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Response of different levels of farm yard manure and boron on growth and yield of bael (*Aegle marmelos* Corr.)

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ABSTRACT : A field experiment was conducted to study the effect of farm yard manure (FYM) and boron on growth and yield of Bael (*Aegle marmelos*) during, 2011-12. The results revealed that application 100 kg FYM significantly increased plant growth. Maximum fruit yield and its parameters recorded maximum *viz*., fruit weight (971.83 g), fruit yield (20.40 kg) and number of fruit (23.0) however, fruit cracking (4.41 %) was recorded minimum with application of 50 kg FYM. Quality parameters like TSS, sugar and ascorbic acid were also found maximum under this treatment. Application of foliar spray of borax 0.6 per cent was significantly increased fruit weight (962.0 g) and fruit yield (21.21 kg). Whereas, minimum fruit cracking (2.14 %) and peel thickness (2.41 mm) were also observed with application of 0.6 % borax. This treatment also improved quality parameters of fruit. The combined effect of FYM (50 kg tree^{-1}) and foliar spray of borax 0.6 per cent was found significant pertaining to gain in tree height (49.20 cm), stem girth (2.75 cm), fruit weight (980.0 g) and fruit yield (36.34 q/ha) compared to control.

KEY WORDS : Bael, Borax, FYM, growth, Yield, Interaction

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The *Bael* (*Aegle marmelos* Corr.), an ancient fruit of India being grown throughout the tropical and subtropical regions of the country. It belongs to the family *Rutaceae* and thrives well up to on elevation of 1200 meter. *Bael* is a quite hardy, prolific bearer and highly remunerative even without, much care under hot arid climatic conditions. It is a slow growing, sub-tropical deciduous fruit tree, which is suitable for various soil conditions ranging from swampy to dry soils and can tolerate alkaline soils and is not injured by temperature as low as -7 °C (Singh and Roy, 1984). *Bael* is considered as religious tree in India because it is one of the beloved fruits of "*Lord Shiva*". It is also called Bengal quince, golden apple, holy fruit, stone apple, shriphal or *belpatra* in India. The fruits of *bael* are nutritious and a fair source of riboflavin (1.19 mg), vit. A (186 IU), vit. 'C' (8 mg), carbohydrate (31.80 g) per 100 g pulp. It also contains 61.5 g water, 1.8 g protein, 0.39 g fat ,1.7 g mineral, 55 mg carotene, 0.13 mg thiamine, 1.1 mg niacin per 100 g edible pulp (Gopalan *et al*.,1971).

Among the various factors responsible for higher yield potential, application of adequate quantities of FYM is considered as one of the most effective way for boosting the crop yield in soils of Western Rajasthan, which are very poor in organic matter and content. Organic manures especially FYM not only increase the yield but also improve physical, chemical and biological properties of the soil which in turn improve fertility, productivity and water holding capacity of soil. Besides this, Use of FYM increases soil organic matter content and had greater residual effects (Kumaran *et al*., 1998).

Boron also plays a significant role in improving fruit set, retention at maturity, weight, quality and yield. Boron is associated in membrane integrity and cell wall development which affects permeability, cell division, and cell extension, translocation and transformation of sugars, uptake of calcium by plant and K/Ca ratio (Zende, 1998).

RESEARCH METHODS

The experiment was conducted at College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during 2011-12. The experiment of consisted of three levels of FYM (0, 50 and 100 kg tree^{-1}) and four levels of boron (control, 250 g, 500 g and spray of borax 0.6 %) and their combinations. Boron was applied in the soil as a borax form in the month of first week of August 2011. The first spray of borax 0.6 per cent was done at the time of fruit set and second spray after 30 days after the first spray. FYM was given in the last week of July 2011. The factorial randomized block design was used with three replications. Growth parameters *viz.* height of tree and spread (N-S and E-W) and stem girth were recorded twice in a year, before imposing the treatment (July 2011) and after completion of experiment (April 2012). The difference in two measurements was taken as "gain" for the year. Height of tree was recorded from soil surface to the apex of the longest branch in centimeters by meter tape. Spread of tree was measured in two opposite directions (NS-EW) with the help of measuring tape and average spread of the tree was calculated in centimeters. Stem girth was measured on 30 cm above the ground level with the help of thread and meter scale. Fruit yield/tree (kg/tree) of matured fruits were harvested periodically and the, weight was recorded without cracked fruits by summing up the total weight of fruits at different pickings obtained from each tree. Total number of fruits per tree was counted in April on each plant before harvesting. It was confirmed by counting again the number of fruits per tree at the time of harvesting. For average weight of fruit (g), a sample of five randomly selected fruits from each tree was weighed with the help of a balance and average fruit weight was computed and expressed in g/fruit. Diameter of five randomly picked fruits from each plant was measured in centimeter using vernier callipers. Length of five randomly picked fruits from each plant was measured in centimeter with the help of vernier calliper. Fruit cracking per cent numbers of cracked fruits were counted in April on each plant before harvesting.

