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Effect of Foliar Feeding of KNO_3 and K_2SO_4 on Yield and Quality of Some Pomegranate Cultivars Grown in Laterite Soils of West Bengal

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Abstract: *The influence of foliar application of water soluble fertilizers viz., KNO_3 and K_2SO_4 on the fruit yield and quality of 7-pomegranate cultivars was investigated. The experiment consists of seven cultivars and two spray conditions (sprayed and unsprayed). A total of 14 treatments were replicated three times in factorial Randomized Block Design. The results indicated that foliar application of KNO_3 and K_2SO_4 significantly improved the physical as well as chemical attributes of pomegranate fruits compare to control (Unsprayed). The pomegranate cultivars varied significantly for yield and quality traits. Among the cultivar, Bassein Seedless had the highest number of fruits (42.16) per plant and fruit yield per plant (6.63kg), while cultivar Jyothi had the highest average fruit weight (225.00 g). Other cultivars Amlidana had maximum juice percentage (54.28); finally Ruby cultivar had highest TSS (14.9 °Brix), TSS/acid ratio (48.33) and minimum acid content (0.310%). Among interactions of the treatments, Bassein Seedless with KNO_3 and K_2SO_4 sprayed condition had highest number of fruits (43.66) per plant and fruit yield per plant (9.08 kg), while the treatment combination Jyothi with water soluble fertilizers KNO_3 and K_2SO_4 sprayed condition had maximum fruit weight (255.00 g); incase of maximum juice percentage (56.41 %) had the treatment combination G-137 with KNO_3 and K_2SO_4 sprayed combination. The interaction between G-137 with water soluble fertilizers KNO_3 and K_2SO_4 sprayed condition had highest TSS (15.2°Brix); While Ruby with water soluble fertilizers KNO_3 and K_2SO_4 sprayed condition had highest TSS/acid ratio (55.55) and minimum acid content (0.26 %). From this study concluded that Bassein Seedless had highest fruit yield and Ruby had good quality fruits by foliar application of water soluble fertilizers KNO_3 and K_2SO_4 among seven cultivars grown in laterite soils of West Bengal. In general, all the 7-cultivars responded well in respect to fruit yield, fruit size and taste (TSS/acid ratio), to foliar feeding of nutrients as compared to un-sprayed (control).*

Keywords: *Cultivars, KNO_3, K_2SO_4 Laterite soils, Pomegranate, Quality, Water soluble fertilizers and Yield.*

INTRODUCTION

Pomegranate (*Punica granatum* L.*)* belongs to the family punicaceae is one of the favorite table fruits of tropical and subtropical regions. The fruit is native of Iran and is extensively cultivated in the Mediterranean countries like Spain, Morocco, Egypt, Iran, Afghanistan and Baluchistan (Lal and Ahmed, [10]). Pomegranate is commercially grown for its sweet-acidic taste. It is gaining popularity in arid and semi-arid regions of India due to its wide adaptability, higher yield, drought hardiness and tolerance to salinity. As a cultivated crop the pomegranate is grown in many states of India like Maharashtra, Gujarat, Rajasthan, U.P., Haryana, Andhra Pradesh, Karnataka and Tamilnadu, it consists area of 113.2 (000 ha), 745.0 MT production and 6.6 MT/ha productivity ((NHB, [14]). In West Bengal, the crop has been introduced in the red laterite zone of the state for its dry and hot climatic condition (Tarai and Ghosh, [18]). In the recent years, foliar feeding of nutrients became most popular among fruit tree growers since foliar application of nutrients is capable to satisfy plant's nutrient requirement and is highly efficient also (Inglese *et al*., [6]). Foliar fertilization has the advantage of low application rates, uniform distribution of fertilizer materials and quick response to applied nutrients and zero loss of nutrients as happen in soil

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application. Moreover, hidden hungers can easily and quickly be managed [Umer, 1999]. Potassium (K) is particularly well adapted to this form of fertilization (KNO_3 and K_2SO_4) because it can be rapidly translocated from the leaves (Mengel, [13]). Southwick *et al*. (17) indicated that uptake of K from foliar spray may be more predictable and efficient than uptake from the soil, where soil-cation interactions may hinder the process. They added that if the rate of demand is greater than the rate of soil K availability, deficiency will develop regardless of soil amendment. Although K is not a constituent of any organic molecule or plant structure, it is involved in numerous biochemical and physiological processes vital to plant growth, yield, quality and stress [Marschner, [12] and Cakmak, [1]. There is less report about the effect of foliar feeding on pomegranate cultivars in respect of yield, fruit size and quality and no report is available in pomegranate grown in laterite soils where availability of nutrients is a major problem due to low pH. Therefore, the aim of this study was to assess the effect of foliar spray of water soluble potassium fertilizers on some pomegranate cultivars grown in laterite soils of West Bengal.

