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Integrated nutrient management in bael (*Aegle marmelos* Corr.) in New Alluvial soil

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ABSTRACT

Considering the demand of bael fruits in *Ayurvedic* and preservative industry, an attempt was made to know the effect of organic and inorganic fertilizers on bael grown in gangetic alluvial soil. The experiment was conducted on 4-year old budded plants of local elite type, planted at 6 x 6 m spacing at the Horticultural Research Station of Bidhan Chandra Krishi Viswavidyalaya, Mandouri, Nadia, West Bengal. There were 11 treatments applied per plant/ year in two equal split doses following randomized block design having five replication of each treatment. The treatments were: T_1-Control, T_2-FYM at 30 Kg, T_3-Vermi compost at 8 kg, T_4-mustard cake at 4 kg, T_5-FYM 16 kg + mixed fertilizer (10:26:26) 800g, T_6-FYM 16 kg + mixed fertilizer (10:26:26) 1600g, T_7-FYM 16 kg + DAP 800 g + MOP 400 g, T_8- FYM 16 kg + DAP 1600 g + MOP 400 g, T_9- FYM 16 kg + urea 800 g + SSP 1600g +MOP 400 g, T_{10}-FYM 16 kg+ Mustard cake 2.4 kg and T_{11}-FYM 16 kg + vermi-compost 4 kg.

Results of two successive years of investigation revealed that growth of the plant in terms of height, basal girth and plant spread towards East-West and North-South direction was maximum in the plant received yearly application of mustard cake at 4 kg followed by the plant with FYM 16 kg+ Mustard cake 2.4 kg. Highest fruit yield of 14.7 kg /plant was recorded from the plant received yearly application of FYM 16 kg+ Mustard cake 2.4 kg this was associated with foliar N and P values of 1.60 and 0.46 percent respectively. The lowest yield was obtained from the control plants. Highest organic carbon content of soil (0.84%) was recorded from the plots of the treatment with FYM 16 kg+ Mustard cake 2.4 kg/ plant. TSS and ascorbic acid content of the fruit were more in the plant received the treatment of FYM 16 kg+ Mustard cake 2.4 kg. The acidity content in the pulp of different treated plants did not vary significantly.

Key words: Bael, fruit quality, integrated nutrient management, new alluvial soil, yield,

INTRODUCTION

Bael (*Aegle marmelos* Corr.) is one of the most important underutilized fruits of the family Rutaceae of international importance. It is well known for its medicinal and nutritional values. It is utilized in day-to-day life in various forms and is highly nutritive crop due to presence of riboflavin (1.19 mg), carbohydrates (31.8g), protein (1.8 g), vitamin C (8-18 mg) and niacin (1.1 mg) per 100 g of edible pulp. Besides, it contains good amount of Fe, Zn, Cl and Na (Barthakur and Arnold, 1989). Beside fruit, every part of the tree viz., leaves, wood, roots and bark are used for preparation of various types of Ayurvedic medicine and other uses. The plant is best suited for low rainfall areas (> 1500 mm per annum) of tropical and subtropical regions. It can be grown in such land situation like poor and marginal lands, saline, alkaline, acidic and rocky soils having P^H 5 to 10 where many crops are failed to grow successfully. It is grown in various parts of South East Asia including India, Sri Lanka, Pakistan, Burma, Bangladesh, Thailand, etc. In spite of its nutritive and therapeutic values, cultivation of this important fruit crop in the form of organized orchard is absent. It is found in scattered way here and there which is seedling origin with no management practices resulting erratic and low yield. For obtaining quality fruits with good yield, use of suitable variety with proper management practices is the foremost criteria in any fruit crop.

Considering the demand in ayurvedic and processing industries and due to having long physiological maturity period, nutrition through organic sources may be the most practical approach of bael nutrition. Research information or literature on any aspect of nutrition of bael is very scanty and most of the recommendation is based on experience basis which has no scientific data base. Considering the importance in bael nutrition, an investigation was made in alluvial soil to find out the effect of organic and inorganic fertilizers on bael in respect of growth, bearing, fruit quality, NPK status of leaves and soil.

