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Ranjeet Jamra
K.N.K. College of Horticulture, Mandsaur, Madhya Pradesh, India

Jyoti Kanwar
K.N.K. College of Horticulture, Mandsaur, Madhya Pradesh, India

Rajiv Dubey
K.N.K. College of Horticulture, Mandsaur, Madhya Pradesh, India

Ramesh Chandra Chaudhary
K.N.K. College of Horticulture, Mandsaur, Madhya Pradesh, India

Corresponding Author:
Ranjeet Jamra
K.N.K. College of Horticulture, Mandsaur, Madhya Pradesh, India

Effect of integrated nutrient management practices on growth, productivity and profitability of aonla

Ranjeet Jamra, Jyoti Kanwar, Rajiv Dubey and Ramesh Chandra Chaudhary

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Abstract
The experiment was conducted with an aim to evaluate the effect of integrated nutrient management on vegetative growth, yield and profitability of aonla cv. NA-7 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. Randomized block design (RBD) having three replications 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 combination 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 maximum vegetative growth and yield (67.68 kg/tree) for improving the reproductive parameters and it also gave maximum net income (Rs. 73174.14). The next best treatment combination were 600:400:800 g NPK + 40 g *Azotobacter* per plant, 800:200:400 g NPK + 50 g PSB per plant and 200:0:400 g NPK + 10 Kg Vermicompost + 40 g *Azotobacter* per plant in descending order.

Keywords: Aonla, integrated nutrient management, yield, profitability

1. Introduction
Aonla *(Emblica officinalis* Gaertn) also known as Indian gooseberry is an important fruit crop of commercial significance. It is quite hardy, prolific bearer and remunerative even without much care. It is an under-utilized fruit tree with medicinal and herbal qualities. Its fruit is a tonic for diuretic, laxative, antioxidant and act as cooling refrigerant. It is the richest source of vitamin "C" (600 mg/100 g) among all fruits, except Barbados cherry and fruit contain 89 - 94% Pulp, 0.8 -2.0 % Fibre, 10-14% Total Soluble Solids, 1.4 - 2.4 % Acidity, 2.4-3.1% Pectin and 2.0 -3.0 % Phenols (Singh *et al*., 1993) [7]. The forest of M.P has a rich diversity of Aonla. Major Aonla producing areas in Madhya Pradesh are Sheopur, Betul, Balaghat, Satna, Sidhi, Panna, Ratlam, Mandsaur and Neemuch districts.
The Integrated Nutrient Management (INM) has a very important role in improving quality and productivity of fruits. It also has a beneficial role in recovery of nutritional and physiological disorders in fruit trees. INM involves a proper combination of organic and inorganic sources of fertilizers 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. Indirectly it improves the physical properties of soil such as aggregation of soil, permeability and water holding capacity. 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. Economical and eco-friendly crop production approach warrants the use of biofertilizer. 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. 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) [3]. 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 growth, yield and profitability of aonla.

2. Materials and method

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.

3. Results and discussion

3.1 Growth Parameters

Data presented in Table 1 indicated that plant-height (m), canopy spread EW (m) and N-S (m) and canopy height (m) were significantly influenced by integrated nutrient management. The maximum plant-height, canopy spread and canopy height was found 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* whereas minimum increase in plant-height, canopy spread and canopy height was observed with control.

The notable improvement with respect to growth parameters with the use of biofertilizers, organic manures and inorganic fertilizers may be attributed due to sufficient availability of Nitrogen, Phosphorus, Potassium and other essential nutrients. Besides this, the soils are deficient in soluble forms of Phosphorus, one of the major essential macronutrient required for plant growth. It makes about 0.2% of plant dry weight. The plants obtained their Phosphate requirement from the soil pool, which occurs in soil as inorganic phosphate. The PSB had played a very significant role in making the essential nutrient Phosphorus (P) 'bio-available' form. Solubilizaton 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 PSB. The Azotobactor is also associated with the production of growth promoting substance, antifungal components and cytokines which in turn might have lead to better root development, better transport and uptake of nutrients which resulted in increasing growth parameter. While, under control, lack of availability of nutrients for uptake resulted poor in vegetative growth parameters. The similar results have also been observed by Shrivastava (2008) [6].

3.2 Yield Parameters and Yield

Data presented in Table 1 revealed that number of fruits per shoots; number of shoots per tree, fruit weight (g) and yield per tree (kg) was significantly influenced by integrated nutrient management (INM). Statistical analysis of the data showed all the parameters of yield and yield per tree were 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 parameters under control treatment may be due to lack of availability of nutrients.

