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Effect of Foliar Feeding of Plant Growth Regulators on Vegetative Growth, Yield and Quality of Phalsa (*Grewia subinaequalis* DC)

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A B S T R A C T

A field experiment was carried out at Punjab Agricultural University, Regional Research Station, Gurdaspur during the years 2015-16 and 2016-17 to assess the influence of NAA 25, 50 ppm and 75ppm; GA_3 50, 100 ppm and 150ppm; kinetin 15,30 and 45 ppm; ethrel 250, 500 ppm and 750ppm along with control on vegetative growth, yield and quality parameters of phalsa. Among all the treatments, maximum number of shoots/ plant (130.25), shoot length(4.15cm), number of leaves/shoot (72.5), internodal length (11.5cm), number of fruits/ node (21.55) and number of fruiting nodes/ shoot (20.76) were recorded with the application of GA_3 at 150 ppm. Maximum fruit yield (4.85kg/plant), fruit length (1.60cm). Fruit breadth (1.72cm) and pulp weight (65.55gm) were observed in GA_3 at 100ppm. Minimum stone weight (10.22g) with maximum pulp to stone ratio (37.89) was observed in GA_3 100ppm. Maximum TSS (27.50°Brix) with minimum titratable acidity (2.3%) were observed with ethrel 500ppm. Maximum TSS to acidity ratio (11.96) was obtained with ethrel 500ppm. Total sugars (29.00%), reducing sugars (21.50%) and non-reducing sugars (7.50%) were significantly higher in ethrel 750ppm. Highest ascorbic acid content (44.25mg/100gm of pulp) was noticed in GA_3 100ppm.Maximum shelf life (53.51hours) of fruits was observed with kinetin 30ppm.

Introduction

The Phalsa (*Grewia subinaequalis* DC) also known as star apple, it is a sub-tropical fruit native to India, belongs to the family Tiliaceae with chromosome no. 2n=36. This family has about 41 genera and 400 species, which are mostly distributed in the tropical and sub-tropical region of the world. Its fruit is known as berry. Phalsa is a quick growing shrub which thrives well in arid and semi-arid regions as well as in salt affected wasteland conditions because of its hardy nature and capacity to tolerate high temperature and even to be grown under prolonged dry spells (Singh *et al.*, 2011). India is considered to be the home of phalsa and it is grown in Punjab, Haryana, Rajasthan, Uttar Pradesh, Madhya Pradesh, Bihar and West Bengal (Zeeshan and Singh, 2017). In Punjab, it is mostly grown in

