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# Effect of shoot pruning and paclobutrazol on vegetative growth, flowering and yield of lemon (*Citrus limon* Burm.) cv. pant lemon-1

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**Abstract**
The present investigation was carried out at Horticultural Research Centre, Patharchatta and Department of Horticulture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, district Udham Singh Nagar (Uttarakhand), India to study the "effect of shoot pruning and paclobutrazol on growth, flowering and yield of lemon (*Citrus limon* Burm.) cv. Pant Lemon-1" during the year 2015 to 2017.The trial was laid out using Randomized Block Design with three replications. The treatments consists of half shoot pruning at 45 cm intensity from the terminal portion and paclobutrazol application @ 2.5 ml/tree in October to April and their combination in January, February and March and were compared with control. The result revealed that the vegetative growth, flowering, yield significantly affected by half shoot pruning and paclobutrazol application from October to April and their combinations. The treatment comprising half shoot pruning in October and application of paclobutrazol @2.5 ml/tree in March were found to more effective in terms decrease in plant height, spread, canopy volume and cross trunk sectional area, number of new shoots, shoot length, number of male flower cluster, number of hermaphrodite flowers, number of fruits, yield kg per tree and yield distribution. The harvesting period can be early in date i.e. May-June under *Tarai* condition of Uttarakhand by proper manipulation of early half shoot pruning and application of paclobutrazol.

**Keywords:** shoot pruning, paclobutrazol, lemon, (*Citrus limon* Burm), vegetative growth, flowering, yield

## Introduction
Lemon (*Citrus limon* Burm.) is one of the popular fruit and is successfully grown all over India. In India is the second largest lemon producing country with a total area of 286 thousand ha and production of 2835 thousand metric tonnes contributing 18.2 % of world total lemon production (National Horticulture Broad, 2015). It is good source of citric acid, iron and phosphorus. Lemon has better yield capacity as well as it is tolerant to citrus decline and other physiological disorders. Lemon is an important fruit crop of *Tarai* region of Uttarakhand. Among the several cultivars grown, Pant Lemon-1 is most promising. It is the best replacement for Kagzi lime in this area. It produces round shaped fruits with greenish yellow colour throughout the year. It has three main flowering flushes as spring, summer and autumn but the main crop from spring season flush, whereas, rest of flowering flushes are distributed in summer and autumn seasons (Bisht, 1975) [4]. However, in spring flush there is problem of cracking of fruits which is probably a physiological disorder. A loss to the extent of 44 per cent has been in reported in Pant Lemon-1 due to fruit cracking (Lavania *et al.*, 1986). These fruits are worthless and non-marketable and cause heavy loss to the growers (Randhawa *et al.*, 1958) [12]. Generally the requirement of lemon fruit is high in the summer months of May-June but at this time no lemon crop is available, the crop comes in the month of July-August. It would be, therefore, desirable to regulate the cropping season in such a way that spring flush crop is advanced to the May-June instead of July-August so that the grower may get better price in the market. Crop in the month of May-June is most profitable. It is possible to distribute the pattern of cropping at own will in many crops by reducing the crop load in main season which will be compensated by increased cropping in the subsequent seasons. Therefore, there is great need to regulate the crop load in the spring season in such a way that main crop is advanced to early maturity with better uniform coloured fruits for the consumption and better return to the growers.

Pruning and application of paclobutrazol are simple and effective strategies recommended in many fruit crops for controlling the tree vigour and promoting flowering and enhanced production efficiency. Pruning is an important tree management practice to regulate vegetative growth and flowering in many crops including in citrus species. Similarly, chemical induced

manipulations in vegetative growth have been attempted in many fruit crops (Erez, 1984 and Sarkar and Rahim, 2012) [7]. Investigations have revealed the beneficial effect of paclobutrazol in restriction of vegetative growth and successful induction of flowering. Since no work has been on the effect of shoot pruning and on paclobutrazol on vegetative growth, flowering and yield of lemon cv Pant lemon-1. Therefore, the present study was undertaken to test the hypothesis that the effectiveness of paclobutrazol and its date of application and shoot pruning in inducing early flowering of lemon and regulate the lemon crop under *tarai* region of Uttarakhand.

## Material and Methods

### Experiment site

The investigations were conducted during the year 2015-2017 at the experimental farm i.e. Horticulture Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand - 263145, India is situated at 29º8N latitude, 79.38ºE longitude and at an altitude of 243.8 meters above the mean sea level in foothills of the Himalayas. Ten year old tree of lemon cv. Pant Lemon-1 was raised on seedling rootstock planting at 5 x 5 m spacing.