The increase in yield due to the fact that nitrogen is the constituent of proteins, enzymes and chlorophyll and involves in all the processes associated with photosynthesis and growth, hence increase in weight and yield due to nitrogen application is obvious. The increase in weight and yield by addition of adequate quantity of phosphorus was possibly due to its association with various chemical reactions in the cell and is responsible for the synthesis of protoplasm. Hence, an increase in the vegetative growth was resulted in more carbohydrates assimilation, which may partly be responsible for higher yields. It is assumed that potassium plays an important part in carbohydrate and protein synthesis and in the regulation of water relations in living cells. It may also act as a catalyst in the formation of more complex substances and in the acceleration of enzyme activity. These carbohydrates and co-enzymes are beneficial in increasing size of fruits and ultimately weight of the fruit. *Azotobacter* application may be increased the nutrient status as well as their uptake by the plants in association with PSB, which also has defined role in plant metabolism such as cell division, development, photosynthesis and regulation of metabolic pathway. Higher leaf chlorophyll content caused by *Azotobacter* inoculation,

which increased meristematic activities, photosynthesis rate and carbohydrates in turn increasing yield characters. PSB has very significant role in making the essential nutrient phosphorus (P) 'bio-available' form. Solubilizaton 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 and ultimately yield. The similar results were also in consonance with the findings of Mandal *et al.* (2013), Mustafa *et al.* (2013) [4] and Yadav *et al*. (2007) [8] in aonla Ravishanker *et al.* (2010) [5] and chaudhri *et al.* (2001) [1] in papaya.

3.3 Economic Analysis

Economic analysis of the various integrated nutrient management practices is shown in Table 1. The maximum net returns (Rs. 73174.14) were found with the application of 600:200:800 g NPK+50 g PSB +40 g *Azotobactor* but maximum C:B ratio (1:3.78) was found with the application of 200:0:400 g NPK+10 kg vermicompost +50 g PSB +40g *Azotobacter*. This was economically viable over rest of the treatments.

Table 1: Effect of integrated nutrient management on growth parameters, yield parameters, yield and economics of aonla

Treatment	Growth Parameters				Yield Parameters			Yield per tree (kg)	Economics	
	Plant-height (m)	Canopy spread (m)		Canopy height (m)	Number of fruits /shoot	Number of shoots /tree	Fruit weight (g)		Net income (Rs)	C:B Ratio
		E-W	N-S							
Control	0.29	0.39	0.36	0.36	168.00	9.31	17.33	35.80	33870.71	1:2.14
800:400:800 g NPK	0.44	0.44	0.42	0.43	180.00	10.20	19.57	36.12	28702.49	1:1.34
400:200:400 g NPK+10 kg FYM	0.50	0.54	0.53	0.46	188.00	10.87	23.17	41.65	39132.21	1:2.09
400:200:400 g NPK+10 kg Vermicompost	0.52	0.60	0.56	0.58	199.00	11.80	26.63	50.07	50776.33	1:2.71
800:200:400 g NPK+50 g PSB	0.57	0.58	0.56	0.56	210.33	12.10	27.40	63.00	68202.54	1:3.53
600:400:800 g NPK+40 g *Azotobactor*	0.61	0.63	0.58	0.62	218.33	12.42	28.50	64.54	68475.57	1:3.24
600:200:800 g NPK+50 g PSB+40 g *Azotobactor*	0.63	0.65	0.61	0.63	225.00	12.54	29.47	67.68	73174.14	1:3.51
400:0:400 g NPK+10 kg FYM +50 g PSB	0.48	0.52	0.48	0.41	192.00	10.32	23.40	48.60	49382.88	1:2.73
400:0:400 g NPK+10 kg Vermicompost +50 g PSB	0.50	0.53	0.52	0.50	202.00	10.83	24.57	50.09	51406.90	1:2.83
200:0:400 g NPK+10 kg FYM+50 g PSB +40 g *Azotobactor*	0.53	0.54	0.54	0.54	208.00	11.22	25.23	53.79	56637.19	1:3.13
200:0:400 g NPK+10 kg Vermicompost +50 g PSB+40 g *Azotobactor*	0.55	0.60	0.56	0.60	210.67	11.87	27.13	62.33	68452.60	1:3.78
S.Em.±	0.02	0.02	0.02	0.02	9.53	0.72	0.92	1.91		
C.D. at 5%	0.06	0.06	0.05	0.07	28.10	2.13	2.72	5.63		

4. Conclusion

The findings of present study suggest that for higher yield and profit, application of 600:200:800 g NPK+50 g PSB +40 g *Azotobactor* may be advocated.

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