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Influence of pruning intensity on growth and yield of pomegranate (*Punica granatum* L.) CV. super bhagwa under organic conditions

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Abstract
A field experiment on influence of pruning intensity on growth and yield of pomegranate (*Punica granatum* L.) cv. Super Bhagwa under organic conditions was carried out during 2016-2017 at Department of fruit science, sector 70, University of Horticultural sciences, Bagalkot. The experiment consisted of types of organic conditions (farm yard manure and vermicompost) and three levels of pruning (0 cm, 15 cm, 30 cm pruning) and laid out in two factorial randomized block design.

Keywords: pruning, growth, *Punica granatum*, pomegranate

Introduction
India is the world's leading country in pomegranate production. Total area under pomegranate in India is 1.93 lakh hectares total production is 21.98 lakh tones (Anon, 2017) [2]. Pomegranate is a rich source of carbohydrate (14.5 %), protein (1.6 %), calcium (10 mg/100g), phosphorus (70 mg/100g), iron (0.3 mg/100g) and vitamin C, besides its calorific value of 65 Kcals/100g. Hence, this fruit is referred as 'Elixir of life' (Patil and Manjunath, 2014).
Organic farming is becoming increasingly popular with rapidly growing global demand for organic products. It offers considerable benefits over conventional farming system particularly with respect to sustainable yield, better quality and hazard free produce. Fruits often eaten raw are more vulnerable to contamination with chemicals due to their residual toxicity as compared to cereals and pulses (Reddy *et al*., 2014) [16]. Organic foods are safer and preferred by the consumers due to its quality and taste. The quality of fruit is often higher in organic system as compared to conventional one (Dutta and Talang, 2014) [7].
Canopy management of tree is pre requisite that deals with development and maintenance of their structure in relation to fruit size and shape. Pruning is one of the important cultural practices that manipulate the tree vigour and use the maximum availability light and temperature to increase the productivity. Pomegranate exhibits tendency to flower throughout the year resulting in scattered yield which is not preferable for commercial cultivation. Therefore, plants are forced to flower under three distinct seasons of flowering by adopting certain techniques in northern Karnataka. Usually, farmers practice *hast bahar* flowering in the month of August - September gives good yield, attractive fruit colour and best quality fruits which are free from diseases with higher marketable price.

Material and Methods
A field experiment on influence of pruning intensity on growth and yield of pomegranate *(Punica granatum* L.) cv. Super Bhagwa under organic conditions was carried out during 2016-2017 at Department of fruit science, sector 70, University of Horticultural sciences, Bagalkot. It is ssituated in Northern Dry Zone (Zone 3) of Karnataka.
The experiment consists of 6treatments as detailed below.

M_1T_1 M_1T_2 M_1T_3
M_2T_1 M_2T_2 M_2T_3

a. Factor A (Main plot)
M1: 100 per cent RDN through FYM
M2: 100 per cent RDN through vermicompost

b. Factor B (Sub plot)
T1: Unpruned (Control)
T2: 15 cm pruning (Removal of 15 cm tip of shoot)
T3: 30 cm pruning (Removal of 30 cm tip of shoot)
Other details:
Plot size: Gross plot 8.2 m × 3.6 m =29.52 m^2 Spacing: 3.6 m × 1.8 m

Application of organic manure: Two types of organic manures were used during the experiment, the first was farm yard manure and second one was vermicompost. Based on the nutrient composition quantity of organic manures were calculatedand applied to plants.

Pruning at different levels: Bahar treatment is an important operation in pomegranate in which plants are given rest by stopping water for one month to create artificial stress. Cosequently, pruning was done at 3 different intensities includes the control (unpruned), 15 cm pruning and 30 cm pruning then irrigation was given to the orchard through drip system with recommended discharge of water. The plant protection measures were taken up periodically to manage the pests and diseases.

Number of shoots per plant: The number of main shoot present in pomegranate plant was counted as primary branches. The number of secondary branches on each primary branch was counted and average was computed to express as number of secondary branches.

Shoot length of current season (cm): Newly developed shoot from the base was measured and expressed in centi meter.

Number of flowers per shoot: Number of flowers per shoot was recorded by counting flowers of 5 randomly selected shoots in each of experimental plant.

Number of days taken for initiation of flowering: Experiment trees were regularly observed and when two or three flower bud differentiation occurred, was considered as date of emergence of flower and it was counted from date of pruning.

Number of fruits per plant and fruit weight: The number of fruits per plant was physically counted after maturity and was expressed as numbers per tree. Five randomly selected pomegranate fruits were weighed using digital analytical balance and the average value of fruit was expressed in gram.