MATERIALS AND METHODS

The present study was carried out at the private farm at Jhargram, Paschim Midnapore district of West Bengal during 2014. Seven pomegranate varieties *viz*. Jyothi, Ruby, Amlidana, Bassein Seedless, Jalore Seedless, Mridula, and G-137 were used in the study. Six year old plants spaced at 3.0m × 3.0m, with uniform vigour were selected. All the recommended cultural practices were followed. Four shoots per plant were tagged in four directions for recording observation on fruit yield and quality. Treatments applied as Potassium Nitrate (KNO_3) 13:0:45-8g per liter at 20 days' interval two sprays 20/3/14 and 10/4/2014 after fruit set and Sulphate of Potash (K_2SO_4) 0:0:50-8g per liter at 20 days interval two sprays 30/4/14 and 20/5/2014 during fruit development period. The experiment was laid out in a factorial randomized block design with 7-treatments and each treatment was replicated thrice. The fruits of Ambe-bahar flowering (January-February) were harvested during May-June. The plants were forced to Ambe bahar flowering by withholding irrigation. Plant yield at harvest time (last week of May), the number of fruits per tree was counted and fruit yield/plant was weighted as Kg/tree. Samples of randomly mature fruits from each replicate were used for measuring various fruit physical and chemical parameters assessed such as: fruit weight (g), Juice percentage, total soluble solids (TSS) percentage using a hand refractometer, total acidity percentage as citric acid (g/100 g fresh weight).

RESULTS AND DISCUSSION

From table1 and 2 results showing that among the treatments and control, foliar application of water soluble fertilizers was found best which resulted maximum number of fruits per plant, average fruit weight, fruit yield, total soluble solids, TSS/acid ratio and minimum acidity content. While in control these were lowest in all the seven selected varieties, *viz*.,

Table 1
Effect of foliar feeding of water soluble fertilizers KNO_3 and K_2SO_4 on number of fruits per plant, average fruit weight, juice percentage and yield of pomegranate varieties grown in laterite soils of west Bengal.

Treatments	*Number of fruits per plant*			*Average fruit weight (g)*			*Total juice content (%)*			*Fruit yield Kg/plan*		
	Sprayed	*Control*	*Mean A*	*Sprayed*	*Control*	*Mean A*	*Sprayed*	*Control*	*Mean A*	*Sprayed*	*Control*	*Mean A*
Jyothi	19.33	18.33	18.83	255	195	225	53.33	53.01	53.17	4.92	3.57	4.25
Ruby	37.33	27.33	32.33	150	144	147	52.63	52.08	52.35	5.6	3.93	4.76
Amlidana	28.00	26.66	27.33	162	158	160	54.76	53.8	54.28	4.53	4.21	4.37
Bassein Seedless	43.66	40.66	42.16	208	103	155.5	53.81	52.94	53.37	9.08	4.18	6.63
Jalore seedless	34.00	28.66	31.33	196	208	202	54.61	52.83	53.72	6.66	5.96	6.31
Mridula	24.33	23.00	23.665	92	82	87	53.33	50.6	51.96	2.23	1.88	2.06
G-137	36.33	20.00	28.165	166	154	160	56.41	50.98	53.69	6.03	3.08	4.55
Mean B	31.85	26.377	–	175.571	149.143	–	54.126	52.32	–	5.58	3.83	-
Factors	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)
Factor (A)	1.368	0.662	0.468	5.332	2.58	1.824	N/A	0.95	0.672	0.192	0.093	0.066
Factor (B)	0.731	0.354	0.25	2.85	1.379	0.975	1.049	0.508	0.359	0.103	0.05	0.035
Factor(A × B)	1.935	0.936	0.662	7.541	3.648	2.58	N/A	1.343	0.95	0.272	0.132	0.093

Table 2
Effect of foliar feeding of water soluble fertilizers KNO_3 and K_2SO_4 on quality of pomegranate varieties grown in laterite soils of west Bengal.

