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# Effect of organic manure and biofertilizers on soil properties and growth of aonla under rainfed conditions of hot semi-arid environment

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**Abstract**

The experiment was conducted on seven and eight years old trees of NA-7 *aonla* to evaluate the influence of various levels of organic (FYM, biofertilizers) and inorganic (NPK) sources of nutrients on morphometrix, productivity and quality attributes of aonla and soil quality during 2009-10 and 2010-11 under hot semi-arid ecosystem. Significant improvement was recorded in soil quality by application of different combinations of N P K, FYM and biofertlizers. The vegetative growth and soil quality were influenced significantly by different sources of nutrients. Maximum vegetative growth was recorded in the plants which were applied with standard doses of N P K which was closely followed by Farm Yard manure plus 50% of the standard dose NPK. The soil properties in terms of *pH,* EC showed declining trend whereas level of hydraulic conductivity, organic carbon increased with the application of various combinations of FYM and biofertilizers, whereas pH, EC, hydraulic conductivity, bulk density and organic carbon of the basin soil applied with standard dose of NPK were not improved considerably.

**Key words:** *Aonla, organic, inorganic, nutrients, FYM, biofertilizers.*

## Introduction

*Aonla or* Indian gooseberry (*Emblica officinalis* Gaertn), is hardy known for its highly nutritive fruit. The tree is being grown successfully across the country in varied agro-climatic conditions in an area of more than 50,000 ha area in the country with 1.75 lakh tones production (Pathak *et al.,* 2005). Its cultivation has gained significance in Gujarat because of its wider adaptability to harsh edepho-climatic conditions; higher productivity and general freedom from sever attack of insect, pest and diseases. In the recent years, aonla has been identified as an ideal plant for various kinds of wastelands of arid and semi-arid ecosystem (Korwar *et al.,* 2006*;* Pathak and Pathak, 2001). The demand of *aonla* fruit is increasing day by day owing to its utilization in cosmetic, pharmaceutical and processing industries (Ranjan and Ghosh, 2006). Since *aonla* is consumed for its medicinal and nutraceutical properties, its organic production has gained great significance during the recent years.

In recent years, decline in soil health with respect to physical, chemical and biological properties is evident owing to indiscriminate use of fertlizers. Continuous use of chemical fertilizers without organic fertilizers causes problem of soil health, while use of organic fertilizers without augmentation of inorganic fertilizers may not be able to meet the high nutrient requirement of the crop due to low nutrient content and slow acting in nature. (Marathe *et al.,* 2009). Application of biofertilizers into the soil enhances microbial activity and soil fertility. Further, due to increase in the cost of chemical fertilizer coupled with their limited production, it has become essential to evolve low cost input management practices for sustainable production of quality fruit (Pathak, *et al.,* 2005 and Pathak, 2003). Like other crops, in aonla too, integrated nutrient management is the key factor to achieve higher yield per unit area with improved produce quality. Integrated nutrient management encourages integration of different sources of nutrients such as organic, biological and inorganic fertilizers etc. In view of the factors like increasing demand of organically grown fruits by consumers coupled with unsustainable productivity of fruits, organic farming is claimed to be most benign alternative, for which role of organic manure and biofertilizers become important for sustainable production with quality fruits. Keeping the utility of organically produced *aonla* in view, an experiment was initiated by integrating the microbial and chemical fertilizers to find out its effect on soil properties and plant health, fruit yield and quality of aonla variety AN-7.