Fruit diameter (cm) and Fruit length (cm): Fruit diameter in each treatment was measured with the help of digital vernier calipers at widest middle point where, the maximum girth was noticed and it was expressed in centimeters (cm). The measurement of fruit length was made on the polar axis, that is between the apex and end of the stem along the curve by using thread and expressed in centi metre.

Fruit yield (kg/plant) and Fruit yield (t/ha): The fruit yield was recorded at the time of harvest and expressed in kilo gram per plant. The fruit yield per hectare was computed by multiplying the yield per plant with the number of plants that was accommodated in one hectare and was expressed in tones per hectare.

Results and Discussion
Increase in number of secondary branches per plant was significantly influenced by types of organic conditions. The maximum number of secondary branches (28.75/plant, 32.91/plant, 37.83/plant, 41.95/plant, 42.66/plant) at 30, 60, 90, 120 and 150 days after pruning respectively, was recorded in M_2 (100 % RDN through vermicompost) as compared to M_1(100 % RDN through FYM) which recorded minimum number of secondary branches (25.75/plant, 30.50/plant, 34.54/plant, 37.29/plant and 39.25/plant) at 30, 60, 90, 120 and 150 days after pruning, respectively (Table 1). By the application of organic manures like vermicompost might be due to better moisture retention capacity, supply of micronutrients and easy availability of major nutrients to the plants from the soil. Improvement in soil parameters might have helped in increasing the absorption of nutrients from soil. These results are also in confirmation with Naik and Babu, (2007) [11].
At 60, 90, 120 and 150 days after pruning, T_3 (30 cm pruning) recorded the maximum number of secondary branches (32.87/plant, 37.68/plant, 41.31/plant and 42.62/plant respectively). However, the minimum number of secondary branches (30.00/plant, 34.06/plant, 37.12/plant and 38.87/plant) was recorded in T_1 (unpruned) at 60, 90, and 120 and 150 days respectively (Table 1). Since, pruning remove carbon starved, fruiting exhausted shoots and promotes new growth to build up carbohydrates reserves for flowering and allows the sprouting of lateral buds which, ultimately influenced plant growth and other vegetative characteristics of the plant. The findings are in accordance with Sharma *et al.* (1997) [19] in New castle in apricot.
The interaction effect between the types of organic conditions and pruning intensity was found to be statistically non significant with respect to number of secondary branches at 60, 90, 120 and 150 days after pruning.
Length of shoot significantly increased at all the stages of crop growth (Table 2) due to application of organic manures. The maximum shoot length (23.75 cm, 33.25 cm, 46.16 cm, 50.58 cm and 57.14 cm) was recorded at 30, 60, 90, 120 and 150 days after pruning respectively, recorded in M_2 (100 % RDN through vermicompost) compared to M_1 (100 % RDN through FYM) which recorded minimum length of shoot (21.50 cm, 30.04 cm, 42.95 cm, 45.95 cm and 53.95 cm) at 30, 60, 90, 120 and 150 days after pruning, respectively. The presence of humic substance in vermicompost was the additional source of poly phenols that might have acted as respiratory catalysts, which in turn enhanced the rate of respiration and metabolic activity of the plants and thereby increasing the cholorophyll content which enhances the photosynthesis process.
The length of shoot significantly increased at all the stages of crop growth (Table 2) due to effect of pruning. The maximum shoot length of 25.62 cm, 35.12 cm, 49.50 cm, 54.12 cm and 60.80 cm was recorded in T_3 (30 cm pruning) at 30, 60, 90, 120 and 150 days after pruning, respectively. Whereas T_1 (unpruned) recorded minimum shoot length of 19.62 cm, 28.06 cm, 40.68 cm, 43.37 cm and 51.01 cm at 30, 60, 90, 120 and 150 days after pruning, respectively (Table 3). Severity of pruning increases the shoot length which might be due to the quick response of the supply of food material absorbed by the roots and transmission of the same to the main trunk. Similar findings were reported by Shaban and Haseeb (2009) [17] in guava.
Interaction effect did not varied significantly with respect to shoot length at 30 and 60days after pruning. However,

interaction combination of M_2T_3 (100 % RDN through vermicompost+30 cm pruning) shows significant increase in shoot length of 52.00 cm, 57.25 cm and 62.37 cm at 90, 120 and 150 days after pruning respectively (Table 2).

The number of flowers per shoot varied significantly with types of organic conditions (Table 3). M_1 (100 % RDN through FYM) recorded the maximum number of flowers per shoot (6.70). Whereas, the minimum number of flowers per shoot were recorded in treatment M_2 (6.10). The prolonged availability of nutrients during the growth period, from organic manure might have enhanced the flowering and increase in number of flowers per shoot.

