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Short communication

Effect of fertigation using low cost drip irrigation system on physico-chemical characteristics in pomegranate cv. Bhagwa

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Pomegranate (*Punica granatum* L.) is one of the favorite table fruit of tropical and subtropical region and belongs to family punicaceae. Irrigation and fertilizers are the most important inputs which directly affect the plant growth, development, yield and quality of produce. Application of irrigation water and fertilizers through drip are the most effective ways of supplying water and nutrients to the plant roots. Farmers generally irrigate the pomegranate through surface method of irrigation, which needs more water to irrigate the crop and huge quantity of water losses occur through leaching and evaporation. Similarly, farmers are using solid fertilizers for fruit crop production but these are not totally water soluble and hence are less available to plants and some of the fertilizers contain salts of sodium and chloride which not only affect the quality and quantity of crop production but they are also harmful to the soil. The drip irrigation method is an appropriate answer, particularly for horticultural and cash crops as it permit the irrigator to limit the watering as per water requirement of plants and optimum application of fertilizers through drip irrigation system. A large number of studies have been conducted on low cost drip irrigation system to study hydraulic parameters of lateral and micro tubes, productivity of different crops, performance, economics and suitability of system. However, the information regarding drip irrigation and fertigation scheduling in newly planted pomegranate under high density planting system is lacking. Keeping these in view the present experiment on "Effect of fertigation through low cost drip irrigation system on physico-chemical characteristics in pomegranate cv. Bhagwa" was carried out at Horticultural Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology Udaipur.

The present study was conducted during 2009-10 on one year old pomegranate plants cv. Bhagwa growing under high density planting system (2 m × 2 m). Thirty two one-year-old plants were considered as experimental material and subjected to give various treatments. The experimental set up of drip and hand watering system was laid out as per the treatment. The experiment comprised of 8 treatment combinations consisting of fertigation levels (75, 100, 125 and 150% recommended dose of fertilizers) and irrigation methods (Hand watering and Drip irrigation). The experiment was laid out in Factorial Randomize Block Design with 4 replications. Recommended dose of urea, single super phosphate and muriate of potash used were 100, 250 and 500 g per plant, respectively (Shukla *et al*., 7) and these conventional fertilizers were applied by ring method for plants which were irrigated through hand watering. In conventional method, full quantity of phosphorus and potassium and half quantity of nitrogen were applied just prior to the first irrigation. The remaining half quantity of nitrogen was given as top dressing one and half month after first dose. Fertilizers for drip irrigated plants were applied by water soluble fertilizers through drip irrigation system in six equal split doses at fifteen days interval. In drip irrigation system water was applied at one day interval and at weekly interval in case of hand watering. Pan evaporation method was used for estimating crop water requirement (Mane *et al*., 6).

$$V = \frac{CA(m^2)\,x\,PE\,x\,P_C\,x\,K_C\,x\,PWA}{E_U}$$

Where, V =Volume of water required (l/day/plant), CA=Crop area (m^2), PE = Maximum pan evaporation (mm/day), P_C = Pan Coefficient, K_C = Crop coefficient, PWA= Percentage wetted area, E_U = Emission uniformity, decimal. Irrigation time is the ratio of volume of water applied to the plant and discharge rate of emitters. Keller and Karmeli (2) suggested the equation for the evaluation of emission uniformity "EU" measures the degree of uniformity of application of water in the field. These are denoted as EU_f (field emission uniformity) and EUa (Absolute emission uniformity).

$$EU_f = \left(\frac{q_n}{q_a}\right) \times 100$$

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Table 1. Effect of irrigation methods on physico-chemical characteristics of pomegranate cv. Bhagwa.

Treatment	Total chlorophyll content (mg 100 g^{-1} FW)	Carbon assimilation (μmol m^{-2} s^{-1})	N (%)	P (%)	K (%)
I_0 (HW)	2.24	2.96	1.74	0.16	1.17
I_1 (DI)	2.85	5.87	1.93	0.16	1.33
CD at 5%	0.03	0.07	0.03	NS	0.02

HW = Hand watering DI = Drip irrigation

Table 2. Effect of fertigation levels on physico-chemical characteristics of pomegranate cv. Bhagwa.

Treatment	Total chlorophyll content (mg 100 g^{-1} FW)	Carbon assimilation (μmol m^{-2} s^{-1})	N (%)	P (%)	K (%)
F_0 (75% RDF)	2.38	3.25	1.75	0.15	1.20
F_1 (100% RDF)	2.52	3.95	1.80	0.16	1.22
F_2 (125% RDF)	2.61	5.20	1.88	0.16	1.28
F_3 (150% RDF)	2.68	5.27	1.90	0.16	1.29
CD at 5%	0.05	0.10	0.04	NS	0.03

RDF= Recommended dose of fertilizers

$$EUa = 100 \times \left[\frac{Q_{min}}{Q_{avg}} + \frac{Q_{avg}}{Q_x} \right] 0.5$$

Where, EU_f = Field emmission uniformity, EUa = Absolute emmission uniformity, q_n = The average of lowest 1/4 of the emitter flow rate (l/h), q_a = The average of all emitters flow rate (l/h), q_x = The average of the highest 1/8 of the emitters flow rate (l/h). Total chlorophyll content was measured by DMF (N-N Dimethylformamide), Carbon assimilation by CIRAS-2 portable photosynthesis system under natural radiation, Nitrogen by Nesseler's reagent colorimetric method, Phosphorus by Ammonium vanadomolybd- phosphoric acid yellow colour method and Potassium by Flame photometer method.

