Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(2): 151-154
Received: 13-01-2020
Accepted: 15-02-2020

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Effect of split application of fertilizers and multi-micronutrient mixture on growth and yield of pomegranate cv. Bhagwa

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Abstract
The objective of this study was to determine the effect of split application of fertilizers and multi-micronutrient mixture on growth and yield parameters of pomegranate cv. Bhagwa. The selected trees were applied with different split doses of fertilizers and foliar sprayed with different concentrations of micronutrient mixture in the crop of *Ambe bahar* during the year 2018. The treatments comprised of four levels of fertilizers split (S) *viz*., S_1= No split, S_2= Two splits, S_3= Three splits and S_4= Four splits and two different levels of multi-micronutrient mixture (M) *viz*., M_1= Foliar spray at 0.5% and M_2= Foliar spray at 1.0%. Among the different treatments, application of fertilizers in four splits and foliar application of micronutrient mixture @ 1.0% found superior in various growth and yield parameters.

Keywords: Pomegranate, Bhagwa, split application, multi-micronutrient mixture

Introduction
Pomegranate (*Punica granatum* L.) is an important commercial fruit plant belonging to the family Punicaceae. Pomegranate is a good source of protein, carbohydrates, minerals, antioxidants and vitamins. Pomegranate juice contains antioxidants properties (Michel *et al*., 2005) [9]. They are also used to make products like bottled juice, syrup, jelly and wine (Chace *et al*., 1930 and La-Rae, 1969) [5, 8]. In India commercial pomegranate orchards are found in rainfed areas, which characteristically have nutrient deficient soils, low in organic matter, irregular distribution of rainfall and generally experience water deficiency during plant growth period (Panwar and Tarafdar, 2006) [15]. Only fertilizer application is not important in any crop but make sure that nutrients are available to plants at their developing stages, otherwise most of the applied fertilizers are lost due to leaching or by other reasons, which results in wastage of fertilizers and even damage to crops. To optimize fertilizer use, the approach of split application of fertilizer plays a very important role in a nutrient management strategy. Split application of fertilizers plays an important role in a nutrient management strategy that is productive, profitable and somewhat eco-friendly to soil and environment. In pomegranate when RDF of N and K applied in four splits it resulted into the highest number of fruits per plant than in one split (Sheikh and Rao, 2001) [22]. Micro nutrients are used in smaller quantities, but they are as important as macro nutrients in respect of their functions in plants. Furthermore, they help to increase the use efficiency of macro nutrients. They play an essential role in improving growth, yield and quality of many crops. Foliar application of micronutrients during crop growth was successfully used for correcting their deficits and improving the mineral status of plants as well as increasing the crop yield and quality (Kolota and Osinska, 2001) [7]. Foliar sprays of $ZnSO_4$ (0.25%) and boric acid (0.15%) significantly improved the yield and quality of fruit as compared to control in pomegranate (Balakrishnan *et al*., 1996) [3].

Materials and Methods
The present investigation was carried out on a farmer's field which is located in Junagadh during *Ambe bahar* season of 2018. The experiment was conducted on four year old pomegranate trees of cv. Bhagwa with nine treatments and three replications in Factorial Randomized Block Design. The total number of trees included in experiment was 50 and were spaced at 3.0 × 4.0 m spacing. Treatments were as follow: S_1 :- No split (whole dose in March), S_2 :- Two splits (1st split in March and 2nd split in April), S_3:- Three splits (1st split in March, 2nd split in April and 3rd split in May) and S_4:- Four splits (1st split in March, 2nd split in April, 3rd split in May and 4th split in June). Nitrogen and potash were applied at the rate of 500 g and 125 g per plant, respectively. Multi-micronutrient mixture grade-IV was applied in two different concentrations; M_1 (0.5% grade-IV micronutrient) and M_2 (1.0% grade-IV micronutrient). Micronutrient grade-IV contains Zn (6%), Fe (4%), Mn (1%), Cu (0.5%) and

B (0.5%). First spray was given 15 days before full bloom and 2nd spray was given at 30 days after 1stspray.