$$\text{Fruit cracking (\%)} = \frac{\text{Number of cracked fruits}}{\text{Total number of fruits}} \text{ x } 100$$

RESEARCH FINDINGS AND DISCUSSION

A data presented in Table 1 revealed that application of FYM 50kg/tree significantly increased the number of fruit per tree (21.83) and maximum fruit diameter (16.17 cm), fruit length (16.13 cm) and minimum fruit cracking (4.41%) were found under this treatment. However, minimum peel thickness was observed with 100 kg FYM/tree. All these characters were at par with application of FYM at 100kg/ tree. Further, organic manure would have improved the soil physical condition and increased nutrient availability resulting in a better vegetative growth and increased yield. The better growth and development of plants with application of farm yard manure might be due to increased availability of nitrogen as well as other required nutrients to the plants throughout the fruiting season. This may be due to increased vegetative and reproductive growth of plant and better nutrient supply with the application of FYM. It not only adds organic matter and macro and micro nutrients to soil but also improves the physico-chemical properties of soil and hence provides better conditions for plant growth and development (Dudi *et al.,* 2004).

Table 1 showed that the significantly higher fruit weight (962.0 g), fruit diameter (16.43 cm) and fruit length (16.38 cm) were observed in spray of borax 0.6 per cent, while minimum at control. Boron is associated in the cell division that might be reason for increase in the fruit weight and size by rapid cell division. The increase in fruit size and yield attributing characters might be due to the foliar application borax and consequently rapid fruit development caused by the easy availability of the boron to the plants. These findings

Table 1 : Effect of FYM and boron on yield and quality of bael

Treatments	Fruit weight (g)	Peel thickness (mm)	Yield (kg/tree)	No. of fruit/tree	Fruit cracking (%)	Fruit diameter (cm)	Fruit length (cm)	TSS (^{0}B)	Ascorbic acid (mg/100g)	Total sugar (%)	Reducing sugar (%)
FYM(0kg)	900.58	2.75	15.86	17.75	6.65	14.10	14.39	28.85	15.04	16.97	3.76
FYM(50kg)	968.75	2.45	19.90	21.83	4.41	16.17	16.13	31.81	17.27	18.07	3.81
FYM(100kg)	971.83	2.36	20.40	23.00	4.68	16.24	16.58	32.49	17.56	18.15	3.84
S.E..±	1.26	0.017	0.36	0.96	0.46	0.15	0.16	0.25	0.11	0.12	0.03
C.D. (P=0.05)	3.72	0.050	1.07	2.83	1.36	0.45	0.48	0.74	0.34	0.35	NS
Borax(0 g)	921.88	2.61	16.81	19.33	8.10	14.90	15.10	30.02	15.60	16.98	3.72
Borax(250g)	942.22	2.57	18.25	20.00	5.61	15.21	15.52	30.47	16.41	17.56	3.76
Borax(500g)	948.77	2.50	18.61	20.55	5.14	15.48	15.80	31.17	16.72	17.87	3.82
Borax(0.6% spray)	962.00	2.41	21.21	23.55	2.14	16.43	16.38	32.55	17.77	18.48	3.91
S.E..±	1.46	0.020	0.42	1.11	0.53	0.17	0.18	0.29	0.13	0.14	0.03
C.D. (P=0.05)	4.29	0.058	1.24	3.26	1.57	0.52	0.55	0.86	0.40	0.41	0.11