Treatments	*Total soluble solids (°Brix)*			*Acidity (%)*			*TSS/acid ratio*		
	Sprayed	*Control*	*Mean A*	*Sprayed*	*Control*	*Mean A*	*Sprayed*	*Control*	*Mean A*
Jyothi	13.8	13.2	13.5	0.4	0.49	0.445	34.5	26.93	30.71
Ruby	15.0	14.8	14.9	0.26	0.36	0.310	55.55	41.11	48.33
Amlidana	13.6	13.2	13.4	0.55	0.74	0.645	24.72	17.83	21.28
Bassein Seedless	13.8	13.4	13.6	0.37	0.42	0.395	37.29	31.90	34.60
Jalore seedless	14.2	13.0	13.6	0.27	0.36	0.315	52.59	36.11	44.35
Mridula	12.4	12.2	12.3	0.35	0.37	0.36	35.42	32.97	34.20
G-137	15.2	13.8	14.5	0.39	0.54	0.465	38.97	25.55	32.26
Mean B	14.0	13.371	–	0.370	0.469	–	39.86	30.34	–
Factors	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)	C.D.	SE(d)	SE(m)
Factor(A)	0.527	0.255	0.18	0.013	0.006	0.005	1.734	0.839	0.593
Factor(B)	0.281	0.136	0.096	0.007	0.003	0.002	0.927	0.448	0.317
Factor(A X B)	N/A	0.36	0.255	0.019	0.009	0.006	2.452	1.186	0.839

Jyothi, Ruby, Amlidana, Bassein Seedless, Jalore seedless, Mridula, and G-137. From table 1 more number of fruits per plant (31.85) recorded with foliar spray of water soluble fertilizers KNO_3 and K_2S0_4 compare to control (26.37). Among selected cultivars highest number of fruits per plant (42.16) was recorded in Bassein Seedless and second highest 31.33 in Jalore Seedless. The variation in number of fruits per plant may be due to their genetic make-up or environmental. In treatments and varietal interaction maximum number of fruits per plant has recorded in Bassein Seedless (43.66), Ruby (37.33), G-137 (36.33), Jalore seedless (34), Amlidana (28), Mridula (24.33) and Jyothi (19.33) respectively with spraying of water soluble fertilizers KNO_3 and K_2S0_4 and lowest number of fruits per plant recorded in control (water) i.e. Jyothi (18.83), G-137 (20), Mridula (23), Amlidana (26.66), Ruby (27.33), Jalore seedless (28.66) and Bassein Seedless (40.66). Similar results reported by (Prakash and Balakrishnan, [15]) in pomegranate.

Fruit weight (g) significantly improved with the application of water soluble fertilizers KNO_3 and K_2SO_4 and maximum were recorded with spray condition (175.57 g) followed by control (149.14) irrespective of varieties. Among the varieties, maximum fruit weight was recorded in Jyothi (225 g), Jalore seedless (202 g), Bassein Seedless (155.5 g), G-137 (160 g), Amlidana (160 g) , Ruby (147 g) and Mridula (87 g) respectively. In treatment x varietal interaction means differ significantly and maximum fruit weight ((255 g) has recorded with treatment water soluble fertilizers KNO_3 and K_2SO_4 application in Jyothi lowest (82 g) was found in Mridula in control. The foliar spray of potassium nitrate had increased fruit weight that was in agreement with Khayyat, *et al*., [8] on barberry. Fisher, *et al*., [5] and Marschner, 11, reported that the potassium as an essential element increasing fruit enlargement and cell turgidity by reducing carbohydrate contents.

Total juice content (%) recorded maximum (54.12%) in treatment with water soluble fertilizers application followed by control (52.32%). In treatments and varietal interaction it was found non-significant for total juice content, even though maximum juice content (56.41%) recorded in G-137 with water soluble fertilizer KNO_3 and K_2SO_4 spray application. The highest total juice content in pomegranate was recorded due to spraying of potassium nitrate 250 mg L^{-1} earlier reported by Khayyat *et al*., [9].