Ropar, Hoshiarpur, Gurdaspur and Amritsar districts. The area under phalsa in Punjab is only 30 hectares with an annual production of 196 tonnes (Pujari, 2015). Ripe phalsa fruits are deep reddish brown colour, sub acidic in taste, pleasant flavour, rich source of vitamins (A, C) and minerals (phosphorus and iron). Fruit contains protein 1.3g, fat 0.9g, carbohydrates 14.7 g, fibre 1.2 g, minerals 1.1g, phosphorus 39 mg, calcium 129mg, iron 3.1 mg, carotene 0.48 mg, niacin 0.3 mg and vitamin C 22 mg per 100gm of pulp.. The energy value is 300 cal/100g.The fruits are very delicious, tasty and used as table purpose. The fruits are excellent for making juice and squash, quality beverages, ready to serve, nectar, syrup. The ripe phalsa fruits are consumed fresh, as desserts or processed into refreshing fruit and soft drinks enjoyed during summer months in India (Salunkhe and Desai, 1984). Its cultivation is favoured around big cities where fruits find a read and quick sale. Regarding keeping quality, it is highly perishable in nature. Because of short shelf life, its fruits are suitable for local market or need to be processed immediately after harvesting (Salunkhe and Desai, 1984). It may be grown as an intercrop with mango, aonla, bael and ber. Phalsa is a bushy plant and can be grown in kitchen garden also. It produces fruits in clusters in the axil of leaves of the current season growth. Despite its hardy fruits, high nutritional and medicinal values, phalsa has not received the deserving attention due to its uneven ripening, small fruits and high perishability creating a problem in marketing and storage. Growth, yield and quality of phalsa can be increased by adopting proper cultural practices, supplying balanced doses of nutrients and through use of growth regulators. The plant growth regulators are relatively new in use. Plant growth regulators are chemicals that effect root growth, prevention and promotion of stem elongation, flowering, ageing and color enhancement of phalsa fruits. A 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 gibberellic acid (GA_3), 1-Naphthalene acetic acid(NAA), ethrel, kinetin are widely used for enhancing superior characters of the fruit crop. Application of growth substances *viz.*, auxins and gibberellins has been effective in increasing fruitset and yield in several fruit crops including phalsa (Randhawa *et al.*, 1959). Gibberellic acid is an important plant growth substance which plays a vital role on overall performance including growth, flowering and quality of fruits. It increases cell division and cell elongation in the plants. Application of GA_3results in increased yield and better grade of phalsa (Debnath *et al.*, 2011). The use of bioregulator like GA_3 has proved effective for increasing the size of berry or fruit and improved quality in crop like grape, citrus, beretc (Kacha *et al.*, 2012). Parthenocarpic development of fruits is also a result of gibberellins action (Krishnamoorthy, 1981). Application of GA_3 results in increased yield and better grade phalsa fruits (Randhawa *et al.*, 1967). NAA is widely used in horticulture for various purposes and play many important roles in flowering, fruit setting and tissue culture, increase in fruit set or prevent fruit drop in mango and citrus, blossom thinning in peach and guava and fruit thinning in apple and pear.It is thought that NAA may influence the rate of metabolic activity of developing embryoes and even also stimulate ethylene biosynthesis which inhibits 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 total soluble solids (TSS), reducing and total sugar (Kacha *et al.*, 2014). 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 (Kacha *et al.,* 2014). Ethrel sprayed at full bloom stage found to be increasing TSS content of the phalsa fruits (Rema and Sharma, 1991). The bioregulators 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. Cytokinin results in the promotion of cell division. Along with auxin, cytokinin initiates bud and root formation in the callus tissue in plant tissue culture. Cytokinin promotes the growth of lateral buds when added in the medium even if the apical bud is intact. Cytokinin breaks the dormancy of seeds and promotes germination. Application of cytokinin delays the process of ageing in plants. Efficacy of kinetin in increasing shelf life by reducing the physiological loss of weight of fruit crops was shown by various workers (Dedolph *et al.*, 1961 and Randhawa *et al.,* 1976).

Nevertheless, a lot of approaches have been made on foliar feeding of plant growth regulators on different fruit crops, however, meagre work has been done on phalsa crop. Keeping the role of bioregulators in view, the present study was carried out for improved growth, fruit set, yield and quality of phalsa.

Materials and Methods

The present study was under taken at Punjab Agricultural University, Regional Research Station, Gurdaspur, Punjab (India) during the year 2015-16 and 2016-17. The experiment was laid out in a Randomized Block Design with thirteen treatments and replicated thrice. Ten years old, 39 uniform phalsa plants in two units transplanted at 3×3 meters were selected for present investigation. Manures, fertilizers and other orchard management practices were followed as per recommended package and practices for phalsa. The treatments consisted of NAA 25, 50 ppm and 75ppm; GA_3 50, 100 ppm and 150ppm; kinetin 15, 30 and 45 ppm; ethrel 250, 500 ppm and 750ppm along with control. NAA, $GA_3$and kinetin were sprayed at fruit set, whereas ethrel was sprayed 20 to 25 days prior to harvesting to find out the optimum concentration of these bioregulators. The observations were recorded on the parameters *viz*. number of shoots per plant, length of shoot (m), number of leaves per plant, internodal length (cm), number of fruiting nodes per shoot, number of fruits per node, fruit yield per plant (kg), fruit length(cm), fruit breadth(cm), pulp weight(gm), stone weight(gm), pulp:stone ratio, ascorbic acid (mg/100g of pulp), TSS (°Brix), titratable acidity (%), TSS to acidity ratio, total sugars (%), reducing sugars (%), non-reducing sugars, shelf life (hours). Fruits were harvested at fully ripe stage and quality parameters are calculated as per standard AOAC, (1980) methods. Data was analysed statistically by Randomized Block Design as described by Singh *et al.,* (1998) and the effects of treatments were tested at 5 percent level of significance.