### Treatments details

Pruning was carried out by removing half shoot (45 cm) from the terminal portion of shoot of the tree during first week of the every month. Paclobutrazol was applied once as trunk link soil pour method (TSLP) during first week of the every month. Only water was used for the paclobutrazol untreated trees. The different treatment were coded as $T_1$-half shoot pruning in October, $T_2$- half shoot pruning in November, $T_3$-half shoot pruning in December, $T_4$-half shoot pruning in January, $T_5$-half shoot pruning in February, $T_6$-half shoot pruning in March, $T_7$-half shoot pruning in April, $T_8$-paclobutrazol @2.5 ml/tree in October, $T_9$- paclobutrazol @2.5 ml/tree in November $T_{10}$- paclobutrazol @2.5 ml/tree in December, $T_{11}$- paclobutrazol @2.5 ml/tree in January, $T_{12}$-paclobutrazol @2.5 ml/tree in Feburary, $T_{13}$- paclobutrazol @2.5 ml/tree in March, $T_{14}$-paclobutrazol @2.5 ml/tree in April, $T_{15}$-half shoot pruning in January + paclobutazol @2.5 ml/tree $T_{16}$- half shoot pruning in Feburary + paclobutazol @2.5 ml/tree $T_{17}$- half shoot pruning in March + paclobutazol @2.5 ml/tree $T_{18}$- Control( pruning and water application only).During the experimentation the average maximum and minimum temperatures were 29.4 and 17.0 º C respectively, relative humidity 75.6 and total rainfall 933.2 mm.

### Observation and method of estimation

### Tree height

The height of tree was measured with the help of the measuring tape from the soil surface to the highest crown level in for calculation of plant volume.

### Stem girth

The stem girth was measured at graft union with the help of tree callipers in the month.

### Plant spread

Plant canopy spread was measured in the before initiation of experiment and after harvesting of crop. Plant canopy spread was measured in both the directions i.e. East-West and North-South and calculated by the following formula, Tree canopy spread = (N-S) + (E-W)/2.

### Tree volume

Tree volume was calculated as per formula of Westwood and Robert (1970) [21] Plant volume ($m^3$) = $4/3\pi$ $a^2b$Where, S = Half of the spread, H = Half of the height

### Cross trunk sectional area

The girth of the plant which was measured at 20 cm above ground level was converted into cross trunk sectional area by using the formula of Glenn and Rogers (1964) [8].

$CTSA = (Girth)^2 / 4\pi$

### Number of new of shoots

The average number of shoots, both terminal and lateral emerged per branch were counted for number of shoots in each season.

### Shoot length

New shoots emerging in each season (spring, summar and autum), 150 shoots per plant were tagged during 2015 for measuring the length of shoot at the end of season (August, November and March). The shoot length was recorded in centimetres by using a graduated scale. Therefore sixty shoots per treatment were used for recording this observation.

### Number of male flowers

The male flowers were conducted on selected tagged cluster in all four directions and average number was expressed as number of male flower per tree.

### Number of hermaphrodite flowers

The female were counted in each tagged cluster per tree and expressed as number of hermaphrodite of flower per cluster per tree.

### Fruit yield per tree

Fruit yield per tree was recorded by weighing the fruits at the time of each picking and then the total yield per tree was calculated by summing the weight of fruits of all picking and presented as kg fruits per tree.

### Yield distribution

Yield distribution was recorded by harvesting the fruit on different dates and weighing the fruits at time of each picking.

### Statistical analysis

The experimental data were analysed statistically as per method of Randomized Block Design given by Cochran and Cox (1992) [5]. The significance of variance among the treatments were observed by applying the 'F-test' and critical difference at 5 % level was calculated to complete the mean values of treatments for all the characters. The results are presented with help of tables.

