Gomez (1984). The critical difference at 5 per cent level of probability and standard error of mean was worked out for comparing the significance among treatment means.

Results and discussion

Fruit Yield:

The data related to fruit yield of aonla per plant presented in Table 1 revealed that application of ¾thofRDF+FYM +*Azotobacter* +*Azospirillum* +PSB was substantially better over all the treatments except ½ofRDF+FYM+*Azotobacter*+*Azospirillum*+PSBand exhibiting maximum fruit yield (159.60 and 161.68 kg/tree). This may be due to the fact that the use of FYM and Bio fertilizers (Azotobacter, Azospirillum and PSB) supplemented the use of inorganic fertilizers to a considerable extent. The application of bio fertilizers along with different dose of NPK and FYM was effective to maintain the nitrogen level of the soil as the microbial population under such treatments was much higher and the fertility of the soil and enhance yield. The absorbed nitrogen combined with carbohydrates in leaves could lead to the synthesis of amino acids, nucleic acid, proteins, chlorophyll, alkaloid and amides (Jones and Embleton, 1982; Spehia *et al.*, 2020; Singh *et al.*, 2021). These metabolites are involved in building up of new tissues and are related to a number of metabolic steps (Singh *et al.*, 2018). Biofertilizers are known to enrich the soil by way of biological N-fixation and improving the availability of different nutrients to plants (Singh and Singh, 2019).

Table1:EffectofNPK,FYMandBiofertilizersonfruityieldof Aonla cv. NA-7

Treatments	Averagefruityield(kg/tree)	
	2019	2020
Recommended Dose of Fertilizers (RDF) (NPK @ 1000:500:1000 g/tree) as control	132.60	131.84
¾thof RDF+ FYM	132.76	134.64
¾thofRDF+FYM+*Azotobacter*	146.39	147.56
¾thofRDF+FYM+*Azospirillum*	140.47	140.87
¾thofRDF+FYM+Phosphatesolubilizingbacteria (PSB)	148.75	151.49
¾thofRDF+FYM +*Azotobacter* +*Azospirillum* +PSB	159.60	161.68
½ofRDF+FYM	133.69	134.86

½ofRDF+ FYM+*Azotobacter*	136.96	139.12
½ofRDF+ FYM+*Azospirillum*	140.47	141.39
½ofRDF+ FYM+PSB	137.22	137.30
½ofRDF+FYM+*Azotobacter*+*Azospirillum*+PSB	155.32	156.92
S.E. (diff)	**4.255**	**4.958**
CDat 5% level	**8.877**	**10.343**

Chemical properties:

The chemical parameters of fruit viz. TSS, acidity, total sugar and ascorbic acid as affected by various treatments was recorded and presented in Table 2 reported that TSS and sugar were highest with the application of half dose of RDF, FYM with *Azotobacter*, *Azospirillum* and PSB. According to Childers (1996) nitrogen has been shown to stimulate the activities of biological enzymes involved in the various bio-chemical processes which might have resulted in an increase in TSS content of fruit with increasing levels of nitrogen. Similar results were reported by Yadav (2010) and Yadav (2006)in aonla *cv.* 'Neelam' who noted increasing trend of TSS and total sugar with the application of graded dose of nitrogen.The minimum titratable acidity (2.24 and 2.22%) was observed with the application of ½ofRDF+FYM+*Azotobacter*+*Azospirillum*+PSB and highest in control. similar results were also reported by Yadav (2006) and Tewari *et al.* (2015), **Vishwakarma***et al.* (2017) in acid lime and Singh *et al.* (2007) in muskmelon. The observation on ascorbic acid would reveal that application of ½ofRDF+FYM+*Azotobacter*+*Azospirillum*+PSBgave highest ascorbic acid content (551.10 and 556.321 mg/100g ofpulp). The possible reasons for increased ascorbic acid may be due to conversion of soluble sugars into ascorbic acid and can be confirmed by the findings reported by Tarai and Ghosh (2005) in aonla. Finally, it can be concludedthatapplicationofhalfofofRDF(500:250:500g)+FYM+*Azotobacter*+Azospirullum+ PSB per plant proved to be the most suitable treatment for improving physico- chemical characters of NA-7 aonla fruit.

Table 2: Biochemical quality attributes of aonla fruits after application of biofertlizers as a component of INM

Treatments	TSS (^{0}Brix)		Acidity(%)		Total sugar(%)		Ascorbicacid (mg/100pulpwt.)	
	2019	2020	2019	2020	2019	2020	2019	2020
T_0	11.50	11.40	2.53	2.58	4.21	4.21	533.86	531.86
T_1	11.83	11.92	2.48	2.49	4.22	4.23	534.82	535.20
T_2	12.20	12.30	2.40	2.37	4.30	4.32	538.40	539.42
T_3	12.33	12.38	2.34	2.31	4.31	4.33	540.12	542.82
T_4	12.66	12.90	2.29	2.28	4.36	4.37	544.88	550.66
T_5	12.80	13.10	2.28	2.25	4.42	4.46	550.22	555.21
T_6	11.75	11.80	2.35	2.32	4.24	4.25	535.39	537.86
T_7	12.00	12.33	2.30	2.29	4.28	4.29	539.42	540.49
T_8	12.40	12.40	2.35	2.33	4.31	4.34	542.86	543.86
T_9	12.90	13.30	2.26	2.24	4.32	4.35	546.80	549.82
T_{10}	13.25	13.35	2.24	2.22	4.62	5.42	551.10	556.21
S.E. (diff)	**0.41**	**0.272**	**0.056**	**0.026**	**0.023**	**0.011**	**1.769**	**2.542**
CDat 5%	**0.855**	**0.567**	**0.118**	**0.0557**	**0.048**	**0.0239**	**3.691**	**5.303**

Conclusions:

Thus, application of ½ of RDF + FYM + Azotobacter + Azospirillum + PSB recorded higher fruit yield, **TSS (^{0}Brix), Total sugar(%), Ascorbicacid** which was followed by application of ¾thofRDF+FYM +*Azotobacter* +*Azospirillum* +PSB except acidity.Thus, application of ½ of RDF + FYM + Azotobacter + Azospirillum + PSB was found to best for improving the soil nutrient status which will in turn help in improving the yield of Aonla.

