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# Effect of dormancy breaking chemicals, garlic extract and summer pruning on the cropping behaviour of low chilling peach (*Prunus persica* L. Batsch)

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**ABSTRACT**

*The present investigation on the effect of dormancy breaking chemicals, garlic extract and summer pruning on the cropping behavior of low chilling peach was carried out in the experimental farm of Department of Fruit Science. The study was conducted on Glohaven and Royal Paradelux peach cultivars planted at a spacing of 2×2m. In the experiment, dormancy breaking chemicals comprised of 12 treatments including control were applied on 24th December and 1st January. The vegetative parameters, flowering, fruiting parameters and biochemical parameters were observed in all the treated plants and were compared to untreated control. The results of the study indicated that bud break, full bloom, yield, fruit set, retention, length, diameter, weight, TSS, acidity, ascorbic acid and sugar content were found best with treatment dormex @ 3%.*

***Keywords***: Dormancy breaking chemicals, flowering, low chilling and *Prunus persica*.

The peach [*Prunus persica* (L.) Batsch] is an important stone fruit of temperate zone and native to the region of Northwest China between the Tarim Basin and the north slopes of the Kunlun Mountains. It belongs to the family Rosaceae and sub family Prunoidae. The peach fruits have a high nutritive value being rich in sugars, vitamins, minerals and carotene (Wills *et al*., 1983). The consumption of peach fruit juice is also increasing rapidly in the form of nectar, fruit drinks and breakfast drinks. Peaches have been grown in Asia for more than two thousand years and it is the third most important temperate fruit cultivated in India. The major peach producing countries in the world are USA, Italy, France, Greece, Spain, Russia and China. In India, It is cultivated on an area of about 19 thousand hectares with the annual production of 117 thousand tons and productivity of 6.15 t $ha^{-1}$ (NHB, 2017). In India, peach is mainly cultivated and successfully grown in the states of Jammu and Kashmir, Himachal Pradesh and Uttarakhand. In Himachal Pradesh, it is cultivated on an area of 5090 hectares with the production of 7262 tons with productivity of 1.42 tons per ha (NHB, 2017). It is grown in the districts like Shimla, Kullu, Mandi, Chamba, Kangra, Solan, Sirmaur, Una and Hamirpur.

The fruits come in the market early in the season, particularly, from the low chilling cultivars grown in warmer regions of Himachal Pradesh. Most deciduous fruit trees with a high or medium chilling requirement do not grow successfully in these regions due to the insufficient chilling accumulation during dormancy. Peach also being a winter dormant plant requires certain chilling hours for releasing the buds from dormancy and make the plant flowers in the following spring. The cultivars Glohaven and Royal Paradeluxe are late season cultivars under sub-tropical conditions. The initiation of bud break in these cultivars occurs late in comparison to the other cultivars. Due to insufficient chilling hours and warm weather conditions in the subtropical areas, the bud break is poor, pollination seems to be improper and the flowering period of these cultivars is of longer duration. Thus, they flowers late and matures late. The late and non-synchronized bud break in these cultivars delays the fruit maturity due to which the fruits are available in the late June to early July, which get competition from other fruit crops. Endo-dormancy in peach is broken by winter chilling and the amount of chilling required depends upon the species and cultivar. In order to obtain early and uniform bud break, there is a need to identify chemicals, growth regulators and standardize their concentration, stage and time of application. The application of these chemicals in the fall or in the spring before bud break has been reported to induce bud break in fruit trees (El-Agamy *et al*., 2001). These chemicals supplement chilling temperature and are helpful in making transition of both floral and vegetative buds of semi-deciduous sub-tropical fruits trees from dormant to active state. Chemical rest breaking agents have been used commercially with success on apples and pear in South Africa and other countries that experiences warm winter conditions to ensure the greater uniformity in bud break and to alleviate these problems associated with delayed foliation.

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## MATERIALS AND METHODS

This study was conducted in the experimental farm of Department of Fruit Science,College of Horticulture and Forestry, Neri, Hamirpur, Himachal Pradesh, during the years 2018 and 2019. In this study, the effect of chemical treatments on peach was observed on the breaking of dormancy, flowering and fruiting parameters and biochemical parameters. Plant material consisted of two cultivars of peach *viz*., Glohaven and Royal Paradelux. Trees were spaced at 2 × 2m. The chemical treatments consisted of dormancy breaking chemicals and garlic extract. Trees were arranged in the Randomized Block Design with 3 Replication and 12 treatments. The plants were treated in the dormant season. The different concentrations of chemicals were made and applied to the plants with the help of sprayer.

In the dormant season, the treatments applied to the plants consisted of $T_1$- dormex @ 3%, $T_2$- thidiazuron @ 250 ppm, $T_3$- thiourea @ 5%, $T_4$- thiourea @ 2.5%, $T_5$- $KNO_3$ @ 1.5%, $T_6$- $GA_3$@ 100 ppm, $T_7$- $GA_3$ @ 200 ppm, $T_8$- garlic extract @ 10%, $T_9$- garlic extract @ 15%, $T_{10}$- summer pruning, $T_{11}$- summer pruning + garlic extract @ 15% and $T_{12}$- control. The time of application was 24$^{th}$ December and 1$^{st}$ January. The vegetative parameters, flowering, fruiting parameters and biochemical parameters were observed in all the treated plants and were compared to untreated control.

The date of bud break was noted when bud started to burst on the selected shoots. The time of full bloom was noted when 75% of the flowers opened in the selected shoots. The annual shoot growth and trunk girth was measured with the help of measuring tape. The shoot diameter was measured with the help of digital vernier caliper. Number of fruits /m$^2$ was calculated by counting number of fruits in one meter length of shoot. Fruit set was determined by counting the total number of flower and then counting the number of fruits 20 days after full bloom. Fruit retention was determined by counting the number of fruits retained at the time of harvesting. Total yield was calculated by weighing the fruits on top pan balance. Fruit length and fruit diameter was determined with the help of digital vernier caliper. Fruit was recorded on the electronic balance and the fruit volume was determined by the water displacement method. TSS was determined with the help of refractometer. Titratable acidity was calculated by titrating the pulp against 0.1 N NaOH solution. Sugar contents were estimated by volumetric method. Fruit maturity was estimated by change in the colour of fruits and TSS content. The data generated from these investigations were appropriately computed, tabulated and analysed by using MS-Excel and OPSTAT. The values of data were subjected to analysis of variance as procedures outlined by Gomez and Gomez (1984) for Randomized Block Design.