MATERIALS AND METHODS

The experiment was conducted on 4-year old budded plants of local elite type, planted at 6 x 6 m spacing at the Horticultural Research Station of Bidhan Chandra Krishi Viswavidyalaya, Mondouri, Nadia, West Bengal. The site is subtropical humid climate with average annual rainfall varies between 1500-2000 mm. The experimental field was situated at 23.5^0 N latitude and 89^0 E longitudes with an elevation of 9.75 m above mean sea level. The soil texture of the experimental field was sandy loan

having pH 6.8; available nitrogen was 230 kg/ha, available P_2O_5 was 35.20 kg/ha and available K_2O was 88.0 kg/ha. There were 11 treatment combination applied per plant/year following RBD having five replications. The treatments were: T_1 : Control (No organic manure and fertilizer) ; T_2 : Farm yard manure (FYM) at 30 kg ; T_3 : Vermicompost at 8 kg ; T_4 : Mustard cake at 4 kg ; T_5 : FYM at 16 kg + mixed fertilizer (10 : 26 : 26 : : N : P : K) at 800 g ; T6 : FYM at 16 kg + Mixed fertilizer at 1600 g ; T_7 : FYM at 16 kg + Di-ammonium phosphate (DAP) at 800 g + Muriate of potash (MOP) at 400 g; T_8 : FYM at 16 kg + DAP 1600 g + MOP 400 g ; T_9 : FYM at 16 kg + Urea 800 g + SSP (Single super phosphate) 1600 g + MOP 400 g ; T_{10} : FYM at 16 kg + Mustard cake 2.4 kg : T_{11} : FYM at 16 kg + Vermicompost 4 kg. The treatments were applied in two equal split doses i.e., during 2nd week of June and 2nd week of October every year. The manures and fertilizers were applied in a circular ring of one feet wide, prepared at 3 feet apart from the plant with a depth of 10-12 cm. The plants were grown under rainfed condition i.e. without any irrigation during off season. The plant protection measures were taken as and when it was necessary.

For estimation of foliar N, P and K content, the leaves of 5-6 month old from 5th-7th positioned were taken for the study in the month of September (Ghosh *et al*., 2014). Nitrogen content of the leaf was determined by micro-kjeldahl's method (Jackson, 1973) and it was expressed as percentage. Available phosphorus was determined by spectrophotometer. It was determined by vandomolybdo phosphoric acid yellow colour method (Jackson, 1973). The left out aliquot for phosphorus estimation was used for potassium estimation. 1 ml of aliquot from each filtered sample which was prepared as in phosphorus estimation taken in injection vial and add 9 ml of distilled water. The readings were taken in a flame photometer.

For analysis of soil, soil from 0-15 cm depth was collected after experiment and was subjected to analysis for pH, organic carbon and NPK status. The soil pH was determined with glass electrode pH meter using soil and water in the ratio of 1:2.5. Organic carbon was determined by Walkley and Black's method as described by Jackson (1973). Available nitrogen of soils was determined by micro-kjeldhl's method (Jackson, 1973). Available phosphorous of soil sample was determined colorimaetrically. Chlorostanous reduced molybdophosphric blue colour method in a hydrochloric acid system as described by Jackson in 1973. The soil sample was leached with neutral ammonium acetate and the available potassium was estimated by flame photometry method (Jackson, 1973).

Observations on plant growth, fruit yield, physico-chemical characteristics of fruits were estimated following standard procedures. The total soluble solids of the fruits were measured with the help of hand refractometer calibrated in 0^0Brix. Total titrable acidity was determined by titration of the extracted juice against /10 NaOH using phenolphthalein as indicator (Ruck, 1969). The ascorbic acid content of fruit was estimated following the method described by A.O.A.C (1984) and was expressed as mg/100g of pulp.

RESULTS AND DISCUSSION

Plant growth

The results presented in Table 1 revealed that maximum rate of growth of the plant in respect of height (96.2%) basal girth (171.0%), plant spread towards East-West (199.2%) and North-South (122.3%) direction was recorded with mustard cake applied @ 4 kg / plant followed by the plant with FYM at 16 kg + mustard cake at 2.4 kg per plant. Minimum rate in plant height (27.9%), basal girth (115.2%), and plant spared (39.0% in East-West and 46.9% in North-South direction) was recorded in the control plant. Results of two years of investigation clearly indicated that the 'bael', a neglected fruit crop, is very responsive to fertilizer application as evident by better plant growth in all the treatments as compared to the control plant (No manures and fertilizer).