Results and Discussion

Number of shoots/plant

Number of shoots per plant was also influenced significantly by the application of plant growth regulators.However, the maximum (130.25) number of shoots per plant was measured with foliar spray of $GA_3$150ppm followed with the spray of $GA_3$100ppm (Table1). Number of shoot per plant was increased with the application of plant growth regulators spray. Increase in plant growth parameters might be due to fact that gibberellin (given in the form of GA_3 sprayed) is a constituent of protein which is essential for formation of protoplasm and

thus, affecting cell division and cell elongation. All these contributed in enhancing shoot length and number of shoots per plant of phalsa. The present findings are in agreement with the report of Kumar *et al.,* (2014) in phalsa. Positive impact of GA_3 application on plant spread and crown volume was recorded by Eelkim *et al.,* (2003) in Satsuma mandarin, where they reported increased number the vegetative shoots in response to progressive increase in the doses of treatments (25, 50 and 100 ppm concentrations of GA_3).

Shoot length

Foliar spray of plant growth regulators significantly effect the shoot length. However, the maximum shoot length (4.15m) was measured with foliar spray of $GA_3$150ppm followed by spray of $GA_3$100 ppm (Table1). Similar results has been reported by Alam and Kumar, (2017) and Singh *et al.,* (2017) that maximum shoot length was observed in phalsa with foliar spray of $GA_3$150ppm. The increase in vegetative growth of the phalsa plant with the spray of plant growth regulators may be attributed to the association of nitrogen in the synthesis of protoplasm and in the primary manufacture of amino acids and increased auxin activities. As a result, meristematic activities increased which in increase the vegetative growth.

Number of leaves per shoot

The number of leaves per shoot increased significantly with the application of foliar feeding of plant growth regulators. Highest number of leaves (72.5) was obtained with foliar spray of GA_3 150ppm followed by $GA_3$100ppm (Table1). The favourable effect of GA_3 in promoting number of leaves might be due to abundant supply of GA_3 on plant growth. The increase in vegetative growth may be attributed to an increase uptake of these elements which being a constituent of protein component of protoplasm, favourably influenced chlorophyll content in leaves. All these factors contributed to cell multiplication, which has resulted in to better photosynthetic activity and it's translocation to promote better vegetative growth. Therefore, increased number of leaves per shoot with the spray of GA_3. The findings are in agreement with result of Singh *et al.,* (2011) and Kumar *et al.,* (2014) in phalsa.

Internodal length

The internodal length was increased significantly with plant growth regulators. The maximum intermodal length (11.5cm) was achieved with foliar spray of $GA_3$150 ppm followed by GA_3 100ppm (Table1).

Higher internodal length achieved might be due to cell division, cell elongation and growth enhancing properties of gibberellin as reported by Kumar *et al.,* (2014) and Singh *et al.,* (2015) in phalsa. Similar results has been reported by Alam and Kumar, (2017) and Singh *et al.,* (2017) that maximum shoot length was observed in phalsa with foliar spray of GA150ppm.

Number of fruiting nodes per shoot

The maximum number of fruiting nodes per shoot (21.55) was counted on the plants with the spray of $GA_3$150 ppm followed by $GA_3$100ppm (Table1). It might be possible because gibberellin causes vegetative growth for development of fruiting nodes.

Gibberellin and auxin helps in the translocation of carbohydrates and other metabolites for better reproductive growth of plants. These results are in close conformed with finding of Kumar *et al.,* (2014) in phalsa.

Number of fruits per node

The maximum number of fruits per node (20.76) was obtained with foliar spray of GA_3 150 ppm followed with the spray of NAA 200ppm (Table1). The higher number of fruits per node might be due to fact that nitrogen is component of chlorophyll and gibberellic acid and auxin help in chlorophyll formation that regulate the build-up of proper C:N ratio, which controls the flowering and fruiting of plants. It is also assumed that gibberellin and auxin play significant role in photosynthetic activity and better translocation of metabolites for developing fruit lets. These results are in close conformed with finding of Kumar *et al.,* (2014) in phalsa. Similar results has been reported by Alam and Kumar, (2017) and Singh *et al.,* (2017) that maximum shoot length was observed in phalsa with foliar spray of $GA_3$150ppm.

