Original Research Article

Influence ofirrigation scheduling and Fertigationon quality ofBhagwacultivar of pomegranate under semi-arid conditions of Rajasthan

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ABSTRACT : The field experiment was conducted at Horticulture farm, Rajasthan Agricultural Research Institute, Durgapura (Jaipur-Rajasthan) during 2019-20 and 2020-21. The experiment comprised of 12 treatment combinations consisting of 3 drip irrigation levels (50%, 75% and 100% at PE level) and 4 fertigation levels (100%, 75%, 50% of recommended dose of fertilizers through drip and 100% of RDF as basal dose). The experiment was laid out in factorial Randomized Block design.The experimental results revealed that among different treatment combinations highest fruit quality characters such as TSS (B^0), TSS:Acid, reducing sugar (%), total sugar (%)and lowest value for acidity (%) and non-reducing sugar (%) of pomegranate fruit was found under treatment I_2F_3 (75% irrigation at PE level + 75 % RDF through drip).

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Keywords: Irrigation, Fertigation, Pomegranate, Bhagwa,Qualitative parameters

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INTRODUCTION:

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Irrigation water and nutrients are the most crucial inputs which directly affect the plant vegetative growth, development, yield and quality of product. Application of irrigation water and fertilizers together through drip is the most efficient way of applying water and nutrient to the plant root zone. These inputs are efficiently harnessed by plants as these are placed near root zone of the plant. For proper water management, scheduling of water is beneficial (Tan, 1980). Scheduling of irrigation is the process which helps an irrigator to determine the timing, frequency and quantity of water that is to be applied to the crop. The main task is to estimate crop water requirement in the perspective of growth stages of plant and climate (Tan and Layne, 1981). Pomegranate needs supplemental irrigation for proper growth and for commercial cultivation of pomegranate in dry and arid region, water itself is a limiting factor (Prasad *et al*., 1997).Through fertigation both water and fertilizer can be applied more precisely, in controlled quantity and at appropriate time and

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Comment [M11]: dry and arid regions,

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Comment [M13]: a controlled quantity, and frequency directly to the root zone with drip irrigation as per the crop requirements at different growth stages (Yadav*et al*., 1998).Fertigation through drip can minimize the fertilizer usage up to 25-40 per cent (Kale, 1995; Hasan*et al*., 2007; Thakur *et al*., 2012) andincreased fertilizer use efficiency (Ranghaswami*et al*., 2006).

MATERIALS AND METHODS:

The present study was conducted on five-year-old pomegranate plants *cv.*Bhagwa growing under high density planting system (3 m×3 m spacing), at the Horticulture Farm, Rajasthan Agricultural Research Institute, Durgapura, Jaipur. The experiment was conducted on 36 plants in randomized block design. The experiment comprised of 12 treatment combinations consisting of 4 fertigation levels (100%, 75%, 50% of recommended dose of fertilizers through drip and 100% of RDF as basal dose) and 3 drip irrigation levels (50%, 75% and 100% at PE level).The **"*MrigBahar*"**(June-July)crop had been chosen for the present experiment. Recommended dose of N,P and K used wereapplied@ 625, 250 and 250 g per plant respectively.Water soluble fertilizers were applied through dripirrigation system (fertigation). Amount of watersoluble fertilizes were determined by calculating the amount of nitrogen, phosphorus and potassium inrecommended dose. All fertilizers were applied in ten equal split doses at weekly interval (from 16 August to 30 October in both the years).Weighed quantity of watersoluble fertilizers (19:19:19) along with urea as per treatment requirement were mixed in water and injected through venturi meter.Pan Evaporation method was used for estimating crop water requirement (Mane *et al*., 3).

OBSERVATIONS:

1. **TSS (^{0}Brix):**Total soluble solids of juice was recorded with the help of "Digital Refractometer" (Brix: 0.0 to 53.0 %) by taking a drop of juice of composite sample on prism of the refractometer and observing it against the light as it works on the principle of refraction of light.

2. **Acidity (%):** The titrable acidity of the fruit juice was determined by the method given by Ranganna, 1986. For this 10 ml of juice was titrated against 0.1N NaOH using phenolphthalein as an indicator. The percentage acidity of the juice was expressed as citric acid in grams in 100 ml of fruit juice.