## RESULTS AND DISCUSSION

The annual shoot growth was found to be highest (35.17 cm) in the $GA_3$treated plants @ 100 ppm (Table 1) and the possible reason for this augmentation of growth by $GA_3$ is its effect on the cell division and enlargement (Hedden and Phillips, 2000; O'Neil and Ross, 2002). Similar results were also obtained by Kassem *et al.* (2010) who reported increment in shoot length by the application of potassium nitrate and gibberellic acid in Persimmon. Shoot diameter (19.45%) and trunk girth (10.15%) was highest in plants treated with potassium nitrate @ 1.5% (Table 1).The probable reason for the increase is the role of potassium in nutrient and sugar translocation in plants and turgor pressure of plant cell. Potassium also activates numerous enzyme systems involved in the formation oforganic substances and in the building of compounds such as starch and protein. Potassium is also involvedin the plant meristematic growth (Mengel and Kirkby, 1987).

The fruit set was enhanced by the application of various treatments over control with maximum fruit set (73.53%) in the dormex @ 3% which, was found to be at par with treatment of $GA_3$ @ 100 ppm with fruit set value 71.23% (Table 1). The lowest fruit set (60.08%) was observed in the untreated control, which was statistically at par with application of thiourea @ 2.5% and 5% where fruit sets were 60.14% and 62.23%, respectively. The fruit set of cultivar Glohaven (67.27%) was found to be statistically higher than cultivar Royal Paradelux (64.55%). The interaction between treatments and cultivar was also found to besignificant in respect of fruit set. The maximum fruit set (75.74%) was observed in the treatment combination of dormex @ 3% and Glohaven, and the minimum fruit set (57.60%) was observed in the combination of thiourea @ 2.5% and Glohaven.

The plants treated with dormex @ 3% produced maximum (75.84%) fruit retention (Table 1), which was statistically at par with the applications of $KNO_3$ @ 1.5%, $GA_3$ @ 100 ppm and $GA_3$ @ 200 ppm which showed 72.60, 75.07 and 71.49 % fruit retention, respectively. The least retention of fruit (61.05%) was recorded with treatment $T_{12}$ which was found to be at par with the treatment of garlic extract @ 10% and thiourea @ 2.5% with fruit retention values 63.68 and 62.68 %, respectively. The cultivar Glohaven had significantly high retention of fruit (70.45%) as compared to cultivar Royal Paradelux (67.25%). The interaction effect of treatments and cultivars had significant effect on fruit retention. The maximum fruit retention (80.76%) was recorded with treatment combination of dormex @ 3% × Glohaven and the minimum value (57.86%) was recorded in the thiourea @ 2.5% and Glohaven combination.

All the treatments advanced the date of bud break over the control. In cultivar Glohaven (Fig. 2), the plants sprayed with Dormex @ 3% resulted in the earliest bud break viz. on 25th February which was followed by the treatment of $GA_3$ @ 200 ppm that showed bud break on 28th February. The plants which did not received any chemical application (control) took longest duration to bud break viz. on 17th March. In cultivar Royal Paradelux (Fig. 3), treatment $T_1$ *i.e.* plants that were treated with dormex @ 3% was noticed to show bud break earliest *viz*. on 1st March which was closely followed by the application of $GA_3$ @ 200 ppm that showed bud break on 2nd March. Among all the treatments, the control was last to induce bud break *viz*. on 20th March. These results are in agreement with the results of George *et al*. (1992) who obtained similar results with the application of hydrogen cyanamide which advanced the date of bud break of peach by 5-14 days over the control. In another experiment by George and Nissen (1993; 1988), the dormex was found to advance the bud break in peach by 40 days over the control.

The favourable effect of dormex on the date of floral bud break may be due to their stimulation effect on natural gibberellins (Luna *et al*., 1993). Yang *et al*. (1990) concluded that cyanamide ion may play a role in inducing enzyme activity, promoting the re-translocation of stored reserves and increasing the uptake of nitrogen leading to bud break.

In Glohaven (Fig. 3), the treatment $T_1$ (dormex @ 3%) resulted in earliest opening of first flower on 5th March which was followed by treatment $T_7$ ($GA_3$ @ 200 ppm) that showed first flower opening on 7th March. In control plants, the first flower opened on 24th March which was last among all the treatments. In cultivar, Royal Paradelux (Fig. 4), the plants sprayed with dormex @ 3% were earliest to show opening of first flower *viz*. on 8th Marchwhich was followed by the treatment $T_7$ ($GA_3$ @ 200 ppm) that showed opening of first flower on 10th March. The plants that were left untreated showed opening of first flower on 27th March.The date of full bloom also followed a similar trend as that of opening of first flower and bud break. The plants sprayed with dormex @ 3% were the earliest to show full bloom on 15th March in cultivar Glohaven and on 17th March in cultivar Royal Paradelux. In both cultivars, the time of full bloom was preceded by treatment $T_7$($GA_3$ @ 200 ppm) and the plants under controltook the maximum time to full bloom viz. 2nd April and 5th April in cultivar Glohaven and Royal Paradelux, respectively. The results are in line with the findings of Zavala and Alcazar (2000) who found that dormex application advanced the full bloom of peach by 7 days. Mohamed and Sherif (2015) also obtained similar results and found the advancement in full bloom by 14 days in the peach by the use of HCN over the control. The probable reason for the advancement in the flowering was due to the early bud break induced by hydrogen cyanamide.

Fruit length (5.88 cm) was observed maximum in dormex @ 3%, which was found to be at par with the $GA_3$ @ 200 ppm where fruit length was registered as 5.78 cm (Table 2). The least size (5.17 cm) of fruits were found undertreatment $T_{12}$ (control) which was statistically at par withtreatment $T_2$(thidiazuron @ 250 ppm) with fruit length 5.27 cm. The cultivar Royal Paradelux was observed with higher fruit length (5.75 cm) than Glohaven (5.33 cm).The interaction between treatments and cultivars also had significant effect on the fruit length of peach. The maximum fruit length (6.08 cm) was observed under treatment combination of dormex @ 3% and Royal Paradelux.

