The Pharma Innovation Journal 2019; 8(11): 176-181

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(11): 176-181

www.thepharmajournal.com
Received: 28-09-2019
Accepted: 30-10-2019

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Effect of various growth controlling strategies on vegetative growth, flowering and nutrient concentration in Chinese sand pear

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Abstract
Nakh Kashmiri or Chinese sand pear is the most important cultivar of *Pyrus pyrifolia* group considering its yield potential as well as its consumer acceptability. But due to excessive vigour there is problem of reduced flower bud development, light penetration and increased incidence of insect pests and diseases. In order to stimulate flower bud formation in pear, it is imperative to control vigour of plants. Root pruning, trunk incision and pruning are considered the major growth controlling strategies which were tested in the present study. In addition, application of growth regulators (paclobutrazol and ethephon) were tested for their efficiency in controlling tree vigour and flower induction. The study was conducted on twenty-year-old Chinese Sandy pear trees. Plants treated with root pruning + paclobutrazol showed better results with minimum trunk growth, leaf area, nitrogen, phosphorous and potassium contents and maximum carbohydrate content (shoots and leaves), flower intensity.

Keywords: Pear, root pruning, paclobutrazol, trunk incision and summer pruning

Introduction
Among temperate fruits, pear is next only to apple in importance, acreage and production with high degree of adaptability under different climatic conditions. The genus *Pyrus* has probably originated in the mountainous region of western China from where it spreaded world wide (Mitra *et al*., 1991) [22]. *Pyrus pyrifolia* is vigorous (7-18 metre in height) and spreading tree. Growth control is one of the important elements in pear orchard management. Excessive vigour reduces the light penetration, increases the incidence of insects and pests and reduces the flower bud development in the plants (Miller, 1995) [23]. The primary method developed for size control is the clonal rootstock. Although, the change in size controlling root stock's has been very beneficial and they are widely accepted yet a number of problems have been recognized. There is considerable variability in the growth potential of a given rootstock with respect to soil type, frequently resulting in a planting which is too dense. Many are susceptible to diseases, poorly anchored thus requiring staking, or produce a larger tree than desired. In the interim, horticultural practices which induce smaller tree size and stimulate flower buds to obtain regular and high production levels must be used to obtain the desired effect. Both non-chemical and chemical (growth regulators) methods have been followed to control growth and stimulate flowering in fruit crops. Among, these root pruning, trunk incision, shoot bending, summer pruning, ethephon and paclobutrazol application are the most commonly used growth control strategies and to induce flower bud formation in fruit plants.
Root pruning is the most primitive method of limiting the tree growth (Webster, 2006) [38] and promote the flower bud initiation and fruiting (Geisler and Ferree, 1984) [15]. Several authors have suggested the usefulness of root pruning in reduction of vegetative growth and induction of flowering (Asin and Vilardell, 2008, Mass, 2008 and Alexander and Maggs, 1971) [5, 21, 2]. Root pruning and trunk incision in combination with foliar sprays of ethephon reduce the shoot length and improve the flower bud number, yield and fruit quality in 'Conference' pear (Mass, 2008) [21]. Summer pruning on the other hand, received the scientific attention during the early 1900s. Although there are several hypothesis including endogenous growth control, hormone regulation and shoot to root ratio to explain the various responses of summer pruning (Ferree *et al.*, 1984 and Saure, 1992) [14, 30] but its effect on vegetative and reproductive growth in apple trees have been inconsistent. Suppression of growth by paclobutrazol occurs because the compound blocks three separate steps in the terpenoid pathway for the production of

gibberellins (blocks the oxidation of Kaurene to Kaurenic acid). One of the main role of gibberellic acid is the cell elongation and when its production is inhibited, cell division still occurs, but the new cells do not elongate. The result is that the shoot with the same number of leaves and internodes become compressed into a shorter length. Natural production of ethylene in the plants is also known to counteract the gibberellic acid action and tend to produce more flowers. Faust (1989) [13] observed a higher concentration of ethylene in apples at the location where flower bud development is to take place as compared to the wood of one year old shoot that rarely produce flower buds. Since, Chinese sand pear is premier variety of Kashmir, fetches good price in the market as it is highly juicy, sweet and has good shelf life but its excessive vigorous nature reduces flower bud development and hence yield. Also during the last few years pear growers of Jammu and Kashmir valley have been complaining of the problem of non-flowering of Chinese Sand pear trees. The recommendations being given to the farmers are adhoc which do not have any scientific base as no work has been conducted in the university on this crucial and important problem so far. Keeping in view these facts, the present was, therefore undertaken at fruit orchard of Division of Fruit Science, SKUAST-K, Shalimar with the following objectives: to evaluate the various tree vigour control strategies on shoot growth and flowering in pear and to find out the best strategy for optimizing tree growth and flowering in a pear orchard.