All the selected trees were almost uniform in growth and vigour. The trees were given uniform cultural operations during the course of investigation. Observations on number of branches, shoot length, canopy spread (N-S and E-W), number of fruit set/plant, days taken to harvest, number of fruits harvested per plant, fruit weight, fruit yield (kg/tree and t/ha) were recorded during experimentation. Statistical analysis was done by using method of analysis of variance (ANOVA) for Factorial Randomized Block Design (FRBD) by Panse and Sukhatme (1967) [14].

Result and Discussion

Among the different levels of split application of fertilizers, application of 500 g N and 125 g K in four splits (S_4) showed significantly maximum number of branches (15.58), net increase in plant spread (0.98 m N-S and 0.50 m E-W), while the length of shoot was found non-significant for all treatments. The beneficial effect of continuous availability of nitrogen in plant growth is mainly due to promotion of synthesis of proteins and amino acids. Split application of fertilizers helps to avail plant nutrients in more quantities. High levels of nitrogen and potassium especially potassium enhance the photosynthetic efficiency which in turn cause greater synthesis, translocation and accumulation of carbohydrates. The increased growth rate due to split application of fertilizers was also found by various workers; (Purohit (1977) [17], Ravitchandirane *et al*. (2002) [20], Parmar (2017) [16] in papaya; Babu *et al*. (2004) [2], Nalina *et al*. (2009) [10] and Navaneethkrishnan *et al*. (2013) [11] in banana).

Significantly the highest number of fruit set per plant (96.22), number of fruits harvested (77.93), maximum average fruit weight (265.85 g) and the highest yield (20.74 kg/tree and 17.27 t/ha) were recorded by the plants supplied with 500 g N and 125 g K in four splits while days taken to harvest was found non-significant for this factor. Fruit yield was increased with treatment S_4 might be due to increased number of fruit set, fruit harvested, increased fruit length, diameter and fruit weight. The increased fruit set in this treatment might be due to the reduced leaching losses under more split application and better reserves of N and K during the maximum utilization period of crop development, which resulted in sufficient food supply to sink and consequently reflected on better development in fruit set. These findings are confined with those reported by Sheikh and Rao (2001) [22], Rao and Subramanyam (2009) [19], Thakur (2014) [23] in pomegranate; Rajeevan and Mohankumar (1992) [18], Babu *et al*. (2004) [2], Nalina *et al*. (2009) [10] in banana and Purohit (1977) [17] in papaya.

Similarly, significantly maximum number of branches (11.69) and maximum net increase in plant canopy spread (0.70 m N-S and 0.48 m E-W) were recorded with treatment M_2. The micronutrient increased the concentration of Fe and Zn micronutrient. The increased growth rate due to micronutrients might be due to zinc which stimulates photosynthetic activity and produce more biomass as well as zinc helps to enhance synthesis of auxin in plant and several other micronutrients activate the enzymes which help in protein and carbohydrate metabolism. Metabolism of hormones such as auxin (IAA) and tryptophan increases with increase in zinc concentration.

The highest number of fruit set per plant (84.22), number of fruits harvested (66.42), average fruit weight (257.19 g), the highest fruit yield (17.18 kg/tree and 14.30 t/ha) and the lowest days taken to harvest (169 days) were observed in treatment M_2. It might be due to foliar application of micronutrients play a very important role in various physiological processes as well as enzymatic activity. These findings are in agreement with Yadav *et al*. (2013) [24] in banana; Bambal *et al*. (1991) [4], Pandey (2010) [13], Hasani *et al*. (2012) [6], Obaid and Mustafa (2013) [12] Yadav *et al*. (2018) [25] in pomegranate; Further, zinc enhanced the synthesis of auxin in plant which stimulates the flowering (Ryugo, 1988) [21]. Minimum days taken to harvesting may be due to reduced maturity duration which could be attributed to enhancing effect of zinc in enzymatic reaction, cell division as well as in growth (Yadav *et al*., 2013) [24]. Zinc and boron reduce fruit drop and increase fruit retention might be due to the fact that zinc play important role in biosynthesis of IAA (Alloway, 2008) [1].