Maximum fruit diameter (5.45 cm) was observed with treatment of dormex @ 3%, which was statistically at par with the treatment, thiourea @ 5%), $GA_3$ @ 200 ppm and garlic extract @ 10% where fruit diameter values were 5.30 , 5.36 and 5.24 cm, respectively (Table 2). The minimum fruit diameter observed in the untreated control was at par with the thidiazuron @ 250 ppm, thiourea @ 2.5% and summer pruning. The cultivar, Royal Paradelux had higher fruit diameter (5.20 cm) than Glohaven (4.95 cm).The interaction between treatments and cultivars also showed significant effect on the fruit diameter of peach. The maximum fruit diameter (5.51 cm) was observed with combination of dormex @ 3% and Royal Paradelux.

The highest fruit weight (94.31g) was recorded with treatment $T_1$ (dormex @ 3%) which was significantly similar with treatment $T_3$ (thiourea @ 5%), $T_6$($GA_3$ @ 100 ppm), $T_7$ ($GA_3$ @ 200 ppm) and $T_8$ (garlic extract @ 10%)having fruit weight 91.06 g, 84.90g, 93.85g and 85.52g, respectively (Table 2).The least fruit weight (72.11 g) was recorded with treatment $T_{12}$(control) was statisticallyat par withtreatment$T_2$ (thidiazuron @ 250 ppm), $T_4$ (thiourea @ 2.5%), $T_5$ ($KNO_3$ @ 1.5%), $T_9$ (garlic extract @ 15%), $T_{10}$ (summer pruning) and $T_{11}$ (summer pruning + garlic extract @ 15%) with fruit weight 75.29 g, 81.73 g, 82.19 g, 74.75 g, 79.40 g and 81.87 g, respectively. The cultivar Royal Paradelux had more fruit weight (89.57 g) as compared to cultivar Glohaven (76.88 g). Among the first order interaction, maximum fruit weight (95.27 g) was observed with treatment combination $T_1$ (dormex @ 3%) × Royal Paradelux.

The fruit volume was recorded maximum with the treatment dormex @ 3%, being 106.39 $cm^3$,which was statistically at par with the thiourea @ 5% and $GA_3$ @ 200 ppm (Table 2). There was a significant difference

**Table 1: Effect of dormancy breaking treatments on growth and fruiting parameters of peach**

| Treatments | Annual shoot growth (cm) | | | % increase in shoot diameter* | | | % increase in trunk girth* | | | Fruit set ** (%) | | | Fruit retention** (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $V_1$ (Glo-haven) | $V_2$ (Royal Paradelux) | Mean | $V_1$ (Glo haven) | $V_2$ (Royal Paradelux) | Mean | $V_1$ (Glo haven) | $V_2$ (Royal Paradelux) | Mean | $V_1$ (Glo haven) | $V_2$ (Royal Paradelux) | Mean | $V_1$ (Glo haven) | $V_2$ (Royal Paradelux) | Mean |
| $T_1$: Dormex @ 3% | 35.00 | 34.00 | 34.50 | 18.37 | 19.67 | 19.02 | 8.99 | 9.40 | 9.20 | 75.74 | 71.33 | 73.53 | 80.76 | 70.92 | 75.84 |
| | | | | (4.40) | (4.54) | (4.47) | (3.16) | (3.22) | (3.19) | (60.56) | (57.61) | (59.08) | (63.97) | (57.35) | (60.66) |
| $T_2$: Thidiazuron @ 250 ppm | 26.33 | 31.00 | 28.67 | 17.27 | 17.91 | 17.59 | 7.62 | 8.08 | 7.85 | 68.37 | 62.31 | 65.34 | 70.02 | 65.29 | 67.66 |
| | | | | (4.27) | (4.35) | (4.31) | (2.93) | (3.01) | (2.97) | (55.76) | (52.11) | (53.93) | (56.78) | (53.89) | (55.33) |
| $T_3$: Thiourea @ 5% | 31.33 | 31.67 | 31.50 | 15.35 | 15.39 | 15.37 | 6.84 | 7.10 | 6.97 | 62.16 | 62.30 | 62.23 | 75.19 | 63.16 | 69.17 |
| | | | | (4.04) | (4.05) | (4.05) | (2.80) | (2.84) | (2.82) | (52.02) | (52.10) | (52.06) | (60.19) | (52.61) | (56.40) |
| $T_4$: Thiourea @ 2.5% | 29.67 | 33.33 | 31.50 | 17.95 | 18.07 | 18.01 | 8.50 | 9.66 | 9.08 | 57.60 | 62.67 | 60.14 | 57.86 | 67.51 | 62.68 |
| | | | | (4.35) | (4.37) | (4.36) | (3.08) | (3.26) | (3.17) | (49.36) | (52.33) | (50.84) | (49.62) | (55.23) | (52.42) |
| $T_5$: KNO3 @ 1.5% | 30.33 | 37.33 | 33.83 | 18.94 | 19.96 | 19.45 | 10.06 | 10.24 | 10.15 | 74.49 | 64.29 | 69.39 | 77.86 | 67.33 | 72.60 |
| | | | | (4.47) | (4.58) | (4.52) | (3.32) | (3.35) | (3.34) | (59.67) | (53.29) | (56.48) | (62.49) | (55.12) | (58.81) |
| $T_6$: $GA_3$ @ 100 ppm | 31.67 | 38.67 | 35.17 | 17.01 | 18.93 | 17.97 | 9.70 | 9.97 | 9.84 | 72.94 | 69.51 | 71.23 | 79.66 | 70.49 | 75.07 |
| | | | | (4.24) | (4.47) | (4.35) | (3.27) | (3.31) | (3.29) | (58.64) | (56.47) | (57.56) | (63.17) | (57.08) | (60.13) |
| $T_7$: $GA_3$ @ 200 ppm | 28.33 | 35.00 | 31.67 | 18.87 | 18.64 | 18.75 | 9.56 | 9.20 | 9.38 | 70.08 | 70.53 | 70.31 | 72.94 | 70.04 | 71.49 |
| | | | | (4.46) | (4.43) | (4.44) | (3.25) | (3.19) | (3.22) | (56.82) | (57.11) | (56.96) | (58.65) | (56.81) | (57.73) |
| $T_8$: GE @ 10% | 31.00 | 30.67 | 30.83 | 15.70 | 15.88 | 15.79 | 7.24 | 8.51 | 7.88 | 65.02 | 61.96 | 63.49 | 63.78 | 63.59 | 63.68 |
| | | | | (4.09) | (4.11) | (4.10) | (2.87) | (3.08) | (2.98) | (53.73) | (51.90) | (52.81) | (52.98) | (52.87) | (52.92) |
| $T_9$: GE @ 15% | 29.00 | 33.00 | 31.00 | 16.23 | 16.43 | 16.33 | 8.29 | 8.84 | 8.57 | 63.44 | 67.76 | 65.60 | 67.85 | 69.76 | 68.80 |
| | | | | (4.15) | (4.18) | (4.16) | (3.05) | (3.14) | (3.09) | (52.80) | (55.39) | (54.09) | (55.45) | (56.62) | (56.03) |
| $T_{10}$: SP | 28.00 | 28.00 | 28.00 | 16.26 | 17.20 | 16.73 | 8.06 | 9.05 | 8.56 | 69.38 | 61.77 | 65.58 | 69.90 | 68.87 | 69.39 |
| | | | | (4.15) | (4.27) | (4.21) | (3.01) | (3.17) | (3.09) | (56.39) | (51.79) | (54.09) | (56.71) | (56.10) | (56.40) |
| $T_{11}$:SP + GE @ 15% | 28.67 | 30.33 | 29.50 | 16.62 | 16.79 | 16.71 | 7.15 | 7.89 | 7.52 | 67.37 | 60.62 | 64.00 | 68.99 | 68.54 | 68.77 |
| | | | | (4.20) | (4.22) | (4.21) | (2.85) | (2.98) | (2.92) | (55.15) | (51.12) | (53.13) | (56.14) | (55.87) | (56.01) |
| $T_{12}$: Control | 27.33 | 27.00 | 27.17 | 14.78 | 15.11 | 14.95 | 6.69 | 6.51 | 6.60 | 60.62 | 59.54 | 60.08 | 60.66 | 61.44 | 61.05 |
| | | | | (3.97) | (4.01) | (3.99) | (2.77) | (2.74) | (2.75) | (51.12) | (50.48) | (50.80) | (51.14) | (51.60) | (51.37) |
| **Mean** | **29.72** | **32.50** | | **16.95** | **17.50** | | **8.23** | **8.70** | | **67.27** | **64.55** | | **70.45** | **67.25** | |
| | | | | **(4.23)** | **(4.30)** | | **(3.03)** | **(3.11)** | | **(55.17)** | **(53.47)** | | **(57.27)** | **(55.10)** | |
| **LSD (0.05)** | **T** | **3.08** | | | **0.13** | | | **0.18** | | | **1.68** | | | **3.66** | |
| | **V** | **1.25** | | | **0.05** | | | **0.07** | | | **0.69** | | | **1.50** | |
| | **T × V** | **4.35** | | | **NS** | | | **NS** | | | **2.37** | | | **5.18** | |