Material and Methods

The details of the materials used and the techniques followed during the course of investigation are described below. The experimental farm is located at an elevation of 1570 m above mean sea level and between 34^0 75' North latitude and 74^0 50' East longitudes.

Experimental Details

The present study was conducted on 20-year-old Chinese Sand pear trees grown on seedling rootstock. Trees of similar vigour and size were selected, marked and maintained under uniform cultural operations as per the recommended package of practices for pear of SKUAST-K, Shalimar. The treatments were given during dormancy (root pruning and trunk incision), full bloom and 15 days after full bloom (foliar sprays of paclobutrazol and ethephon) and in mid June (summer pruning) details given below. On each selected tree four limbs, one along each direction (N-S and E-W) were marked for various observations. A total of sixteen treatments were given comprising three replications in each treatment and the data was analyzed by Randomized Block Design using CPCS1 software.

The growth controlling strategies tried are detailed hereunder:

Strategy	Year 2011	Year 2012
RP	Root Pruning[1]	-
RP+E	Root Pruning[1] + Ethephon[2]	Ethephon[2]
RP+P	Root Pruning[1] + Paclobutrazol[3]	Paclobutrazol[3]
TI	Trunk Incision[4]	-
TI+E	Trunk Incision[4] + Ethephon[2]	Ethephon[2]
TI+P	Trunk Incision[4] + Paclobutrazol[3]	Paclobutrazol[3]
SP	Summer Pruning[5]	-
SP+E	Summer Pruning[5] +Ethephon[2]	Ethephon[2]
SP+P	Summer Pruning[5] + Paclobutrazol[3]	Paclobutrazol[3]
RP+SP	Root Pruning[1] + Summer Pruning[5]	-
RP+SP+E	Root Pruning[1] + Summer Pruning[5] +Ethephon[2]	Ethephon[2]
RP+SP+P	Root Pruning[1] + Summer Pruning[5] + Paclobutrazol[3]	Paclobutrazol[3]
TI+SP	Trunk Incision[4] + Summer Pruning[5]	-
TI+SP+E	Trunk Incision[4] + Summer Pruning[5] + Ethephon[2]	Ethephon[2]
TI+SP+P	Trunk Incision[4] + Summer Pruning[5] + Paclobutrazol[3]	Paclobutrazol[3]
C	Control	Control

[1] Dormant season (35 cm depth and 30 cm away from trunk on both sides)
[2] At full bloom (200 ppm) and 15 days after full bloom (100 ppm)
[3] At full bloom (800 ppm) and 15 days after full bloom (500 ppm)
[4]Dormant season (20% of trunk diameter on both the side at 30 cm distance)
[5] Mid June (Thinning out of most of extension shoot from middle of canopy + 50% from upper and lower canopy)

Observations recorded

Trunk girth was measured with the help of measuring tape at a height of 15 cm above the graft union and the average increment was calculated by subtracting it from base value and expressed in centimeters**.** Twenty leaves from each marked shoot from each tree were collected and leaf area was measured with leaf area meter (model Systronic 211). First flowering stage was observed visually when 10 per cent of flowers were open, full bloom was observed visually when 90 per cent of flowers were open and end of flowering was recorded visually when 90 per cent of flowers showed petal fall The date of occurrence for each tagged tree was recorded taking reference date into consideration for both the years.. The total number of flowers from each marked branch of a tree was counted. Flowering intensity was calculated by using formula:

Flower intensity = No. of flowers per metre shoot length.

