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Govind Vishwakarma
Deptt. of Horticulture, N.D.U.A. & T., Kumarganj-Faizabad, U.P, India

AL Yadav
Deptt. of Horticulture, N.D.U.A. & T., Kumarganj-Faizabad, U.P, India

DK Yadav
Deptt. of Horticulture, N.D.U.A. & T., Kumarganj-Faizabad, U.P, India

Deepti Srivastava
Institute of Agriculture Science, B.H.U., Varanasi, UP, India

Correspondence
Govind Vishwakarma
Deptt. of Horticulture, N.D.U.A. & T., Kumarganj-Faizabad, U.P, India

Effect of integrated nutrient management on vegetative growth, yield and yield attributing characters of bael (*Aegle marmelos* Correa) *cv.* Narendra Bael-9

Govind Vishwakarma, AL Yadav, DK Yadav and Deepti Srivastava

Abstract
The present investigation was carried out at Main Experiment Station, Horticulture, Narendra Deva University of Agriculture and Technology, Kumarganj Faizabad (U.P.) under sodic soil condition during the years 2014-15 and 2015-16 to evaluate the response of organic manure, inorganic fertilizer and bio-fertilizer on growth, yield and yield attributing characters. The experiment keeps nine treatments *viz.* T_1-100% NPK, T_2-50 Kg FYM, T_3-50 Kg FYM + 100% NPK, T_4-50 Kg FYM + 75% NPK, T_5-50 Kg FYM + 50% NPK, T_6-50 Kg FYM + 200g each (*Azotobacter* + PSB), T_7-50 Kg FYM + 100% NPK + 200g each (*Azotobacter* + PSB), T_8-50 Kg FYM + 75% NPK + 200g each (*Azotobacter* + PSB) and T_9-50 Kg FYM + 50% NPK + 200g each (*Azotobacter* + PSB) and these treatments were replicated four times. The growth character like plant height, plant girth and plant spread (East-West and North-South) flowering and fruiting behaviuor like number of flower per shoot, fruit set, fruit retention, fruit yield were noted maximum with minimum fruit drop by the use of 50 Kg FYM + 100% NPK + 200g each (*Azotobacter* + PSB) followed by the application of T_8-50 Kg FYM + 75% NPK + 200g each (*Azotobacter* + PSB) and T_3-50 Kg FYM + 100% NPK than other treatments. The treatment of T_2-50 Kg FYM was recorded the lowest results as comparatively all other treatments.

Keywords: Organic manures, Inorganic fertilizer, Bio-fertilizers, FYM, NPK, Bael

Introduction
The bael (*Aegle marmelos* Correa) is an important fruit of India, which belongs to family Rutaceae. It has been known in India from prehistoric times and has a great mythological significance. It is regarded as sacred tree for Hindus, because worship of Lord Shiva's cannot be accomplished without its leaves. The bael has been frequently mentioned in Ramayana, Yajurveda, Buddhist and Jain literature. It is known with different names in different languages; Bel, Beli, Belgiri (Hindi), Shivadruma, Shivapahala, Vilva (Sanskrit), Bael, (Assamese and Marathi), Bilvaphal (Gujrati), Marredy (Malayam), Belo (Oriya), Vilvom, Vilva marum (Tamil) and Bilva pandu (Telgu). Every part of plant such as fruit, seed, bark, leaf, flower and root are important ingredients of several traditional formulations. The twigs and leaves are used as fodders, sweet scented water is distilled from the flower, and leaf juice is applied to body before taking a bath to remove the bad smell. The most valuable part of the tree is fruit due to its curative properties. It is one of the most useful medicinal plants of India from pre-historic time and has been essential in the ancient system of medicinal "Ayurveda". The bael fruit is highly nutritious. Physico-chemical studies have revealed that bael fruit is rich in mineral and vitamin contents like Vitamin A, B and C and high content of carbohydrates. The ripe fruit is a tonic as restorative, laxative and good for heart and brain problems. No other fruits have such a high content of Riboflavin, Marmelosin ($C_{14}H_{12}O_4$) is most probably the therapeutically activity principle of bael fruits. Bael seedling (Deshi) tree takes 7-8 years to commence in bearing while budded plants start bearing from fourth year after planting. It grows throughout the Indian peninsular as well as in Sri Lanka, Pakistan, Bangladesh, Burma, Thailand and most of the south east Asian countries, the tree are found in the wild states in Utter Pradesh, Orissa, Bihar, West Bengal, Madhya Pradesh etc, However, data on area and productivity per unit area and suitability under various kinds of wasteland situation, the cultivation of this fruit is being popular day by day. It is being cultivated in limited areas is Gonda, Basti, Deoria, Mirzapur and Etawah districts of Utter Pradesh and several districts of Bihar and Madhya Pradesh. It is a very hardy subtropical, deciduous tree that can thrive well in various soil-climates conditions and can tolerate alkaline soil and is injured by temperature as low as 7 ^{0}C and p^H up to 9. Bael is deciduous and hardy in nature, which can thrive well in salt affected soil up to 30 ESP and 9dSm^{-1}.