Yield per plant

Foliar spray of plant growth regulators significantly influenced fruit yield. The maximum fruit yield per plant (4.85kg) was recorded with the spray of $GA_3$100ppm followed by GA_3 150ppm (Table1). These results are in close conformed with finding of Grshtein, (1973) in orange, Sharma *et al.,* (2008) in mango, Kaur *et al.,* (2008) in Plum, Tripathi *et al.,* (2009) in ber, Gill and Bal, (2011) in ber, Rohit, (2014) in mango, Anawal *et al.,* (2015) in pomegranate and Rajput *et al.,* (2015) in guava. The increase in the fruit yield due to GA_3 treatment is due to increase in fruit set and fruit weight. The higher fruit yield might be due to GA_3 mediating process for faster translocation and mobilization of stored metabolites or photosynthates from source to sink points (Krishnamoorthy, 1981 and Singh *et al.,* 2003). Increased yield due to GA_3 application of phalsa was also reported by Randhawa *et al.,* (1959); Singh *et al.,* (1966); Reddy, (1977) and Singh *et al.,* (1986). Debnath *et al.,* (2011) also reported that phalsa bushes treated with GA_3 at 100 ppm produced significantly higher fruit yield. This may be due to the better physiology of developing fruits in terms of better supply of water and other compounds vital for their proper growth and development which resulted in improved size ultimately greater yield. These can be attributed to nature of gibberellins to increase to vegetative growth due to which more food material might be made available to the developing fruits. Kaur *et al.,* (2018) reported that plants treated with GA_3 150 ppm registered maximum fruityield in phalsa.

Fruit length and Breadth

Significantly highest fruit length (1.60cm) and breadth (1.72cm) were observed in GA_3 100ppm leads to maximum fruit size followed by $GA_3$150ppm (Table1). Alam and Kumar (2017) and Kaur *et al.,* (2018) reported that $GA_3$150 ppm significantly increased the fruit length and breadth of phalsa. 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. Fruit length and breadth varied significantly due to various levels of GA_3.

These finding are similar to the findings of Chundawat and Randhawa, (1973) in grape, Brahmchariand Rani, (2001) in litchi, Shukla *et al.,* (2011) in aonla, Singh *et al.,* (2011) in phalsa and Kundu *et al.,* (2014) in pear and Chandra *et al.,* (2015). These can be attributed to nature of gibberellins to increase to vegetative growth due to which more food material might be made available to the developing fruits, hence leads to increased fruit size.

Pulp weight

Bushes treated with GA_3 at 100 ppm produced significantly higher pulp weight (65.55g/100 fruits) over other treatments followed by GA_3 at 150 ppm (62g/100 fruits) (Table1). On the other hand, minimum pulp weight was recorded (45.11g/100 fruits) in control. Similarly, bushes treated with GA_3 at 100 ppm produced significantly higher pulp weight (Debnath *et al.,* 2011).

The increase in the pulp weight may be due to the cell multiplication and cell enlargement or may be enhanced uptake of water and accumulation of sugar and other food reserves in greater amount as well as increased volume of intercellular spaces in the pulp of fruit due to GA_3. This finding are in agreement with the earlier reports on this aspects by Khan *et al.,* (1976), Singh and Lal, (1980) in litchi, Rani and Brahmachari, (2004) in mango. Prasad and Bajpai (1963) who also observed similar response of GA_3 on phalsaplants.$GA_3$150 ppm treated plants gave fruits with maximum weight which might be due to the fact that gibberellins increase the cell division, cell enlargement and translocation of food material (Chandra *et al.,* 2015).

Stone weight

Bushes treated with $GA_3$100 ppm produced fruits with significantly minimum stone weight (10.22g) and maximum stone weight was recorded (20.50g) in control (Table2). GA_3 were found effective in producing parthenocarpic fruits in multiseeded fruits but in single seeded fruits they reduced the size and weight of the seed. These results are in agreement with the findings of Rao and Rao, (1963) in phalsa, Islam and Siddique, (1973) in guava and Sharma and Dhillon, (1984) in litchi.

Pulp to stone ratio

Pulp stone ratio of fruit was recorded maximum with $GA_3$100ppm (37.89) followed by $GA_3$100ppm (Table2). Similarly, phalsa bushes treated with GA_3 at 100 ppm produced fruits with significantly higher pulp to stone ratio (Debnath *et al.,* 2011). It may be due to the involvement of GA_3 to increase the cell division, growth and translocation of food material which might be responsible to improve the weight of fruits. These findings are supported by the results of Kacha *et al.,* (1914) in phalsa and Chandra *et al.,* (1915) in aonla fruits and Singh *et al.,* (2015) in phalsa.