The number of flowers per shoot varied significantly with levels of pruning intensity (Table 3). Treatment T_1 (unpruned) recorded maximum number of flowers per shoot (6.97), Where as the lowest number of flowers per shoot (5.65) was recorded in treatment T_3 (30 cm pruning). The results were in close conformity with findings of Pawar *et al*. (1994) [14] in pomegranate and Prabhakar *et al*. (2014) [15] in guava.

Interaction effect between types of organic conditions and pruning intensities were found non-significant with respect to number of flowers per shoot (Table 3).

The number of days taken for initiation of flowering varied significantly with types of organic conditions (Table 3). M_2 (100 % RDN through vermicompost) recorded the maximum number of days taken for initiation of flowering (16.54 days) compared to M_1 (15.85 days). The application of organic manures might have increased the production of organic acids which play a leading role for availability of phosphorus that have induced earliness in flowering.

The number of days taken for initiation of flowering was found to be significant with different levels of pruning (Table 3). Among the different levels of pruning T_3 (30 cm pruning) recorded significantly the maximum days taken for initiation of flowering (17.18 days) followed by T_2 (16.14 days). The observations were in conformity with the results obtained by Pawar *et al*. (1994) [14] in pomegranate.

There was significant difference between types of organic conditions and level of pruning intensities on number of days taken for initiation of flowering (Table 3). Maximum number of days taken for initiation of flowering (17.83 days) was noticed in M_2T_3 (100 % RDN through vermicompost + 30 cm pruning) followed by M_1T_2 (16.56 days) where as the minimum number of days taken for initiation of flowering (14.58 days) was noticed in M_1T_1(100 % RDN through FYM + unpruned).

Among main factors, M_1 (100 % RDN through FYM) showed maximum number of fruits (55.28/plant) compared to M_2 (51.89/plant). The prolonged availability of nutrients during growth period, from FYM might have enhanced flowering and better fruit set, ultimately leads to increase in the number of fruits per plant (Table 4). The obtained results were in line with by Marathe *et al*. (2017) [11] in pomegranate.

Number of fruits per plant varied significantly with respect to level of pruning intensity (Table 4). Among various level of pruning treatments, maximum number of fruits (58.35/plant) was recorded in T_1 (unpruned) and minimum number of fruits per plant was observed in T_3 (50.50/plant) which was on par with T_2 (51.92/plant). Pomegranate bears on the spurs as well as current shoots so due to the availability of more bearing area (spurs) in unpruned plant due to non-removal of bearing area might have increased the number of fruits per plant. Number of fruits decreased with increase in intensity of pruning. Similar results were recorded by Bajapai *et al*. (1973) [3] in guava cv. Allahabad Safeda.

Maximum number of fruits (61.13/plant) was recorded in M_1T_1 (100 % RDN through FYM+ unpruned) which was followed by M_2T_1 (55.57/plant) and lowest number (51.00/plant) was recorded in M_1T_3 (100 % RDN through FYM +30 cm pruning).

Among the types of organic conditions, maximum fruit weight was recorded in M_1 (260.00 g) and minimum fruit weight was noticed in M_2 (234.45 g).Similar results were reported by Marathe *et al.* (2017) [11] in pomegranate (Table 4). The increase in fruit weight ascribed due to sustained availability of balanced nutrient through the growing period and contribution of wider C:N ratio might also due have helped in increased nutrient uptake especially potassium which has prominent role in increasing the fruit weight. Similar results were obtained in the study of Dhaker *et al*. (2013) [5] in bael.

Among the levels of pruning intensity, maximum fruit weight (285.87 g) was recorded in T_3 (30 cm pruning) and minimum fruit weight (191.25 g) was observed in T_1 (unpruned). Increase in fruit weight might be due to utilization of whole photosynthates among the fewer fruits in severe pruned trees. Similar results are obtained earlier by Bajapai *et al.* (1973) [3] in guava.

Interaction effect between the types of organic conditions and levels of pruning intensity had significant influence on fruit weight (Table 4). Highest fruit weight (312.25 g) was recorded in M_1T_3 (100 % RDN through FYM+30 cm pruning) which was followed by M_1T_2 (272.5 g) and lowest (187.00 g) was observed in M_2T_1 (100 % RDN through vermicompost + unpruned).

The fruit length differed significantly among the different types of organic conditions. The highest fruit length (8.32 cm) was recorded from M_1 (100 % RDN through FYM) where as lowest length was recorded from M_2 (8.06 cm). Application of FYM has resulted in enhanced production of growth promoting substances like gibberlic acid, indole acetic acid and dihydrozeatin.