References:

Chadha.K.L.(2001).DrylandHorticulturecrops. *IndianHort.*,**46**: 18-20.

Gomez, K.A. and Gomez, A.A. (1984).Statistical procedures of Agricultural Research (2[nd] edition), John Wiley and Sons. Inc. New York.

Kalloo, K. 2003**.** Research and extension activities on organic agriculture in India. Organic farming in Horticulture for sustainable production, 29-30 August, CISH, Lucknow, p. 1.

Korwar, G.R., Pratibha, G., Ravi, V. and Palanikumar, D. 2006**.** Influence of organic andinorganicongrowth, yieldofaonla(*Embilicaofficinalis*)andsoil qualityinsemiand tropics. *Indian Journal of Agricultural Sciences*, **76**(8): 457-461.

Kulkarani, P., Pandey, H., Sharma, A. K. and Joshi, D. C. 2017.Physicochemical properties of aonla fruit and juice. *Chem. Sci. Rev. Lett.* **6** : 1343-1347.

Ramamurthy, V.; Prasad, Jadish. Prasad, V.N. and Gajbhiye, K.S. 2005.Effect of inorganic fertilizerand biofertilizeron productivity ofsoybean. Biofertilizer *News Letter*, **13**: 18-20.

Ranganna, S. 1986. Hand book of analysis and quality control of fruit and vegetable products. New Delhi, Tata Mcgraw Hill Publishing Company Ltd. p.253.

Singh,D.,Singh,S.K. andDamathia,L.B. 2019.ImpactoffertigationonPapayacropunderprotected conditions. *Ecology Environment and Conservation*, **25**(1):295-299.

Singh, S., Thakur, A. and Singh, S. K. 2021.Physiological studies on the growth of temperate fruit crops (Walnut and Cherry): a review. *Plant Cell Biotechnology Mol. Bio.* **22**: 38-45.

Singh, S.K. & Sharma, M. 2016. Evaluating Significance of Vermicompost and Intercropping *Amorphophallus* for integrated Indian Goose Berry Orchard Management. *International Journal of Agriculture Sciences*, **8**(39), 1809-1812.

Singh, S.K., Sharma, M., Reddy, K.R., & Venkatesh, T. 2018**.** Integrated application of boron and sulphur to improve quality and economic yield in potato.*Journal of Environmental Biology*, ***39***(2), 204-210.

Singh, V., Dashora, L.K., Rathore, R. S. and Meena, C. L. 2007.Flowering and yield of guava (*Psidium guajava* L.) cv. “Sardar” as influenced by various organic and inorganic sources. *Current Agriculture*, **31**(1-2): 67-71.

Vedamani, G.M.; Ramavatharam, N. and Haribabu, K. 2006.Effect of graded levels of nitrogen through organic and inorganic sources on yield and quality of acid lime (*Citrus aurantifolia* Swingle). *The Orissa J. Hort.***34** (1): 49-51.

Yadav, R., Singh, H.K. and Yadav; A.L. 2006. Effect of integrataed nutrient management on productivity and quality of aonla *(Emblica officinalis* Gaertn). *Plant Archives*, **7** (2): 881- 883.

Yadav, S. 2010.Integrated Nutrient Management Studies in subtropical peach cv. Saharanpur Prabhat under high density system. Thesis Ph.D., C.S.A. Univ. Agril. Tech., Kanpur.

Table 3: Effect of NPK, FYM and Biofertilizers on total bacterial population in rhizosphere of Aonla plants (Cell x 10^5 /g Soil).

Treatments	2019				2020			
	December*	**March**	**August**	**October**	**December****	**March**	**August**	**October**
T_0	15.32	26.64	39.42	34.64	32.48	28.45	34.82	25.62
T_1	16.45	29.32	41.26	36.84	33.66	35.42	44.12	30.80
T_2	17.07	33.78	49.39	43.24	40.42	42.46	52.18	36.43
T_3	17.00	30.72	48.34	42.24	36.84	38.60	50.14	35.32
T_4	17.05	25.42	39.64	33.20	34.58	36.42	45.16	38.36
T_5	17.10	43.65	59.39	50.24	42.64	48.86	60.18	41.36
T_6	15.80	39.30	63.30	56.34	32.70	40.84	65.15	33.42
T_7	22.34	58.63	88.15	85.42	56.42	63.42	92.14	81.46
T_8	18.65	51.62	86.16	83.62	54.32	58.16	90.64	75.36
T_9	18.42	50.30	83.14	73.26	51.62	56.18	88.68	71.42
T_{10}	26.43	79.42	96.14	90.14	63.18	76.42	101.14	91.82
S.Em±	0.894	1.909	2.864	2.764	1.768	2.070	2.928	2.999
C.D at 5% level	1.865	3.98	5.975	5.767	3.689	4.318	6.109	6.257

***** Before first inoculation
****** Before second inoculation