Duration of flowering consists of days from first bloom to the end of flowering. First bloom was visually observed when around 10 per cent of flowers were open and the end of flowering almost when almost all the flowers had opened. Nitrogen content of shoots and leaves was calculated by the method as described Amma (1989) [3], phosphorous content was determined by kitson and Milton 1944 while potassium concentration was determined by Toth *et al.*, 1948 [37]. Total carbohydrates of leaves and shoots was estimated by the method described by Dubois *et al.*, 1956 [12]

Results and discussions

All the growth controlling strategies showed reduction in trunk girth with maximum increament in trunk girth was observed in untreated plants (0.96 cm) which was at par with summer pruning (0.94 cm) while the minimum trunk girth increment was noticed in plants treated with root pruning + paclobutrazol (0.48 cm) followed by trunk incision + paclobutrazol (0.51 cm) (Table 1). Similarly, plants treated with root pruning + paclobutrazol in first year and again with paclobutrazol sprays in second year recorded minimum trunk girth (0.36 cm) increment whereas the maximum trunk girth increment was observed in control plants (0.97 cm). The data presented in Table 1 depict the effect of various growth controlling strategies on leaf area in Chinese Sand pear. The leaf area ranged between 23.10 to 28.96 cm^2 during the first year. Minimum leaf area was noticed in root pruning + paclobutrazol treated plants (23.10 cm^2) followed by trunk incision + paclobutrazol (23.76 cm^2) while summer pruning (28.75 cm^2) and control plants (28.96 cm^2) recorded maximum leaf area. In next year, average leaf area ranged from 23.50 to 28.11 cm^2 with minimum value (23.50 cm^2) in plants treated with root pruning + paclobutrazol in first year and with paclobutrazol in second year and maximum in control (28.11 cm^2) followed by summer pruning (27.86 cm^2). The mechanism for the influence of root pruning on growth is complex. Randolph and Wiest (1981) [26] suggested three possible ways by which growth may be influenced by root pruning: limited water absorption which may induce water stress, reduced mineral absorption and assimilation and reduced hormone synthesis. Reduction in xylem water by root pruning during dormant season at predawn and midday was observed in Sundrop apricot over the control apricot plants (Arzani *et al.*, 2000) [4]. Root pruning has been observed to reduce the water potential thereby leaving the plant in water deficit and hence reduced plant growth (Breueden and Hodges, 1978) [9] as minimum level of water is necessary for plant cells to expand (Kremer and Kozlowski, 1979) [19]. Growth inhibition due to triazole is primarily due to reduced gibberellin biosynthesis, triazoles specifically inhibit the microsomal oxidation of kaurene, kaurenol and kaurenal which is catalyzed by kaurene oxidase (Dalziel and Lawrence, 1984) [10].

Pruning of root to a depth of 30 cm and 20 cm away from trunk on both sides resulted in decreased trunk girth and leaf area, in five years old Breaburn, Royal Gala, Oregon Red Delicious, Splendour, Granny Smith and Fuji apples under high density (Khan *et al.*, 1998) [17]. Reduction in leaf area by root pruning and trunk incision may be due to lowering of leaf expansion (Smart *et al.*, 2006) [33] possibly by creating water stress. Root pruning alters the distribution of photosynthates within plants (Ghobrial, 1983 and Benjamim and Wren, 1980) [16, 7] which are directed to the wounded root system and therefore, result in limited shoot growth and leaf development (Schupp, 1985) [34].

All the growth controlling strategies showed non-significant influence on initial bloom dates (Table 1). The first flowering started 27 days after reference dates in control and ended 28.5 days after reference date in root pruning + paclobutrazol. Similar trend of influence was observed during second year of study. The effect of all growth controlling strategies on full bloom was non-significant (Table 1). However, plants treated with root pruning, trunk incision, trunk incision + ethephon, summer pruning, root pruning + summer pruning and trunk incision + summer pruning + ethephon were recorded in full bloom after 35 days of reference date whereas root pruning + paclobutrazol bloomed after 36.5 days of reference date. Similar, non-significant influence of all growth controlling strategies on time of full bloom was observed during the second year of study. The perusal of data presented in Table 1 reveal the effect of various growth controlling strategies on flower intensity of pear trees. Maximum number of flowers was recorded in root pruning + paclobutrazol (193.20) treated plants followed by trunk incision + paclobutrazol (181.40) while the minimum number of flowers were recorded in control plants (48.50) followed by summer pruning (50.02). Similar results were observed in the second year, the minimum flower intensity was recorded in control (47.28) plants followed by summer pruned (49.20) plants whereas plants treated with root pruning + paclobutrazol in first year and with paclobutrazol in second year again registered maximum flower numbers (210.50). A non significant influence of growth controlling strategies on end of flowering was noticed from the Table 1. It is clear that petal fall started 44.5 days after reference date in summer pruning, and ended after 46.5 days in root pruning + paclobutrazol treated plants. Similar trend of influence on end of flowering was observed in the second year of study. The data presented in Table 1 show non-significant impact on flowering duration by various growth controlling strategies. The flowering duration ranged from 9.0-10.5 days with maximum duration 10.5 days in root pruning + paclobutrazol and minimum 9.0 days in root pruning + ethephon. In next year, flowering duration ranged from 8.5-11.5 days among the treatments which was again non-significant.

