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Effect of dormancy breaking chemicals on flowering, fruit set and quality in Asian pear (*Pyrus pyrifolia* L.)

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A field experiment was carried out during 2006 to 2007 on eight years old pear plants cv. Netarhat Selection using growth regulators viz., GA_3, Thio-urea and H_2O_2, which were sprayed with different concentrations and times. Two times spray of thio-urea 10% concentration resulted in 8 to 14 days earlier bud breaking than control as well as the maximum flowering of 11.0 and 53.3% during 2006 and 2007, respectively. The maximum yields of 10.6 and 20.6 kg/plant were obtained from two time's spray of thio-urea 10% during 2006 and 2007, respectively. In 2007, two times spray of thio-urea 5 and 10% was at par. Thiourea increased C: N ratio which resulted in increasing spur maturity.

Key words: Pear, dormancy breaking chemicals, flowering, fruit set, yield.

INTRODUCTION

Pear plant (*Pyrus* spp.) is one of the most important temperate fruit crops grown and occupies second position in area (23 k ha) and production (200 k tones) among temperate fruits in India (Anonymous, 2005). In Jharkhand pear is cultivated around the Netarhat hills. Only low chilling requirement pear cultivar may successfully be cultivated in low-lying areas of Ranchi, Gumla and Lohardaga, where the winter low temperature is not sufficient for the chilling requirement of pear to flower. Therefore, most of the pear orchards remain unproductive even after plants get matured. Different regulators, such as gibberellin A3 (GA_3), hydrogen peroxide (H_2O_2) and thiourea, have been tried during winter season as a complement to enhance pear flowering in warmer regions. GA_3 at higher dose (250 ppm) recorded flowering in pear culivar Le-Contee in Egypt (Bahlool et al., 1999). H_2O_2 content was increased and came at peak in late dormancy, when endodormancy was broken (Kuroda et al., 2005). Thiourea (1.5%) was most effective to break bud rest in apple, plum, peach and apricot in Kenyan highlands (Erez and Lavi, 1985). Thiourea (2%) induced flowering in twenty years old 'Pathernakh' pear in India (Singh and Mann, 2002).

Keeping above point in view, the present investigation with different growth regulators was carried out to induce flowering and fruit set in pear orchard commercially under sub-humid subtropical conditions in eastern plateau region.

MATERIALS AND METHODS

The experiment was conducted at Research Centre, Research Complex for Eastern Region (RCER), Indian Council of Agricultural Research (ICAR), Ranchi during 2006 and 2007. This area is situated 620 m above mean sea level (msl) and at 23°25' N latitude and 85°20' East longitude experiencing an average annual rainfall of 110 to 140 cm. Soil is acidic and pH range from 5.0 to 6.5, which is suitable for pear cultivation. The treatments applied to induce flowering were GA_3 100 and 200 ppm, thio urea 5 and 10%, and H_2O_2 6 and 10% as single and double spray. Spraying was done on 21 January and 4th February in both the years. The experiment was laid out in randomized block design with four replications. Data were taken on flowering, fruit set percentage and on fruit quality. Flowering percent was calculated by number of flower buds over 100 total buds on a branch. Initial fruit set was calculated three weeks after flowering. Final fruit set percentage of replicated trees was studied after 60 days of fruit set and calculated by the following formula:

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Table 1. Effect of different growth regulators on bud spouting, flowering and fruit set in pear during 2006.

Treatment	Date of bud sprouting	Days taken for spouting from last spray (4-2-06)	Perfect flowering (%) (5-6 flowers in a cluster)	Weak flowering (%) (2-4 flowers in a cluster)	Final fruit set (%)
Single spray of GA_3 100 ppm	24-2-06	20	4.11	1.71	12.94
Single spray of GA_3 200 ppm	25-02-06	21	5.77	2.04	14.60
Single spray of Thiourea 5%	18-2-06	14	6.14	2.42	15.75
Single spray of Thiourea 10%	18-2-06	14	8.83	3.25	19.34
Single spray of H_2O_2 6%	25-2-06	21	4.46	1.62	9.86
Single spray of H_2O_2 10%	25-2-06	21	4.86	1.64	12.28
Two times spray of GA_3 100 ppm	24-2-06	20	4.58	1.58	12.12
Two times spray of GA_3 200ppm	24-2-06	20	5.77	2.27	14.82
Two times spray of Thio-urea 5%	17-02-06	13	5.30	2.08	15.96
Two times spray of Thio-urea 10%	17-02-06	13	11.08	4.69	25.15
Two times spray of H_2O_2 6%	24-02-06	20	4.87	2.84	14.27
Two times spray of H_2O_2 10%	23-02-06	19	6.42	3.57	15.27
Control (No spray)	25-02-06	21	3.59	1.46	9.42
CD at 5%	-	-	2.93	1.37	6.19