Fruit yield was highest (5.58 kg/plant) with water soluble fertilizer application followed by control (3.83 kg/plant) in all the varieties. Among varieties maximum yield per tree recorded in Bassein Seedless (6.63 kg/plant), Jalore seedless (6.31 kg/plant), Ruby (4.76 kg/plant), G-137 (4.55 kg/plant), Amlidana (4.37 kg/plant), Jyothi (4.25 kg/plant) and Mridula (2.06 kg/plant) respectively. Treatments and varieties interaction means was found significant and maximum yield was recorded in treatment of water soluble fertilizers spray application in Bassein Seedless (9.08 kg/plant), Jalore seedless (6.66 kg/plant), G-137(6.03 kg/plant), Ruby(5.6 kg/plant), Amlidana (4.53 kg/plant), Jyothi (4.92 kg/plant) and Mridula (2.23 kg/plant) respectively as compared to control. Some of the workers also reported an

increase in fruit yield with $K_2 SO_4$ sprays (Kaur and Dhillon [7] and Dutta [4] in guava; Yamdagni *et al*., [21] in ber). The highest fruit yield due to spraying of potassium nitrate in mango cv. Pairy in Akola, Maharashtra, India (Dalal, *et al*., [2]) and pomegranate *cv* Bhagwa in periyaculam, Tamilnadu, India (Prakash and Balakrishnan, 2014), has got the similarity with the present result. The highest fruit yield which obtained by foliar spray of KNO_3 may be attributed to the best uptake of N, P, K and Ca. There is no doubt that K, as important nutritional elements, plays its part in regulation of many physiological criteria in plant which in turn affect the resulted total yield.

Total soluble solids (TSS) content in the fruits significantly increased with application of water soluble fertilizers (14° Brix) followed by control (13.37° Brix). Among cultivars the highest TSS content (14.9° Brix) was recorded in Ruby followed by G-137 (14.5° Brix) (Table 2). Treatments and varietal interaction was found non-significant for the total soluble solids. In the present studies, it seems that K play a significant role in accumulation of sugars and other soluble solids in the fruit and it finds support from the well established fact that potassium plays an important role in sugars translocation. These findings are also supported by the work of Khayyat *et al*., [9] in pomegranate and Tossar *et al*., [19] who reported an increase n TSS with K and micro-nutrients in guava.

Acidity content in the fruits significantly decreased with application of water soluble fertilizers (0.370%) followed by control (0.469%). Among cultivars minimum Acidity content (0.310%) was recorded in Ruby followed by Jalore Seedless (0.315%) (Table 2). In treatments and varietal interaction means differ significantly and minimum acidity content (0.26%) has recorded with treatment water soluble fertilizers application in Ruby followed by Jalore Seedless (0.27%). Delgado *et al*., [3] showed that application of potassium may decrease the amount of tartaric acid in grape.

TSS/acid ratio which determines organoleptic test of fruits was differ significantly with the spraying of water soluble fertilizers application treatments and control. Highest TSS/acid ratio (39.86) recorded in KNO_3 and K_2SO_4 foliar sprays followed by control (30.34) irrespective of varieties. Comparison of among varieties, mean maximum TSS/acid ratio content noted in Ruby (48.33), Jalore Seedless (44.35), Bassein Seedless (34.60), Mridula (34.20), G-137 (32.26), Jyothi (30.71), and Amlidana (21.28). Treatments and varieties interaction means was also found significant and maximum TSS/acid ratio (55.55) recorded in Ruby sprayed as compared to control in Amlidana (17.83), G-137 (25.55), Jyothi (26.939), Bassein Seedless (31.90), Mridula (32.97), Jalore Seedless (36.11) and Ruby (41.11) cultivars respectively.

Thus from the current study, it can be concluded that fruit yield and fruit quality parameters as number of fruits per plant, average fruit weight, juice content, fruit yield, TSS, TSS/acid ratio and titrable acidity can be improved significantly by foliar application of water soluble fertilizers KNO_3 and K_2SO_4 in pomegranate cultivars grown in laterite soils of West Bengal.

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