*Note:* Figures in parentheses indicate square root transformed .values. ** Figures in parentheses indicate angular transformed values*

**Table 2: Effect of dormancy breaking treatments on physical quality parameters of peach**

| Treatments | Fruit length (cm) | | | Fruit diameter (cm) | | | Fruit weight (g) | | | Fruit volume ($cm^3$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $V_1$ (Glohaven) | $V_2$ (Royal Paradelux) | Mean | $V_1$ (Glohaven) | $V_2$ (Royal Paradelux) | Mean | $V_1$ (Glohaven) | $V_2$ (Royal Paradelux) | Mean | $V_1$ (Glohaven) | $V_2$ (Royal Paradelux) | Mean |
| $T_1$: Dormex @ 3% | 5.69 | 6.08 | 5.88 | 5.39 | 5.51 | 5.45 | 93.35 | 95.27 | 94.31 | 105.66 | 107.11 | 106.39 |
| $T_2$: Thidiazuron @ 250 ppm | 5.04 | 5.50 | 5.27 | 4.63 | 4.95 | 4.79 | 65.53 | 88.41 | 76.97 | 69.93 | 93.83 | 81.88 |
| $T_3$: Thiourea @ 5% | 5.27 | 5.89 | 5.58 | 5.18 | 5.43 | 5.30 | 87.06 | 95.06 | 91.06 | 89.74 | 101.34 | 95.54 |
| $T_4$: Thiourea @ 2.5% | 5.64 | 5.61 | 5.63 | 4.79 | 5.09 | 4.94 | 68.76 | 94.70 | 81.73 | 74.07 | 100.72 | 87.39 |
| $T_5$: KNO3 @ 1.5% | 5.20 | 5.83 | 5.51 | 4.95 | 5.29 | 5.12 | 75.07 | 89.31 | 82.19 | 88.61 | 97.47 | 93.04 |
| $T_6$: $GA_3$ @ 100 ppm | 5.44 | 5.94 | 5.69 | 5.02 | 5.34 | 5.18 | 74.79 | 95.00 | 84.90 | 83.93 | 101.00 | 92.47 |
| $T_7$: $GA_3$ @ 200 ppm | 5.58 | 5.98 | 5.78 | 5.32 | 5.39 | 5.36 | 92.45 | 95.25 | 93.85 | 101.83 | 103.94 | 102.89 |
| $T_8$: GE @ 10% | 5.51 | 5.75 | 5.63 | 5.26 | 5.22 | 5.24 | 90.56 | 80.48 | 85.52 | 98.89 | 87.47 | 93.18 |
| $T_9$: GE @ 15% | 5.37 | 5.34 | 5.35 | 5.10 | 4.85 | 4.97 | 74.50 | 74.99 | 74.75 | 80.35 | 81.01 | 80.68 |
| $T_{10}$: SP | 5.12 | 5.69 | 5.41 | 4.53 | 5.15 | 4.84 | 67.32 | 91.49 | 79.40 | 73.33 | 98.90 | 86.12 |
| $T_{11}$: SP + GE @ 15% | 5.30 | 5.80 | 5.55 | 4.83 | 5.19 | 5.01 | 70.94 | 92.80 | 81.87 | 75.93 | 99.07 | 87.50 |
| $T_{12}$: Control | 4.81 | 5.53 | 5.17 | 4.44 | 5.02 | 4.73 | 62.18 | 82.04 | 72.11 | 69.80 | 85.97 | 77.88 |
| **Mean** | **5.33** | **5.75** | | **4.95** | **5.20** | | **76.88** | **89.57** | | **84.34** | **96.48** | |
| **LSD (0.05)** | **T** | **0.16** | | **0.21** | | | **10.74** | | | **11.09** | | |
| | **V** | **0.06** | | **0.08** | | | **4.39** | | | **4.53** | | |
| | **T × V** | **0.22** | | **0.29** | | | **15.19** | | | **15.68** | | |

