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# Effect of Integrated Nutrient Management on Flowering and Fruiting Behavior of Aonla Cv. Francis

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The present investigation was carried with aim to know the effect of integrated nutrient management on fruiting of aonla cv. Francis. The experiment was conducted in two consecutive years. The experiment comprised of ten treatments, replicated thrice with randomized block Design. The study revealed the fruit set and retention per cent for both the year was noted maximum with the use of $T_7$, whereas $T_6$ was found to equally good with $T_1$. The maximum fruit size was recorded with the use of $T_7$ during both the year which was at par with the soil application $T_6$. The study concluded that the application of 75% RDF + 30 kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB produced quality fruit yield.

*Keywords: INM; fruit set; fruit retention; fruit and fruit size; Aonla.*

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## 1. INTRODUCTION

In the realm of horticulture and agriculture, optimizing crop productivity and enhancing fruit quality have always been paramount goals for researchers and cultivators alike. Aonla (*Emblica officinalis* Gaertn.), commonly known as Indian Gooseberry, is a commercially significant fruit tree species that holds immense value in traditional medicine, food processing, and the nutraceutical industry. Among the diverse Aonla cultivars, the variety "Francis" stands out for its exceptional attributes, making it an intriguing subject for scientific investigation. It has been grown and known in India for last more than 3500 years. In fact, it finds a special mention in ancient Indian text 'Ayurveda' by Sushruta, the father of ancient medicine during 1500 BC-1300 BC. The aonla tree is native to tropical Southeast Asia, particularly central or southern India, Pakistan, Bangladesh, Sri Lanka, Malaya, Southern China and to Mascarene Islands and it is also growing naturally in Cuba, Hawaii, Florida, Iran, Iraq, Java, West Indies, Trinidad, Singapore, southern Thailand, Pakistan, Malaya and China and Panama Canal regions. In India, aonla seedling trees are of common occurrence in the mixed deciduous dry forests ascending from sea level (Western and Eastern ghats, Aravali and Vindhyan hills) to 1300 m amsl, from northwest Himalayas (Jammu & Kashmir, Himachal Pradesh, Uttarakhand) to eastern Himalayas in Assam, Meghalaya, Mizoram, Manipur and Tripura. India ranks first in production of aonla. It occupies an area of 94 thousand hectares with a production of 1098 thousand metric tone [1]. In Jammu and Kashmir State, aonla successfully grown in Kathua, Samba, Akhnoor, parts of Udhampur and Reasi districts on an area of 1701 hac. with annual production of 3780 metric tons, respectively [2]. Aonla is richest source of vitamic C among fruits next to Barbados Cherry. Due to its maximum capacity of productivity per unit area, hardy in nature, highest medicinal value and extensiveuses, particularly under wasteland conditions, in salt affected soils, the area under aonla cultivation is increasing in the India. Aonla is considered as ideal crop for arid and semi-arid regions. Due to its importance and medicinal uses, it is also known as "Amrit Phal" and "Wonder Drug" [3].

In Uttar Pradesh Aonla cultivation is maximum in belt of Pratapghar and Faizabad district. The area under the production of Aonla is 15.75 ('000Ha), production is 63.00 ('000MT) and productivity is about 4.0 (MT/Ha). Pratapgarh is a leading district of aonla cultivation on commercial scale throughout the country (Pathak et al. 1993). In last two decades, there has been tremendous increase in the area under aonla cultivation across the country, utilizing the wasteland. This has resulted in efficient utilization of resources leading to better income to farmers, nutritional security coupled with enhanced employment and rehabilitation of wastelands (Singh et al. 2014c).

In recent years, the importance of integrated nutrient management (INM) strategies has gained prominence in sustainable agriculture practices. INM involves the judicious integration of various sources of nutrients, such as organic manures, chemical fertilizers, and biofertilizers, to achieve balanced nutrition, enhance soil health, and maximize crop yield [4-6]. Soil type,fertility and nutrient management play important roles in obtaining higher growth and yields of aonla. Now a days cost of inorganic fertilizers are gradually increasing. Indiscriminate use of chemical fertilizers, pesticides, weedicides etc. over the last four decades had adversely affected the soil fertility, soil quality, water quality, fruit size,yield and quality of the produce and increased level of resistance in pests (Kalloo, 2003). To maintain soil health and production quality more emphasis should be given on organic nutrients for better soil health andimproved production. The integrated nutrient management paves a way to overcome of these pollutions and maintain fruit quality as well as productivity. Therefore, efficient use of integrated plant nutrient supply system is a prerequisite for achieving continuous advances in productivity of fruits crops in ecologically sustainable manner [7]. This calls for moving away from chemical agriculture and embracing organic matter management, which improves all soil properties and brings nitrogen and phosphorus through organic manures and useful microorganisms. INM is the best approach for sustainable crop production. The flowering and fruiting stages of a plant's life cycle are critical periods, directly influencing the eventual yield and quality of fruits [8,9]. Thus, investigating the impact of INM on the flowering and fruiting behavior of Aonla Cv. Francis can provide valuable insights into optimizing its productivity and overall performance. This research paper aims to delve into the effects of INM on the flowering and fruiting characteristics of Aonla Cv. Francis. By comprehensively evaluating the responses of this cultivar to different nutrient management approaches, this study intends to contribute vital