0.0064 x Volume of NaOH used

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Comment [M21]: The recommended dose of N, P, and K used was applied @ 625, 250, and 250 g per plant respectively.
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$$\text{Acidity (\%)} = \frac{\qquad}{\text{Volume of sample taken}} \times 100$$

3. TSS: Acid ratio : From T.S.S. and acidity of fruit juice, T.S.S.: Acid ratio was worked out by dividing T.S.S.(^{0}B) by acidity(%).

4. Sugars:

Reducing sugar (%): The reducing sugar was estimated by DNS method (Miller, 1959).

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Reagents:

(i) Dinitrosalicyclic acid (DNS) reagent:

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Dinitrosalicyclic acid	=	1g
Crystalline phenol	=	200mg
Sodium sulphite	=	50mg
1 per cent NaOH	=	100 ml

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(ii) Rochelle salt :

Na-K tartrate	=	40g
Volume	=	100 ml

(iii) Standard glucose solution: (1mg/ml)

Dissolve 100 mg glucose in 100 ml of distilled water.

(iv) Working standard solution: (100µg/ml)

10 ml standard solution make up to 100 ml with distilled water.

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Estimation: Reducing sugar was estimated by using DNS reagent and Rochelle salt. Pulp (0.5ml) (100 times diluted) was added with 2.5ml D.W., 3ml DNS reagent and heated in boiling water bath, cooled and 1 ml of Rochelle salt was added. The absorbance was measured at 510 nm on spectrophotometer, model Spectronic–20. The value was plotted against a standard curve prepared from glucose. The figure was expressed on percentage basis.

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Total sugar (%): Total sugar was estimated by Anthrone reagent method (Dubois *et al.*, 1951).

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Reagent:

A.	Anthrone reagent	=	2 mg/ml in conc. H2SO4
B.	Standard glucose solution	=	1mg/ml

100 mg glucose was dissolved in 100 ml distilled water.

C. Working Standard Solution = 100 µg/ml

10 ml standard solution was dissolved in 100 ml distilled water.

Estimation: Total sugar content was determined by using Anthrone reagent method (Dubois *et al.,* 1951). 0.5ml of diluted pulp (100 times) was taken. 0.5 ml of diluted H2O and 4ml Anthrone reagent was put in chilled water for 5-10 times and absorbance was measured at 630 nm on Spectronic-20.

The amount of sugar present in the pulp was plotted against standard curve prepared from glucose. The content was expressed on per cent basis.

Non-reducing sugar (%): The amount of non-reducing sugar was obtained by dividing the total sugar by factor 0.95 and subtracting the reducing sugar from the resultant.

Non-reducing sugar (%) = (Total Sugar (%) × 0.95) – Reducing Sugar (%)

RESULTS:

Total Soluble Solids (^{0}Brix) :

The data on T.S.S. (^{0}B) of pomegranate as affected by drip irrigation levels, fertigation and their interaction are presented in the table. The results are presented as pooled value for both the years of experiments.

As obvious from the table that irrigation levels significantly affected the T.S.S. (^{0}B) in pomegranate. Pooled data of both the years presented showed that the maximum and minimum T.S.S. (^{0}B) (14.24 and 12.59) was found under treatments I_2 and I_1 respectively. Among fertigation levels, the maximum and minimum T.S.S. (^{0}B) (14.21 and 12.86) was found under treatments F_3 and F_4 respectively.

Interaction effect (I x F): Interaction effect of drip irrigation levels and fertigationpresented in the table showed significant effect on T.S.S. (^{0}B). Based on the found data, Pooled data for both the years showed that maximum T.S.S. (^{0}B)(14.92) was recorded in the treatment I_2F_3 and minimum T.S.S. (^{0}B) (11.94) was recorded in the treatment I_1F_4.

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Acidity (%):

The data regarding acidity (%) of pomegranate as affected by drip irrigation levels and fertigation and their interaction are presented in Table 1.The data revealthat the different irrigation levels significantly affected the acidity (%), where Pooled data for both the years showed that the mean minimum (0.46 %) and mean maximum acidity (%) (0.54 %) was observed in treatment I_2 and I_1 respectively.Similarly, different fertigation levels significantly affected the acidity (%), where pooled data for both the years showed that the mean minimum (0.48 %) and mean maximum acidity (%) (0.52 %) was observed in treatment F_2 and F_4 respectively.