Total soluble solids

Significantly higher content of TSS (27.50°Brix) was obtained when the bushes were sprayed with ethrel 500 ppm followed by ethrel 750 ppm. Similar results are reported by Debnath *et al.,* (2011) with ethrel 500ppm in phalsa. Increased in the TSS by ethrel may be due to quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from the leaves to the developing fruits (Tripathi and Sukhla, 2007). Similar finding was also reported by Rema and Sharma, (1991) in phalsa. Kaur *et al.,* (2018) reported that significantly higher TSS was observed in phalsa fruits obtained from plants treated with ethrel 1000 ppm.

Acidity

Ethrel 500 ppm was more effective in reducing acidity (2.30%). Similar results have been reported by Kaur *et al.,* (2018) in phalsa with ethrel 500ppm. The acidity of the fruit under the influence of growth regulators applied declined because it might have converted fastly into sugar and their derivatives (Kumara *et al.,* 2007) or due to faster degradation of organic acids (Dutta *et al.,* 2008). Prasad, (1990) also reported

similar results with GA_3 in phalsa and Sharma and Dhillon, (1984) in litchi. Significantly lower titratable acidity was noticed with foliar spray of GA_3 100ppm in phalsa (Debnath *et al.,* 2011). Kaur *et al.,* (2018) observed that fruits with minimum acidic content were obtained from plants treated with ethrel 1000 ppm.

TSS: Acidity

Maximum TSS: acidity ratio (11.96) has been reported by ethrel 500ppm followed by GA_3 750ppm. Kaur *et al.,* (2018) reported maximum TSS: acidity ratio with ethrel1000ppm.Maximum TSS: acidity ratio was also observed with GA_3 100 ppm followed by ethrel 250 ppm (Debnath *et al.,* 2011). This might be due to early and rapid degradation of acid and its conversion into sugars (Kumara *et al.,* 2007). This is in conformity with the findings of Thilak, (1980) in Thompson seedless and Mohammed and Hulamani, (2001) in Arkavati grapes.

Table.1 The effect of foliar feeding of plant growth regulators on growth and fruiting behaviour of Phalsa

Treatments	Number of shoots per plant	Shoot length (m)	Leaves per shoot	Internodal length (cm)	Number of fruiting nodes per shoot	Number of fruits per Node	Yield per plant (kg)	Fruit length (cm)	Fruit breadth (cm)	Pulp weight
NAA 25ppm	95.12	2.35	56.12	8.55	15.15	15.00	3.72	0.96	1.18	55.52
NAA 50ppm	97.00	2.50	59.21	8.75	16.00	15.50	4.00	1.05	1.26	58.12
NAA 75ppm	10.24	2.91	62.00	9.15	16.52	16.10	3.85	0.98	1.20	56.00
GA_3 50ppm	100.15	3.00	63.11	9.50	16.71	15.00	4.25	1.15	1.33	59.52
GA_3 100ppm	115.50	3.50	66.00	10.00	18.10	17.12	4.85	1.60	1.72	65.55
GA_3 150ppm	130.25	4.15	72.50	11.50	21.55	20.76	4.52	1.25	1.46	62.00
Kinetin 15ppm	85.53	2.10	48.15	8.12	14.10	13.51	3.30	0.93	1.14	52.00
Kinetin 30ppm	88.00	2.15	50.00	8.52	14.50	13.11	3.52	0.95	1.17	54.52
Kinetin 45ppm	91.55	2.30	53.55	9.00	14.54	14.00	3.40	0.94	1.16	53.12
Ethrel 250ppm	81.12	1.85	43.12	6.52	12.00	11.12	1.50	0.90	1.11	49.22
Ethrel 500pm	83.15	1.90	45.15	7.00	12.50	12.00	2.00	0.92	1.13	51.00
Ethrel 750ppm	85.00	2.00	47.00	7.55	13.12	12.60	1.75	0.91	1.12	50.15
Water spray (control)	80.00	1.80	40.00	6.00	11.00	10.00	2.50	0.84	1.06	45.11
CD (5%)	2.93	0.83	3.37	1.99	2.10	2.20	0.80	0.40	0.06	3.35

Table.2 The effect of foliar feeding of plant growth regulators on fruit quality of Phalsa