Root pruning promote flowering by stimulating root regeneration, root activity and more hormone (cytokinins) production (Gleiser and Ferree, 1984) [15] and flowering spurs per tree (McArtney and Belton, 1992 and Schupp, 1992) [25, 35]. Paclobutrazol promotes flowering in two ways: it can speed up and increase the synthesis of the floral stimulus in an inductive cycle, or more plausibly, affect the ratio between flower promoting and flower inhibiting factors (Kulkarni, 1988) [20]. Induction of profuse flowering and high sex ratio was observed by soil application of paclobutrazol (5ml/m^2) 90 days before bud break in Litchi cv. Rose scented (Ahmad *et al.*, 2000) [1].

As pe the nutrient concentration is concerned the maximum nitrogen per cent (1.57) was recorded in untreated plants and minimum in root pruning + paclobutrazol treated plants (1.30%) (table 2). Similarly, sequential application of paclobutrazol in second year on root pruning + paclobutrazol treated plants registered minimum per cent of nitrogen (1.31%) whereas maximum (1.58%) was observed in reference plants. Root pruning + paclobutrazol treated plants recorded minimum leaf phosphorus (0.169%) content which was at par with plants treated with trunk incision + paclobutrazol (0.170%) (Table 2)while the maximum phosphorous was noticed in untreated plants (0.193%) followed by plants treated with summer pruning (0.192%). In second year, consecutive application of paclobutrazol on root pruning + paclobutrazol (0.171%) treated plants again registered minimum phosphorous concentration which was at par with trunk incision + paclobutrazol (0.173%) treated plants in first year and with paclobutrazol only in second year. Summer pruning again recorded maximum phosphorous (0.190%) content which was similar as in control plants (0.190%). The data in Table 2 showed that in first year maximum potassium concentration was noticed in untreated

plants and summer pruning (0.60%) while root pruning + paclobutrazol recorded minimum potassium (0.39%) content followed by trunk incision + paclobutrazol (0.40%). Plants which were previously treated with root pruning + paclobutrazol in first year and with paclobutrazol only in second year again registered minimum leaf potassium (0.40%) and the maximum was noticed in untreated plants (0.62%).

All the growth controlling strategies except summer pruning showed significantly higher carbohydrate percentage in comparison to control plants (Table 2). It is evident from data that the most effective strategies with maximum carbohydrate content was root pruning + paclobutrazol (5.28%) which was at par with trunk incision + paclobutrazol (5.26%) while the minimum carbohydrate content (4.88%) was observed in reference plants. Similar results were observed in the second year were the minimum carbohydrate in leaves was noticed in control (4.77%) plants which was at par with summer pruned (4.74%) plants. Plants treated with root pruning + paclobutrazol in first year and with paclobutrazol in second year again registered maximum carbohydrate (5.35%) content followed by paclobutrazol treated plants previously treated with trunk incision + paclobutrazol (5.30%).

The perusal of data in Table 3 reveal that maximum shoot nitrogen (0.99%) was recorded in control plants and summer pruned plants and Plants treated with root pruning + paclobutrazol (0.70%) showed minimum nitrogen percentage followed by trunk incision + paclobutrazol (0.73%). Similarly, plants treated with root pruning + paclobutrazol in first year and again with paclobutrazol sprays in second year recorded minimum shoot nitrogen (0.72%) percentage whereas the maximum nitrogen (1.00%) was observed in control plants. It is vivid from the table 3 that growth controlling strategies had significant influence on shoot phosphorous percentage with maximum in untreated plants and minimum in root pruning and paclobutrazol treated plant. Similarly, sequential application of paclobutrazol in second year on root pruning + paclobutrazol treated plants registered minimum per cent phosphorous (0.80%) whereas maximum (1.30%) was observed in untreated plants. Root pruning + paclobutrazol treated plants recorded minimum shoot potassium (0.61%) content which was significantly lower than plants treated with trunk incision + paclobutrazol (0.63%). Root pruning + paclobutrazol treated plants again registered minimum potassium (0.63%) content by consecutive application of paclobutrazol in second year followed by plants treated with trunk incision + paclobutrazol in first year and with paclobutrazol in second year (0.65%). Summer pruning recorded maximum potassium (0.88%) content among treatments which was same as with control plants.