Interaction effect (I x F): Interaction effect of drip irrigation levels and fertigation presented in the table showed significant effect on acidity (%). Based on the found data, pooled data for both the years showed that minimum acidity (%) (0.45 %) was recorded in the treatment I_2F_2 and maximum acidity (%) (0.56) was recorded in the treatment I_1F_4.

TSS: acid ratio :

The data on TSS: acidof pomegranate as affected by drip irrigation levels, fertigation and their interaction are presented in Table 1. As obvious from the table that irrigation levels significantly affected the TSS: acidin pomegranate.. Pooled data of both the years showed that the maximum and minimum TSS: acid (30.17 and 24.23) was found under treatments I_2 and I_1 respectively. Similarly, fertigation levels significantly affected the TSS: acidin pomegranate.. Pooled data of both the years showed that the maximum and minimum TSS: acid(30.28 and 25.77) was found under treatments F_3 and F_1 respectively.

Interaction effect (I x F): Interaction effect of drip irrigation levels and fertigationpresented in thetable showed significant effect on TSS: acid. Based on the found data, Pooled data for both the years showed that maximum TSS: acid(32.94) was recorded in the treatment I_2F_3 and minimum TSS: acid(22.93) was recorded in the treatment I_1F_1.

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Sugars (reducing sugar, non-reducing sugar, total sugar) :

Reducing sugar:

The data on reducing sugar (%) of pomegranate as affected by drip irrigation levels, fertigation and their interaction are presented in Table 1. As obvious from the table that irrigation levels significantly affected the reducing sugar (%) in pomegranate. Pooled data of both the years showed that the maximum and minimum reducing sugar (%) (8.45 and 7.24) was found under treatments I_2 and I_1 respectively. As presented in the table that fertigation levels significantly affected the reducing sugar (%) in pomegranate. Pooled data of both the years showed that the maximum and minimum reducing sugar (%) (8.36 and 7.70) was found under treatments F_3 and F_4 respectively.

Interaction effect (I x F): Interaction effect of drip irrigation levels and fertigationpresented in the table showed significant effect on reducing sugar (%). Based on the pooled data for both the years the maximum reducing sugar (%) (8.81) was recorded in the treatment I_2F_3 and minimum reducing sugar (%) (6.95) was recorded in the treatment I_1F_4.

Total Sugar (%) :

The data on total sugar (%)of pomegranate as affected by drip irrigation levels, fertigation and their interaction are presented in Table 1. As obvious from the table that irrigation levels significantly affected the total sugar (%)in pomegranate. Pooled data of both the years showed that the maximum and minimum total sugar (%)(8.93 and 8.09) was found under treatments I_2 and I_1 respectively. As presented in the table that fertigation levels significantly affected the total sugar (%)in pomegranate.. Pooled data of both the years showed that the maximum and minimum total sugar (%)(8.94 and 8.30) was found under treatments F_3 and F_4 respectively.

Interaction effect (I x F): Interaction effect of drip irrigation levels and fertigationpresented in the table showed significant effect on total sugar (%). Based on the found data, Pooled data for both the years showed that maximum total sugar

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(%)(9.26) was recorded in the treatment I_2F_3 and minimum total sugar (%)(7.79) was recorded in the treatment I_1F_4.

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Non-reducing sugar (%):

The data regarding non-reducing sugar (%) of pomegranate as affected by drip irrigation levels and fertigation and their interaction are presented in Table 1. The data revealed that the different irrigation levels significantly affected the non-reducing sugar (%), where pooled data for both the years showed that the mean minimum (0.93 %) and mean maximum non-reducing sugar (%) (1.25 %) was observed in treatment I_3 and I_1 respectively.Similarly, different fertigation levels significantly affected the non-reducing sugar (%), where pooled data for both the years showed that the mean minimum (1.00 %) non-reducing sugar (%) was observed in treatment F_3 and mean maximum non-reducing sugar (%) (1.07 %) was observed in treatment F_4 which was found statistically at par with $F_{2.}$

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Interaction effect (I x F): Interaction effect of drip irrigation levels and fertigation presented in the table showed significant effect on non-reducing sugar (%). Based on the found data, pooled data for both the years showed that minimum non-reducing sugar (%) (0.89 %) was recorded in the treatment I_3F_3 and maximum non-reducing sugar (%) (1.27 %) was recorded in the treatment I_1F_4 which was statistically at par with I_1F_2 treatment.

