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Effect of different pruning levels and foliar application of PGRs on quality fruit production of Phalsa (*Grewia asiatica* L.)

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Abstract
The present investigation was carried out under Allahabad agro-climatic conditions at the experimental field of the department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology & Sciences, Allahabad (U.P.) entitled "Effect of different pruning levels and foliar application of PGRs on quality fruit production of Phalsa (*Grewia asiatica* L.). The pruning (3 °Cm, 6 °Cm and 9 °Cm) was done from old shoots of phalsa plant with the help of looper by manual labour and PGRs namely NAA (150 and 200 ppm) and GA_3 (100 and 200 ppm) were applied as foliar spray after new shoots growth. The results revealed that treatment T_6 (90 cm + GA_3 @ 200 ppm + NAA @ 200 ppm) was recorded significantly the maximum number of sprouted shoots per canes (30.30) at 120 DAP, total number of flowers per plant (2927.41) at 75 days after pruning, Number of fruiting nodes per shoots (27.72) at 120 days, fresh weight of 10 fruits (9.57 g), dry weight of 10 fruits (2.40g), fruit yield per bush (4.78 kg), fruit yield per hectare (6.94t/ha), total soluble solids (22.82°Brix), total sugar (12.33%), and titratable acidity (2.78%) and minimum days taken to first flower (61.24). The minimum number of sprouted shoots per canes (14.11) at 120 DAP, total number of flowering per plant (1633.34), number of fruiting nodes per shoots (14.52), fresh weight of 10 fruits (6.63), dry weight of 10 fruits (1.27), yield per bush (1.45 kg), fruit yield (2.06 t/ha), total sugar (8.36%), TSS °brix (15.37) and the maximum number of days taken to first flowering (75.37) were recorded with treatment T_0.

Keywords: Bush, GA_3, NAA, Pruning levels and quality fruit production

Introduction
Phalsa (*Grewia asiatica* L.) is a sub- tropical fruit crop and also known as star apple. It is originated from India with belong to family of tiliaceae. This family has about 41 genera and 400 species, which are mostly distributed in the tropical and sub-tropical region of the world. It is commercially grown in Uttar Pradesh, Punjab, Haryana, Gujarat, Maharashtra and Bihar. Its cultivation is favoured around big cities where fruits find a read and quick sale. Regarding keeping quality, it is highly perishable in nature. 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.

Phalsa is good crop for arid and semi – arid regions because of its hardy nature and capacity to tolerate high temperature and even grown under prolonged dry spell with little care. It is bushy in nature and bears small berry like fruit of deep reddish brown colour. As being a sub – tropical fruits its flower in the month February and the fruit ripen by the end of April and continue till mid of June.

Phalsa is deciduous in habit in northern India and sheds its leaves during winter season, which makes it capable of withstanding the frost. Phalsa produces fruits in clusters in the axils of leaves of the young shoots. It is one of the hardiest fruit crop with regard to the attack of insect pest and diseases. Phalsa can tolerate up to 44 °C high temperature which favours in ripening of the fruits. Phalsa start fruiting after second year of its plantation and thus the growers can obtained much income returns.

Ripe fruits are sub acidic and good source of vitamin A and vitamin C they are also fair source of phosphorus and iron. Fruits contain 50-60% juice 10-11% sugar and 2.02% acid (Aykroyd, 1983) [18]. The fruits are used for making excellent juice and squash, it is also used as table fruit for children. The composition of phalsa berries, it contains 80.80% moisture, 14.40% carbohydrates, 1.5% protein, 0.90% fat and minerals calcium 129 mg, phosphorus 89mg, iron 3.1mg, niacin 0.3mg, vitamin C 2.2 mg and carotene 4.9 mg/100g of pulp (NHB, 2014).

The fruit possess high medicinal properties. Its ripe fruits exert cooling effect, cure inflammation, heart attack, blood pressure, fever and constipation.

Phalsa has great utility and its own importance and usefulness. It is grown as minor fruit in the country. The main problems in the cultivation of phalsa is the unseen ripening and small berries, which are to be picked individually, thereby increasing the cost of harvesting and becomes a major constraint to phalsa growers.

Application of growth substances *viz.*, auxins and gibberellins has been effective in increasing fruit set and yield in several fruit crops including phalsa. Application of GA_3 results in increased yield and better grade phalsa fruits (Rema and Sharma, 1991) [11].

The GA_3 at 15, 30 and 60 ppm in phalsa applied them at flower as well as at bud stage. According to them all the concentrations of GA_3 when applied at flower stages resulted in cent percent fruit setting, compare with 84% control. (Rao and Reddy, 1989) [9]. Pruning and plant growth regulators (PGR's) have been commonly used in modifying various physiological processes with advantage in plant growth, flowering, fruit yield and other attributes in phalsa crop. Pruning and PGR's give the significant results like increasing the yield and quality of phalsa. An application of GA_3 150 ppm significantly reduced acidity (2.55 per cent) and increased ascorbic acid content in fruit of (39.50 per cent) (Kacha *et al.* 2014) [7].