Data presented in Table 3 show that there is significant influence on total shoot carbohydrate content due to various growth controlling treatments. The data showed that in first year minimum carbohydrate in shoots was observed in untreated plants (21.63%) followed by summer pruning (21.95%). Root pruning + paclobutrazol was the strategy that demonstrated maximum carbohydrate content (27.48%) followed by trunk incision + paclobutrazol (27.09%), Plants which were previously treated with root pruning + paclobutrazol in first year and with paclobutrazol only in second year registered maximum carbohydrates (27.67%) and the minimum was noticed in untreated plants (22.64%).

The higher level of carbohydrates with the application of paclobutrazol (50 ppm and 100 ppm) might be due to increased chlorophyll metabolism and its direct effect on carbohydrate metabolism partitioning is also reported by Sharma *et al.*, (2002). Reduced uptake of nutrients by paclobutrazol might be due to reduced length and density of roots and hence the use of soil resources (Atkinson, 1986) [6], by existence of inverse relationship between daily water flux and paclobutrazol (Rieger and Scalabrelli, 1990) [29] and by reducing root hydraulic conductivity (Bigot and Boucuad, 1998) [8]. Paclobutrazol is also known to alter inner structure of roots and thereby affecting nutrient uptake (Rieger and Scalabrelli, 1990) [29]. The inhibition in the growth of roots and weakening of root system under the influence of paclobutrazol might be the cause of reduced nutrient uptake and increased carbohydrates in shoots and leaves (Steffens and Wang, 1986 and Atkinson, 1986) [6].

Table 1: Effect of growth controlling strategies on vegetative growth and flowering of Chinese Sand pear plants

Strategies		Increment in Trunk Girth (cm)		Leaf Area (cm^2)		First Flowering * (Days)		Full Bloom* (Days)		flower intensity (no. of flowers/mt shoot)		End of Flowering* (Days)		Duration of Flowering (Days)	
Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year
RP	-	0.58	0.48	24.33	24.49	28.0	28.5	35.0	36.0	164.80	178.20	45	45	10.0	9.0
RP+E	E	0.54	0.44	24.07	24.15	27.0	27.5	35.5	35.0	176.50	192.30	44.5	44.5	9.0	9.5
RP+P	P	0.48	0.36	23.10	23.50	28.5	28.5	36.0	36.0	193.20	210.50	46.5	47.5	10.5	11.5
TI	-	0.65	0.56	24.61	25.22	27.5	27.0	35.0	36.5	153.80	164.50	45	45	10.0	8.5
TI+E	E	0.62	0.52	24.49	24.94	27.0	27.5	35.0	36.5	162.70	170.60	45	45	10.0	8.5
TI+P	P	0.51	0.41	23.76	23.84	28.0	28.5	36.0	36.0	181.40	201.40	46.5	46	10.5	10.0
SP	-	0.94	0.93	28.75	27.86	27.0	28.0	35.0	35.0	50.02	49.20	44.5	44.5	9.5	9.5
SP+E	E	0.91	0.90	28.50	27.50	27.5	27.0	35.5	36.0	85.70	84.56	45.5	45.5	10	9.5
SP+P	P	0.79	0.76	27.71	26.63	27.5	28.0	36.0	36.5	115.30	109.20	46.5	46.5	10.5	10.0
RP+SP	-	0.84	0.80	27.96	26.94	27.5	28.0	35.0	35.5	96.20	102.00	44.5	44.5	9.5	9.0
RP+SP+E	E	0.73	0.69	25.73	26.02	27.5	27.0	35.5	35.5	123.30	125.60	45.5	45.5	10.0	10.0
RP+SP+P	P	0.68	0.58	25.14	25.49	28.5	28.5	35.5	36.0	145.60	157.80	46	45.5	10.5	9.5
TI+SP	-	0.87	0.85	28.22	27.12	27.5	27.5	35.5	35.0	89.11	94.32	46	45	10.5	10.0
TI+SP+E	E	0.76	0.73	26.07	26.35	28.0	27.0	35.0	36.0	117.40	115.50	44.5	44.5	9.5	8.5
TI+SP+P	P	0.71	0.63	25.43	25.82	28.0	28.0	35.5	35.5	134.00	139.40	46	45.5	10.5	10.0
C	-	0.96	0.97	28.96	28.11	27.0	28.5	35.0	35.5	48.50	47.28	44.5	44.5	9.5	9.0
CD ≤ 0.05		0.025	0.027	0.24	0.25	NS	NS	NS	NS	2.19	2.21	NS	NS	NS	NS