The continuous applications of huge amount of chemical fertilizers hamper the fruit quality, soil health and generate pollution. The integrated nutrient management paves a way to

overcome these problems. Plant nutrient can be supplied from different sources viz., organic manures, crop residues, bio-fertilizers and chemical fertilizers for better utilization of resources and to produce crop with less expenditure, INM is the best approach for sustainable crop production. In this approach all the possible sources of nutrients are applied, based on economic consideration. Organic manures enhance nutrient availability in order to improve the soil health, soil structure and provide conducive environment for the treatment of soil micro-flora. Potentially of using organic manures along with balanced fertilizers are well established in increasing crop yield and sustained crop production (Nambiar and Abrol, 1992). The importance of integrated nutrient supply system which involves the combined use of various plant nutrient sources has now assured significance in the field of fruit production. The conjugation use of bio-fertilizers with nitrogenous fertilizers increases the efficiency of nitrogen, improve the soil health and control the soil pollution. It is therefore, necessary to standardize other possible sources of nutrients to a specific soil and agro-climate condition for better plant growth, production and quality of fruits.

Material and methods

The present investigation entitled "Effect of integrated nutrient management on vegetative growth, yield and yield attributing characters of bael (*Aegle marmelos* Correa) *cv.* NB-9 fruit" was carried out at Main Experimental Station and P.G. Laboratory of the Department of Horticulture, N.D. University of Agriculture & Technology, Kumarganj, Faizabad (U.P.) during the years 2014-15 and 2015-16. The 20 years old plants of the bael cultivars Narendra Bael-9 having uniform vigour was selected randomly. The experiment keeps nine treatments *viz.* T_1-100% NPK, T_2-50 Kg FYM, T_3-50 Kg FYM + 100% NPK, T_4-50 Kg FYM + 75% NPK, T_5-50 Kg FYM + 50% NPK, T_6-50 Kg FYM + 200g each (*Azotobacter* + PSB), T_7-50 Kg FYM + 100% NPK + 200g each (*Azotobacter* + PSB), T_8-50 Kg FYM + 75% NPK + 200g each (*Azotobacter* + PSB) and T_9-50 Kg FYM + 50% NPK +200g each (*Azotobacter*+ PSB) and these treatments were replicated four times. The experiment was conducted using Randomized Block Design (R.B.D.) under sodic soil condition to evaluate the response of organic manure, inorganic fertilizer and bio-fertilizer on plant height, plant girth and plant spread (East-West and North-South), while flowering and fruiting behaviour like number of flower per cent, fruit set per cent, fruit drop, fruit retention and fruit yield. The region falls under sub-humid and sub-tropical climate receiving a mean annual rainfall of about 1200 mm out of which about 85 per cent is precipitated from mid June to end of September. The winter months are cold, dry and occasional frost occurs during the period, hot wind starts from the month of April and continue up to onset of monsoon.

Results and discussion

Growth behaviours

It is clear from the data presented in Table-1 that soil application of organic manure inorganic and bio-fertilizer gave the best result. The maximum (28.32% and 32.16%) per cent increase in plant height was noted by the soil application of T_7-50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB) followed with the use of T_8-50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB) and T_3-50 kg FYM+ 100% NPK during both the years (2014-15 and 2015-16) respectively. The treatment T_1-100% NPK and T_2-50 kg FYM was recorded minimum results as comparison to other treatments. Whereas the maximum (17.30% and 19.75%) per cent increase in plant girth of bael plant was recorded with the use of T_7-50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB) followed with the use of T_8-50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB) and T_3-50 kg FYM+ 100% NPK during both the years. The lowest result was recorded under the treatment of T_2-50 kg FYM. It seems from the Table-2 that plant spread was found better per cent increase in both the direction (East-West and North-South) by the use of Integrated Nutrient Management. The maximum plant spread (E-W and N-S) were noted with the use of T_7-50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB) which was found at par with the treatment of T_8-50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB) (East-West and North-South) and T_3-50 kg FYM+ 100% NPK (East-West) followed with the use of T_9-50 kg FYM+ 50% NPK+200g each (*Azotobacter*+PSB) during both the years of experimentation (2014-15 and 2015-16) respectively. Whereas the treatment comprised 50 kg FYM was recorded lowest result than all other treatments during both the years of investigation.