## Result and Discussion

### Vegetative characters

From the results, it was apparent that the vegetative growth attributes like plant height, stem girth and plant spread were significantly reduced by half shoot pruning alone and paclobutrazol alone and their combinations (Table 1). Maximum increase in plant height (0.291 m) was recorded with treatment $T_{17}$ and minimum (0.110 m) under treatment $T_{12}$ in trees treated with paclobutrazol in February as compared to control. Maximum increase in stem girth (0.715 cm) was recorded with treatment $T_{12}$ followed by $T_{16}$ (0.722

cm) and minimum (0.375 cm) under treatment $T_2$. Stem girth was significantly increased with paclobutrazol application. Maximum increase in stem girth (1.353m) was recorded with treatment $T_{12}$ followed by $T_9$ (1.264m) and minimum (1.045 m) under treatment $T_2$. Maximum increase in canopy volume (11.31 $cm^2$) was recorded with treatment $T_7$ followed by $T_3$ (7.99 $cm^2$) and minimum (3.05$cm^2$) under treatment $T_{16}$. Maximum increase cross trunk sectional area (0.040 $m^3$) in recorded with treatment $T_{12}$ followed by $T_{15}$ (0.039 $m^3$) and minimum (0.011 $m^3$) under treatment $T_2$. The above results confers the findings of Balamohan and Gopu (2014) [3] in Alphanso that the light pruning of current season's growth is advantageous for tree vigour regulation without influencing the flowering. Such growth reduction responses of pruning might be result of decline in photosynthetic area, delay in leaf development and changes photosynthetic production and their translocation. Similarly, the plant growth response of pruning and paclobutrazol was observed in the study are in line with the findings of (Srilatha *et al*., 2015) and (Sarkar and Rahim, 2012) in mango and in Lemon (Jain *et al*., 2002) [11] respectively, could be consequences of modifications in photosynthesis besides reduction of gibberellins. The results indicated that the combined treatments of pruning and paclobutrazol of tree vigour as compared to pruning of paclobutrazol treatments alone. The data on number of new shoot emergence and shoot length under different treatment including control (no half shooting pruning and water supply) were statistically analysed. In spring season, maximum number of new shoots (3.54) was recorded with treatment $T_6$ and $T_7$ and minimum (2.51) under treatment $T_{15}$.In summer season, maximum number of new shoots (3.56) was recorded with treatment $T_7$ followed by $T_6$ (3.44) and minimum (2.46) under treatment $T_{15}$. In autumn flush, all the treatments was not significant effect on number of new shoots. Early pruning in ber cv. Kaithali was produced maximum number of shoots reported by (Shukla *et al*., 2007) [17]. It might have been due to availability of higher amount of photosynthesis and nutrients in the severely pruned trees which triggered vegetative growth by enhancing cell division and formation of more tissues (Dhaliwali *et al.,* 2014) in peach. Shoot length significantly was recorded with all the treatments. In spring season, maximum shoot length (20.37 cm) was recorded with treatment in $T_1$ followed by $T_2$ (20.23 cm) and $T_7$ (20.08 cm) and minimum (11.23) under treatment $T_{15}$.In summer flush, maximum shoot length (17.63 cm) was recorded with treatment in $T_1$ followed by $T_2$ (17.40 cm) and $T_7$ (16.60 cm) and minimum (10.34) under treatment $T_{15}$. In autumn flush, all the treatments was not significantly effect on shoot length. Similar result were obtained by **(**Arzani *et al*., 2009) [2] and (Samini, 2014) [15] in peach**.**

**Flowering and yield characters**

Effect of half shoot pruning and paclobutrazol on flowering and yield characters are significant with respect of number of male flower, number of hermaphrodite flower and yield per kg (Table 2). In Spring season, maximum number of male flower cluster (131.27) under treatment in $T_1$ followed by $T_2$ (122.73) while minimum number of male flower cluster (22.63) found under treatment $T_6$. In spring season, maximum number of male flower cluster (99.50) as recorded with in case of treatment $T_6$ followed by $T_7$ (97.10) $T_5$ 90.56 and $T_{13}$ (84.31). The minimum number of male flower cluster (17.73) was recorded with treatment $T_{15}$ In autumn flush, maximum number of male flower cluster (51.56) was recorded with in case of treatment $T_{13}$ followed by $T_{14}$ (39.17) and $T_{12}$ (37.01). The minimum number of male flower cluster (6.14) was recorded with treatment $T_{15}$.In spring flush, maximum number of hermaphrodite flower cluster (87.51) under treatment in $T_1$ followed by $T_2$ (81.82) while minimum number of hermaphrodite flower cluster (15.08) found under treatment $T_6$.In summer flush, maximum number of hermaphrodite flower cluster (59.44) was recorded with in case of treatment $T_6$ followed by $T_7$ (58.14) and $T_{13}$ (55.26). The minimum number of hermaphrodite flower cluster (10.24) was recorded with treatment $T_{15}$.In autumn flush, maximum number of hermaphrodite flower cluster (22.10) was recorded with in case of treatment $T_{13}$ followed by $T_{14}$ (16.79) and $T_{12}$ (15.86). The minimum number of hermaphrodite flower cluster (2.63) was recorded with treatment $T_{15}$ Similar Result showed by (Ingle, 2001) and (Tripathi and Dhakal, 2005) [19] in acid lime and (Singh *et al.*, 2012) [18] in litchi cv. Culcuttia.