Interaction effect of split application of fertilizers and foliar spray of multi-micronutrient mixture did not reach to the level of significance for any of the growth and yield parameters.

Table 1: Effect of split application of fertilizers and foliar sprays of multi-micronutrient mixture on growth parameters of pomegranate cv. Bhagwa

Treatments	Number of branches	Shoot length(cm)	Net increase in plant spread (N-S) (m)	Net increase in plant spread (E-W) (m)
Split application of fertilizers				
S_1	7.37	15.10	0.40	0.40
S_2	9.02	15.09	0.50	0.35
S_3	12.38	15.32	0.45	0.38
S_4	15.58	15.56	0.98	0.50
S.Em±	0.32	0.16	0.02	0.01
C.D. at 5%	0.96	NS	0.05	0.03
Foliar sprays of multi-micronutrient mixture (Grade - IV)				
M_1	10.48	15.25	0.46	0.39
M_2	11.69	15.29	0.70	0.48
S.Em±	0.23	0.11	0.01	0.01
C.D. at 5%	0.68	NS	0.03	0.02
Interaction (S × M)				
S.Em±	0.45	0.22	0.02	0.02
C.D. at 5%	NS	NS	NS	NS
Control vs rest				
Control	6.13	13.56	0.03	0.17
Rest	11.09	15.27	0.58	0.41
SE(d)	0.34	0.17	0.02	0.01
C.D. at 5%	1.01	0.50	0.05	0.04
C.V. %	7.42	2.54	7.93	7.35

Table 2: Effect of split application of fertilizers and foliar sprays of multi-micronutrient mixture on yield parameters of pomegranate cv. Bhagwa

Treatments	No. of fruit sets/plant	Days taken to harvest	No. of fruits harvested/plant	Average fruit weight (g)	Fruit yield (kg/tree)	Fruit yield (t/ha)
Split application of fertilizers						
S_1	68.36	177.50	52.77	225.50	11.93	9.91
S_2	74.95	175.00	58.03	247.07	14.27	11.88
S_3	80.25	172.00	62.94	253.77	15.99	13.31
S_4	96.22	168.00	77.93	265.85	20.74	17.27
S.Em±	3.60	3.35	2.78	7.17	0.70	0.58
C.D. at 5%	10.80	NS	8.34	21.48	2.10	1.75
Foliar sprays of multi-micronutrient mixture (Grade - IV)						
M_1	75.66	177.25	59.42	238.90	14.28	11.88
M_2	84.22	169.00	66.42	257.19	17.18	14.30
S.Em±	2.55	2.37	1.97	5.07	0.50	0.41
C.D. at 5%	7.63	7.09	5.90	15.19	1.49	1.24
Interaction (S × M)						
S.Em±	5.09	4.73	3.93	10.13	0.99	0.83
C.D. at 5%	NS	NS	NS	NS	NS	NS
Control vs rest						
Control	65.52	184.00	52.94	188.59	9.97	8.30
Rest	79.94	173.13	62.92	248.05	15.73	13.09
SE(d)	3.82	3.55	2.95	7.60	0.74	0.62
C.D. at 5%	11.45	10.64	8.85	22.79	2.23	1.86
C.V. %	11.26	4.70	11.03	7.27	11.39	11.41

Conclusion

From foregoing discussion, it can be inferred that in pomegranate, application of 500 g N and 125 g K in four equal splits in the form of urea and muriate of and foliar application of multi-micronutrient (grade-IV) @ 1.0% showed the better performance for getting higher growth and yield of fruits in *Ambe bahar* crop of pomegranate.

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