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Effect of integrated nutrient management practices on physical, bio-chemical properties and yield of aonla (*Emblica officinalis* Gaertn)

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Abstract
The experiment was conducted at the *Instructional cum Research Fruit Orchard,* K.N.K. College of Horticulture, Mandsaur (Madhya Pradesh), Department of Fruit Science. Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (Madhya Pradesh) during 2014-15 to evaluate the effect of NPK alone or in combinations with FYM, vermicompost and biofertilizers on yield and quality parameters of aonla cv. NA-7. Randomized block design (RBD) having three replication was applied in the experiment. Eight years old uniform trees of Aonla *(Emblica officinalis* Gaerth) cv. NA-7 (Narendra Aonla-7) were selected for this study. There were eleven treatment combinations (Control, 800:400:800 g NPK per plant, 400:200:400 g NPK + 10 kg FYM per plant, 400:200:400 g NPK + 10 kg Vermicompost per plant, 800:200:400 g NPK + 50 g PSB per plant, 600:400:800 g NPK + 40 g *Azotobactor* per plant, 600:200:800 g NPK + 50 g PSB + 40 g *Azotobactor* per plant, 400:0:400 g NPK + 10 kg FYM + 50 g PSB per plant, 400:0:400 g NPK + 10 kg Vermicompost + 50 g PSB per plant, 200:0:400 g NPK + 10 kg FYM + 50 g PSB + 40 g *Azotobactor* per plant and 200:0:400 g NPK + 10 kg Vermicompost + 50 g PSB + 40 g *Azotobactor* per plant. The results of present experiment shows that the treatment 600:200:800 g NPK + 50 g PSB + 40 g *Azotobacter* per plant has been found most appropriate integrated nutrient dose under agro-climatic conditions of Malwa plateau for obtaining good physical and biochemical properties and yield of aonla.

Keywords: Aonla, integrated nutrient management, physical properties, biochemical properties, yield

Introduction
Aonla (*Emblica officinalis* Gaertn) is an important fruit crop of India belongs to the family Euphorbiaceae. It is indigenous to tropical South Eastern Asia, particularly in Central and Southern India. Aonla can be grown under diverse soil-climatic situations. However, well-drained, fertile loamy soil is the best. It can also do well even in moderately alkaline soils. Aonla is drought hardy fruit crops which is characterized by a deep system and exhibits deciduous nature due to abscission and shedding of determinate shoots during February–March.

The Integrated Nutrient Management has a very important role in improving fruit set, productivity and quality of fruits. The basic concept of Integrated Nutrient Management (INM) is the adjustment of plant nutrient supply to an optimum level for sustaining the desired crop productivity. It involves a proper combination of chemical fertilizers, organic manure and biofertilizers suitable to the system of land use and ecological, social and economic conditions. The Farm Yard Manure (FYM) seems to be directly responsible in increasing crop yields either by accelerating the respiratory process by increasing cell permeability by hormone growth action or by a combination of all these processes. It supplies nitrogen, phosphorus, potassium and sulphur in available forms to the plants through biological decomposition. Vermicompost is an ecofriendly natural fertilizer prepared from biodegradable organic wastes and is free from chemical inputs. Vermicompost is rich in beneficial micro flora such as N fixers, P- solublizers etc. It also improves the nutrient status of soil both macro-nutrients and micro-nutrients, water retention capacity of soil because of its high organic matter content and promotes better root growth and nutrient absorption. Vermicompost has very 'high porosity', 'aeration', 'drainage' and 'water holding capacity'. Biofertilizers are like *Azotobacter,* PSB, *Azospirillum,* Azolla, Blue Green Algae, VAM substance which contains living microorganisms, they colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant.

(Hazarika and Ansari, 2007) [3]. The PSB has highly efficient phosphate solubilizing microorganism (PSM) that grow and secrete organic acids, which dissolve this unavailable phosphate like tricalcium, iron and aluminium phosphates into a soluble form and make it available to the plants (Muraleedharan and Perumal, 2010) [5]. Thus, the residual phosphate fertilizers in the soil can be well utilized and external application can be optimized.

Hence, in order to develop a sustainable integrated nutrient management technology for aonla , the present investigation was undertaken. Keeping the above facts in the mind, the present investigation was undertaken with an aim to study the effect of NPK alone or in combinations with FYM, vermicompost and biofertilizers on yield and quality parameters of aonla.