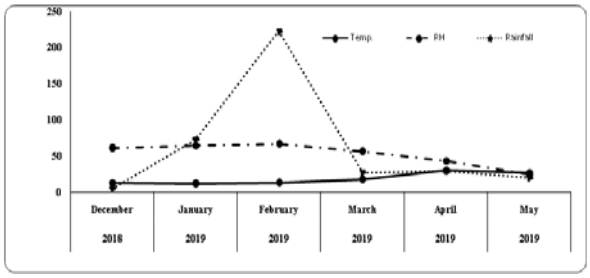


**Fig. 1: Mean monthly meteorological data of the experimental site (Meteorological Centre, Shimla, 2017)**

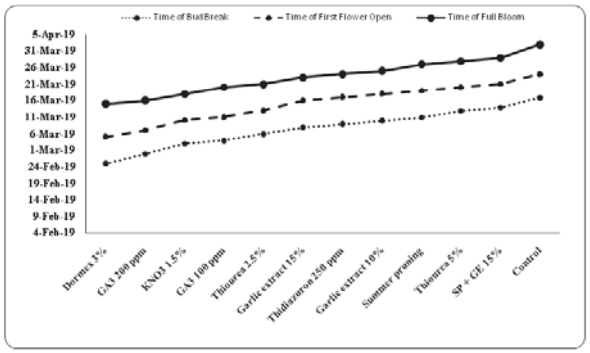


**Fig. 2: Effect of dormancy breaking treatments on bud break, time of opening of first flower and full bloom of Glohaven**

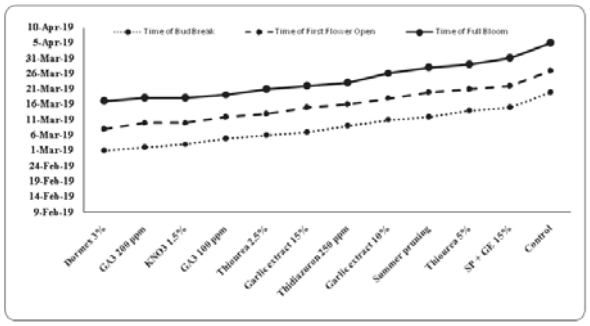


**Fig. 3: Effect of dormancy breaking treatments on bud break, time of opening of first flower and full bloom of Royal Paradelux**

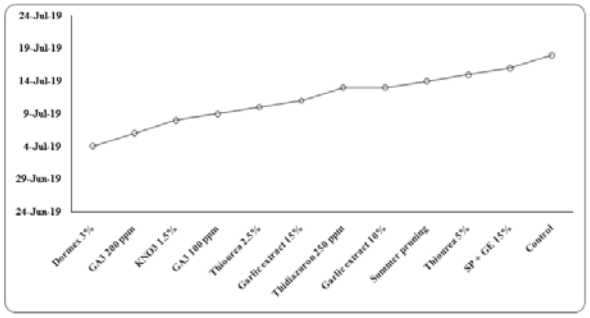


**Fig. 4: Effect of dormancy breaking treatments on fruit maturity of Glohaven**

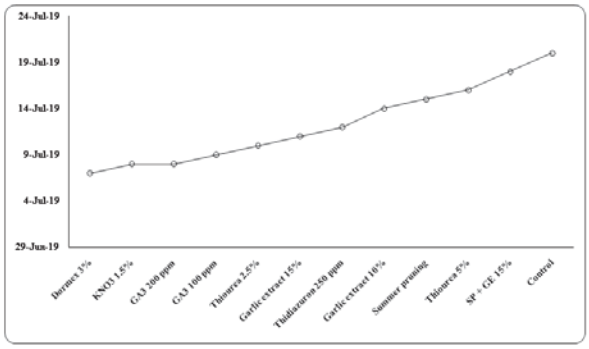


**Fig. 5: Effect of dormancy breaking treatments on fruit maturity of Royal Paradelux**

among cultivars for fruit volume and Royal Paradelux was observed to have more fruit volume (96.48 $cm^3$) than Glohaven (84.34 $cm^3$). The interaction between treatments and cultivar was also found to be significant. The maximum fruit volume (107.11 $cm^3$) was observed with treatment combination dormex @ 3% × Royal Paradelux.

In the present experiment, the maximum fruit dimensions, fruit weight and volume were observed in the fruits from the plants treated with dormex. The minimum value in respect of these parameters was shown by control plants. Wahdan *et al*. (2003) also found that hydrogen cyanamide application to the peach plants resulted in the increased average weight of the fruits. George and Nissen (1993) also found the increment in mean fruit weight by the application of dormex in association with potassium nitrate in peach. George and Nissen (1988) during their work on peach observed that mean fruit weight was increased by dormex application. Fahmy *et al*. (2015) during their work on peach observed the increment of fruit weight by the use of dormex either alone or in combination with the brassinolide. The increment in fruit volume was also obtained by dormex application in association with brassinolide. Mohamed and Sherif (2015) also found similar results in terms of increment in fruit weight, fruit volume and diameter by the spray of dormex in combination with brassinolide. Dormex alone resulted in the increased value of fruit length, diameter, weight and volume over the control (Mohamed and Sherif, 2015). El-Kassas*et al*. (1996) on peach and nectarines noticed the improvement in fruit weight, size and volume of the fruits after the application of dormex. Petri (1989) suggested that an advancement in flowering lead to an increase in fruit weight as fruits from earlier opened flowers have faster initial growth rates than the fruits from later flowers (Abbott, 1984).