knowledge that could help horticulturists, farmers, and agricultural researchers make informed decisions about sustainable practices for Aonla cultivation.

## 2. MATERIALS AND METHODS

The investigation was laid out at Main Experiment Station (MES) Horticulture Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) on 28-year-old plants of aonla uniformly healthy and well-maintained square system of an orchard.The climatic condition of experimental site comes under the semi-arid comprising of three district seasons viz rainy or wet, winter and summer or hot. The rainy season starts from the last week of June to last September or extends up to October with an average rainfall of 1200 mm. Sporadic rains also occur during winter. The winter season starts from November and continuous up to the first week of March with mean temperature ranging from 15-25°C. The month of December and January are very coldduring December minimum temperature is about 7.5-5.9ºC while January is the coldest month with a lower temperature up to 6.4-5.0ºC. The hot season prevails from April to June. The temperature during summer is intense and recording a little below 45°C. The relative humidity during summer <2- varies from 35 to 60 per cent. Severe drought occurs quite frequently A accompanied by very low relative humidity, sensitive and wind velocity. There were thirteen treatment viz.,T1:100% RDF (Recommended Dosage of Fertilizer) (1:0.5:1: N: P: K + 10kg Farm Yard Manure (FYM) plant$^{-1}$), T2:75% RDF + 10 kg Vermicompost, T3:75% RDF + 10 kg Vermicompost + 250 g Azotobacter + 250 g PSB, T4:75% RDF + 20 kg Vermicompost, T5:75% RDF + 20 kg Vermicompost + 250 g Azotobacter + 250 g PSB,T6:75% RDF + 30 kg Vermicompost, T7:75% RDF + 30 kg Vermicompost+ 250 g Azotobacter+ 250 g PSB, T8:50% RDF + 10 kg Vermicompost, T9:50% RDF + 10 kg Vermicompost + 250 g Azotobacter + 250 g PSB, T10:50% RDF + 20 kg Vermicompost, T11:50% RDF + 20 kg Vermicompost + 250 g Azotobacter + 250 g PSB (Phosphate Solubilizing Bacteria), T12:50% RDF + 30 kg Vermicompost,T13:50% RDF+ 30 kg Vermicompost + 250 g Azotobacter + 250 g PSB. Observations was recorded on the basis of following procedure-

**Fruit set (%):** It is calculated as the number of fruit set, divided by the number of flowers appeared. It is expressed in percentage.

$$Fruitset = \frac{Numberofsetflower}{Totalnumberofflowersmarked} \times 100$$

**Fruit Retention (%):** It were computed as the number of fruits retained till maturity divided by the number of fruit sets and expressed in per cent.

$$\text{Fruit retention\%} = \frac{\text{Number of fruit retained till maturity}}{\text{Number of fruit set}} \times 100$$

**Fruit Yield (kg/plant):** At time of fruit harvesting Fruit yield/ plant (kg) are recorded with the help of balance.

**Fruit Weight (g):** Weight of five fruits are taken on balance and the average value are expressed in gram.

**Analysis of Data:** The two years data obtained during experimentation were statistically analysed as per the method given by Panse and Sukhatme (1985) and the result were evaluated at 5% level of significance.

The standard error (SEm±) for the difference of treatment means were computed as follows.

$$\text{SEm}\pm = \sqrt{\frac{2\text{MSE}}{\text{r}}}$$

Where,

MSE= Mean sum squares due to error
r= number of replication

The calculation of CD at 5% of table value were carried out with the help of following formula.

