Effects of foliar application of boron and gibberellic acid on seed index and yield of phalsa
(Grewia asiatica L.)

Abhay Kumar Yadav, JP Singh, Harendra Pratap Singh Choudhri, Suneel Kumar Patel and Prabhakar Yadav

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Abstract
The present experiment entitled “Effects of Foliar Application of Boron and Gibberellic Acid on seed index and yield of Phalsa (Grewia asiatica L.)” was conducted at Garden, College of Horticulture, Department of Fruit Science, Chandra Shekhar Azad University of Agriculture and Technology Kanpur, Uttar Pradesh in the year 2018-2019. It was carried out in randomized block design with 10 treatments and each treatment replicated thrice. The results of this study on the effect of Boron level from 20-50 ppm and GA₃ 30 ppm (with and without) foliar spray on Phalsa of growth regulators boron (Bo) and GA₃ were discussed and interpreted in the light of previous research in India and abroad. The study showed significant findings and concluded that T₃ (40 ppm boron+30ppm GA₃) resulted as the maximum seed index (59.82 g) and fruit yield per plant (6.01 kg) and per hectare (82.57 q) was maximum.

Keywords: Boron, gibberellic acid, phalsa seed index, yield, significant

Introduction
Phalsa (Grewia subinaequalis D.C.), which is also known as star apple is a subtropical fruit of India. It belongs to the family “Tiliaceae”. This family have about 41 genera and 400 species which are mostly distributed in the tropical and subtropical region of the world. Among various fruits grown in the country, minor fruits in spite of high nutritive content and health benefits have not received much attention with respect to value addition because of low yield and lack of improved cultivars.

Phalsa fruit is ready for picking in the south from March to April and in north, from May to June. Phalsa is being a hardy plant, can withstand drought and can be grown under adverse climatic condition Phalsa fruit is ready for picking in the south from March to April and in north, from May to June. Phalsa is being a hardy plant, can withstand drought and can be grown under adverse climatic condition Phalsa fruit are small and born in profusely. They do not ripen with a definite spell of time and thus become a problem to grower.

Ripe fruit are good source of vitamin A and vitamin C. They are also fair source of phosphorous and iron. The fruits are highly perishable in nature and due to its perishability, it cannot be exported but its processed products are very appreciable. Ripe fruits are consumed fresh in desserts, or processed into refreshing soft drinks like squash, RTS, sharbat etc. which are enjoyed during hot summer months in India. The attractive crimson red to dark purple colour of phalsa fruit is due to anthocyanin pigments mainly, delphinidin-3-glucoside, cyanidin-3-glucoside and pelargonidin-3, 5 diglucoside (Tiwari et al., 2014) [5]. The fruits are used in processing industry for making excellent juice and squash and also as table fruit, since it has sub-acidic taste. The fruit are also possessing high medicinal properties. Its ripe fruit exert cooling effect, cure inflammation, heart disease, fever and constipation.

Keeping in view of there need to work out the effective dose of boron on seed index and yield attributes of phalsa, the present experiment was undertaken with following objectives:
1. To study the effect of foliar application of boron and GAs on seed index.
2. To study the effect of foliar application of boron and GAs on yield per plant.
3. To study the effect of foliar application of boron and GAs on yield per hectare of phalsa.
Material and Method
The experiment was conducted in the Garden, Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh) during the year 2018-2019. The effect of foliar application of boron on plant growth, flowering and yield of Phalsa (Grewia asiatica L.) was carried out under Kanpur agro climatic conditions at the research farm. As the fruits are born on new growth regulators therefore application of fertilizer is essential to encourages vegetative growth. Recommended dose of N, P & K was applied to get proper growth and higher yield of better quality fruits. Well established thirty plants of phalsa cv. Sharbatli were taken for the present experiment and uniform cultural practices were done timely. Healthy bushes of phalsa were pruned to a height of 60 cm from the ground level on 25 December during 2018-2019. The data obtained on each aspect on each treatment were statistically computed in factorial RBD design with 10 treatments and each treatment thrice replicated by which making the total number of 30 plant and their spacing row to row 3×3 m and plant to plant 2.5×2.5 m. The observations regarding seed index yield per plant and yield per hectare of phalsa plant were recorded.

Statistical analyses of the data obtained in the different sets of experiments were calculated as suggested by Panse and Sukhatme and results were evaluated at 5% significance.