Fruit yield

Judicious application of nutrients is necessary not only for sustainable production of quality fruits but also to save our costly soil. In the present investigation, treatment with organic manures or chemical fertilizers and their different combinations of organic manures and chemical fertilizers showed marked increase in yield and physicochemical characters of fruits. Similar types of results were also obtained by Tayeh (2003) in navel orange, Shi *et al.* (2007) in mandarin orange cv. Bendizao and Dheware *et al.* (2010) in sweet orange cv. Nuceller. Experiment conducted with inorganic fertilizers and organic manures revealed that organic manures were better than inorganic fertilizers in terms of fruit production. Highest fruit yield of 14.7 kg (Average of two years) was recorded from the plant with FYM 16 kg + mustard cake at 2.4 kg per plant annually; followed by mustard cake at 4 kg (11.6 kg/plant) and FYM at 30 kg (10.5 kg/plant). It was observed that vermicompost singly (8 kg / plant) or in combination with FYM was less effective as compared to FYM or mustard cake. It was also noted that fruit yield in all the treatments (Table 1) increased with the aging of the plants. It was further noted that yield variation among the treatments was very high which may be due to younger age of the plants which showed different degree of response in various kinds of manures and fertilizers and their doses. Ghosh *et al.* (2012) also noted wide differences

in yield and fruit quality among the different manurial treatments (manures and fertilizers applied singly and in combination) in pomegranate.

Foliar NPK

Leaf nutrient status, which is considered to be an indicator tool for nutrient management programme in fruit crops (Bhargara, 1999), was significantly varied due to different treatments. Highest foliar nitrogen content (1.60%) was measured from the plant received FYM at 16 kg + mustard cake at 2.4 kg per plant annually. Highest fruit yield was also observed from this plant i.e., the plant that showed highest foliar N value. The phosphorus content in leaves was measured maximum (0.46%) from the same plant; showed highest foliar N value. Potassium content in the leaves in different treatment did not tally with the corresponding plant having higher fruit yield. The control plant showed the lowest N, P, K values in the leaves (0.60%, 0.25% and 0.50% respectively).

Soil pH, organic carbon and NPK

Effect of organic manures and inorganic fertilizers on chemical composition of soil in bael orchard has been presented in the Table 2. As the soil of the experimental field was sandy loam (gangetic alluvial), the pH of the soil was near about neutral. The pH in all the treated plots had lower values as compared to control plot. However soil of the inorganic fertilizers treated plots had acidic tendency as compared to organic manure treated plots.

Beneficial effect of organic manures was noticed as improvement in organic carbon content in the soil. Higher organic carbon content was noticed in the plots treated with mustard cake singly or in combination with FYM (0.84%) and minimum organic matter content was recorded from soils of the control plots (0.65%). The available soil N was estimated highest (472.5 kg/ha) in the plot treated with FYM (16 kg) + DAP (0.8 kg) + MOP (0.4 kg). The highest content of soil P (122.7 kg/ha) and K (165.2 kg/ha) were estimated from the plot treated with FYM (16 kg) + Urea (0.8 kg) + SSP (1.6 kg) + MOP (0.4 kg). The lowest content of soil NPK was estimated from the control plot (347.2 kg/ha; 59.3 kg/ha; 114.2 kg/ha respectively). Although nutrient status in the plots under different treatments was better than control plot but differences among the treatments may not be considered as final due to short term experimentation.

Fruit weight

The data in Table 3 revealed that fruit weight was highest (1220 g) in the plant, received FYM (16 kg/plant + mixed fertilizers (1.6 kg/plant) followed by the plant (1160 g) with FYM (16 kg/plant) + DAP (1.6 kg/plant) + MOP (0.4 kg/plant). The lowest fruit weight was recorded from the control plant (360 g). There was vast difference in fruit weight between control and treated plants which may be due to younger age of the plants (4-5 years) and shorter period of experimentation (two years only).

Fruit pulp

Pulp content was maximum (74.9%) in the fruit of the plant treated with FYM (16 kg) + mustard cake (2.4 kg) followed by the plant (70.5%) with mustard cake (4 kg/plant) (Table 3). The minimum pulp content was measured from the control plant (45.0%). In bael, pulp content is one of the important parameters in respect of its utilization as fresh or processed from. It is clear from the result that nutrition has positive effect on improvement in pulp content in the bael fruit.

Fruit quality

TSS content in the fruit pulp was significantly improved due to application of organic manures and inorganic fertilizers. Highest TSS content (48.0^0 Brix) was measured from the fruits treated with FYM at 16 kg + mustard cake at 2.4 kg/plant and lowest (38.0^0 Brix) from the control plant. Acidity content in the fruit pulp did not vary significantly among the different treatments. Ascorbic acid content in the fruit pulp was significantly improved due to application of organic manures and inorganic fertilizers. Highest ascorbic acid content (10.78 mg/100 g) in the fruit pulp was noted from the fruits treated with FYM (16 kg) + mustard cake (2.4 kg) and lowest from the control plant (7.56 mg/100 g). Beneficial effect of combined application of FYM and mustard cake on fruit yield and quality (TSS) may be explained from the fact that bael has long physiological growth period where manures (slow release of nutrients in nature) were seem to be helpful in meeting the demand of required nutrients during such long growth period.