## Material and Methods

A field experiment was conducted on *aonla* trees of

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*aonla* cv. NA-7 at Central Horticultural Experiment Station (CIAH), Vejalpur, Panchamahals (Godhra), Gujarat. The treatments were; $T_1$, standard dose of N P K, $T_2$, FYM + 50 % of recommended dose of N P K, $T_3$, FYM + *Azotobactor* + PSB, $T_4$, FYM + *Azospirillum* + PSB, $T_5$, FYM + *Azotobactor* + VAM, $T_6$, FYM + *Azospirillum* + VAM. Biofertlizers; A*zotobactor, Azospirillum*, PSB and VAM were applied @ 250g per tree/year soon after first rain in monsoon season. FYM @ 30 kg/tree and NPK @ 100, 75 and 50 g were applied during first year. The FYM @ 5 kg/ tree/ year and NPK doses were increased in same proportion every year. Thus the dose of FYM was applied @ 60 kg and 65 kg per tree during 2009-10 and 2010-11, respectively, while chemical fertilizer *viz*, N P K were applied at the rate of 700, 525 and 350 g / tree during 2009-10, and 800, 600 and 400 g/ tree during 2010-11, respectively in two split doses (last week of June and first week of September). The soil was analyzed for organic carbon, EC, $p^H$, N, P and K (Bhargava and Raghupati, 1393), and soil bulk density and hydraulic conductivity (Page *et al.*, 1982) before the initiation of the experiment. The soil was characterized with low organic carbon (4.3g $kg^{-1}$), low N (180.65 kg $ha^{-1}$) and medium K (115.10 kg $ha^{-1}$) and medium P (11.00 kg $ha^{-1}$). The initial values of pH, EC, Bulk density, hydraulic conductivity (H.C.) were recorded to the tune of 7.60, 0.13 dS $m^1$, 1.39 Mg $m^{-1}$and H. C. 0.32 cm / hr, respectively. The experiment was laid out in randomized block design with six treatments and four replications considering two plants as unit. The soil depth ranged from 0.70 to 1.0 m and it is derived from mixed alluvial basalt, quartzite, granite, and layers of limestone, and the region falls under semi-arid hot climate. The uniform cultural practices were applied to the experimental trees, which were grown purely under rainfed condition of hot semi-arid ecosystem of western India.

**Results and Discussion**

Perusal of data indicated that the physico-chemical properties of soil were influenced significantly by use of different kind of sources of nutrients (Table 1). The results of the study of various organic and inorganic sources of nutrients on soil reaction (pH) revealed that the treated basin soil declined from its initial value of 7.60 to 6.60, 6.70, 6.71 and 6.72 during 2009-10 whereas it was declined from its initial value to 6.52, 6.62, 6.64 and 6.65 during 2010-11with $T_5$, $T_3$, $T_6$ and $T_4$, respectively while pH of the basin soil was not influenced significantly with the application of NPK alone ($T_1$). The EC of the soil decreased from its initial value 0.13 dS $m^{-1}$ to 0.11 and 0.10 dS $m^{-1}$ in being lowest in $T_6$, but the differences among the treatments were found to be non significant. This decrease in soil pH and EC may be attributed to the continuous use of organic manure which releases various organic acids upon its decomposition and leaching of salts to the lower layers of the soil during rainy season. A decrease in pH of soil under Farm Yard manure may be due to the activation of $Al^{3+}$ and continuous release of basic cation upon its decomposition and gravitational movement of those cations in to lower horizons of soil. These results are in close conformity with the findings of Marathe *et al. (2009*) and Srikanth *et al*. (2000). In the tree basin, addition of Farm Yard Manure and biofertlizers decreased the bulk density from its initial value1.39 Mg $m^{-3}$ to 1.28, 1.29, 1.32 and 1.33 Mg $m^{-3}$ in 2009-10 with the treatments $T_5$,$T_3$, $T_6$ and $T_4$ and 1.25,1.27,1.25,1.30 Mg $m^{-3}$ in 2010-11 with $T_5$, $T_3$,$T_4$ and $T_6$, respectively, while bulk density was recorded maximum in $T_1$(1.36 Mg $m^{-3}$) which may be due to increase in organic matter in soil. Hydraulic conductivity was observed the highest in FYM + *Azotobactor* + VAM ($T_5$) followed by FYM + *Azotobactor* + PSB ($T_3$) and it was recorded lowest in $T_1$ (NPK alone). The bulk density and hydraulic conductivity were not much influenced by treatments comprising the inorganic sources of nutrients ($T_1$). The results suggested that the application of manures reduced the bulk density and compactness of the soil particles and improved the hydraulic conductivity. These findings are in agreement with the results of Srikanth *et al.* (2000) and Ram and Rajput (2000). Organic carbon and NPK content of basin soil was enhanced by the application of various types of manure used in different combinations (Table 2). The organic carbon increased from its initial value 4.30 g $kg^{-1}$ to 5.25, 5.20, 5.15, 5.10, 5.00 and 4.33 $kg^{-1}$ (2009-10) and 5.35, 5.30, 5.23 5.21, 5.20 and 4.40 $kg^{-1}$ in the treatment $T_6$, $T_3$, $T_4$, $T_6$, $T_2$ and $T_1$, respectively, which may be due to application of farmyard manure and different biofertilizers. However, maximum build up of organic carbon was observed in FYM + *Azotobactor* + VAM ($T_5$), which were found to be 22.09 and 24.41 per cent increment from their initial value. Organic manure may have increased organic carbon content by adding organic matter directly in the basin soil. These results are in accordance with the findings reported by Korwar *et al.* (2006). Available N was recorded maximum with the application of standard dose of NPK ($T_1$) followed by FYM+ 50 % of the standard dose of NPK ($T_2$), FYM + *Azotobactor* + VAM ($T_6$) and FYM + *Azotobactor* + PSB ($T_3$). Addition of organic manure improved the physical properties of soil thus creating favourable conditions for microbial activity resulting to an increase in the nutrient availability. These