Table 1: Treatment and their contribution for experiment

| S. No. | Treatment Symbol | Treatment Contribution |
|--------|------------------|------------------------|
| 1.     | T₁₆             | Control (water spray)  |
| 2.     | T₁   | Boron 20 ppm        |
| 3.     | T₂   | Boron 30 ppm        |
| 4.     | T₃   | Boron 40 ppm        |
| 5.     | T₄   | Boron 50 ppm        |
| 6.     | T₅   | GA₃ 30 ppm          |
| 7.     | T₆   | Boron 20 ppm + GA₃ 30 ppm |
| 8.     | T₇   | Boron 30 ppm + GA₃ 30 ppm |
| 9.     | T₈   | Boron 40 ppm + GA₃ 30 ppm |
| 10.    | T₁₀  | Boron 50 ppm + GA₃ 30 ppm |

Result and Discussion
The findings of the present study as well as relevant discussion have been presented under following heads:

1. Seed Index
The foliar nutrition of boron with and without GA₃ significantly influenced the test weight of phalsa fruit during the experimental year. The data obtained were statistically analysis. The mean values were summarised and displayed in table-2. In this regard, the maximum test weight 59.82g was expressed in the plants which was treated under coupled treatment of boron 40 ppm + GA₃ 30 ppm (T₈) followed by treatment of T₁₀ (boron 50 ppm + GA₃ 30 ppm) revealing 59.03 g test weight against the untreated plants (control) which were revealed 51.43 g test weight being significant lesser during the experimentation followed by treatment T₂ (52.16 g). Treatments T₃, T₄, T₅ and T₇ presenting 52.94, 54.31, 64.67 and 55.16 g test weight of phalsa respectively, these treatments exhibited at par values when compared with control, as well as when compared among one another same trend was observed, whereas, remained all other treatments showed significant variation when compared with control. Treatments of T₁ and T₆ were exhibited 55.78 and 56.98 g test weight when compared in between found to be non-significant, whereas, when compared with control varied significantly.

Table 2: Effect of foliar nutrition of boron with and without GA₃ on seed index of phalsa fruit (g)

| Symbol | Treatments                  | weight of 100 fruits (g) |
|--------|-----------------------------|--------------------------|
| T₁₆    | Control (water spray)       | 51.43                    |
| T₁     | Boron 20 ppm                | 52.16                    |
| T₂     | Boron 30 ppm                | 52.94                    |
| T₃     | Boron 40 ppm                | 54.31                    |
| T₄     | Boron 50 ppm                | 55.78                    |
| T₅     | GA₃ 30 ppm                  | 54.67                    |
| T₆     | Boron 20 ppm + GA₃ 30 ppm   | 55.16                    |
| T₇     | Boron 30 ppm + GA₃ 30 ppm   | 56.98                    |
| T₈     | Boron 40 ppm + GA₃ 30 ppm   | 59.82                    |
| T₉     | Boron 50 ppm + GA₃ 30 ppm   | 59.46                    |
| T₁₀    | GA₃ 30 ppm + GA₃ 30 ppm     | 59.46                    |
| S.E. Difference |                          | 1.938                    |
| C.D. @ 5%                     |                          | 4.07                     |

3. Yield per plant of phalsa (kg/plant)
Yield per plant of phalsa was profoundly and consistently influenced by different levels of micronutrient boron, GA₃ 30 ppm and coupled treatment of boron with GA₃ 30 ppm. The data obtained were subjected to statistically analysis. The mean values summarised and displayed in table-3. The plants which were treated with coupled treatment of Boron 40 ppm + GA₃ 30 ppm (T₃) produced significantly maximum (6.01 kg) fruit per plant of phalsa closely followed by treatment of Boron 50 ppm + GA₃ 30 ppm (T₁₀) expressed (5.93 kg) fruits per plant against untreated plant i.e. control produced significantly lesser 3.92 kg fruits per plant. Remaining treatments T₁ (boron 20 ppm), T₂ (boron 30 ppm), T₃ (boron 40 ppm), T₄ (boron 50 ppm), T₅ (GA₃ 30 ppm), T₆ (boron 20 ppm+ GA₃ 30 ppm) and T₇ (boron 30 ppm+ GA₃ 30 ppm) presenting 4.21, 4.72, 5.00, 5.51, 5.21 and 5.53 kg fruit/plant respectively, among these treatments when compared one another did not bring significant variation barring treatment of T₂ and T₅ producing 4.21 and 4.72 kg fruits/plant respectively. As well as all the treatments were exhibited significantly greater in fruit production of phalsa when compared with control (3.92 kg) barring the treatment of boron 20 ppm (T₁) which produced 4.21 kg fruits/plant during investigation.