Table 2: Effect of growth controlling strategies on mineral nutrient and total carbohydrate content in leaves of Chinese Sand pear plants

Strategies		Nitrogen (%)		Phosphorous (%)		Potassium (%)		Total Carbohydrates (%)	
Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year
RP	-	1.37	1.39	0.174	0.176	0.43	0.45	5.19	5.20
RP+E	E	1.35	1.36	0.173	0.174	0.41	0.44	5.23	5.24
RP+P	P	1.30	1.31	0.169	0.171	0.39	0.40	5.28	5.35
TI	-	1.41	1.42	0.177	0.186	0.48	0.47	5.14	5.12
TI+E	E	1.40	1.40	0.176	0.177	0.46	0.45	5.16	5.14
TI+P	P	1.32	1.33	0.170	0.173	0.40	0.42	5.26	5.30
SP	-	1.57	1.56	0.192	0.190	0.60	0.62	4.89	4.74
SP+E	E	1.54	1.55	0.190	0.187	0.58	0.58	4.93	4.80
SP+P	P	1.49	1.50	0.185	0.185	0.54	0.55	5.02	4.95
RP+SP	-	1.51	1.52	0.187	0.186	0.56	0.57	4.98	4.91
RP+SP+E	E	1.46	1.49	0.180	0.181	0.51	0.51	5.04	5.06
RP+SP+P	P	1.43	1.45	0.179	0.179	0.50	0.59	5.11	5.11
TI+SP	-	1.52	1.53	0.188	0.186	0.56	0.58	4.95	4.85
TI+SP+E	E	1.49	1.50	0.183	0.182	0.53	0.53	5.05	5.00
TI+SP+P	P	1.43	1.46	0.180	0.180	0.51	0.49	5.07	5.09
C	-	1.57	1.58	0.193	0.190	0.60	0.62	4.88	4.77
CD ≤ 0.05		0.004	0.005	0.001	0.003	0.005	0.007	0.02	0.04

Table 3: Effect of growth controlling strategies on mineral nutrient and total carbohydrate content in shoots of Chinese Sand pear plants

Strategies		Nitrogen (%)		Phosphorous (%)		Potassium (%)		Total Carbohydrates (%)	
Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year	Ist Year	IInd Year
RP	-	0.76	0.79	0.84	0.86	0.68	0.70	26.26	26.42
RP+E	E	0.75	0.76	0.82	0.84	0.66	0.68	26.67	26.84
RP+P	P	0.70	0.72	0.79	0.80	0.61	0.63	27.48	27.67
TI	-	0.81	0.82	0.85	0.87	0.71	0.74	25.48	25.64
TI+E	E	0.79	0.81	0.84	0.86	0.70	0.71	25.81	26.03
TI+P	P	0.73	0.75	0.81	0.82	0.63	0.65	27.09	27.23
SP	-	0.99	0.98	1.20	1.00	0.85	0.88	21.95	22.98
SP+E	E	0.97	0.98	0.98	0.99	0.83	0.86	22.36	23.37
SP+P	P	0.90	0.93	0.93	0.94	0.80	0.83	23.52	24.53
RP+SP	-	0.93	0.94	0.95	0.96	0.80	0.84	23.14	24.11
RP+SP+E	E	0.87	0.89	0.90	0.89	0.76	0.80	24.31	24.46
RP+SP+P	P	0.84	0.85	0.87	0.88	0.73	0.76	25.09	25.24
TI+SP	-	0.95	0.96	0.96	0.98	0.82	0.86	22.74	23.77
TI+SP+E	E	0.87	0.91	0.91	0.92	0.78	0.81	23.94	24.84
TI+SP+P	P	0.84	0.88	0.87	0.89	0.74	0.79	24.71	24.87
C	-	0.99	1.00	1.20	1.30	0.85	0.88	21.63	22.64
CD ≤ 0.05		0.003	0.002	0.005	0.007	0.004	0.005	0.51	0.53

Conclusion

In view of results obtained in the present study, it is concluded that flowering and fruiting in pear (*Pyrus prrifolia*) cv. Chinese Sand pear can be regulated by way of controlling tree vigour through adaption of proper growth controlling strategies including use of paclobutrazol, root pruning and trunk incision. Root pruning + paclobutrazol in one year followed by application of paclobutrazol in second year was found to be the best strategy in controlling tree vigour and optimizing flowering in Chinese Sand pear.

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