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Neena Chauhan
Assistant professor
Regional Horticultural Research and Training Station, Mashobra, Shimla, HP, India

Naveen Sharma
Dept. of Fruit Science,
YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP, India

M S Mankotia
Regional Horticultural Research and Training Station, Mashobra, Shimla, Himachal Pradesh, India

Correspondence
Neena Chauhan
Assistant professor
Regional Horticultural Research and Training Station, Mashobra, Shimla, HP, India

Hydrogen Cynamide (Dormax) impacts on vegetative bud break, yield and quality of apple cv. Starking delicious

Neena Chauhan, Naveen Sharma and M S Mankotia

Abstract
Hydrogen Cynamide (Dormax) was examined over a two years period for its effect on vegetative bud break, yield and quality of apple cv. Starking Delicious. The experiment was carried out at experimental farm of RHR&TS, Mashobra, Shimla situated at an elevation of 2286m amsl. Hydrogen Cynamide (Dormax) was applied @ 0.5%, 1.0%, 2.0% and 0.0% 4 weeks prior to expected bloom. These treatments were replicated five times and were laid out in Randomized Block Design. All treatments of Dormax advanced vegetative bud sprouting in both the years as compared to control. Maximum bud sprouting (85.58% and 91.43%) was observed in trees treated with 4.0% Dormax 4 weeks prior to expected bloom during 2015 and 2016. Maximum yield (22.33 and 27.14kg/tree), Fruit size in terms of length and breadth (58.87x66.53mm and 59.30x67.18), fruit weight (127.17g and 142.60g) and fruit volume (94.33 and 97.14cc) was recorded maximum in trees treated with Dormax @1.0% applied 4 weeks prior to expected bloom during 2015 and 2016.

Keywords: Hydrogen Cynamide (Dormex), bud break, apple, fruit quality

Introduction
Delayed leafing, prolong flowering period and non-homogenous bud break are problems of deciduous fruit trees initiated as a result of warm climate in winter. A major problem in the cultivation of deciduous fruit trees is the lack of chilling hours that need to break bud dormancy. Winter chill is essential for most of the plants that fall dormant in the winter in order to avoid frost damage and do not resume growth until a certain amount of winter chill has accumulated for fulfilling their chilling requirement. Apple Cultivars differ in the amount of chilling necessary to break dormancy. Most commercial apple varieties require 800 to 1600 hours of chilling in order to achieve satisfactory bud break. Some (Anna, Dorset Golden) require as little as 250-300 CU and others (McIntosh) require much more chilling (1000-1600 CU) and can only be grown at higher latitude of temperate zones. Climate change is likely to affect chilling requirement of apple fruit significantly and therefore, the opportunity to meet this requirement will be reduced as the climate becomes warmer. The resultant of these climate changes are clearly apparent in the shifting of apple cultivation from lower elevations to higher altitudes in India. It has been reported that the rise in average temperature, long spells of drought during summer, delay in start of winter, reduced snowfall have reduced large area supposed to be marginally suitable for apple cultivation. In areas where there are only low levels of chilling can lead to poor lateral branches and buds through terminal bud dominance. Even in areas that receive chilling close to these levels, reduced bud break, prolonged flowering, lower fruit set and uneven fruit size can occur due to "delayed foliation".
Dormex (Hydrogen cyanamide) is a plant growth regulator, which may be used in apples to increase and advance budburst and flowering. Two main purpose of using hydrogen cyanamide are for improving level of bud break and for advancing bloom and vegetative bud development (Erez, 1993) [4]. Hydrogen cyanamide can break dormancy by increasing respiration and that induces early and more uniform bud break (Georg *et al*., 1988) [6]. Response of plants to hydrogen cyanamide application varied according to time of application and physiological stage of bud development amount of chilling accumulated (Fuchigami and Nee, 1988). Hydrogen Cynamide accelerates vegetative and flower bud break and shorten fruit development period (Sagredo *et al*., 2005) [10]. Dormex application advanced full bloom, fruit set and fruit maturity (Kaundal *et al.,* 1998).