The harvest maturity was advanced by the application of chemicals and summer pruning. The maximum advancement in fruit maturity (14 days in Glohaven and 13 days in Royal Paradelux) was observed in the plants

**Table 3: Effect of dormancy breaking treatments on the biochemical properties and yield of peach**

| Treatments | Fruit TSS (°brix) | | | Fruit acidity (%) | | | Ascorbic acid (mg $100^{-1}$ g) | | | Total sugars (%) | | | Fruit yield (kg $tree^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $V_1$ (Glo-haven) | $V_2$ (Royal Paradelux) | Mean | $V_1$ (Glo-haven) | $V_2$ (Royal Paradelux) | Mean | $V_1$ (Glo-haven) | $V_2$ (Royal Paradelux) | Mean | $V_1$ (Glo-haven) | $V_2$ (Royal Paradelux) | Mean | $V_1$ (Glo-haven) | $V_2$ (Royal Paradelux) | Mean |
| **$T_1$: Dormex @ 3%** | 13.50 | 13.80 | 13.65 | 0.75 | 0.72 | 0.74 | 13.19 | 13.33 | 13.26 | 7.39 | 7.62 | 7.50 | 3.73 | 3.82 | 3.78 |
| **$T_2$: Thidiazuron @ 250 ppm** | 12.50 | 12.30 | 12.40 | 0.87 | 0.91 | 0.89 | 12.24 | 12.19 | 12.22 | 6.37 | 6.06 | 6.22 | 2.80 | 3.00 | 2.90 |
| **$T_3$: Thiourea @ 5%** | 12.40 | 12.83 | 12.62 | 0.90 | 0.79 | 0.84 | 12.01 | 12.92 | 12.47 | 6.19 | 6.75 | 6.47 | 3.10 | 3.17 | 3.13 |
| **$T_4$: Thiourea @ 2.5%** | 12.67 | 12.50 | 12.58 | 0.94 | 0.83 | 0.88 | 11.92 | 12.65 | 12.28 | 6.00 | 6.44 | 6.22 | 2.62 | 3.37 | 2.99 |
| **$T_5$: KNO3 @ 1.5%** | 12.87 | 12.17 | 12.52 | 0.83 | 0.95 | 0.89 | 12.60 | 12.06 | 12.33 | 6.74 | 5.98 | 6.36 | 3.61 | 3.45 | 3.53 |
| **$T_6$: $GA_3$ @ 100 ppm** | 13.03 | 13.60 | 13.32 | 0.81 | 0.73 | 0.77 | 12.83 | 13.24 | 13.03 | 6.88 | 7.49 | 7.19 | 3.47 | 3.75 | 3.61 |
| **$T_7$: $GA_3$ @ 200 ppm** | 13.37 | 13.00 | 13.18 | 0.76 | 0.78 | 0.77 | 13.10 | 13.01 | 13.06 | 7.27 | 7.01 | 7.14 | 3.58 | 3.54 | 3.56 |
| **$T_8$: GE @ 10%** | 12.23 | 13.43 | 12.83 | 0.85 | 0.73 | 0.79 | 12.38 | 13.15 | 12.76 | 6.55 | 7.32 | 6.93 | 3.32 | 2.88 | 3.10 |
| **$T_9$: GE @ 15%** | 13.20 | 12.40 | 12.80 | 0.79 | 0.88 | 0.83 | 13.01 | 12.38 | 12.69 | 7.03 | 6.19 | 6.61 | 3.21 | 2.81 | 3.01 |
| **$T_{10}$: SP** | 12.43 | 13.17 | 12.80 | 0.89 | 0.75 | 0.82 | 12.15 | 13.06 | 12.60 | 6.25 | 7.15 | 6.70 | 3.38 | 2.67 | 3.03 |
| **$T_{11}$:SP + GE @ 15%** | 12.80 | 12.67 | 12.73 | 0.84 | 0.79 | 0.81 | 12.51 | 12.83 | 12.67 | 6.61 | 6.62 | 6.62 | 2.92 | 3.21 | 3.07 |
| **$T_{12}$: Control** | 12.10 | 12.57 | 12.33 | 0.98 | 0.82 | 0.90 | 11.83 | 12.51 | 12.17 | 5.90 | 6.31 | 6.11 | 2.50 | 2.73 | 2.62 |
| **Mean** | **12.76** | **12.87** | | **0.85** | **0.81** | | **12.48** | **12.78** | | **6.60** | **6.74** | | **3.19** | **3.20** | |
| **LSD (0.05)** | **T** | **0.27** | | | **0.09** | | | **0.53** | | | **0.33** | | | **0.34** | |
| | **V** | **0.11** | | | **0.04** | | | **0.22** | | | **0.14** | | | **NS** | |
| | **T × V** | **0.38** | | | **0.12** | | | **0.76** | | | **0.47** | | | **0.48** | |

treated with dormex @ 3% (Fig. 4, 5). In Glohaven (Fig 4), the fruits attained maturityby 4th of July which was followed by the treatment of $GA_3$ @ 200 ppm in which fruits attained maturity by 6th of July. The fruits of untreated plants attained maturity in the last amongall the treatments *viz*. on 18th July in cultivar Glohaven. In Royal Paradelux (Fig 5), the fruits of the plants treated with dormex @ 3% attained maturity earliest viz. by 7th July.The advancement of fruit maturity was followed by $GA_3$ @ 200 ppm ($T_7$) in both the cultivars under study.These results are in agreement with the findings of George *et al*. (1992) and George and Nissen (1993) where maturity of fruit and harvesting had been advanced in peach by 1-3 days over the control by the application of dormex. The early harvesting and maturity induced by HCN may be due to early bud break and early flowering in the plants (Lloyd and Firth (1993).