Materials and Methods

The present investigation was carried out under Allahabad agro-climatic conditions at the experimental field of the department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology & Sciences, Allahabad (U.P.). Allahabad is situated at 25.57 ^{0}N latitude and 81.50^{0}E longitude and at an altitude of 987 m above mean sea level. Allahabad has subtropical and semi – arid climate with the monsoon commencing from July and withdrawing by the end of September. The temperature reaches up to 47.5 °C in summer and goes down as 1.50 ºC in winter.

The pruning was done with the help of lopper by manual labour. Prior to start the pruning, only 8-12 canes were selected from each bush for the observation. All the pruned canes were almost similar in diameter. The average diameter per cane was 2.5 cm. An experiment was laid out with Randomized Block Design (RBD) with 13 treatments and each treatment replicated thrice, thus making a total 39 plants. The allocation of treatment to the individual plots was done using random number in each replication.

The various combination of pruning (cm) and different Plant growth regulators were as: T_0- Control (water control), T_1 – (30 cm + GA_3 @ 100 ppm + NAA @ 150 ppm), T_2–(30 cm + GA_3 @ 200 ppm + NAA @ 200 ppm), T_3–(60 cm + GA_3 @ 100 ppm + NAA @ 150 ppm), T_4 – (60 cm + GA_3 @ 200 ppm + NAA @ 200 ppm), T_5 –(90 cm + GA_3 @ 100 ppm + NAA @ 150 ppm), T_6 –(90 cm + GA_3 @ 200 ppm + NAA @ 200 ppm)), T_7–(30 cm + GA_3 @ 100 ppm + NAA @ 200 ppm), T_8 – (30 cm + GA_3 @ 200 ppm + NAA @ 150 ppm), T_9– (60 cm + GA_3 @ 100 ppm + NAA @ 200 ppm) T_{10} – (60 cm + GA_3 @ 200 ppm + NAA @ 150 ppm), T_{11}– (90 cm + GA_3 @ 100 ppm + NAA @ 200 ppm)) and T_{12}– (90 cm + GA_3 @ 200 ppm + NAA @ 150 ppm).

The following observations were recorded number of sprouted shoots per canes (120 DAP), days taken to first flower, total number of flowers per plant at 75 days after pruning, number of fruiting nodes/shoots of phalsa, fresh fruit weight, dry fruit weight, yield per bush, yield per hectare, total soluble solids (TSS) °Brix, total sugar (%), and titratable acidity (as % Malic acid).

Results and Discussion

At 120 DAP is clear that the treatment T_6 (90 cm + GA_3 @ 200 ppm + NAA @ 200 ppm) recorded significantly the maximum number of sprouted shoots per canes (30.30) closely followed by T_{11} (90 cm + GA_3 @ 100 ppm + NAA @ 200 ppm) (27.34). The data on the days taken to first flowering as influence by different growth regulators are presented in it is evident from the table that there significant differences among the treatment T_6 took significantly less number of days first flowering (61.24) followed by T_5 (62.37) and the maximum number of days taken to first flowering was observed in treatment T_0 (75.37). Similar results were also reported by Singh and Singh (2003) [14].

The maximum total number of flowers per plant (2927.41) was obtained with T_6 which were significantly superior over other treatments followed by T_{11} (2776.65) and the minimum total number of flowering per plant (1633.34) was noticed with treatment T_0 (control). Similar results were also reported by Singh *et al.* (2004) [19]. The number of fruiting nodes per shoots as influenced by different growth regulator is presented in table. The treatment T_6 (90 cm + GA_3 @ 200 ppm + NAA @ 200 ppm) was recorded significantly by the maximum number of nodes per shoots of phalsa (27.72) closely followed T_{12} (25.06) at 120 DAP. Similar result was also reported by Abid *et al.* (2012) [2]. The minimum number of nodes per shoots was recorded with control (14.52). Similar results were also reported by Singh and Singh (2003) [14].

The data on fresh weight of 10 fruits as influenced by pruning and different growth regulators are presented in table. The fresh weight of 10 fruits was significantly influenced by different treatments T_6 was highest fresh weight of fruit (9.57 g) followed by T_{12} (9.40 g). Similar results were also reported by Singh *et al.* (2006) [16]. The minimum fresh weight of 10 fruits was noticed with treatment T_0 (6.63 g). The dry weight of 10 fruits was significantly influenced by different treatments T_6 (90 cm + GA_3 @ 200 ppm + NAA @ 200 ppm) was given the maximum number of fruits per bush (2.40 g) followed by treatment T_5 (90 cm + GA_3 @ 100 ppm + NAA @ 150 ppm) (1.93 g). The minimum dry weight of 10 fruits was noticed with control (1.27g). Similar results were also reported by Brar *et al.* (1997) [4].