Materials and Methods

The experiment was conducted at the *Instructional cum Research Fruit Orchard*, K.N.K. College of Horticulture, Mandsaur (M.P.), Department of Fruit Science. Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during 2014-15. The soil of the orchard is rich in organic matter, black in colour, little heavier and possesses good water holding capacity. The soil having pH 8.05; EC 0.99 mm mhos/cm, available N, P and K of 166, 9.80 and 680.80 kg/ha respectively. The experiment was laid out in randomized block design (RBD) with three replication. Eight years old uniform trees of Aonla *(Emblica officinalis* Gaerth) cv. NA-7 (Narendra Aonla-7) were selected for this study. There were eleven treatment combinations (Control, 800:400:800 g NPK per plant, 400:200:400 g NPK + 10 kg FYM per plant, 400:200:400 g NPK + 10 kg Vermicompost per plant, 800:200:400 g NPK + 50 g PSB per plant, 600:400:800 g NPK + 40 g *Azotobactor* per plant, 600:200:800 g NPK + 50 g PSB + 40 g *Azotobactor* per plant, 400:0:400 g NPK + 10 kg FYM + 50 g PSB per plant, 400:0:400 g NPK + 10 kg Vermicompost + 50 g PSB per plant, 200:0:400 g NPK + 10 kg FYM + 50 g PSB + 40 g *Azotobactor* per plant and 200:0:400 g NPK + 10 kg Vermicompost + 50 g PSB + 40 g *Azotobactor* per plant).

The whole of the organic manure was applied as a basal dose on the onset of monsoon. Then required doses of fertilizers were applied in one split doses in the month of July and then bio-fertilizers were applied one week after each application of inorganic fertilizer. For application of manure and fertilizers the top soil around the tree equal to the leaf canopy of the tree was dug up to 30 cm and the fertilizers were uniformly mixed into the soil, which was then leveled. Irrigation was supplied immediately after fertilizer application.

Results and Discussion

Physical Parameters

The data pertaining to volume of fruit (ml), specific gravity, fruit length (cm), fruit diameter (cm), flesh thickness (cm) was significantly influenced by integrated nutrient management. Statistical analysis of the data depicted that all the physical parameters was significantly maximum with 600:200:800 g NPK+50 g PSB +40 g *Azotobactor* followed by application of 600:400:800 g NPK+40 g *Azotobacter* while the minimum was observed with the control. Stone weight was found non significant. The increase in fruit length, diameter and flesh thickness by the application of integrated nutrient treatments might be due to optimum supply of proper plant nutrients and growth hormones in right amount during the entire crop period causing vigorous vegetative development of the plants and ultimately production of more photosynthesis.

The nutrient combinations accelerate the metabolic activities of the plant. Nitrogen positively influence the vegetative growth of the plant, manufacturing greater amount of food materials and the same when translocated into the fruit bearing areas leading to enhancement in weight and size of the fruits. Phosphorus plays an important role in photosynthesis and accumulation of food material and Potassium in carbohydrate and protein synthesis and in the regulation of water relations. It may also act as a catalyst in the formation of more complex substances and in the acceleration of enzymatic activities, which ultimately leads to improvement in physical characters of the fruit. The Azotobactor also encouraged better growth and accumulates optimum dry matter with induction of growth hormones, which stimulated cell division, cell elongation, activate the photosynthesis process, enhances translocation of water and nutrients, growth and development of roots as well as energy transformation which in turn causes increase in Length, Diameter, Thickness and Volume of the fruits and other physical characters. Solubilisation of P improved by the secretion of organic acids and enzymes from applied PSB biofertilizer, which facilitates the crop to assimilate phosphorus easily. It also produces amino acids and growth promoting substance which help in better growth of plants. The present findings are in accordance with the results reported by Mahendra *et al.* (2009) [4] in ber, Diwedi *et al.* (2010) in guava and Yadav *et al.* (2009) [7] in strawberry.

Bio-chemical Parameters

The data associated with bio-chemical parameters viz. Total soluble solids (^{0}Brix), acidity (%), ascorbic acid (mg/100 g of fresh pulp), total sugar (%) and juice (%) was significantly influenced by the integrated nutrient management. all the biochemical parameters was observed maximum with the 600:200:800 g NPK+50 g PSB +40 g *Azotobactor* followed by application of 600:400:800 g NPK+40 g *Azotobacter* while the minimum was measured under control.