Final fruit set (%) = FR* 100/AVF*NF
FR= number of fruits /shoot
AVF= Average number of flowers/inflorescence
NF=Number of inflorescences /shoot

Titratable acidity was estimated by titrating the fruit extract with 0.1 N NaOH using phenolphthalein as an indicator and expressed as percent malic acid equivalent. Total soluble solid (TSS) was recorded by hand refractrometer. Total sugars were estimated by Lane and Eynon method (Ranganna, 1977). Carbohydrates were estimated by Anthrone Method where as Phenol was estimated by Folin-Ciocalteu Reagent (FCR) and proteins were estimated by Micro-Kjeldahl method (Thimmaiah, 1999) in floral or vegetative buds.

RESULTS AND DISCUSSION

Data on effect of different growth regulators on bud spouting, flowering and fruit set in pear during 2006 and 2007 have been presented in Tables 1 and 3, respectively. A close perusal of the Tables 1 and 3 revealed that earlier bud break was noticed in case of thio-urea application in both the years. Two times sprays of thiourea 10% resulted in 8 days (17-02-06) and 14 days (16-02-07) earlier bud break than control during 2006 and 2007, respectively. These findings corroborate the result of Singh and Mann (2002). They observed that the time of bud burst and flowering was advanced by 6 days by spraying of thio-urea 2% in cv. Pathernakh under cold climate of North Indian (Punjab). Two percent thio-urea generally provided 360 h of chilling which caused early bud break in pear (Lin et al., 1987). From Table 1, it was evident that all the spraying treatments significantly increased initial fruit set and yield /tree as compared to the control trees which recorded the significantly lowest values of these parameters in both the seasons of our study.

An observation of the data of Table 3 revealed that all spraying treatment significantly increased in perfect flowering compared to the control trees during 2007 but not in 2006. However, two times sprays of thio-urea (10) accounted for the maximum perfect flowering of 11.08 and 53.34% during 2006 and 2007, respectively. But in 2007, two times spay of thio-urea 5% resulted in 52.45% perfect flowering which was at par with results from two times sprays of thio-urea 10% (53.34% perfect flowering). The similar types of results have also been reported by Gil et al. (1994) with 2% thio-urea in pear. Two times spray of thio-urea 10% accounted for the maximum fruit set percent of 25.15 and 20.25 during 2006 and 2007 respectively. In both the years, fruit set resulted from single spay of thio-urea 10% was at par with two times spays of thio-urea 10%. It has been observed that dormancy breaking chemicals forced to flower from semi mature spur, which gave weak flower cluster containing 2 to 4 flowers. Two times sprays of thio-urea resulted in 4.69 and 7.85% weak flowering in 2006 and 2007, respectively. However, two times sprays of H_2O_2 treatment promoted bud break of 5.74%, which was at par with single spray of thio-urea 5% and double sprays thio-urea 10%. Flowering percent was low in 2006 but fruit set percent was high because tree supports the sink from source effectively. On the other hand, in 2007 trees entered into natural chilling temperature (below 7%C) for four hours and therefore, it triggered the flowering process and further hastening of flowering through chemical application which resulted in heavy flowering. No scorching effect of H_2O_2 and thio-urea 10% were observed in any treatment, concentration and time. April heat wave resulted in severe fruit drop even after spraying of copper oxi-chloride 0.2% and GA3 (20 ppm) at peanut stage during 2007.

Table 2. Effect of dormancy breaking agents on yield and physico chemical property of pear during 2006.