It is a clear from the table that fruit yield per bush was significantly influenced by different treatments and the treatment T_6 was the maximum of fruits per bush (4.78 kg) followed by T_5 (4.71 kg). The minimum Yield per bush was noticed with treatment T_1 (1.45 kg). The fruit yield (t/ha) was significantly influenced by different treatments and T_6 was given the highest fruit yield (6.94 t/ha) followed by T_{12} (6.75 t/ha). The minimum Fruit yield was noticed with control (2.06 t/ha). Similar results were also reported by Rathore *et al.* (2008) [10], Kumar *et al.* (2011) [17], Jamil *et al.*, (2006) [6] and Rema and Sharma (1993) [12].

TSS $^{\circ}$Brix was significantly influenced by different treatments T_6 was given the maximum number of fruits per bush (22.82 $^{\circ}$Brix) followed by T_{11} (21.49°Brix). The minimum T.S.S. was noticed with treatment (15.37 $^{\circ}$Brix). Similar results were also reported by Singh *et al.* (2011) [17] and Rathore *et al.* (2008) [1]. The highest total sugar was observed with treatment T_6 (12.33%) followed by T_{11} (11.72%) and the minimum total

sugar was noticed with treatment T_0 (8.36%). Similar results were also reported by Kacha *et al.* (2012) [8]. The maximum tritratable acidity was noticed with treatment T_0 (2.86%) and minimum with the treatment T_{10} (2.51%). Similar results were also reported by Chaturvedi and Ram (2014) [5], Rema and Sharma (1993) [12] and Shanker (1985) [20].

Table 1: Effect of different pruning heights and foliar application of PGRs on quality fruit production of Phalsa (*Grewia asiatica* L.)

Treatments No.	Number of sprouted shoots per canes (120 DAP)	Days taken of first flower	Total number of flowers per plant 75 DAP	Fruiting nodes per shoots at 120 DAP	Fresh weight of 10 fruits (g)	Dry weight of 10 fruits (g)	Fruit Yield per bush (Kg)	Fruit yield (t/ha)	TSS (°Brix)	Total sugar (%)	Tritratable acidity (as% malic acid)
T_0	14.11	75.37	1633.34	14.52	6.63	1.27	1.45	2.06	15.37	8.36	2.86
T_1	23.03	63.41	2310.34	20.33	8.50	1.45	3.25	3.76	17.27	8.41	2.74
T_2	22.01	63.38	2133.54	24.27	9.23	1.44	3.35	5.06	19.15	10.86	2.57
T_3	22.70	65.64	2090.48	25.52	7.70	1.73	3.33	5.15	17.59	10.58	2.71
T_4	24.88	67.39	2420.54	21.31	8.67	1.74	3.50	5.45	16.32	9.29	2.53
T_5	28.26	62.37	2760.41	20.44	8.37	1.93	4.71	5.74	21.33	9.41	2.59
T_6	30.30	61.24	2927.41	27.72	9.57	2.40	4.78	6.94	22.82	12.33	2.78
T_7	21.24	65.20	1932.54	23.53	8.43	1.75	3.70	6.23	19.67	10.59	2.58
T_8	21.10	63.31	2064.65	21.51	9.33	1.71	3.66	5.55	18.60	11.49	2.55
T_9	23.95	64.52	2449.41	20.74	9.32	1.63	3.58	5.45	17.65	10.57	2.56
T_{10}	24.92	62.38	2365.41	21.34	8.37	1.48	3.81	5.33	17.38	10.38	2.51
T_{11}	27.34	63.60	2776.65	23.72	8.18	1.49	4.18	6.65	21.49	11.72	2.71
T_{12}	24.13	66.75	2733.65	25.06	9.40	1.56	4.30	6.75	21.43	9.69	2.73
C.D. at 0.5%	1.483	0.220	0.126	0.400	0.356	0.383	0.252	0.365	0.337	0.328	0.121

DAP= Days after pruning

Conclusion

The present investigation was carried out under Allahabad agro-climatic conditions at the experimental field of the department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology & Sciences, Allahabad (U.P.). It was concluded that the best performances of fruit yield and quality of phalsa was recorded with the treatment T_6 (90 cm + GA_3 @ 200 ppm + NAA @ 200 ppm) likes the number of sprouted shoots per canes at 120 DAP, the lowest days taken to first flowers, total number of flowers per plant at 75 days after pruning, number of fruiting nodes per shoots of phalsa, fresh fruit weight, dry fruit weight, yield per bush, yield per hectare, total soluble solids (TSS), total sugar and titratable acidity.

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