

Original Research Article

Influence of bio-regulators on the fruit quality and yield attributes of phalsa (*Grewia subinaequalis* DC)

ABSTRACT

Aims: To examine the influence of bio regulators on the fruit quality and yield attributes of phalsa.

Study design: Randomised Block Design.

Place and Duration of Study: Phalsa orchard, Department of Horticulture, Khalsa College, Amritsar during 2015-2016

Methodology: The present study comprised of ten treatments which replicated thrice. The treatments were consisted of Gibberellic acid (GA₃ @ 50, 100 and 150 ppm), Naphthalene Acetic Acid (NAA @ 25, 50 and 75 ppm), Ethrel (@ 250, 500 and 1000 ppm) and control. The thirty plants of uniform vigour were randomly selected for the study and these were applied with different concentrations of NAA and GA₃ at fruit set whereas ethrel was sprayed at 20 to 25 days before fruit harvest. Uniform sized mature fruits were harvested and a sample of ten randomly selected fruits was being taken from each replication for fruit physical and bio chemical analysis and then average was worked out for each parameter. The observations were recorded viz., fruit length (cm), fruit breadth (cm), fruit weight (g), fruit colour, total soluble solids (TSS%), titratable acidity (%), TSS: acid ratio, reducing sugars (%), total sugars (%), ascorbic acid (mg/100 g pulp), stone length (cm), stone breadth (cm), stone weight (g), harvesting span (days), number of pickings and fruit yield per plant (kg).

Results: The results revealed that GA₃ 150 ppm treated plants yielded fruits with maximum fruit length (1.26 cm), fruit breadth (1.43 cm), fruit weight (1.20 g), reducing sugars (7.49 %), ascorbic acid (31.10 mg/100 g pulp) and yield (3.48 kg/plant). Minimum stone length (0.50 cm), stone breadth (0.33 cm) and stone weight (0.045 g) was recorded in fruits obtained from plants treated with NAA 25 ppm. Ethrel 1000 ppm significantly improved TSS (20.23%), fruit colour (purple black), total sugars (12.79 %) whereas reduced the titratable acidity (1.54 %), harvesting span (22.81 days) and number of pickings (3.90).

Conclusion: The results of the present study concluded that plants treated with GA₃ 150 ppm registered significant improvement in fruit physical and biochemical parameters and also fruit yield per plant was increased. The fruits obtained from the plants treated with NAA 25 ppm had small sized and minimum weighed stone. Whereas the yield attributes were enhanced with the application of ethrel 1000 ppm in terms of advancement of harvesting and also reduction in number of pickings. Hence ethrel 1000 ppm may be applied to improve the fruit quality parameters as well as yield parameters and also to fetch the premium price in the market due to their attractive colour appearance than control.

Keywords: Phalsa; bio-regulators; fruit physical parameters; fruit biochemical parameters; yield

1. INTRODUCTION

The Phalsa (*Grewia subinaequalis* DC) belonging to the family Tiliaceae, is an important indigenous fruit for arid and semi- arid region because of its hardy nature and capacity to tolerate high temperature and even to be grown under

prolonged dry spells [1]. India is considered to be the home of phalsa and it is commercially cultivated in Punjab, Uttar Pradesh, Madhya Pradesh, Haryana and Rajasthan [2]. In Punjab it is mostly grown in Ropar, Hoshiarpur, Gurdaspur and Amritsar district. Area under phalsa in Punjab is only 30 hectares with an annual production of 196 tonnes [3].

Plant growth regulators are chemicals that effect flowering, ageing, root growth, prevention and promotion of stem elongation, color enhancement of phalsa fruits. Very small concentration of these substances produces major growth changes. They are widely used for increasing fruit set, controlling fruit drop, enhancing quality and uniform maturity. Among growth regulators GA₃, NAA, Ethrel are widely used for enhancing superior characters of fruit crop. Application of GA₃ results in increased yield and better grade of phalsa [4]. The use of bio regulator like GA₃ has proved effective for increasing the size of berry or fruit and improved quality in crop like grape, citrus, ber etc [2]. **Parthenocarpic development of fruits is also a result of gibberellins action [19].** It is thought that NAA may influence the rate of metabolic activity of developing embryos and even also stimulate ethylene biosynthesis which inhibit fruit growth and promote the abscission of weaker fruits. **Naphthalene acetic acid shows positive attitude towards the reduction of fruit drop in many fruit crops.**