Table 3: Effect of foliar nutrition of boron with and without GA₃ on yield/plant of phalsa (kg)

| Symbol | Treatments | yield/plant of phalsa (kg) |
|--------|------------|----------------------------|
| T₁₆    | Control (water spray) | 3.92                      |
| T₁     | Boron 20 ppm         | 4.21                      |
| T₂     | Boron 30 ppm         | 4.72                      |
| T₃     | Boron 40 ppm         | 5.00                      |
| T₄     | Boron 50 ppm         | 5.51                      |
| T₅     | GA₃ 30 ppm           | 5.02                      |
| T₆     | Boron 20 ppm + GA₃ 30 ppm | 5.21                   |
| T₇     | Boron 30 ppm + GA₃ 30 ppm | 5.53                   |
| T₈     | Boron 40 ppm + GA₃ 30 ppm | 6.01                    |
| T₉     | Boron 50 ppm + GA₃ 30 ppm | 5.93                    |
| S.E. Difference |                          | 0.33                     |
| C.D. @ 5%                     |                          | 0.70                     |

4. Yield / hectare of phalsa (q/ha)
After final picking, yield obtained at different harvest were summed up and yield per hectare was calculated during the experimental period. Data thus, obtained were subjected to statistically analysis. The mean values summarised and presented in table-4. It is apparently clear from mean values that yield of phalsa fruit/ha varied significantly. Application of coupled treatment of boron 40 ppm+GA₃ 30 ppm (T₈) produced significantly greater yield i.e. 82.57 q/ha closely
followed by coupled treatment of Boron 50 ppm+GA$_3$ 30 ppm (T$_{10}$) produced 81.26 q/ha. Untreated plants i.e. controls revealed the minimum 54.05 q/ha yield being significant during investigation. Remaining treatments i.e. boron 20 ppm (T$_2$), boron 30 ppm (T$_3$), boron 40 ppm (T$_4$), boron 50 ppm (T$_5$), GA$_3$ 30 ppm (T$_6$), boron 20 ppm + GA$_3$ 30 ppm (T$_7$) and boron 30 ppm + GA$_3$ 30 ppm (T$_8$) producing 58.05, 65.08, 68.95, 75.98, 69.22, 71.84 and 76.25 quintal yield per hectare respectively. When a deep vision focused on mean values it was found that treatment of T$_5$ and T$_8$ did not bring significant influences, whereas treatment T$_6$ and T$_7$ when compared in between exhibited significant variation, as well as treatment of T$_2$, T$_3$, and T$_4$ when compared among themselves expressed significant variation. Similarly treatments of T$_3$, T$_6$ and T$_7$ when compared among them there were also found to be significant differences.

Table 4: Effect of foliar nutrition of boron with and without GA$_3$ on yield/ha of phalsa (q/ha)

| Symbol | Treatments           | yield/ha of phalsa (q) |
|--------|----------------------|------------------------|
| T$_1$  | Control (water spray)| 54.05                  |
| T$_2$  | Boron 20 ppm         | 58.05                  |
| T$_3$  | Boron 30 ppm         | 65.08                  |
| T$_4$  | Boron 40 ppm         | 68.95                  |
| T$_5$  | Boron 50 ppm         | 75.98                  |
| T$_6$  | GA$_3$ 30 ppm        | 69.22                  |
| T$_7$  | Boron 20 ppm+GA$_3$ 30 ppm | 71.84 |
| T$_8$  | Boron 30 ppm+GA$_3$ 30 ppm | 76.25 |
| S.E. Difference |                         | 0.65                  |
| C.D. @ 5%       |                         | 1.94                  |

Conclusion

On the basis of summary of results treatment of boron 40 ppm coupled with GA$_3$ 30 ppm (T$_4$) increases the seed index, yield per plant and per hectare of phalsa fruit. Other treatment of different level of boron, GA$_3$ 30 ppm as well as remained couple treatments of boron with GA$_3$ also improved above parameters though, the maximum attributor characters including yield were enhanced by the coupled treatment of boron 40 ppm with GA$_3$ 30 ppm. So it is advice to orchardist, grower and research workers to spraying of boron 40 ppm + GA$_3$ 30 ppm for improving seed index and yield for enhancing economy and prosperity of phalsa growing region and country.

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