Treatment	Yield (kg/plant)	Fruit wt (g)	Fruit size (cm^2)	T.S.S (^0B)	Acidity (%)	Reducing sugars (%)	Total sugars (%)
Single spray of GA_3 100 ppm	2.80	148.05	45.35	10.2	0.20	4.39	4.8
Single spray of GA_3 200 ppm	3.98	171.66	45.83	10.2	0.24	4.29	5.38
Single spray of Thio-urea 5%	3.45	197.28	48.02	10.8	0.24	5.23	5.78
Single spray of Thio-urea 10%	6.40	184.62	51.47	10.6	0.21	4.39	4.99
Single spray of H_20_2 6%	3.12	166.77	45.98	10.6	0.16	4.78	5.18
Single spray of H_2O_2 10%	3.44	174.67	44.29	10.6	0.20	5.61	5.66
Two times spray of GA_3 100 ppm	3.31	174.2	42.1	11.0	0.21	4.78	5.29
Two times spray of GA_3 200 ppm	3.43	256.00	55.34	11.4	0.22	5.09	5.18
Two times spray of Thio-urea 5%	4.30	187.6	40.56	10.4	0.16	4.10	4.42
Two times spray of Thio-urea 10%	10.63	223.07	48.51	10.8	0.20	5.23	6.54
Two times spray of H_20_2 6%	4.14	169.47	45.19	11.6	0.20	4.58	5.18
Two times spray of H_20_2 10%	4.19	178.32	42.77	11.8	0.27	4.04	5.65
Control (no spray)	1.39	166.8	44.51	10.9	0.25	4.99	5.20
CD at 5%	0.241	24.80	4.57	0.21	NS	NS	0.142

Table 3. Effect of different growth regulators on bud spouting, flowering and fruit set in pear during 2007.

Treatment	Date of sprouting of bud	Days taken for sprouting from last spray (4-2-07)	Perfect Flowering % (5-6 flowers in a cluster)	Weak Flowering% (2-4 flowers in a cluster)	Final fruit set (%)
Single spray of GA_3 100 ppm	23-02-07	19	20.84	5.30	10.57
Single spray of GA_3 200 ppm	25-02-07	21	35.16	5.32	12.94
Single spray of Thio-urea 5%	19-2-07	15	38.68	4.57	11.42
Single spray of Thio-urea 10%	18-2-07	14	43.10	6.41	16.75
Single spray of H_2O_2 6%	21-2-07	17	24.84	3.84	8.64
Single spray of H_2O_2 10%	22-2-07	18	29.29	3.33	11.92
Two times spray of GA_3 100 ppm	25-2-07	21	27.07	2.32	7.14
Two times spray of GA_3 200 ppm	24-2-07	20	31.29	4.29	11.80
Two times spray of Thio-urea 5%	16-02-07	12	52.45	4.05	13.24
Two times spray of Thio-urea 10%	16-02-07	12	53.34	7.85	20.25
Two times spray of H_2O_2 6%	23-02-07	19	36.36	4.92	10.50
Two times spray of H_2O_2 10%	22-02-07	18	36.04	5.747	11.66
Control (No spray)	02-03-07	26	3.82	2.74	6.12
CD at 5%	-	-	3.12	1.32	2.94

A study on yield and bio-chemical analysis of pear in different treatments was conducted during 2006-2007. It was found from the Tables 2 and 4 that maximum yield of 10.63 kg/plant and 20.64 kg/plant were obtained from two times spray of thio-urea (10%) during 2006 and 2007, respectively. In the heavy crop year (2007), two times spray of thio-urea 10% resulted in maximum production of 20.64 kg/plant which was at par with production (19.40 kg/plant) induced by two times spray of thio-urea 5%. It clearly indicated that thio-urea at lower concentration was also effective. During 2006 (Table 2) the maximum fruit weight of 256.00 g was obtained from two times spay of GA_3 200 ppm. The results with GA_3 under present finding are in conformity with the results of El-Banna et al. (1995). But in 2007 (Table 4) the maximum fruit weight of 232 .45 g was obtained from two times spray of thio-urea 10%. Two times spray of H_2O_2 (10%) accounted for the maximum TSS of 12.8°B during 2007. A single spray of H_2O_2 (6%) showed maximum acidity of 0.20%. The maximum total sugars of 6.54 and 6.72% were recorded from two times sprays of thio-urea (10%) during 2006 and 2007, respectively. We also studied effect of different growth regulators on vegetative and floral buds. It has been found that phenol; soluble protein and carbohydrates

Table 4. Effect of dormancy breaking agents on yield and physico -chemical property of pear during 2007.