It was concluded from the results of two years of investigation that annual application of FYM @16 kg along with 2.4 kg of mustard cake per plant in two splits doses (Middle of June and October) was helpful in increasing fruit yield and improving fruit quality in younger plants grown in new alluvial soil of West Bengal.

REFERENCE

A.O.A.C. 1984. Association of Official Analytical Chemists. Official methods of Analysis. 14th Ed. , Washington D.C.

Barthakur, N. N. and Arnold, N.P. 1989. Certain organic and inorganic constituents in Bael (*Aegle marmelos* correa) fruit. *Tropical Agriculture*, **66** (1): 65-68.

Bhargav, B. S. 1999. Leaf analysis for diagnosis nutrients in fruit crops. *Indian Hort*., **43** (4)**:** 6-8.

Dheware, R. M., Gajbhiye, R. P., Munde, G. R., Gawai, M. P., Patil, V. O. K. 2010. Influence of organic, inorganic and biofertilizers on fruit yield of sweet orange. *J. Maharashtra Agric. Univ*., **35**(2): 313-314.

Ghosh, S.N., Bera, B., Roy, S. and Kundu, A. 2014. Studies on effect of nitrogen on yield, fruit quality and foliar NPK status of bael. *Indian J. Fertilizers*, **10**(4): 14-17.

Ghosh, S.N., Bera, B., Roy, S. and Kundu, A. 2012. Integrated nutrient management in pomegranate grown in laterite soil. *Indian J. Hort***. 69** (3): 333-337.

Jackson, M. L. 1973. In: *Soil Chemical Analysis.* 2nd Ed. Prentice Hall of India Pvt. Ltd., New Delhi pp. 111-82.

Ruck, J. A. 1969. Chemical methods for analysis of fruit and vegetable product. Research Station, Sunnerland. B.C. Canda Dept. of Agriculture.

Shi, X. G., Gong, J. Q., Lin, M., Wang, L. H., Wang, Y. B. and Shen, G. X. 2007. Effects of fertilizing formula of N, P, K on the production and quality of mandarin cultivar Bendizao. *South China Fruits*. **5**: 6-8.

Tayeh, E. A. H. 2003. Response of Washington navel orange trees to sources and rates of mineral fertilizer, bio-fertilizer and organic manure. *Annals of Agric. Sci*., **41**(2): 799-817.

Table 1 : Effect of organic manures and inorganic fertilizers on plant growth and fruit yield in bael

Treatment (Per plant/year)	Plant growth (Percentage of increase over 1st reading)				Fruit yield/plant (kg)		Average Fruit yield/Plant(kg)	Foliar content (%) on dry weight basis		
	Height	Basal girth	Plant spread towards		4 year old plant	5 year old plant		N	P	K
			East-West	North-South						
T_1 : Control	27.9	115.2	39.0	46.9	0.4	5.4	2.9	0.60	0.25	0.50
T_2 : FYM – 30 kg	66.5	140.8	114.2	65.9	1.4	19.5	10.5	0.70	0.42	0.64
T_3 : VC – 8 kg	72.8	158.8	75.2	87.7	0.9	17.0	9.0	0.90	0.44	0.63
T_4 : MC – 4 kg	96.2	171.0	119.2	122.3	2.7	20.5	11.6	1.10	0.38	0.61
T_5 : FYM – 16 kg + MF – 0.8 kg	63.9	168.9	112.6	69.7	1.9	15.0	8.4	1.12	0.36	0.79
T_6 : FYM – 16 kg + MF – 1.6 kg	72.9	167.4	67.9	55.7	2.5	18.0	10.3	1.40	0.43	0.64
T_7 : FYM – 16 kg + DAP – 0.8 kg + MOP – 0.4 kg	55.2	148.0	55.0	74.2	2.7	9.0	5.8	1.50	0.44	0.82
T_8 : FYM – 16 kg + DAP – 1.6 kg + MOP – 0.4 kg	53.2	162.2	91.6	97.5	2.3	14.0	8.2	1.06	0.44	0.76
T_9 : FYM – 16 kg + Urea- 0.8 kg + SSP – 1.6 kg + MOP – 0.4 kg	61.4	148.2	89.2	70.0	3.0	16.0	9.5	1.30	0.42	0.75
T_{10} : FYM – 16 kg + MC – 2.4 kg	77.4	169.5	112.6	106.5	2.8	26.5	14.7	1.60	0.46	0.76
T_{11} : FYM – 16 kg + VC – 4 kg	68.6	165.0	91.8	77.2	2.9	12.0	7.5	1.20	0.38	0.62
C.D. at 5%	4.4	6.2	3.8	2.8	0.3	1.6	1.2	0.001	0.01	0.01