Table 1. Effect of various organic and inorganic sources of nutrients on physical properties of soil.

| Treatments | pH(1:2:5) | | | EC (dS $m^{-1)}$ | | | Bulk density (Mg $m^{-3}$) | | | H.C. (cm/hr) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2009-10 | 2010-11 | Mean | 09-10 | 10-11 | Mean | 09-10 | 10-11 | Mean | 09-10 | 10-11 | Mean |
| $T_1$ | 7.25 | 7.30 | 7.28 | 0.13 | 0.12 | 0.125 | 1.37 | 1.35 | 1.36 | 0.35 | 0.37 | 0.360 |
| $T_2$ | 6.85 | 6.73 | 6.79 | 0.12 | 0.11 | 0.115 | 1.33 | 1.30 | 1.32 | 0.41 | 0.41 | 0.410 |
| $T_3$ | 6.70 | 6.62 | 6.66 | 0.12 | 0.10 | 0.110 | 1.29 | 1.27 | 1.28 | 0.42 | 0.44 | 0.430 |
| $T_4$ | 6.72 | 6.65 | 6.68 | 0.11 | 0.11 | 0.110 | 1.32 | 1.30 | 1.31 | 0.40 | 0.43 | 0.420 |
| $T_5$ | 6.60 | 6.52 | 6.56 | 0.11 | 0.10 | 0.105 | 1.28 | 1.25 | 1.26 | 0.45 | 0.47 | 0.460 |
| $T_6$ | 6.71 | 6.64 | 6.67 | 0.12 | 0.11 | 0.110 | 1.32 | 1.30 | 1.31 | 0.43 | 0.44 | 0.435 |
| C D at 5% | 0.38 | 0.32 | ----- | NS | NS | --- | 0.06 | 0.05 | --- | 0.09 | 0.07 | ---- |

findings are in agreement with the results of Srikanth *et al*. (2000), Yaday *et al*., 2007 and Ranjan and Ghosh (2006). Available P concentration increased to 16.00, 15.50, 15.25, 14.78 kg per ha from the initial value 11.00 kg per ha in $T_1$, $T_2$, $T_5$ and $T_3$, respectively in 2009-10, while it was increased from its initial value 11.00 kg per ha to 19.85, 17.00, 16.80, 16.12, 15.43 and 15.00 kg per ha with the treatments $T_1$, $T_2$, $T_5$, $T_3$, $T_4$, and $T_6$, respectively in 2010-11. Release of P in the soil from unavailable to available forms because of reaction of organic acids produced after decomposition of organic manure. More or less similar results have been reported by Korwar *et al.* (2006) and Srikanth *et al*. (2000). The average increase in available K was observed the maximum in standard dose of NPK($T_1$), whereas it increased from initial value 116.60 to 129.31, 123.28 and 121.36 kg per ha in $T_1$, $T_2$ and $T_5$, respectively. There was slight increase in soil K content might be due to release of fixed K owing to reaction of organic acids. These results are in consonance with the findings as reported by Korwar *et al.* (2006), Manjunath *et al*., (2006), Ranjan and Ghosh (2006) and Patel *et al*. (2010).

An effect of application of various kinds of manures, biofertilizers and fertilizers significantly influenced the vegetative growth of plant (Table 3). Among the different combinations of organic and inorganic sources of nutrients evaluated, the growth in terms of plant height, root stock girth, scion girth and plant spread was recorded the highest from the plants treated with standard dose of NPK ($T_1$) followed by FYM + 50 % of standard dose of NPK ($T_2$), FYM + *Azotobactor* +VAM ($T_5$) and the minimum growth was recorded with FYM + *Azospirillim* +VAM ($T_4$). The average annual extension of plant height (61.25 cm), rootstock girth (5.57 cm), scion girth (4.77 cm) and plant spread (50.85 cm) were recorded with $T_1$ followed by $T_2$, $T_5$ and $T_3$.The plant height (57.47cm), was recorded minimum in $T_6$, while root stock girth (5.04 cm), scion girth (3.94 cm)and plant spread (43.03 cm) were the minimum in $T_4$. Differences in the growth among various treatments might be due to availability of nutrients by various sources of nutrients. These results are in accordance with the findings reported by Korwar *et al.* (2006), Balota *et al.* (1995), Patel *et al.* (2009), Dev *et al.*, (2005), Pathak and Tiwari (2002) and Srikanth *et al.* (2000).