Application of ethrel improves fruit quality in terms of TSS, reducing and total sugar [5]. Ethrel is a compound that decomposes to release the natural plant hormone ethylene. Its main use in fruit production is to enhance fruit ripening by permitting its harvest about one week earlier and also reduces the span of harvesting and number of pickings significantly [5]. The bio regulators have proved to be effective in increasing fruit set and yield in phalsa as well as quality of fruit in terms of TSS, reducing sugars and total sugars. Keeping the role of bio regulators in view, the present study was carried out for improved fruit set, quality and yield of phalsa.

2. MATERIALS AND METHODS

The trial was conducted on well maintained 9 years old phalsa orchard of Department of Horticulture, Khalsa College Amritsar during 2015-16. In the trial 30 uniform sized trees were selected and sprayed with different concentrations of bio regulators as NAA (25, 50 and 75 ppm), GA₃ (50, 100 and 150 ppm) and Ethrel (250, 500 and 1000 ppm). NAA and GA₃ were sprayed at fruit set, whereas Ethrel was sprayed 20 to 25 days prior to harvesting to find out the optimum concentration of these bio regulators. Uniform sized mature fruits were harvested for carrying out physico-chemical analysis. A sample of ten randomly selected fruits was being taken from each treatment and their size was noted using the vernier's caliper. The weight of fruits from randomly drawn sample was computed with the help of Wensar PGB 200-1 mg electronic weighing balance. The fruits were evaluated for colour rating by a panel of five judges on score card (maximum 10 points) based on colour. Fruits were rated as follows:

Table 1: Score card for colour rating of phalsa fruits

Acceptability	Grading	Colour
Excellent	9.1-10	Purple black
Very good	8.1-9	Cherry red
Good	7.1-8	Light red
Fair	6.1-7	Greenish red
Poor	6 and below	Light green

The stones from the same sample were extracted and their size and weight were recorded with the similar procedures taken for fruits. The fruit TSS was analyzed with the help of hand refractrometer. Titratable acidity was calculated by titrating diluted juice against N/10 NaOH by using phenolphthalein as an indicator. The diluted juice was prepared by adding distilled water in the ratio of 1:10. The end point of the titration was permanent pink colour. The acidity was calculated and expressed in terms of citric acid [6] by using the below given formula,

$$\text{Titrateable acidity (\%)} = \frac{0.064 \times \frac{N}{10} \text{ NaOH}}{\text{Volume of juice taken}} \times 100$$

54 Reducing sugars and total sugars were analyzed by Lane and Eynon method [7]. Ascorbic acid were analysed by
 55 Indophenol dye method [8]. The fruits were picked at regular intervals when ripe, the number of pickings was recorded
 56 and days taken to ripe from fruit setting were counted as harvesting span. The fruits were picked on alternate days and
 57 were weighed by using physical balance. Average yield per plant was worked out. The recorded data were computed by
 58 the standard procedures of the Randomized Block Design (RBD) and the effects of treatments were tested at 5 per cent
 59 level of significance.

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 61 **3. RESULTS AND DISCUSSION**

62 **3.1 Fruit physical parameters**

63 The data presented in Table 2 revealed that most of the treatments improved the fruit size, however the plants treated
 64 with GA₃ 150 ppm (T₉) yielded fruits with maximum length (1.26 cm) and breadth (1.43 cm). The former treatment was

65 **Table 2. Influence of various bio-regulators on fruit physical parameters of phalsa (*Grewia subinaequalis* DC)**

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Treatments	Fruit Size		Fruit weight (g)	Fruit colour
	Fruit length	Fruit breadth		
	(cm)	(cm)		
T ₁ - NAA 25 ppm	0.91	1.13	0.98	7.60
T ₂ - NAA 50 ppm	1.00	1.22	1.04	7.80
T ₃ -NAA 75 ppm	1.08	1.28	1.07	7.90
T ₄ - Ethrel 250 ppm	1.19	1.33	1.06	8.80
T ₅ - Ethrel 500 ppm	1.09	1.33	1.08	8.90
T ₆ - Ethrel 1000 ppm	1.18	1.42	1.14	9.20
T ₇ - GA ₃ 50 ppm	1.23	1.35	1.13	8.40
T ₈ - GA ₃ 100 ppm	1.23	1.40	1.13	8.60
T ₉ - GA ₃ 150 ppm	1.26	1.42	1.20	8.70
T ₁₀ - Control	0.95	1.11	0.78	7.10
CD (P=.05)	.08	.06	.06	.70