The objective of this study was to see the impacts of hydrogen cynamide (dormax) on vegetative bud break, yield and quality of apple.

Materials and Methods

The present study was carried out at experimental farm of RHR&TS, Mashobra, Shimla situated at an elevation of 2286 m a m s l during two successive years 2015 and 2016 on apple cv. Starking Delicious. The study was initiated to investigate the effect of winter spraying with the breaking dormancy agent Dormex on percentage of bud break, fruit set and fruit quality. The experimental trees were sprayed with Dormex @1.0%, 2.0% 4.0% and 0.0% concentration four weeks prior to expected bloom. The experiment was laid out in Randomized Block Design, with four treatments which were replicated five times.

Table: Description of application of Hydrogen Cynamide (Dormax)

Treatments	Chemical	Concentration (%)	Time of application
T_1	Dormax	1.0%	Four weeks prior to expected bloom
T_2	Dormax	2.0%	
T_3	Dormax	4.0%	
T_4	Untreated (control)		

Bud sprouting data was recorded at weekly interval when the examined buds start opening. The yield of apple fruits under different treatments was determined on the basis of total fruits harvested from each tree under treatment and average yield per tree was calculated and was expressed in kilograms per tree (kg/tree). The length (from calyx end to tip of styler end) and diameter (widest portion of shoulder) of ten randomly selected fruits were measured with the help of digital Vernier Calliper and the values were expressed in millimetre (mm). The weight of ten fruits selected for fruit size was taken on a Top pan electrical balance and the average fruit weight was calculated and expressed in gram (g). Volume of ten selected fruits was recorded by water displacement method and results were expressed in cubic centimetre per fruit (cc). The data recorded on various parameters was analyzed for RBD design as suggested by OPSTAT (Sheoran *et al*, 1988) [11].

Results and Discussions

The per cent bud sprouting was significantly affected by different treatments of Hydrogen Cynamide during both the years 2015 and 2016. When bud sprouting data was recorded at weekly interval it was found that initiation of bud sprouting was early in T_3 (Dormax 4.0%) on 13.03.2015 and there was no initiation of bud sprouting in T_1 (Dormax 1.0%), T_2 (Dormax 2.0%) and T_4 (control) on same date (13.03.2015). Initiation of bud sprouting in T_1 (Dormax 2.0%) and T_2 (Dormax 4.0%) was recorded on 20.3.2015 whereas, there was no bud sprouting in control on same date (20.03.2015). Maximum bud sprouting (85.58%) was observed in T_3 which was closely followed by T_2 and lowest bud sprouting was recorded in T4 (67.17%) on 06.04.2015.

Similar results were found during the year 2016 and initiation of bud sprouting was early in T_3 (Dormax 4.0%) on 9.03.2016 and there was no initiation of bud sprouting in T_1 (Dormax 1.0%), T_2 (Dormax 2.0%) and T_4 (control) on same date (9.03.2016). Initiation of bud sprouting in T_1 (Dormax 2.0%) and T_2 (Dormax 4.0%) and T_4 (control) was recorded on 16.3.2016. Maximum bud sprouting (91.43%) was observed in T_3 which was closely followed by T_2 and lowest bud sprouting was recorded in T_4 (57.85%) on 30.03.2016.

El-Sabagh (1999) [3] Williams *et al*., (2002) [13] and Sagredo *et al*., (2005) [10] showed that different chemical applications had improved and forced bud break when applied to deciduous fruit trees in region where insufficient chilling was a problem. On the other hand, Nir and Lavee (1993) [9] reported that xylem sap cytokinin concentration increased rapidly in response to the rest breaking chemicals and packed just before or at bud break. The rapid increase in cytokinin was closely followed by increasing calcium and magnesium concentrations in the sap. Also, sorbitol levels dropped rapidly as a result of the rest-breaking materials and appeared to be used rapidly in bud-break and early bud growth. Moreover, Bartolini (1997) [1] showed that many of the rest breaking chemicals inhibited catalyse and allowed activation of certain peroxidise.