It might be due to the fact that plant growth promoting rhizobacteria associated with plant rhizosphere presented or multiplied due to application of bio-fertilizers like PSB, *Azotobacter* and FYM may be responsible for growth promotion directly through the synthesis of phytoharmones, N_2 fixatation, reduction of membrane potential of the roots, synthesis of some enzymes that nodulate the level of plant hormones as well as the solubilization of inorganic phosphate and mineralization of organic phosphate which makes phosphates available to the plants and the application of Farm Yard Manure, *Azotobacter* and Phosphate Solubilizing Bacteria along with inorganic fertilizers may be due to the increase in soil temperature which accelerates the internal physiology of the developing plants to grow profusely and in a speedy way at its maximum level.

Results are in close conformity with the finding of Srivastava (2008) [11], with respect to plant height and girth; He reported maximum plant height in papaya with the use of 100% NPK + FYM+ *Azotobacter* + PSB. Similar significant increase in growth parameters due to Vermicompost have been reported by Tripathi *et al.* (2010) [12] and Nawsheen *et al.* (2006) [8] in strawberry cv. 'Chandler', Bakhs *et al.* (2008) [1] in guava and Sahoo *et al.* (2005) [9] strawberry cv. Sweet Charley. Yadav *et al.* (2007) [13] also reported maximum vegetative growth in aonla with the use of 500g N + 250g P + 250g K +100kg FYM + 200 g each (*Azotobacter* + *Azospirillum* + PSB) + 25g Sulphur.

Table 1: Effect of INM on growth behaviuor of Bael cv. NB-9

Treatment	Plant height (% increase)		Plant girth (% increase)	
	2014-15	2015-16	2014-15	2015-16
T_1 : 100% NPK	11.85	12.66	6.47	8.96
T_2 : 50 kg FYM	10.59	11.39	5.35	7.14
T_3 : 50 kg FYM+ 100% NPK	24.03	26.19	12.60	15.36
T_4 : 50 kg FYM+ 75% NPK	17.13	19.16	10.01	12.86
T_5 : 50 kg FYM+ 50% NPK	15.34	16.26	7.73	9.46
T_6 : 50 kg FYM+ 200g each (*Azotobacter*+PSB)	15.79	17.36	8.86	11.96
T_7 : 50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB)	28.32	32.16	17.30	19.75
T_8 : 50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB)	26.24	30.85	14.51	17.67
T_9 : 50 kg FYM+ 50% NPK+200g each (*Azotobacter*+PSB)	22.19	24.79	11.13	13.25
S. Em ±	0.45	0.43	0.87	0.32
CD at 5%	1.32	1.25	2.53	0.94

Table 2: Effect of INM on growth behaviuor of Bael cv. NB-9

Treatment	Plant spread (% increase)			
	East-West		North-South	
	2014-15	2015-16	2014-15	2015-16
T_1 : 100% NPK	7.58	8.00	7.39	7.96
T_2 : 50 kg FYM	4.40	4.80	5.33	5.75
T_3 : 50 kg FYM+ 100% NPK	17.82	18.46	21.25	21.84
T_4 : 50 kg FYM+ 75% NPK	10.48	11.09	16.96	17.52
T_5 : 50 kg FYM+ 50% NPK	8.27	8.95	9.84	10.40
T_6 : 50 kg FYM+ 200g each (*Azotobacter*+PSB)	9.42	9.97	12.45	13.25
T_7 : 50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB)	20.30	20.98	23.87	24.72
T_8 : 50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB)	19.01	19.71	22.57	23.18
T_9 : 50 kg FYM+ 50% NPK+200g each (*Azotobacter*+PSB)	13.40	14.47	18.83	19.66
S. Em ±	0.91	0.89	0.70	0.71
CD at 5%	2.67	2.61	2.05	2.07