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Table:1 - Effect of drip irrigation levels and fertigation on Qualitative parameters

Treatments	TSS (^{0}Brix)	Acidity (%)	TSS : acid ratio	Reducing sugar (%)	Total sugar (%)	Non-reducing sugar (%)
Irrigation Levels (I)						
I_1	12.59	0.54	24.23	7.24	8.09	1.25
I_2	14.24	0.46	30.17	8.45	8.93	0.96
I_3	13.83	0.48	28.79	8.36	8.82	0.93
SEm±	0.22	0.01	0.45	0.13	0.14	0.02
CD (5 %)	0.62	0.02	1.28	0.36	0.39	0.05
Fertigation Levels (F)						
F_1	13.37	0.51	25.77	7.92	8.51	1.05
F_2	13.79	0.48	29.05	8.11	8.72	1.07
F_3	14.21	0.48	30.28	8.36	8.94	1.00
F_4	12.86	0.52	25.84	7.70	8.30	1.07
SEm±	0.25	0.01	0.52	0.15	0.16	0.02
CD (5 %)	0.71	0.03	1.48	0.42	0.45	0.06

Interaction (IxF)						
I_1F_1	12.42	0.55	22.52	7.15	8.00	1.26
I_1F_2	12.80	0.52	25.38	7.33	8.19	1.27
I_1F_3	13.19	0.52	26.45	7.55	8.40	1.20
I_1F_4	11.94	0.56	22.58	6.95	7.79	1.27
I_2F_1	14.05	0.48	28.03	8.34	8.82	0.96
I_2F_2	14.48	0.45	31.61	8.55	9.03	0.97
I_2F_3	14.92	0.45	32.94	8.81	9.26	0.91
I_2F_4	13.51	0.48	28.11	8.11	8.60	0.97
I_3F_1	13.65	0.50	26.75	8.25	8.71	0.93
I_3F_2	14.07	0.47	30.16	8.45	8.92	0.95
I_3F_3	14.50	0.47	31.44	8.71	9.15	0.89
I_3F_4	13.13	0.50	26.83	8.02	8.49	0.95
SEm±	0.43	0.02	0.90	0.25	0.27	0.03
CD (5 %)	1.24	0.04	2.56	0.72	0.78	0.10

I1 - 50% irrigation at PE
I2 - .75% irrigation of PE
I3 - 100% irrigation of PE
F1 - 100 % RDF as basal dose plant^{-1}
F2 - 100 % RDF at weekly interval plant^{-1}
F3 - 75 % RDF at weekly interval plant^{-1}
F4 - 50 % RDF at weekly interval plant^{-1}

DISCUSSION:

It is clear from the results presented in the table obtained that irrigation and fertigation levels significantly enhanced the fruit quality parameters (,TSS, acidity, TSS: acid, sugars) of pomegranate.

The maximum TSS, TSS: acid and juice content,were recorded in plants that received higher RDF through fertigation. It might be possibly due to higher levels of fertigation maximizing the growth of the plant and facilitating the accumulation of more carbohydrates into the fruit. During subsequent fruit development, such metabolites (starch) will hydrolyse in to sugars (Hulme, 1970) which increases the TSS and decreases the acidity. The lesser TSS content under low N fertilization conditions can be elucidated by less transport of photosynthates from the leaves to the fruit. Higher qualitative attributes under fertigation might be due to the prevalence of low temperature at the time of fruit ripening, which not only prevented the excessive loss of respiratory substances but also promoted the translocation of photosynthates from leaves to the fruits (Singh and Dhaliwal, 2004). Better accumulation of metabolites improved the fruit quality of winter crop due to diversion of synthesized food materials of spring flushed crop to monsoon flushed crop (Chandra and Govind, 1995). The similar findings were observed by Ramniwas*et al.*,

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(2012b), Ramniwaset al., (2013), Kumawatet al., (2017), Mahadevanet al., (2017b) in guava andShanmugasundaram andBalakrishnamurthy (2013), Haneefet al., (2014), Tanariet al., (2019), Suman and Jain (2020), Pawar and Dingre (2020) in pomegranate.

Drip irrigation improved the fruit quality parameters by providingconstant moisture regime in the soil due to which root remains active throughout the season resulting in optimum supply of nutrient and proper translocation of food which promoted the fruit growth and improved thefruit quality.Such results are also in conformity with the findings of Athaniet al. (2005a) and Athani et al. (2005b) in guava cv.'Sardar' ,Saroliaet al., (2010) andKumawatet al., 2017 in guava.

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