67 *CD (P=.05) means critical difference among treatments at 5 per cent level of significance

also found to be at par with the treatment T₆ (Ethrel 1000 ppm) with fruit length and breadth of 1.18 cm and 1.42 cm respectively.

The significant increment in fruit size over control by the use of gibberellins had been noticed and this increase might be due to the indirect effect of gibberellins on the level of auxins that ultimately caused cell elongation by enlargement of vacuoles and loosening of cell wall after increasing its palatability. Also increase in fruit size by the use of ethrel could be attributed due to increase in the availability of photosynthates and nutrients to the remaining fruits thereby increasing the size of individual fruits. Increase in fruit size was also observed by [14] with ethrel and by [9] and [10] with gibberellins. GA₃ 150 ppm (T₉) treated plants gave fruits with maximum weight of 1.20 g, which might be due to the fact that gibberellins increase the cell division and translocation of food material [10]. Treatment T₉ was also found to be at par with the treatment T₆ (Ethrel 1000 ppm) with fruit weight of 1.14 g. Results of these findings were confirmed by [4], [1] and [14]. The plants treated with treatment T₆ produced fruits with excellent purple black colour. This might be due to the fact that ethrel enhanced chlorophyll degradation and increased carotene synthesis [11].

3.2 Fruit biochemical parameters

The data regarding fruit biochemical parameters as influenced by various concentrations of ethrel, NAA and GA₃ are presented in Table 3. Significant TSS (20.23 %) was observed in fruits obtained from plants treated with ethrel 1000 ppm. This may be due to the quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from the leaves to the developing fruits [12]. The results of these findings were also confirmed by [4], [2] and [5].

Table 3. Influence of various bio-regulators on fruit bio-chemical parameters of phalsa (*Grewia subinaequalis* DC)

Treatments	TSS (%)	Titratable acidity (%)	Reducing Sugars (%)	Total sugars (%)	Ascorbic acid (mg/100 g pulp)
T ₁ - NAA 25 ppm	15.23	2.97	5.38	9.78	22.60
T ₂ - NAA 50 ppm	15.81	2.27	5.49	10.52	23.86
T ₃ - NAA 75 ppm	15.75	2.29	5.54	10.47	23.91
T ₄ - Ethrel 250 ppm	16.07	2.22	6.02	10.69	25.03
T ₅ - Ethrel 500 ppm	18.48	1.80	6.77	12.75	25.28
T ₆ - Ethrel 1000 ppm	20.23	1.54	7.49	12.79	25.62
T ₇ - GA ₃ 50 ppm	17.13	2.22	6.69	12.35	30.06
T ₈ - GA ₃ 100 ppm	16.78	2.10	7.32	12.04	30.98
T ₉ - GA ₃ 150 ppm	18.09	1.97	7.28	12.62	31.10
T ₁₀ - Control	15.16	2.42	5.27	10.15	20.02
CD (P=.05)	.38	.52	.41	.82	.99

*CD (P=.05) means critical difference among treatments at 5 per cent level of significance

The fruits with minimum acidic content (1.54 %) were obtained from plants treated with ethrel 1000 ppm. This might be due to the fact that ethrel enhance the conversion of organic acids to sugars which increases the sugar content and decreases the acidity [13]. The present study is in conformity with the findings of [1] and [14]. The data related to sugars showed that plants treated with Ethrel 1000 ppm yielded fruits with maximum reducing sugars (7.49 %) and total sugars (12.79 %). This might be due to that ethrel promoted hydrolysis of starch into sugars [5]. The present results are in conformity with the findings of [1] and [14]. Ascorbic acid content in fruits increased significantly by the use of gibberellins. Maximum ascorbic acid content (31.10 mg/100 g pulp) was observed in fruits obtained from plants treated with GA₃ 150 ppm. This might be due to the possible catalytic influence of gibberellic acid on biosynthesis of ascorbic acid from sugar or inhibition of oxidative enzymes or both [15]. The results of these findings are in conformity with [16] and [17].