Yield and yield attributing characters

The data presented in the Table-3 shows that the Integrated Nutrient Management significantly influenced the number of flower per shoot in bael. The maximum (347.18 and 370.24) number of flowers per shoot was recorded with the use of T_7-50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB) followed with the soil application of T_8-50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB). The treatment T_2-50kg FYM shows minimum (148.29 and 195.22) number of flower as comparison to other treatments during both the years of experimentation (2014-15 and 2015-16) respectively. This is might be due to soil application of organic and in-organic fertilizer which increased the photosynthesis efficiency which reflex on vigorous growth of plants and ultimately remitting profuse flowers. While minimum (75.80% and 72.83%) per cent fruit drop and maximum (60.60% and 65.76%) per cent fruit set were recorded with the use of T_7-50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB) which were recorded at par with the soil application of T_8-50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB) followed with the use of T_3-50 kg FYM+ 100% NPK. The treatment T_2-50kg FYM and T_1-100% NPK were recorded the maximum fruit drop and minimum fruit set than all other treatments during both the years of investigation. Table-4 showed the maximum (24.20% and 27.17%) fruit retention per cent was recorded with the use of T_7-50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB) which were recorded at par with the soil application of T_8-50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB) followed with the use of T_3-50 kg FYM+ 100% NPK while T_2-50kg FYM was recorded lowest (17.59% and 18.04%) fruit retention during both the years. The data recorded in respect to fruit yield was shows that the addition of organic manure and inorganic fertilizer with bio-fertilizer respond better for fruit yield of bael fruit per plant. The maximum (130.34kg and 131.65kg) fruit yield per tree was recorded with the use of T_7-50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB) which were recorded at par with the soil application of T_8-50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB) followed with the use of T_3-50 kg FYM+ 100% NPK. The treatment T_2-50kg FYM recorded minimum (78.20kg and 80.24kg) fruit yield per tree during both the years of experimentation (2014-15 and 2015-16) respectively.

The enhancement in yield by this treatment mainly because of proper supply of nutrients and induction of growth increases in number of fruits and weight due to better root development, better translocation of water, uptake and deposition of nutrients. Farm Yard manure have immobilized microflora, which function in soil to produce useful products and having immobilized enzymes like protease, lipase, amylase and cellulose which keep on their function of bio-degradation of macromolecular of agricultural residues in the soil and absorb moisture from the air (Edward, 1998) [2]. Ghosh *et al.* (2012) [3] also found same result with the application of FYM 20 kg along with N-400, P-100 and K-300g/year in papaya fruit whereas Kumar *et al.* (2012) [6] reported highest yield of lemon fruit by using 50% NPK + 15 kg vermicompost + 5 kg neem cake. Kirad *et al.* (2010) [4] and Srivastava (2008) [11] in papaya crop. These results partially supports the findings of Sharma *et al.* (2003) [10], who advocated maximum flowering and fruiting of pomegranate fruit through vermicompost and inorganic fertilizer (50:50). Kumar (2016) [5] reported maximum vegetative growth and yield of strawberry with use of Vermi-compost @ 2.5 t/ha + half dose (recommended dose) of NPK.

Table 3: Effect of INM on flowering and fruiting behavior of Bael cv. NB-9

Treatment	No. of flower per shoot		Fruit set (%)	
	2014-15	2015-16	2014-15	2015-16
T_1 : 100% NPK	185.70	195.22	42.64	44.45
T_2 : 50 kg FYM	148.29	160.26	40.10	42.12
T_3 : 50 kg FYM+ 100% NPK	302.90	325.37	56.49	58.81
T_4 : 50 kg FYM+ 75% NPK	263.26	281.06	48.73	51.23
T_5 : 50 kg FYM+ 50% NPK	203.32	240.66	45.20	48.32
T_6 : 50 kg FYM+ 200g each (*Azotobacter*+PSB)	229.68	250.61	51.41	52.56
T_7 : 50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB)	347.18	370.24	60.60	65.76
T_8 : 50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB)	317.67	335.65	59.18	61.24
T_9 : 50 kg FYM+ 50% NPK+200g each (*Azotobacter*+PSB)	261.89	285.84	53.60	56.64
S. Em ±	7.37	6.48	1.22	1.27
CD at 5%	21.51	18.91	2.51	3.70