Perusal of data presented in Fig 1 and 2 reveals that fruit yield and quality of apple was significantly influenced by different Dormax treatments. Maximum fruit yield (22.33kg/tree and 27.15kg/tree)) was recorded in T_1 which was significantly higher than all other treatments during both the years 2015 and 2016. Whereas, minimum fruit yield (18.33kg/tree and 19.13kg/tree) was recorded in control which was statistically on par with T_2 and T_3 during 2015 and with T_3 during 2016.

Fruit size in terms of length and breadth (58.87 x 66.53mm and 59.30 x 67.1 mm) was recorded maximum in trees treated with Dormax @1.0% applied 4 weeks prior to expected bloom during 2015 and 2016 which was closely followed by T_2 ((58.15 x 65.25mm and 59.06 x 64.04 mm). In the untreated trees, the fruit size recorded was (56.28 x 67.77mm and 54.20 x 61.61 mm) which, was significantly lower than all other treatments. During the year 2015 maximum fruit weight (127.17g) was recorded with trees treated with 1.0% Dormax which was significantly higher than all other treatments, whereas, in 2016 maximum fruit weight (142.60g) was also recorded with trees treated with 1.0% Dormax and was statistically at par with T_2 (132.92g). Fruit volume (94.33 and 97.14cc) was highest in trees treated with 1.0% Dormax sprayed 4 weeks prior to the expected bloom during both the years.

These results are in agreement with those obtained by Gaber (1996) [5] on apple and El-Kssas *et al*, (1996) [2] on peach and nectarine, who reported that Hydrogen Cynamide application increased fruit weight, size and volume of fruit. Mohamed and Mustafa (2013) [8] also recommend using Dormex for early bud break, short period of flowering and high percentages of bud break and fruit set by regulating the contents of proline and BAs in buds. Mohamed and Mehdi (2014) [7] also reported that 4% Dormex advanced the normal bud break by 15 days and flowering by 11 days and improved natural pollination by synchronization of male and female flowers in pistachio nut.

Table 2: Effect of Dormax (Hydrogen Cynamide) on per cent bud sprouting at weekly intervals on apple tree during the year 2015.

Treatments	13.03.2015	20.03.2015	27.03.2015	06.04.2015
T_1	0.00 (1.07)	3.83 (2.16)	29.17 (5.47)	73.12 (8.60)
T_2	0.00 (1.12)	8.00 (2.29)	45.00 (6.78)	80.57 (9.03)
T_3	7.37 (2.00)	15.83 (4.08)	57.5 (7.65)	85.58 (9.28)
T_4	0.00 (2.25)	0.00 (1.00)	15.00 (3.97)	67.17 (8.25)
$CD_{0.05}$	1.18 (0.96)	2.40 (0.37)	4.52 (0.46)	5.62 (0.33)

Table 3: Effect of Dormax (Hydrogen Cynamide) on per cent bud sprouting at weekly interval on apple tree during the year 2016.

Treatments	9.03.2016	16.03.2016	23.03.2016	30.03.2016
T_1	0.00 (1.00)	5.29 (2.47)	39.43 (6.34)	77.14 (8.83)
T_2	0.00 (1.00)	16.14 (4.12)	59.28 (7.71)	85.71 (9.30)
T_3	5.71 (2.46)	46.00 (6.85)	60.00 (7.81)	91.43 (9.61)
T_4	0.00 (1.00)	3.85 (2.09)	27.14 (5.28)	57.85 (7.68)
$CD_{0.05}$	2.54 (0.49)	8.88 (0.58)	4.52 (0.38)	5.62 (0.32)