3.3 Stone parameters

The data presented in Table 4 revealed that all the treatments showed non-significant effect on the stone size in phalsa. Minimum stone length (0.50 cm) and stone breadth (0.33 cm) was registered under the treatment T₁. From the data, it has been observed that NAA 25 ppm treated plants gave fruits with least stone weight (0.045 g). The present study is in conformity with the findings of [10].

Table 4. Influence of various bio-regulators on stone parameters of phalsa (*Grewia subinaequalis* DC)

Treatments	Stone length (cm)	Stone breadth (cm)	Stone weight (g)
T ₁ - NAA 25 ppm	0.50	0.33	0.04
T ₂ - NAA 50 ppm	0.56	0.40	0.07
T ₃ -NAA 75 ppm	0.53	0.40	0.06
T ₄ - Ethrel 250 ppm	0.53	0.40	0.11
T ₅ - Ethrel 500 ppm	0.56	0.43	0.08
T ₆ - Ethrel 1000 ppm	0.56	0.43	0.08
T ₇ - GA ₃ 50 ppm	0.53	0.41	0.10
T ₈ - GA ₃ 100 ppm	0.56	0.43	0.11
T ₉ - GA ₃ 150 ppm	0.56	0.46	0.09
T ₁₀ - Control	0.58	0.40	0.11
CD (P=.05)	NS	NS	0.02

*CD (P=.05) means critical difference among treatments at 5 per cent level of significance

3.4 Yield parameters

The presented data (Table 5) showed that ethrel significantly improved the yield parameters in phalsa. Ethrel 1000 ppm treated plants registered minimum harvesting span (22.81 days) than rest of the treatments. The number of pickings also significantly reduced by the use of ethrel.

Table 5. Influence of various bio-regulators on yield parameters of phalsa (*Grewia subinaequalis* DC)

Treatments	Harvesting span (days)	Number of pickings	Yield (kg/plant)
T ₁ - NAA 25 ppm	27.71	6.56	2.51
T ₂ - NAA 50 ppm	27.32	6.31	2.76
T ₃ - NAA 75 ppm	26.72	6.08	2.80
T ₄ - Ethrel 250 ppm	23.02	4.39	2.85

T ₅ - Ethrel 500 ppm	23.51	4.15	3.17
T ₆ - Ethrel 1000 ppm	22.81	3.90	3.36
T ₇ - GA ₃ 50 ppm	26.42	6.01	3.23
T ₈ - GA ₃ 100 ppm	25.13	5.57	3.47
T ₉ - GA ₃ 150 ppm	24.12	5.26	3.48
T ₁₀ - Control	30.52	7.13	1.95
CD (P=.05)	.07	.58	.15

*CD (P=.05) means critical difference among treatments at 5 per cent level of significance

Minimum number of pickings (3.90) was recorded in plants treated with ethrel 1000 ppm. This might be due to that ethrel hasten the maturation process [18]. These findings are in conformity with the findings of [1] and [5]. The plants treated with GA₃ 150 ppm registered maximum yield (3.48 kg/plant) and was followed by treatments T₈ and T₆ with fruit yield of 3.47 and 3.36 kg/plant respectively. All of these treatments were found to be at par with each other. Yield is a complex character and is characterized by increase in weight of individual fruit and number of fruits. It might be due to the fact that GA₃ increased the translocation and mobilization of photosynthates from source to sink [19]. The results are in accordance with the findings of [4], [16] and [20] in ber, [21] in Plum and [22] in mango.

4. CONCLUSION

The results of the present study concluded that plants treated with GA₃ 150 ppm and ethrel 1000 ppm registered significant improvement in fruit physical and biochemical parameters and also fruit yield per plant was increased. The fruits obtained from the plants treated with NAA 25 ppm had small sized and minimum weighed stone. Whereas the yield attributes were enhanced with the application of ethrel 1000 ppm in terms of advancement of harvesting and also reduction in number of pickings. Hence ethrel 1000 ppm may be applied to improve the fruit quality parameters as well as yield parameters and also to fetch the premium price in the market due to their attractive colour appearance than control.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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