Table 4: Effect of INM on flowering and fruiting behavior of Bael cv. NB-9

Treatment	Fruit drop (%)		Fruit retention (%)		Fruit yield (kg./tree)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
T_1 : 100% NPK	81.62	81.02	18.38	18.98	80.14	83.46
T_2 : 50 kg FYM	82.41	81.96	17.59	18.04	78.20	80.24
T_3 : 50 kg FYM+ 100% NPK	77.89	75.08	22.12	24.92	108.24	110.15
T_4 : 50 kg FYM+ 75% NPK	79.44	78.18	20.56	21.82	100.20	103.52
T_5 : 50 kg FYM+ 50% NPK	80.93	80.22	19.07	19.78	88.50	91.82
T_6 : 50 kg FYM+ 200g each (*Azotobacter*+PSB)	80.10	79.15	19.90	20.85	97.29	100.54
T_7 : 50 kg FYM+ 100% NPK+200g each (*Azotobacter*+PSB)	75.80	72.83	24.20	27.17	130.34	131.65
T_8 : 50 kg FYM+ 75% NPK+200g each (*Azotobacter*+PSB)	76.81	73.95	23.20	26.05	124.87	126.49
T_9 : 50 kg FYM+ 50% NPK+200g each (*Azotobacter*+PSB)	78.47	76.64	21.53	23.36	105.87	109.21
S. Em ±	0.26	0.53	0.26	0.53	3.84	4.80
CD at 5%	0.77	1.53	0.77	1.53	11.23	14.01

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References

1. Baksh H, Yadav R, Dwivedi R. Effect of INM on growth, yield attributing characters and quality of guava cv. Sardar. Prog. Agri. 2008; 8(2):141-144.
2. Edward SI. Effect of organic manure on soil nutrients and growth hormones level of soil. American J. Soil Sci. 1998; 68(2):130-145.
3. Ghosh SN, Bera B, Roy S, Kundu A. Integrated nutrient management in pomegranate grown in laterite soil. Indian J. of Hort. 2012; 69(3):333-337.
4. Kirad KS, Barche S, Singh DB. Integrated nutrient management in papaya (*Carica papaya* L.) cv. Surya. *Acta Hort.* 2010; (851):377-380.
5. Kumar D, Pratap B, Vishwakarma G. Studies of Integrated Nutrient Management on vegetative, flowering and yield attributes of Strawberry (*Fragaria x ananassa* Duch) cv. Chandler. Eco. Env. & Cons. 2016; 22(2):647-650.
6. Kumar V, Singh MK, Singh M, Dev P, Mohan B. Influence of integrated nutrient management (INM) on yield and quality of lemon (*Citrus limon* Burn.) cv. pant lemon-I under western U.P. conditions. A. of H, 2012; 5(1):137-139.
7. Nambiar KKM, Abrol IP. Long term fertilizer experiment in India: An overview. Fertilizer News, 1989; 34(4):11-26.
8. Nowsheen Singh, Aroosa SR, Masarst Shabeena. Yield and growth of strawberry cv. Senga management system. Environment and ecology. 2006; 245(3):651-654.
9. Sahoo SK, Singh DB. Effect of different levels of biofertilizers on growth yield and quality of strawberry (*Fragaria x ananassa* Duch) cv. Sweet Charlie. Orissa J. of Hort. 2005; 33(2):82-85.
10. Sharma BD, Dhandar DG, Bhargava R. Response of pomegranate (*Punica granatum* L.) to integration.n of nutrient sources in sandy soil of acid ecosystem. In: *National Symposium on Organic farming in Horticulture for sustainable production* on held during 29-30 August at CISH, Lucknow. 2003, 33-34.
11. Srivastava A. Integrated nutrient management on papaya (*Carica papaya* L.). Ph.D. Thesis. NDUAT, Kumarganj, Faizabad (U.P.), 2008.
12. Tripathi VK, Kumar N, Shukla HS, Mishra AN. Influence of *Azotobacter*, *Azospirillum* and PSB on growth, yield and quality of strawberry cv. Chandler, paper presented in National Symposium on *Conservation Hort*., during March, 21-23, 2010 at Dehradoon, 2010, 198-199.
13. Yadav R, Singh HK, Yadav AL. Effect of integrated nutrient management on productivity and quality of aonla (*Emblica officinalis* Gaertn). Plant Archives, 2007; 7(2):881-883.