Thus, it may be concluded from the present study that the use of Farm Yard Manure, biofertilizers and NPK in different combinations improved the soil physico-chemical properties and nutrients availability to the plants, which resulted into better plant growth of aonla variety NA-7 under rainfed conditions of hot semi-arid ecosystem.

Table 2. Effect of various organic and inorganic sources of nutrients on chemical pro perties of soil.

| Treatments | O.C. (g kg$^{-1}$) | | | Available N(kg ha$^{-1}$) | | | Available P (kg ha$^{-1}$) | | | Available K(kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2009-10 | 2010-11 | Mean | 09-10 | 10-11 | Mean | 09-10 | 10-11 | Mean | 09-10 | 10-11 | Mean |
| $T_1$ | 4.33 | 4.40 | 4.36 | 200.35 | 208.35 | 204.35 | 16.00 | 19.85 | 17.93 | 128.45 | 130.16 | 129.31 |
| $T_2$ | 5.00 | 5.20 | 5.10 | 196.14 | 205.14 | 200.64 | 15.50 | 17.00 | 16.25 | 121.43 | 125.12 | 123.28 |
| $T_3$ | 5.20 | 5.30 | 5.25 | 192.13 | 196.13 | 194.13 | 14.78 | 16.12 | 15.45 | 116.00 | 123.52 | 119.76 |
| $T_4$ | 5.15 | 5.23 | 5.19 | 191.15 | 195.00 | 193.07 | 13.00 | 15.43 | 14.22 | 117.84 | 121.45 | 119.64 |
| $T_5$ | 5.25 | 5.35 | 5.30 | 194.15 | 198.00 | 196.08 | 15.25 | 16.80 | 16.03 | 118.00 | 124.72 | 121.36 |
| $T_6$ | 5.10 | 5.21 | 5.16 | 190.00 | 194.15 | 192.08 | 13.87 | 15.00 | 14.44 | 115.89 | 120.00 | 117.95 |
| C D at 5% | 0.20 | 0.23 | ------ | 8.40 | 7.50 | ------ | 1.35 | 1.48 | ------ | 8.30 | 8.91 | ------ |

Table 3. Effect of various sources of nutrients on annual extension of vegetative growth of aonla (2009-2011).

| Treatments | Plant height (cm) | | | Root stock girth (cm) | | | Scion girth (cm) | | | Plant spread (cm) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2009-10 | 2010-11 | Mean | 09-10 | 10-11 | Mean | 09-10 | 10-11 | Mean | 09-10 | 10-11 | Mean |
| $T_1$ | 60.15 | 62.34 | 61.25 | 5.53 | 5.60 | 5.57 | 4.13 | 5.40 | 4.77 | 50.00 | 51.70 | 50.85 |
| $T_2$ | 59.00 | 61.00 | 60.00 | 5.40 | 5.30 | 5.35 | 4.10 | 5.20 | 4.65 | 49.55 | 49.12 | 49.33 |
| $T_3$ | 58.14 | 59.12 | 58.63 | 5.00 | 5.23 | 5.12 | 3.95 | 4.05 | 4.00 | 46.00 | 47.03 | 46.51 |
| $T_4$ | 55.14 | 56.12 | 55.63 | 4.90 | 5.19 | 5.04 | 3.88 | 4.00 | 3.94 | 42.00 | 44.05 | 43.02 |
| $T_5$ | 59.73 | 59.95 | 59.84 | 5.43 | 5.50 | 5.47 | 4.00 | 4.09 | 4.05 | 47.34 | 48.13 | 47.73 |
| $T_6$ | 56.15 | 58.79 | 57.47 | 5.12 | 5.00 | 5.06 | 3.87 | 4.02 | 3.95 | 43.00 | 45.50 | 44.25 |
| C D at 5% | 2.45 | 2.63 | --------- | 0.42 | 0.46 | --------- | 0.22 | 0.26 | --------- | 2.36 | 2.75 | --------- |

## Reference


Balota, E. L., Lopes, E.S., Hungria, M. and Dobereiner, J. 1995. Interactions and physiological effect of diazotrophic bacteria and arbuscular mycorrhizal fungi in cassava plants. *Pesq. Agropec. Bras*., 30:1335-45.