are in close accordance with the results obtained by Chauhan and Gupta (1985) and Rajput *et al.* (1976). However, cracking was observed minimum 2.14 per cent with spraying of 0.6 per cent of borax. It may be due to because, boron was helpful in improving the appropriate growth of bael tree and it is constituent of cell membrane and essential for cell-division. In case of boron deficiency cell-division ceases leads to break down of tissues specially leads to disorders like cracking in fruits (Saini *et al.*, 2004). The significantly higher fruit yield (21.21 kg/tree) was observed with 0.6 per cent borax because the effectiveness of boron in increasing the yield of litchi fruits is in complete conformity with the results obtained by Hasan and Chattopadhyay (1990) and Upreti and Kumar (1996). The increase in yield by boron application may be accredited to the positive effect of boron on increasing the rates of carbohydrate and RNA metabolism (Parr and Loughman, 1983) as well as on accelerating the transportation of photosynthates from the leaves to the developing fruits (Rajput and Chand, 1975).

The results of experiment Table 1 further indicated that application of FYM 50 kg/tree significantly increased the quality parameters *viz.*, TSS (31.81 ^{0}Brix), ascorbic acid (17.27 mg/100g), total sugar (18.07%) and reducing sugar (3.81%). Further increase in FYM 50 to 100 kg/tree could not significantly increase the quality parameter of fruit. In case of borax the maximum values of 32.55 ^{0}Brix, 17.77 mg/100g, 18.48 per cent and 3.91 per cent TSS, ascorbic acid, total sugar and reducing sugar, respectively were received with foliar application of borax 0.6 per cent but there was not any significant difference between dose of 250 g and 500 g of borax. This is might be due to that boron is associated in the carbohydrate transport with in plants. The sugars are transported more readily across cell membranes as a borate ion may be associated with the cell membrane where it could complex with sugar molecules and facilitate its passes across the membranes that might be reason of the

Table 2 : Nutrient content in soil and plant leaves after harvesting of bael

Treatments	Nutrient content in soil					Nutrient content in plant leaves after harvesting			
	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)	B (ppm)	Organic carbon (%)	N (%)	P (%)	K (%)	B (ppm)
FYM(0kg)	81.41	17.71	189.34	0.462	0.083	1.54	0.55	1.31	10.0
FYM(50kg)	82.22	19.65	191.07	0.464	0.095	1.68	0.65	1.60	11.0
FYM(100kg)	82.76	20.76	192.80	0.479	0.116	1.69	0.66	1.66	11.4
S.E..±	0.17	0.13	0.58	0.005	0.001	0.005	0.005	0.011	0.13
C.D. (P=0.05)	0.50	0.40	1.72	0.015	0.005	0.015	0.015	0.034	0.39
Borax(0 g)	81.34	17.68	189.41	0.449	0.088	1.49	0.52	1.30	9.4
Borax(250g)	81.55	17.80	190.18	0.456	0.092	1.52	0.51	1.32	10.7
Borax(500g)	81.73	18.00	191.10	0.487	0.093	1.55	0.54	1.31	10.9
Borax(0.6% spray)	81.79	18.12	191.19	0.497	0.091	1.54	0.53	1.33	12.2
S.E..±	0.19	0.16	0.61	0.006	0.002	0.02	0.006	0.13	0.15
C.D. (P=0.05)	NS	NS	NS	0.019	NS	NS	NS	NS	0.45

NS=Non-significant

Table 3 : Combined effect of FYM and boron on growth, yield and economics of bael