The result revealed that fertigation levels and irrigation methods had significant effect on physico-chemical characteristics namely total chlorophyll content, carbon assimilation rate along with leaf N & K status. The present investigation clearly indicated that F_2 (125% RDF) treatment gave good result with respect of carbon assimilation rate (5.20 μmol m^{-2} s^{-1}) and leaf N (1.88%) and K (1.28%) status. However, maximum values of these physico-chemical characteristics were found in F_3 (150% RDF) which was statistically at par with F_2 (125% RDF). Koo (4) reported that fertigation increases the leaf nitrogen in orange. The response for the phosphorus uptake due to fertigation might have not been conspicuous as the phosphorus is immobile element and this may be due to the utilization of phosphorus element as a constituent of amino acids and other protein and their utilization in growth and development of leaves. Similar result had been reported by Hegde and Srinivas (1) in banana. The F_3 (150% RDF) resulted into maximum total chlorophyll content (2.68 mg 100g^{-1}) which was significantly higher than other fertigation levels. Leaf chlorophyll was significantly lower only in the lowest nitrogen fertigation treatment in Starking Delicious apple tree treated with four nitrogen fertigation treatments in drip irrigation (Klein *et al*., 3).

Further, irrigation level I_1 (DI) significantly improved pysico-chemical characteristic of leaves. Application of I_1 (DI) improved total chlorophyll content (2.85 mg 100g^{-1}), carbon assimilation rate (5.87 μmol m^{-2} s^{-1}) and leaf N (1.93%) & K (1.33%) content as compared to I_0 (HW) treatment. Drip irrigation at frequent intervals provides a consistent moisture regime in the soil and therefore, roots remain active for a longer period. The proper and continuous moisture in the soil also increase the availability of nutrients and translocation of food material which accelerates the vegetative growth of plants. In contrast to this, under conventional method of irrigation, there is higher moisture content immediately after irrigation followed by optimum level for few days and moisture stress subsequently in later days which ultimately results in poor plant growth. This was also observed by Lawand and Patil (5) in pomegranate. Hegde and Srinivas (1) observed that banana plants under drip irrigation had increased nitrogen and potassium uptake. Optimum water content in the root zone may reduced the variations in nutrient concentration, thereby increasing their availability to plants and reducing their leaching beneath the root zone.

Similarly, the interaction between fertigation levels and irrigation methods were found to be quite superior to their individual effect. Among different treatment combinations I_1F_1 (DI + 100% RDF) exhibited higher values of total chlorophyll content (2.88 mg 100g^{-1}) and carbon assimilation rate (6.10 µmol m^{-2}s^{-1}). However, maximum values of these physico-chemical characteristics were found in I_1F_3 (DI + 150% RDF) treatment combination which was found at par with I_1F_2 (DI + 125% RDF) and I_1F_1 (DI + 100% RDF). The highest nitrogen content (1.95%) and potassium content (1.35%) were obtained in I_1F_2 (DI + 125% RDF) which was statistically at par with I_1F_1 (DI + 100% RDF). Table 4 showed that the designed low cost drip irrigation system operated excellently as the value of field emission uniformity were higher than the designed criteria of 90 per cent (Keller and Karmali, 2) whereas absolute emission uniformity rated excellently as the value of absolute emission uniformity was also higher than the designed criteria of 90 per cent. Thus, it can be concluded that in newly planted pomegranate under high density planting system physico-chemical characteristics were significantly higher with application of 100 per cent RDF

Table 3. Interaction effect of irrigation methods and fertigation levels on physico - chemical characteristics of pomegranate cv. Bhagwa.

Treatment	Total chlorophyll content (mg 100 g^{-1} FW)	Carbon assimilation (µmol m^{-2} s^{-1})	N (%)	K (%)
I_0F_0	2.09	1.50	1.63	1.10
I_0F_1	2.16	1.81	1.65	1.11
I_0F_2	2.30	4.23	1.81	1.22
I_0F_3	2.42	4.31	1.86	1.25
I_1F_0	2.68	4.99	1.87	1.30
I_1F_1	2.88	6.10	1.94	1.33
I_1F_2	2.91	6.17	1.95	1.35
I_1F_3	2.94	6.22	1.94	1.33
CD at 5%	0.06	0.14	0.06	0.04

Table 4. Irrigation Performance Efficiencies (Uniformity) of low cost drip irrigation system.

Location on Lateral (A&B)	Lateral location on the sub-main (4th, 8th, 12th and 16th)									
	Inlet end 2th emitter		1/3 down 4themitter		2/3 down 6th emitter		Far end 8th emitter		Q_{var} %	
	ml	l/h	ml	l/h	ml	l/h	ml	l/h		
Inlet end A	172	5.16	170	5.10	174	5.22	164	4.92		
4nd Lateral B	176	5.28	175	5.25	165	4.95	160	4.80		
Average		10.44		10.35		10.17		9.72	6.90	
1/3 down A	175	5.25	171	5.13	168	5.04	162	4.86		
8th lateral B	170	5.10	170	5.10	162	4.86	158	4.74		
Average		10.35		10.23		9.90		9.60	7.25	
2/3 down A	165	4.95	160	4.80	158	4.74	146	4.38		
12th Lateral B	160	4.80	162	4.86	159	4.77	155	4.65		
Average		9.75		9.66		9.51		9.03	7.38	
Far End A	155	4.65	158	4.74	150	4.50	148	4.44		
16th Lateral B	162	4.86	156	4.68	161	4.83	141	4.23		
Average		9.51		9.42		9.33		8.67	8.83	
Average of all		10.01		9.92		9.73		9.26	7.59	
Total Avg (Q)										9.73
EU_f (%)										95.14
EU_a (%)										93.14

with drip irrigation at alternate day. The hydraulic performance of low cost drip system under study was found to be satisfactory and it was scheduled on alternate day basis.

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