Bhargava, B. S. and Raghupati, H. B. 1993. Analysis of plant material for macro and micronutrients. Tondon (Ed) Methods of analysis of soil plant water and fertilizer. *Fertilizer Development and Consultation Organization,* New Delhi. pp. 49-82.

Dey, P., Raj, M., Kumar, S., Nath V., Das, B. and Reddy, N.N. 2005. Effect of bio-fertilizer on physico-chemical characteristics of guava (*Psidum guajava* L.) fruit. *Indian J. Agric. Sci.*, 75: 95-96.

Korwar, G. R., Pratibha, G. Ravi, V. and Palanikumar, D. 2006. Influence of organic and inorganic on growth, yield of aonla (*Emblica officinalis* Gaertn) in semi arid tropics. *Indian J. Agric. Sci.*, 76: 457-61.

Manjunatha, Hebbara, Ganiger, V. M., Reddy, B. G. M. and Joshi, V. R. 2006. Integrated nutrient management in sapota (*Manilkara sapota)* using vermicompost

to increase yield and quality of fruits. *J. Agric. Sci.*, 76: 587-90.

Marathe, R.A., Bharambe, P.R., Sharma, R. and Sharma, U.C. 2009. Soil properties of vertisol and yield of sweet orange (*Citrus sinensis)* as influenced by integrated use of organic manures, inorganic and biofertilizers. *Indian J. Agric. Sci.*, 79: 3-7.

Page, A. L., Miller R. H. and Keeney, D. R. 1982. Method of soil analysis (Eds), Part 1 & 2, chemical and microbial properties. American Soc. Agron. Madison, Wiscosin, USA.

Patel, V. B., Singh, S. K., Ram Asrey, Lata, Nain, Singh, A. K. and Singh, L. 2009. Microbial and inorganic fertilizers application influenced vegetative growth, yield, leaf nutrient status and soil microbial biomass in sweet orange. *Indian J. Hort.*, 66:163-68.

Patel, V. B., Singh, S. K., Ram Asrey and Sharma, Y. K. 2005. Response of organic manures and biofertilizer on growth, fruit yield and quality of Amrapali mango under high-density orcharding. *Karnataka J. Hort.*, 1: 51-56.

Pathak, R. K.and Pathak, S. 2001. Fruit production in problematic soil. *Indian J. Hort.*, 58: 16-22.

Pathak, R. K. and Tiwari, R. K. 2002. Cost effective comprehensive technology for aonla cultivaion in sodic soils. (In) Workshop on recent advances in sodic land reclamation technology, UPCAR, Lucknow, pp55-60.

Pathak, R. K. Ram, R. A. and Shukla, S. K. 2005.Cultivating aonla organically. *Indian Hort.*, 50:4-9.

Pathak, R. K. 2003. Status Report on Genetic Resources of Indian Gooseberry- Aonla (*Emblica officinalis* Gaertn) in South and Southeast Asia. IPGRI, New Delhi, pp. 89.

Ram, R. A. and Rajput, M. S. 2000. Role of biofertilizers and manures in production of guava (*Psidium guajava* L.) Allahabad Safeda. *Haryana J. Hort. Sci.*, 29: 193-94.

Ranjan, Tarai and Ghosh, S. N. 2006. Integrated nutrient management in sweet orange cv. Mosambi (*Citrus sinensis* Osbeck.). *Orissa J. Hort.*, 34:72-75.

Srikanth, K. C. Srinivasamurthy A. Siddaramappa R. and Ramkrishnaparama V. R. 2000. Direct and residual effect of enriched compost, FYM, vermicompost and fertilizers on alfisols. *J. Indian Soc. Soil Sci.*, 48:496-99.

Tarai, R. K. and Ghosh, S. N. 2005. Effect of N level on yield fruit quality and foliar NPK status of aonla grown on laterite soil. *Indian J. Hort.*, 62: 394-95.

Yadav, Rajesh, Baksh, Hari, Singh, H. K. And Yadav, A. L. 2007. Effect of integrated nutrient management on productivity and quality of aonla (*Emblica officinalis* Gaertn.) cv. Narendra Aonla-7. *Plant Arch.*, 7: 881-83.