The maximum TSS (13.65ÚBrix) was recorded with the treatment dormex @ 3% which was significantly followed by the treatment $GA_3$ @ 100 ppm and $GA_3$ @ 200 ppm with fruit TSS 13.32ÚBrix and 13.18ÚBrix (Table 3). The minimum TSS (12.33ÚBrix) was recorded with treatment $T_{12}$ (control) which was statistically similar with thiourea @ 2.5%), $KNO_3$ @ 1.5% and thidiazuron @ 250 ppm with TSS 12.58 ÚBrix, 12.52 ÚBrix and 12.40 ÚBrix respectively. The cultivar Royal Paradelux had significantly higher fruit TSS (12.87ÚBrix) than that of Glohaven (12.76ÚBrix). The interaction between treatment and cultivar also had significant effect on the fruit TSS. The maximum fruit TSS (13.80ÚBrix) was recorded with combination of $T_1 \times V_2$ (dormex @ 3% × Royal Paradelux) and the minimum fruit TSS (12.10ÚBrix) was recorded with treatment combination $T_{12} \times V_1$ (control × Glohaven).

Titratable acidity was reduced significantly by application of chemical treatments. The maximum acidity (0.90 %) was observed with treatment control which was statistically at par with treatment $T_2$ (thidiazuron @ 250 ppm), $T_3$ (thiourea @ 5%), $T_4$ (thiourea @ 2.5%) and $T_5$ ($KNO_3$@ 1.5%) with acidity 0.89%, 0.84% 0.88% and 0.89% respectively (Table 3). The least acid content (0.74%) was found with treatment $T_1$ (dormex @ 3%) which was at par with the treatment $T_8$ (garlic extract @ 10%), and treatment $T_6$ ($GA_3$ @ 100 ppm) with acid content 0.79%, 0.77% and 0.77% respectively. The cultivar Royal Paradelux was shown to have least acidity content (0.81%) as compared to the Glohaven which showed 0.85% acidity. The interaction effect between treatment and cultivar was also found to be significant and the maximum acidity (0.98%) was observed with combination control and Glohaven. The minimum acid content (0.72%) was recorded with combination of dormex @ 3% × Royal Paradelux.

The maximum ascorbic acid content of 13.26 mg $100^{-1}$ g was observed in the dormex @ 3%, which was statistically at par with treatment $GA_3$ @ 100 ppm, $GA_3$ @ 200 ppm and garlic extract @ 10% which showed 13.03 mg $100^{-1}$ g, 13.08 mg $100^{-1}$ g and 12.76 mg $100^{-1}$g ascorbic acid content, respectively (Table 3). The least ascorbic acid content (12.17 mg $100^{-1}$ g) was recorded under treatment $T_{12}$(control) which was statistically similar with treatment thiourea @ 5%, thiourea @ 2.5%, $KNO_3$ @ 1.5%, garlic extract @ 15% and summer pruning which showed 12.47 mg $100^{-1}$ g, 12.24 mg $100^{-1}$ g, 12.33 mg $100^{-1}$ g, 12.69 mg $100^{-1}$ g and 12.60 mg $100^{-1}$ g ascorbic acid content, respectively. The cultivar Royal Paradelux recorded significantly higher value of ascorbic acid content (12.78 mg $100^{-1}$ g) as compared to the cultivar Glohaven which showed 12.48 mg $100^{-1}$ g. The interaction between treatment and cultivar also affected significantly the ascorbic acid content of fruit. The maximum ascorbic acid content (13.33 mg/100g) was recorded with treatment combination $T_1 \times V_2$ (dormex @ 3% × Royal Paradelux) and the minimum ascorbic acid content (11.83 mg $100^{-1}$g) was recorded with combination $T_{12} \times V_1$ (control × Glohaven).

The maximum total sugars content (7.50%) was recorded with the dormex @ 3%, which was statistically at par with treatment $GA_3$ @ 100 ppm with total sugars content 7.19% (Table 3). The minimum total sugars content (6.11%) was recorded in the control which was statistically similar with treatment $KNO_3$ @ 1.5%, thiourea @ 2.5% and thidiazuron @ 250 ppm with total sugars values 6.36, 6.22 and 6.22 %, respectively. The effect of cultivar on the total sugars content was also found to be significant. The cultivar Royal Paradelux had significantly more total sugars content (6.74%) than Glohaven (6.60%). The interaction effect between treatment and cultivar exerted significant effect on the total sugars content of the fruit. The maximum total sugars content (7.62%) was recorded with combination of $T_1 \times V_2$ (dormex @ 3% × Royal Paradelux) and the minimum total sugars content (5.90%) was recorded with treatment combination $T_{12} \times V_1$ (control × Glohaven).

Here, the minimum fruit acidity was obtained with dormex application and the maximum by control. The total soluble solids, ascorbic acid and the sugar content were found to be highest with dormex application and minimum with control. These results are in agreement with the findings of Mohamed and Sherif (2015) who obtained higher total soluble solids content and minimum value of acidity by the use of dormex in association with brassinolide in peach. George *et al*. (1992) also found the similar results and obtained higher total soluble solids content over the control after the application of dormex in peach. George and Nissen (1993) observed higher total soluble solids content in the peach fruits after applying dormex in combination with potassium nitrate at all concentrations. El-Kassas *et al*. (1996) and Wahdan *et al*. (2003) also observed that TSS was greatly improved by the application of dormex in peach plants.

The highest fruit yield (3.78 kg) was recorded in the dormex @ 3% which was statistically on par with the treatment of $KNO_3$@ 1.5%, $GA_3$ @ 100 ppm and $GA_3$ @ 200 ppm where fruit yields were 3.53 kg, 3.61 kg and 3.56 kg, respectively (Table 3). The lowest fruit yield (2.62 kg) was recorded with treatment $T_{12}$ (control) which was statistically at par with the treatment $T_2$ (thidiazuron @ 250 ppm), $T_4$ (thiourea @ 2.5%) and $T_9$ (garlic extract @ 15%) with fruit yield values 2.90 kg, 2.99 kg and 2.94 kg, respectively. However, the effect of cultivar on fruit yield was found to be non-significant. The fruit yield of Royal Paradelux (3.20 kg) was almost equal to the fruit yield of Glohaven (3.19 kg). The interaction effect of treatments and cultivars were also found to be significant. In Royal Paradelux, highest fruit yield (3.82) was recordedwith treatment $T_1$ (dormex @ 3%). The plants of Glohaven treated with treatment $T_{12}$ (control) had lowest fruit yield (2.50 kg). The results are in agreement with the previous findings of Mohamed and Sherif (2015) who obtained an increase in fruit set and yield by the use of dormex in association with brassinolide in peach. Dormex alone too showed similar results in respect of fruit set and yield when compared with control. The increase in yield may be due to increase in flower bud formation and higher fruit set (Veloso and Oliveira, 1970). In another study made by Cheng, 1991, he reported that yield enhancement was attributed to increase in the percentage of bud break and synchronization of flowering.