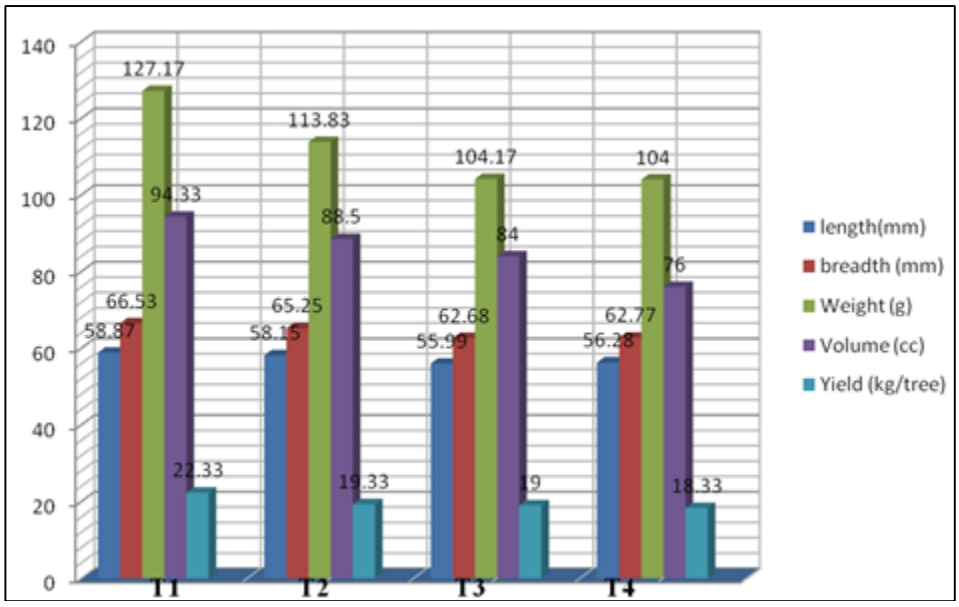

Fig 1: Effect of Dormax (Hydrogen Cynamide) on fruit quality of apple cv. Starking Delicious during the year 2015

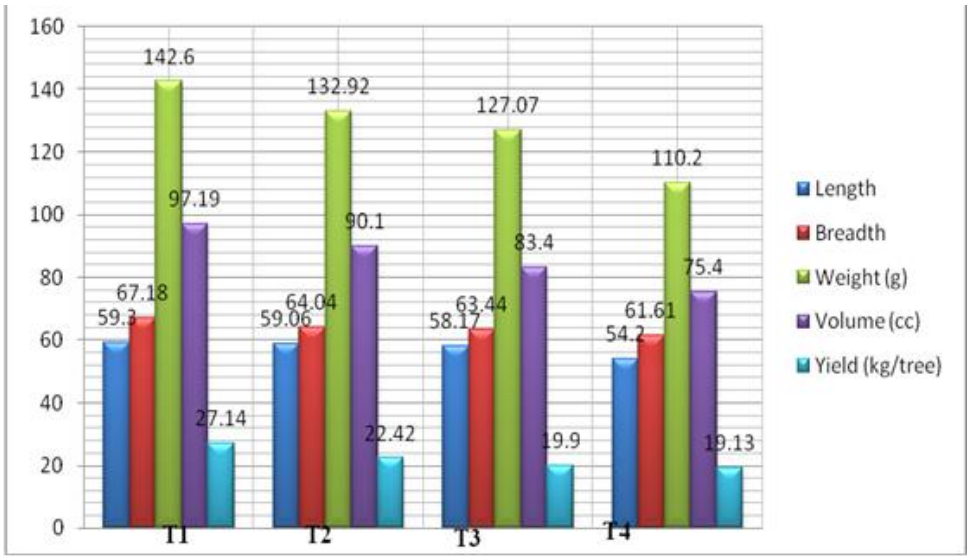

Fig 2: Effect of Dormax (Hydrogen Cynamide) on fruit quality of apple cv. Starking Delicious during the year 2016

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