Treatments	Plant height (cm)	Stem girth (cm)	Fruit weight (g)	Yield (q/ha)	B:C
FYM(0kg) x Borax(0)	37.60	2.02	865.66	20.15	1.86
FYM(0kg) x Borax(250g)	38.52	2.14	897.33	23.66	1.94
FYM(0kg) x Borax(500g)	39.56	2.20	912.00	25.83	1.90
FYM(0kg) x Borax(0.6 spray)	40.42	2.22	927.33	27.36	2.41
FYM(50kg) x Borax(0)	42.58	2.28	940.33	25.86	2.15
FYM(50kg) x Borax(250g)	43.32	2.38	955.00	28.70	2.14
FYM(50kg) x Borax(500g)	44.62	2.43	959.66	30.26	2.05
FYM(50kg) x Borax(0.6 spray)	49.20	2.75	980.00	36.34	2.91
FYM(100kg) x Borax(0)	43.69	2.32	959.66	30.68	2.33
FYM(100kg) x Borax(250g)	45.00	2.37	974.33	32.71	2.25
FYM(100kg) x Borax(500g)	45.50	2.45	974.66	30.31	1.90
FYM(100kg) x Borax(0.6 spray)	46.60	2.56	978.66	33.57	2.45
S.E.±	0.34	0.023	2.53	-	-
C.D. (P=0.05)	1.00	0.070	7.44	-	-

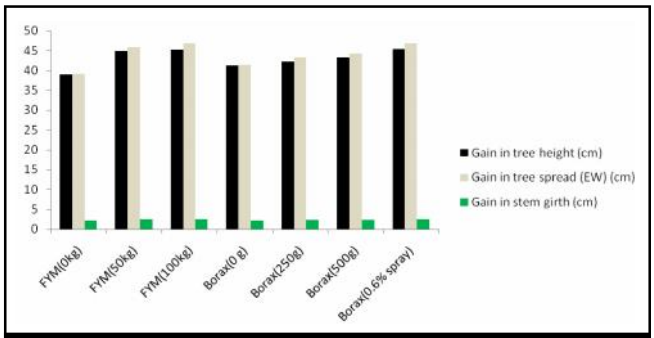

Fig. 1 : Effect of FYM and Boron on growth characters of bael

increased TSS and sugars in the bael fruits (Gauch and Dugger, 1953).

Table 2 reveled that different levels of FYM 0 – 50 and 50 – 100 kg/tree increased the N, P_2O_5, K_2O, boron, organic carbon in the soil after harvesting the crop. The maximum value of N (82.76 kg/ha), P_2O_5 (20.76 kg/ha), K_2O (192.80 kg/ha), boron (0.479 ppm) and organic carbon (0.116 %) were received with application of FYM 100 kg/tree. However, soil and foliar application of borax could not increase any element of the above except boron. Nutrient content in plant leaves were also influenced with application of FYM. Nitrogen and boron content in leaves were significantly increased over control. The maximum value of N, P, K were received 1.69, 0.66 and 1.66 per cent and with FYM 100 kg/tree, respectively. However, FYM level of 50 kg and 100 kg both were at par in case of boron. This might be due to the organic manures improve the nutrient availability in soil and thus benefited the crop. The FYM is capable of supplying adequate macro and micro plant nutrients to the crop during whole crop period and make available more nutrients to the plant from soil with solubilization effect of plant nutrients leads to increased uptake of nutrients (Meena *et al.,* 2007).

Effect of FYM x Boron:

The data presented in Table 3 and Fig. 1 showed significant increase in application of FYM 50 kg/tree along with spray of borax 0.6 per cent in gain in stem girth (2.75 cm), fruit weight (980.00 g), fruit yield (36.34 q/ha), gain in plant height (49.20 cm). Increase in fruit size and yield was might be due to the function of boron in which it concerned with the precipitation of excess cations, buffer action, maintenance of conducting tissues (Singh, 1991). These findings clearly indicate that boron played significant role on enhancing the growth of bael tree. These results are also find support from the result obtained by Banik and Sen (1997) in mango and Shukla (2011) in aonla. Reduction in fruit cracking on application of boron may also have been due to physiological role of boron in the synthesis of pectic substances in cell wall (Singh, 1986) which prevented fruit cracking and splitting. Saini *et al.* (2004) in bael, and Banyal and Rangra (2011) in litchi, also reported similar results. Fruit cracking was minimum with combined application of FYM 50 kg + borax 0.6% application. The maximum B : C ratio was observed with application of 50 kg FYM and borax 0.6% foliar application (2.91) because more number of fruits and size of fruits was observed in this treatment which ultimately increased the yield, maximum B : C ratio was observed in this treatment

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