FYM - Farm Yard Manure; VC - Vermi compost ; MF - Mixed fertilizer (10:26:26::N:P:K); MC - Mustard cake
DAP - Di-ammonium phosphate; SSP – Single super phosphate; MOP - Muriate of potash

Table 2 : Effect of organic manures and inorganic fertilizers on pH and nutrient status in soil (0- 15 cm depth) of bael orchard

Treatment (Plant/year)	pH	Organic carbon (%)	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potassium (kg/ha)
T_1 : Control	6.70	0.65	347.2	59.3	114.2
T_2 : FYM – 30 kg	6.65	0.76	444.7	99.2	136.7
T_3 : VC – 8 kg	6.60	0.78	429.4	76.9	142.6
T_4 : MC – 4 kg	6.60	0.84	430.9	70.1	138.2
T_5 : FYM – 16 kg + MF – 0.8 kg	6.40	0.74	468.8	110.5	140.7
T_6 : FYM – 16 kg + MF – 1.6 kg	6.30	0.74	469.2	112.1	142.5
T_7 : FYM – 16 kg + DAP – 0.8 kg + MOP – 0.4 kg	6.40	0.73	472.5	115.6	156.7
T_8 : FYM – 16 kg + DAP – 1.6 kg + MOP – 0.4 kg	6.25	0.72	468.6	120.8	163.3
T_9 : FYM – 16 kg + Urea 0.8 kg + SSP – 1.6 kg + MOP – 0.4 kg	6.25	0.74	471.7	122.7	165.2
T_{10} : FYM – 16 kg + MC – 2.4 kg	6.60	0.84	436.2	119.3	160.5
T_{11} : FYM – 16 kg + VC – 4 kg	6.50	0.82	433.7	118.4	157.3
C.D. at 5%	0.15	0.01	1.1	0.8	0.2

FYM - Farm Yard Manure; VC - Vermi compost ; MF - Mixed fertilizer (10:26:26::N:P:K); MC - Mustard cake
DAP - Di-ammonium phosphate; SSP – Single super phosphate; MOP - Muriate of potash

Table 3 : Effect of organic manures and inorganic fertilizers on physico-chemicl composition of bael fruit

Treatment (Plant/year)	Fruit weight (g)	Pulp content (%)	TSS (^{0}B)	Acidity (%)	Ascorbic acid content (mg/100 g pulp)
T_1 : Control	360	45.0	38.0	0.35	7.56
T_2 : FYM – 30 kg	705	52.0	43.0	0.42	8.15
T_3 : VC – 8 kg	915	48.0	44.0	0.44	8.69
T_4 : MC – 4 kg	680	70.5	42.0	0.30	9.24
T_5 : FYM – 16 kg + MF – 0.8 kg	685	58.4	47.0	0.32	10.30
T_6 : FYM – 16 kg + MF – 1.6 kg	1220	56.6	47.0	0.26	9.50
T_7 : FYM – 16 kg + DAP – 0.8 kg + MOP – 0.4 kg	540	57.4	42.0	0.42	9.90
T_8 : FYM – 16 kg + DAP – 1.6 kg + MOP – 0.4 kg	1160	59.1	46.0	0.36	8.90
T_9 : FYM – 16 kg + Urea 0.8 kg + SSP – 1.6 kg + MOP – 0.4 kg	985	67.0	44.0	0.35	9.44
T_{10} : FYM – 16 kg + MC – 2.4 kg	855	74.9	48.0	0.38	10.78
T_{11} : FYM – 16 kg + VC – 4 kg	735	58.5	44.0	0.42	10.40
C.D. at 5%	0.5	1.8	0.9	N.S.	0.7

FYM - Farm Yard manure; VC - Vermi compost ; MF - Mixed fertilizer (10:26:26::N:P:K); MC - Mustard cake
DAP - Di-ammonium phosphate; SSP – Single super phosphate; MOP - Muriate of potash