In the experiment, the earliest bud break, time of opening of first flower and full bloom was observed with treatment of dormex @ 3%. The bud break was advanced by 20 days and the full bloom was advanced by 16-19 days in comparison to control. The fruits of the plants treated with dormex @ 3% showed 2 weeks advancement in maturity over the control. All the fruiting parameters, fruit set, retention, yield, fruit size, weight and volume were found to be higher in treatment dormex @ 3%. The highest yield of 3.78 kg $tree^{-1}$ was recorded with dormex @ 3% and the minimum yield was recorded with control. All the quality parameters like TSS, acidity, ascorbic acid content and total sugar content were also improved by dormex application at a concentration of 3%.

**REFERENCES**


Abbott, D.L. 1970. The role of bud scales in the morphogenesis and dormancy of the apple fruit bud. In. *Physiology of Tree Crops* (Eds. Luckwill, L.C. and Cutting, C.V., Academic Press, London, pp. 65-80.

Cheng C. N. 1991. Kiwifruit in Taiwan. *Acta Hortic.*, **297**:175-177.

El-agamy, S.Z., Mohamed, A.K.A., Mostafa, F.M.A. and Abdallah, A.Y. 2001.Effect of $GA_3$, hydrogen cyanamid and decapitation on budbreak and flowering of two apple cultivars under the warm climate of southern Egypt. *Acta Hortic.*, **565** : 109-114.

El-Kassas, S.E., El-Sese, M.A., El-Salhy, A.M. and El-Wasfy, M.M. 1996. Physiological studies on flowering and fruit setting of some peach and nectarine cultivars under Assuit environment. *Assuit J. Agric. Sci.* **27**(2) : 23-36.

Fahmy, M.A., Baghdady, G.A., Abd-Elrazik, A.M., Abdrabboh, G.A. and Kabsha, E.A. 2015.Effect of some dormancy breaking agents on fruit quality and storability of Florida prince peach under cold storage conditions. *Nat. Sci.,* **13**(1) : 21-26.

George, A.P. and Nissen, R.J. 1988. Chemical methods on breaking dormancy of low chill nectarines: preliminary evaluations in subtropical Queensland. *Australian J. Exp. Agric.*, **28** : 425-429.

George, A.P. and Nissen, R.J.1993. Effects of growth regulants on defoliation flowering and fruit maturity of the low chill peach cultivar Flordaprince in subtropical Australia. *Australian J. Exp. Agric.*, **33** : 787-795.

George, A.P., Lloyd, J. and Nissen, R.J. 1992. Effects of hydrogen cyanamide, paclobutrazol and pruning dates on dormancy release of the low chill peach cultivar Florda Prince in subtropical Australia. *Australian J. Exp. Agric.,* **32**:89-95.

Hedden, P. and Philips, A.J. 2000. Gibberllin metabolism: new insights revealed by the genes. *Trends Plant Sci*., **5**: 523-530.

Kassem, H.A., El-Kobbia, A.M., Marzouk, H.A. and El-Sebaiey, M.M. 2010. Effect of foliar sprays on fruit retention, quality and yield of Costa persimmon trees. *Emir. J. Food Agric.,* **22**(4):259-274.

Lloyd, J. and Firth, D.J.1993. Effect of hydrogen cyanamide and promalin on flowering fruit set and harvest time of 'Flordaprince' peach (*Prunuspersica* (L.) Batsch) in subtropical Australia. *J. Hortic. Sci.,* **68**(2):177-183.

Luna, V., Soriano, M.D., Bottini, R., Sheng, C. and Pharis, R.P. 1993. Levels of endogenous gibberellins, abscisic acid, indol acetic acid and naringenin during dormancy of peach flower buds. *Acta Hortic.,* **329**: 265-267.

Mengel, K. and Kirkby, E.A. 1987. Principle of Plant Nutrition.4 Ed. International Potash Institute, Bern, Switzerland.

Meteorological centre, Shimla.2017. http:// weathershimla.gov.in.

Mohamed, S.A. and Sherif, H.M. 2015.Enhancing the Performance of "Florda Prince" Peach Cultivar with Growth Promoter "Brassinolide" and Break Agent "Hydrogen Cyanamide". *J. Hortic. Sci. Ornamen. Plants*, **7**(1) : 39-47.

NHB, 2017. Horticulture at a Glance. http:// www.agricoop.gov.in.

O'Neil, D.P. and Ross, J.J. 2002.Regulation of gibberellin pathway in pea. *Plant Physiol.* **130**:1974-1982.

Petri, J. L. 1989. Interrupting the winter dormancy of apple trees. *BASF Agric. News* **2**:17-20.

Veloso, A. and Oliviera, M. 1970. Effect of hydrogen cyanamide on bud break and yield of kiwifruit in northwest Portugal. *Acta Hortic.*,**444**(2):473-478.

Wahdan, M.T., El-Sheikh, A.F. and Bakry, K.A. 2003.Influence of Dorcy 50 as a breaking dormancy agent on bud behaviour growth fruit retention and quality of peaches. *Egypt. J. Agric. Res*., **1**(1): 129-143.

Wills, R.B.H., Scriven, F.M. and Greenfield, H. 1983. Nutrient composition of stone fruit (*Prunus* spp.) cultivars: apricot, cherry, nectarine, peach and plum. *J. Sci. Food Agric*., **34**:1383-1389.

Yang, Y.S., Chang, M.T. and Shen, B.K. 1990. The effect of calcium cyanamide on bud break retranslocation of accumulated 14C-assimilates and changes of nitrogen in grapevines in Taiwan. *Acta Hortic.*, **279**: 409-425.

Zavala, G.C. and Alcazar, J.R. 2000. Thidiazuron as a promoter of budbreak on peach (*Prunuspersica*L. Batsch) and Japanese plum (*Prunus salicina* Lindl.). *Revista Chapingo Serie Hortic.,* **6**(1): 117-120.