Different pruning treatments also had significant influence on fruit length (Table 5). The maximum length (8.48 cm) was recorded from T_3 (30 cm pruning) which was on par with T_2 (8.41 cm). However, minimum fruit length (7.69 cm) was recorded from T_1 (unpruned). This may be due to more number of fruits in case of unpruned trees resulting in lesser availability of nutrients which leads to smaller sized fruits while, more availability of metabolites under the pruned tree lead to increase in the length of fruits. Similar results recorded by Gupta and Gill (2015) [9] in ber cv. Umran.

The interaction effect between types of organic conditions and levels of pruning was found to be significant (Table 5). M_1T_3 (100 % RDN through FYM + 30 cm pruning) recorded significantly the highest fruit length (8.51 cm) which was on par with M_2T_3 (8.45 cm) and M_2T_2 (8.46 cm). Significantly the lowest fruit length (7.28 cm) was recorded in M_2T_1 (100 % RDN through vermicompost + unpruned).

The highest fruit diameter (8.82 cm) was recorded from M_1 (100 % RDN through FYM) and lowest (8.54 cm) was observed in M_2 (100 % RDN through vermicompost). The results were in close conformity with Ram *et al*. (2007) in guava cv. Allahabad Safeda and Lotter (1990) [10] in guava cv. Fan Retief.

Different pruning treatment also had significant influence on fruit diameter (Table 5). Maximum fruit diameter (8.85 cm) was recorded in T_3 (30 cm pruning) which was on par with T_2 (8.81 cm). However, minimum fruit diameter (8.38 cm) was recorded from T_1 (unpruned). Pruning improves light

distribution throughout the tree, which is important for the development of fruit. The results of Shahein *et al.* (2010) [18] and Goncalves *et al*. (2014) [8] are supported to the above findings.

Interaction effect between types of organic conditions and levels of pruning intensities was found to be non significant with respect to fruit diameter (Table 5).

The maximum yield (13.71 kg/plant) was recorded in M_1 (100 % RDN through FYM) and was significantly highest as compared to M_2 (12.49 kg/plant). Higher fruit yield per plant might be due to increased average fruit weight and size. The results are in confirmity with findings of Shivakumar *et al.* (2012) [20] in papaya, Naik and Sriharibabu (2005) [5] in guava, Bhavidoddi Rahulkumar (2003) [4] in banana and Marathe *et al*. (2017) [11] in pomegranate.

The fruit yield per plant was found to be significant with levels of pruning (Table 6). Among the different levels of pruning, T_3 (30 cm pruning) recorded significantly maximum yield per plant (14.78 kg/plant) over other levels of pruning, followed by T_2 (13.38 kg/plant). The minimum fruit yield per plant (11.14 kg/ plant) was recorded in T_1 (unpruned). Similar results were observed by Bhagawati *et al*. (2015) in guava. Pruning performed on growing shoots removed apical dominance, released lateral buds from correlative inhibition and changed tree form and construction which in turn, increased flower bud initiation from lateral buds and increased the yield. The results are in close conformity with the findings of Dhaliwal and Singh (2004) [6] and Ahmad *et al.* (2006) [1].

Interaction effects of types of organic conditions and levels of pruning intensity were differed significantly (Table 6). M_1T_3 (100 % RDN through FYM+30 cm pruning) recorded significantly highest the fruit yield per plant (15.92 kg/plant) as compared to other interaction treatments followed by M_1T_2 (13.79 kg/plant). The lowest fruit yield per plant (10.86 kg/plant) was recorded in M_2T_1 (100 % RDN through vermicompost + unpruned). It might be due to synergistic effect of both factor help to increased number of fruits and yield

The yield per hectare was found to be significant with types of organic conditions (Table 6). Significantly maximum yield per hectare (21.53 t/ha) was recorded in M_1 (100 % RDN through FYM) as compared to M_2 (20.05 t/ha). The increased yield per hectare in the present investigation might be due to more number of fruits per plant which possessed higher average fruit weight.

The yield per hectare was found to be significant with levels of pruning intensity (Table 6). Significantly maximum yield per hectare (23.16 t/ha) was recorded in T_3 (30 cm pruning) as compared to T_1 (unpruned) (17.30 t/ha).The fruit weight in pruning treatment was found to be higher than that of without pruning.

The yield per hectare was found to be significant with levels of pruning intensity (Table 6). Significantly maximum yield per hectare (23.16 t/ha) was recorded in T_3 (30 cm pruning) as compared to T_1 (unpruned) (17.30 t/ha).The fruit weight in pruning treatment was found to be higher than that of without pruning.

Conclusion

From the present investigation, it was concluded that 100 per cent RDN through farm yard manure with 30 cm pruning was the best combination with respect to higher growth and yield of pomegranate cv. Super Bhagwa.

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