The half shoot pruning and paclobutrazol effect on yield per kg tree in lemon (Table 2). In spring flush, maximum fruit yield (27.87 kg/tree) was observed with the treatment $T_1$ followed by $T_2$ (27.56) and $T_4$ (26.59 kg/tree) while, minimum fruit yield (4.24 kg/tree) was recorded the treatment $T_7$. In summer flush, maximum fruit yield (21.52 kg/tree) was observed with the treatment $T_7$ followed by $T_6$ (21.25 kg/tree) and $T_5$ (18.95 kg/tree). Minimum fruit yield (3.25 kg/tree) was recorded under the treatment $T_{15}$. In autumn flush, maximum fruit yield (10.14 kg/tree) was observed with the treatment $T_9$ followed by $T_{13}$ (8.10 kg/tree) and $T_5$ (7.94 kg/tree). Minimum (1.09 kg/tree) yield per kg tree was recorded under the treatment $T_{15}$. The discussion can further be strengthened by the fact that, increase in yield as observed in present study in paclobutrazol treatment might have been due to its effect on shifting of assimilate partitioning from leaves to roots and increasing carbohydrates in leaves, stem and roots and chlorophyll, mineral elements and soluble proteins in leaves (Hoda *et al.*, 2001) [9]. Similar result were reported by (Saini, 2011) [14] in guava.

Yield distribution in spring flush was influenced by half shoot pruning and paclobutrazol application (Table 3). In spring flush yield distribution was obtained in early date from on 30 May 2017 in spring flush. The data on yield distribution (kg/tree) in spring flush indicated that maximum yield distribution (5.604 kg/tree) with the treatment $T_1$ followed by $T_2$ (5.475 kg/tree), $T_3$ (5.329 kg/tree), $T_4$ (5.165 kg/tree) and $T_{14}$ (4.751 kg/tree) on 30 May 2017. The $T_{14}$ treatment which was *at par* with $T_{13}$(4.701 kg/tree) $T_{12}$(4.675 kg/tree) and $T_{10}$ (4.408 kg/tree). Minimum yield distribution (00 kg/tree) was recorded with the treatment $T_{18}$ in control on 30 May 2017. On 17 June 2017, maximum (7.006 kg/tree) yield distribution was obtained with the treatment $T_1$ followed by $T_2$ (5.475 kg/tree), $T_3$ (5.329 kg/tree), $T_4$ (5.165 kg/tree) and $T_{14}$ (4.751 kg/tree) on 27 June 2017. Maximum yield distribution (3.503 kg/tree) was obtained with the treatment $T_1$ followed by $T_2$ (3.422 kg/tree), $T_3$ (3.330 kg/tree), $T_4$ (3.228 kg/tree) and $T_{14}$ (2.969 kg/tree) on 12 July 2017.Treatment $T_{14}$ was *at par* with the treatment $T_{13}$ (2.938 kg/tree) and $T_{11}$ (2.922 kg/tree). On 30 July 2017, Maximum yield distribution (12.262 kg/tree) was obtained in control followed by $T_1$ (9.341 kg/tree), $T_2$ (9.125 kg/tree), $T_3$ (8.881 kg/tree) and, $T_4$ (8.608 kg/tree). Minimum yield distribution (1.375 kg/tree) was obtained in with the treatment $T_7$. Maximum yield distribution (5.691 kg/tree) kg/tree) was obtained in control followed by $T_2$ (3.187 kg/tree) and $T_4$ (2.647 kg/tree). Minimum yield distribution (0.456 kg/tree) was obtained in with the treatment $T_{15}$. Similar result are line with Young and Koo (1975) [20] of

pruning in lemon, they found that biennial hedging of lemon of the eastern half of lemon trees producer greater yield than western half. Similar result was found by (Jain *et al*., 2000) [10] in Pant lemon-1.Maximum percentage of yield (58.28 per cent) on first and second dates of harvesting which fell on June 16 and July 3 during first year. The fruit maturity was further advanced in paclobutrazol 5 ml ai per tree in January during first year and 61.56 per cent up to 12th June in spring season.