The improvement in various chemical characteristics by application of optimum dose of NPK may be explained by the fact that phosphorus enters into the composition of phospholipids and nucleic acids, the latter combines with proteins and result in the formation of nucleo proteins which are important constituents of the nuclei of the cells. Potassium acts as a catalyst in the formation of more complex substances and in the acceleration of enzyme activity. These carbohydrates and coenzymes are beneficial in the improvement of fruit quality and nitrogen enhances the uptake of phosphorus and potassium. The chain reactions in these components might have possibly been reason of the improvement in quality of the fruit. *Azotobacter* and PSB inoculation resulted in overall increase in fruit quality which can be explained in a way that *Azotobacter* and PSB contribute up to 20-30% N and 25-50% P_2O_5 in soil respectively. Aonla responds well to the application of manures and fertilizers, hence biofertilizers helps in rapid mineralization and transformation of plant nutrients in soil and also through the exertion of plant promoting substances mainly IAA, gibberellic acid and cytokinin like substances, vitamins and amino acid content produced by microorganism. The other possible reason for improvement in biochemical parameters may be attributed to better vegetative growth of the treated plants and which resulted in higher quantities of photosynthates (starch, carbohydrates etc.) and the

translocation to the fruits, thus increasing the various contains of fruit hence quality improvement reflected in fruit chemical character. Similar results have also been reported by Rathore and Chandra (2002) [6], Ghosh *et al*. (2013) [2] in ber.

Yield

Data presented in Table 1 revealed that yield per tree (kg) was significantly influenced by integrated nutrient management (INM). Statistical analysis of the data showed that yield per tree was significantly maximum with the application of 600:200:800 g NPK+50 g PSB +40 g *Azotobactor* followed by application of 600:400:800 g NPK+40 g *Azotobacter* and application of 200:0:400 g NPK+10 kg vermicompost +50 g PSB +40g *Azotobacter* whereas minimum was obtained with the control plot. The least yield under control treatment may be due to lack of availability of nutrients.

Conclusion

Based on one year field experimentation, it is concluded that treatment 600:200:800 g NPK + 50 g PSB + 40 g *Azotobacter* per plant has been found most appropriate integrated nutrient dose for obtaining good physical and biochemical properties and yield of aonla.

Table 1: Effect of integrated nutrient management on physical parameters, bio-chemical parameters and yield of aonla

Treatment	Physical parameters			Bio-chemical parameters								Yield per tree (kg)
	Fruit volume (ml)	Specific gravity	Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (cm)	Stone weight (g)	Total soluble solids (^{0}Brix)	Acidity (%)	Ascorbic acid content (mg/100g pulp)	Total sugar (%)	Juice (%)	
Control	20.42	0.36	2.19	2.40	0.97	1.21	11.23	2.77	610.32	4.13	43.78	35.80
800:400:800 g NPK	23.07	0.42	2.55	3.11	1.17	1.28	11.30	2.10	611.47	5.03	44.83	36.12
400:200:400 g NPK+10 kg FYM	27.80	0.53	2.83	3.23	1.23	1.27	11.67	1.77	611.97	5.13	45.73	41.65
400:200:400 g NPK+10 kg Vermicompost	30.04	0.56	2.94	3.58	1.30	1.36	11.80	1.73	612.25	5.13	48.49	50.07
800:200:400 g NPK+50 g PSB	30.27	0.56	3.08	3.60	1.47	1.22	12.17	1.50	614.80	5.50	53.14	63.00
600:400:800 g NPK+40 g *Azotobactor*	31.30	0.58	3.13	3.64	1.50	1.29	12.83	1.37	618.52	6.53	55.57	64.54
600:200:800 g NPK+50 g PSB+40 g *Azotobactor*	32.23	0.61	3.18	3.67	1.63	1.25	13.07	1.27	620.14	6.57	56.77	67.68
400:0:400 g NPK+10 kg FYM +50 g PSB	24.46	0.48	2.86	3.35	1.27	1.33	11.43	1.80	611.95	5.13	45.15	48.60
400:0:400 g NPK+10 kg Vermicompost +50 g PSB	26.15	0.52	2.92	3.43	1.27	1.34	11.80	1.67	613.47	5.23	51.73	50.09
200:0:400 g NPK+10 kg FYM+50 g PSB +40 g *Azotobactor*	26.92	0.54	2.95	3.48	1.40	1.41	11.87	1.60	614.17	5.53	51.45	53.79
200:0:400 g NPK+10 kg Vermicompost + 50 g PSB+40 g *Azotobactor*	28.33	0.56	3.01	3.60	1.43	1.47	12.53	1.40	617.67	5.83	54.30	62.33
S.Em.±	1.26	0.02	0.07	0.03	0.12	0.06	0.22	0.06	1.42	0.32	0.69	1.91
C.D. at 5%	3.73	0.05	0.21	0.08	0.34	0.09	0.66	0.18	4.18	0.95	2.02	5.63

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