Treatment	Yield (kg/plant)	Fruit wt (gm)	Fruit size (cm^2)	T.S.S (^0B)	Acidity (%)	Reducing sugars (%)	Total sugars (%)
Single spray of GA_3 100 ppm	5.35	152.07	45.48	11.0	0.24	4.35	4.98
Single spray of GA_3 200 ppm	6.25	172.35	45.29	11.2	0.22	4.42	5.05
Single spray of Thio-urea 5%	12.20	196.80	49.05	11.6	0.30	4.83	5.25
Single spray of Thio-urea 10%	18.95	184.20	51.80	11.8	0.22	5.15	5.34
Single spray of H_20_2 6%	4.82	168.40	45.65	11.4	0.20	4.98	5.68
Single spray of H_2O_2 10%	5.84	175.80	45.08	11.4	0.22	5.12	5.77
Two times spray of GA_3 100 ppm	5.72	176.00	43.25	11.2	0.26	4.94	5.20
Two times spray of GA_3 200 ppm	5.90	188.30	51.12	11.6	0.24	5.02	5.36
Two times spray of Thio-urea 5%	19.40	191.40	40.72	12.2	0.27	5.05	5.45
Two times spray of Thio-urea 10%	20.64	232.45	48.89	12.4	0.22	5.17	6.72
Two times spray of H_20_2 6%	8.36	170.07	45.25	12.2	0.26	5.06	5.60
Two times spray of H_20_2 10%	8.75	173.46	43.34	12.8	0.24	4.08	5.82
Control (no spray)	2.02	165.55	45.28	11.0	0.32	5.02	5.06
CD at 5%	1.98	23.72	4.32	0.22	NS	NS	0.342

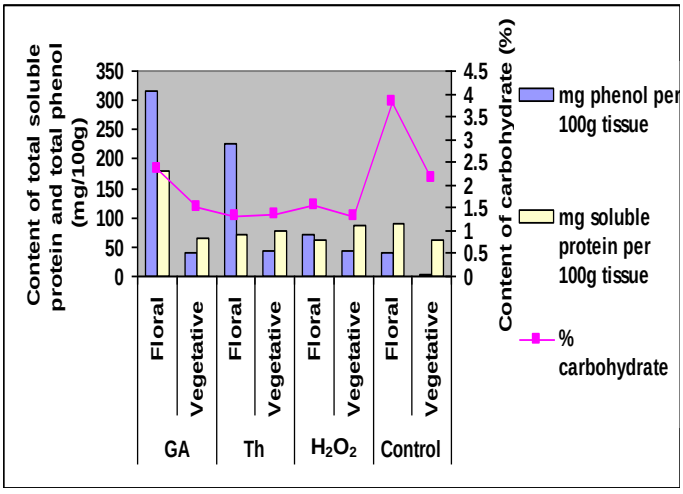

Figure 1. Biochemical constituents in floral and vegetative buds of pear sprayed with different growth regulator.

Figure 2. Treatment effect-Thiourea 5%.

Figure 3. High quality pears with optimum size by treatment of 5% thiourea (2 times).

content were optimum in floral buds sprayed with thiourea (5%) (Figure 1).

Thiourea increases starch content of cells (Rahman et al., 2002) and alters protein structures (Pandey et al., 2013) there by increases C:N ratio of the cell which broke dormancy.

From the present study it can be concluded that two times spraying of thio-urea (5%) at 14 days interval starting from last week of January responds better in respect of early and heavy flowering and fruiting in pear under subtropical eastern plateau of India (Figures 2 and 3). It might be due to formation of optimum superoxide free radicals in cell which causes quick maturity of spurs leading to breaking of dormancy and early flowering

and fruiting in Asian pear under sub-humid subtropical climate of eastern plateau and hill region. Results achieved from this research are conformed to those established by Rehman et al. (2002) and Germchi et al. (2010) on quicksprout germination in potato tubers treated with thiourea. At the vegetative stage, TU application improved the plant growth potential and photosynthetic efficiency. This was concomitant with the onset of early maturity and increased crop yield (Pandey et al., 2013).

This is an indication for growing of Asian pear not only in eastern India but also in other parts of subtropical area of Asia, especially South East Asia, by using thiourea in commercial scale.

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