SEm± = Standard error of the mean

CD = SEm± × t value at 5%
CD = Critical difference

## 3. RESULTS AND DISCUSSION

Perusal of data indicated that the in Table 1 is highest fruit set and fruit retention percentage was recorded with the application of $T_7$(75% RDF + 30 kg Vermicompost+ 250 g Azotobacter+ 250 g PSB,) which was at par with $T_6$(75% RDF + 30kg Vermicompost) and both treatment were significantly superior over rest of the treatments. It may be due to supply of all the plant nutrient and growth hormones in optimum amount and proportion right from starting of the experimentation to the harvest of the crop, which

**Table 1. Effect of Integrated nutrient management on fruit set, fruit retention and fruit yield of aonla**

| Treatments | | Fruit set (%) | | Fruit retention (%) | | Fruit yield (kg/plant) | |
|---|---|---|---|---|---|---|---|
| | | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 |
| $T_1$ | 100% RDF (1:0.5:1: N: P: K + 10 kg FYM plant$^{-1}$) | 22.00 | 64.80 | 64.80 | 10.56 | 64.80 | 66.72 |
| $T_2$ | 75% RDF + 10 kg *Vermicompost* | 22.75 | 66.96 | 66.96 | 10.92 | 66.96 | 69.00 |
| $T_3$ | 75% RDF + 10 kg *Vermicompost*+ 250 g *Azotobacter*+ 250 g PSB | 26.00 | 75.28 | 75.28 | 12.48 | 75.28 | 76.92 |
| $T_4$ | 75% RDF + 20 kg *Vermicompost* | 24.25 | 71.40 | 71.40 | 11.64 | 71.40 | 73.52 |
| $T_5$ | 75% RDF + 20 kg *Vermicompost* + 250 g *Azotobacter* + 250 g PSB | 27.75 | 79.20 | 79.20 | 13.32 | 79.20 | 8095 |
| $T_6$ | 75% RDF + 30 kg *Vermicompost* | 25.00 | 73.16 | 73.16 | 12.00 | 73.16 | 75.84 |
| $T_7$ | 75% RDF + 30 kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB | 28.50 | 85.00 | 85.00 | 13.68 | 85.00 | 90.89 |
| $T_8$ | 50 % RDF + 10kg *Vermicompost* | 22.50 | 66.24 | 66.24 | 10.80 | 66.24 | 68.24 |
| $T_9$ | 50% RDF + 10kg *Vermicompost*+ 250 g *Azotobacter*+ 250 g PSB | 25.50 | 73.76 | 73.76 | 12.24 | 73.76 | 77.32 |
| $T_{10}$ | 50% RDF + 20 kg *Vermicompost* | 23.25 | 68.40 | 68.40 | 11.16 | 68.40 | 70.56 |
| $T_{11}$ | 50% RDF + 20 kg *Vermicompost*+ 250 g *Azotobacter*+ 250 g PSB | 26.50 | 76.90 | 76.90 | 12.72 | 76.90 | 77.76 |
| $T_{12}$ | 50% RDF + 30 kg *Vermicompost* | 23.75 | 69.92 | 69.92 | 11.40 | 69.92 | 72.00 |
| $T_{13}$ | 50% RDF+ 30 kg *Vermicompost*+ 250 g *Azotobacter*+ 250 g PSB | 27.25 | 77.03 | 77.03 | 13.08 | 77.03 | 80.72 |
| | SEm ± | 1.08 | 1.28 | 1.28 | 0.45 | 1.28 | 1.27 |
| | CD | 3.15 | 3.74 | 3.74 | 1.39 | 3.74 | 3.71 |

**Table 2. Effect of Integrated nutrient management on fruit length, width and weight of Aonla**

| 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 + 10 kg FYM plant $^{-1}$ ) | 3.56 | 3.70 | 3.46 | 3.59 | 35.90 | 37.31 |
| $T_2$ | 75 % RDF + 10 kg *Vermicompost* | 3.69 | 3.80 | 3.57 | 3.71 | 37.13 | 38.58 |
| $T_3$ | 75% RDF + 10 kg *Vermicompost*+ 250 g *Azotobacter* + 250 g PSB | 4.21 | 4.37 | 4.09 | 4.24 | 42.43 | 44.10 |
| $T_4$ | 75% RDF + 20 kg *Vermicompost* | 3.93 | 4.07 | 3.81 | 3.95 | 39.58 | 41.13 |
| $T_5$ | 75% RDF + 20 kg *Vermicompost* + 250 g *Azotobacter* + 250 g PSB | 4.50 | 4.66 | 4.36 | 4.52 | 45.29 | 47.06 |
| $T_6$ | 75% RDF + 30 kg *Vermicompost* | 4.05 | 4.20 | 3.93 | 4.07 | 42.16 | 43.81 |
| $T_7$ | 75% RDF + 30 kg *Vermicompost*+ 250 g *Azotobacter*+ 250 g PSB | 4.62 | 4.79 | 4.48 | 4.64 | 46.51 | 48.34 |
| $T_8$ | 50% RDF + 10 kg *Vermicompost* | 3.65 | 3.78 | 3.54 | 3.67 | 36.72 | 38.16 |
| $T_9$ | 50% RDF + 10 kg *Vermicompost*+ 250 g *Azotobacter*+ 250 g PSB | 4.13 | 4.28 | 4.01 | 4.16 | 41.62 | 43.25 |
| $T_{10}$ | 50% RDF + 20 kg *Vermicompost* | 3.77 | 3.91 | 3.65 | 3.79 | 37.94 | 39.43 |
| $T_{11}$ | 50% RDF + 20 kg *Vermicompost*+ 250 g *Azotobacter*+ 250 g PSB | 4.29 | 4.45 | 4.16 | 4.32 | 43.25 | 44.94 |
| $T_{12}$ | 50% RDF + 30 kg *Vermicompost* | 3.85 | 3.99 | 3.73 | 3.87 | 38.76 | 40.28 |
| $T_{13}$ | 50% RDF+ 30 kg *Vermicompost*+ 250 g *Azotobacter*+ 250 g PSB | 4.41 | 4.58 | 4.28 | 4.44 | 44.47 | 46.22 |
| | SEm ± | 0.19 | 0.17 | 0.15 | 0.17 | 1.579 | 1.604 |
| | CD | 0.56 | 0.49 | 0.45 | 0.50 | 4.608 | 4.680 |