Treatments	Stone weight	Pulp: Stone	TSS (°Brix)	Titratable acidity (%)	TSS: Acidity	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	Ascorbic acid (mg/100g of pulp)	Shelf life (hours)
NAA 25ppm	14.62	35.07	22.25	2.800	7.950	24.15	18.50	5.65	39.00	45.25
NAA 50ppm	13.20	34.66	24.00	2.600	9.230	25.00	19.00	6.00	41.00	46.50
NAA75ppm	14.00	35.00	23.15	2.720	8.510	22.55	18.75	5.80	40.00	45.00
GA_3 50ppm	12.52	36.02	23.65	2.540	9.310	24.35	18.60	5.75	41.50	47.52
GA_3 100ppm	10.22	37.89	25.00	2.480	10.080	26.35	19.85	6.50	44.25	50.45
GA_3 150ppm	11.00	36.50	24.85	2.500	9.940	25.05	18.80	6.25	42.22	48.00
Kinetin 15ppm	17.20	34.60	21.25	4.200	5.060	23.90	18.30	5.60	36.00	51.42
Kinetin 30ppm	15.00	34.76	22.50	3.800	5.920	24.32	18.52	5.80	38.55	53.51
Kinetin 45ppm	15.52	34.32	22.00	4.000	5.500	24.15	18.45	5.70	37.12	52.00
Ethrel 250ppm	18.50	33.86	26.32	2.420	10.880	25.35	18.85	6.50	32.11	42.00
Ethrel 500pm	16.25	33.63	27.50	2.300	11.960	29.00	21.50	7.50	34.45	39.00
Ethrel 750ppm	17.00	33.58	26.25	2.360	11.290	26.33	19.33	7.00	33.00	35.00
Water spray (control)	20.50	32.81	20.00	4.800	4.170	21.50	17.00	4.50	28.75	30.00
CD (5%)	3.49	2.62	2.02	0.571	1.612	2.699	1.698	1.416	3.25	3.072

Reducing sugars, Non-reducing sugars and Total sugars

Maximum content of reducing sugars (21.5%), non-reducing sugars (7.5%) and total sugars (29%) were observed in ethrel treatment 500 ppm. Present finding was confirmed with the findings of Remaand Sharma., (1993) with ethrel in phalsa. Kaur *et al.,* (2018) showed that phalsa plants treated with ethrel 1000 ppm yielded fruits with maximum reducing sugars and total sugars. This might be due to that ethrel promoted hydrolysis of starch into sugars (Kacha *et al.,* 2014). The present results are in conformity with the findings of Singh *et al.,* (2011) and Meitei *et al.,* (2013). Increased in reducing sugar with $GA_3$150ppmin phalsa was reported by Debnath *et al.,* (2011). Increased in reducing sugar with higher concentration of GA_3 was reported by Prasad, (1990) in phalsa, Phaniprasasd, (1980) in guava and Thilak, (1980) in Thompson Seedless grapes. Gibberellins have been shown to act through auxin synthesis. Therefore, the exogenous application of GA_3 might have supplemented the endogenous auxin and causes greater influx of sugars in the fruits (Mohammed and Hulamani, 2001).

Ascorbic acid

Maximum ascorbic acid content in phalsa fruits (44.25 mg/100gm of pulp) was observed with $GA_3$100ppm. Similar results have been reported by Kaur *et al.,* (2018) with $GA_3$100ppm in phalsa. Maximum ascorbic acid content in fruit juice was noticed with $GA_3$150 ppm (Alam and Kumar, 2017). The increase in ascorbic acid content may be attributed to quality improving properties of GA_3 is assigned the role of quality nutrient

and may help in synthesis of ascorbic acid in developing fruits. The result is in consonance with the findings of Kher *et al.,* (2005) in guava, Kacha *et al.,* (2014) in phalsa and Rokaya *et al.,* (2016) in mandarin.

Shelf life

Highest shelf life (53.51 hr) of phalsa fruits was recorded with kinetin 30 ppm. Similarly, highest shelf life of phalsa fruits was recorded with kinetin 30 ppm (Debnath *et al.,* 2011). The increased in the shelf life due to kinetin application may be attributed to efficacy of kinetin to increase endogenous kinetins, stimulates protein synthesis as well as nucleic acid synthesis thereby delaying the senescence and reduce the physiological loss of weight during storage. Similar results were reported by earlier worker in grapes (Dedolph *et al.,* 1961; Randhawa *et al.,* 1976 and Dhillon, 1985) and apple (Mir *et al.,* 1996).

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