induces the more flowering and retention of fruit due to production and supply of photosynthesis at critical requirement. The results are in conformed with the findings of Pereira and Mitra [10] and Huchcheet et al., [11]. The fruit length and fruit width were also influenced significantly as treatment applied. It was noted maximum with the use of $T_7$ (75% RDF + 30 kg Vermicompost+ 250 g Azotobacter+ 250 g PSB,). Application of $T_6$ (75% RDF + 30 kg Vermicompost) was found at par with T1 (100% RDF (1:0.5:1: N: P: K + 10kg Farm Yard Manure plant$^{-1}$) and proved equally good. The increase in individual fruit weight due to the optimum supply of plant nutrient and growth hormones in precise amount during entire crop period caused more vegetative growth, ultimately more photosynthesis, resultant more fruit length, weight and diameter. Pereira and Mitra [10] reported highest average fruit weight with the integration of 75 g+100 g+75 g NPK kg/ha+1.5 kg neem cake/plant and Yadav et al. [12] also reported maximum fruit length, width and fruit weight in aonla with the soil application of 50%NPK+100 kg FYM+200 g each Azotobacter + Azospirillum+PSB+25 g sulphur. Integrated nutrient management significantly influenced the yield parameters over the control, prove by Aal et al. [13].

Among the treatments the maximum fruit yields were recorded with the soil application of T6 50%NPK+50% FYM+250 g each (Azotobacter+ Azospirillum +PSB) being at par with $T_5$ 75%NPK+25% FYM+250 g each (Azotobacter+ Azospirillum +PSB) and both are significantly superior. The enhancement in yield mainly because of proper supply of nutrients and induction of growth hormones, which stimulated cell division, cell elongation, increase in number of fruit and weight, ultimately increased fruit yield. Similar findings were also reported by Yadav et al., [14] and Babu and Sharma [15]. Likewise Tiwari et al. (1999) also reported maximum fruit yield in banana with the soil application of bio-fertilizer particularly inoculation with Azospirillum could be substitute 50%N requirement. The present findings are also supported with the results of Bahadur and Manohar [16], Ram and Raj Paut [17]. The increase in yield parameter in present investigation with the application on of NPK + biofertilizers might be due to its dual role in nitrogen fixation and production of phyto hormones and increase uptake of nutrient.

## 4. CONCLUSION

On the basis of findings of present investigation that the maximum increment in term of plant height, spread of plant, fruit set, retention per cent, fruit size, fruit weight and fruit yield were noted with the soil application of $T_7$is maximum during both year which was found at par with $T_5$ ,$T_{11}$and $T_{13}$ . The minimum per cent increment was noticed with the use of T1. So that it is concluded that treatments $T_7$ (75% RDF + 30 kg *Vermicompost*+ 250g *Azotobacter*+ 250g PSB) recorded maximum vegetative growth, yield and fruit quality and cost benefit ratio of aonla can be recommended to aonla growers of eastern Uttar Pradesh for obtaining maximum yield with quality fruits. Understanding the impact of integrated nutrient management on the flowering and fruiting behavior of Aonla Cv. Francis can pave the way for more efficient and eco-friendly approaches to fruit cultivation. It is hoped that this research will not only benefit the Aonla industry but also contribute to the broader realm of sustainable agriculture and horticulture.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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