**Table 1:** Effect half shoot pruning and paclobutrazol on increase in vegetative characters in lemon

| Treatments | Increase in plant height (m) | Increase in stem girth (cm) | Increase in plant spread (m) | Increase in canopy spread ($m^3$) | Increase in cross trunk sectional area ($cm^2$) |
|---|---|---|---|---|---|
| $T_1$ | 0.267 | 0.400 | 1.353 | 17.782 | 0.012 |
| $T_2$ | 0.258 | 0.375 | 1.240 | 17.600 | 0.011 |
| $T_3$ | 0.268 | 0.435 | 1.264 | 15.831 | 0.015 |
| $T_4$ | 0.278 | 0.410 | 1.230 | 14.729 | 0.013 |
| $T_5$ | 0.275 | 0.480 | 1.250 | 14.245 | 0.019 |
| $T_6$ | 0.236 | 0.415 | 1.209 | 12.983 | 0.013 |
| $T_7$ | 0.215 | 0.425 | 1.146 | 10.053 | 0.014 |
| $T_8$ | 0.122 | 0.505 | 1.164 | 10.745 | 0.020 |
| $T_9$ | 0.121 | 0.655 | 1.197 | 9.983 | 0.034 |
| $T_{10}$ | 0.128 | 0.630 | 1.196 | 8.215 | 0.030 |
| $T_{11}$ | 0.112 | 0.620 | 1.133 | 8.692 | 0.030 |
| $T_{12}$ | 0.110 | 0.715 | 1.178 | 7.459 | 0.040 |
| $T_{13}$ | 0.138 | 0.665 | 1.133 | 8.030 | 0.034 |
| $T_{14}$ | 0.125 | 0.675 | 1.163 | 7.106 | 0.035 |
| $T_{15}$ | 0.305 | 0.705 | 1.045 | 4.914 | 0.039 |
| $T_{16}$ | 0.336 | 0.705 | 1.143 | 4.592 | 0.039 |
| $T_{17}$ | 0.291 | 0.690 | 1.139 | 4.306 | 0.037 |
| $T_{18}$ | 0.320 | 0.435 | 1.300 | 14.710 | 0.015 |
| S. Em.± | 0.003 | 0.006 | 0.013 | 0.93 | 0.0008 |
| C.D. at 5 % | 0.008 | 0.017 | 0.036 | 1.68 | 0.002 |

**Table 2:** Effect half shoot pruning and paclobutrazol on vegetative growth, flowering and yield characters in spring, summer and autumn flush in lemon

| Treatments | Number of new shoots | | | Shoot length(cm) | | | No of male flower | | | No of hermaphrodite flower | | | Yield per tree | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Spring | Summer | Autumn | Spring | Summer | Autumn | Spring | Summer | Autumn | Spring | Summer | Autumn | Spring | Summer | Autumn |
| $T_1$ | 2.82 | 2.75 | 2.74 | 20.37 | 17.63 | 17.03 | 131.27 | 21.00 | 7.19 | 87.51 | 13.17 | 3.08 | 27.87 | 3.60 | 2.53 |
| $T_2$ | 2.80 | 2.74 | 2.71 | 20.23 | 17.40 | 16.81 | 122.73 | 23.12 | 7.02 | 81.82 | 14.40 | 3.01 | 27.56 | 4.59 | 2.22 |
| $T_3$ | 2.62 | 2.59 | 2.56 | 17.07 | 14.26 | 14.08 | 113.06 | 21.77 | 30.54 | 75.37 | 16.34 | 13.09 | 26.59 | 11.25 | 5.13 |
| $T_4$ | 2.72 | 2.67 | 2.65 | 17.29 | 14.50 | 14.14 | 91.45 | 64.61 | 34.88 | 60.97 | 42.10 | 14.95 | 26.57 | 13.36 | 3.37 |
| $T_5$ | 3.46 | 3.41 | 3.40 | 18.24 | 15.43 | 15.24 | 79.77 | 90.56 | 14.74 | 53.18 | 54.74 | 6.32 | 14.79 | 18.95 | 7.94 |
| $T_6$ | 3.54 | 3.48 | 3.47 | 19.12 | 16.43 | 16.16 | 22.63 | 99.50 | 10.66 | 15.08 | 59.44 | 4.57 | 9.77 | 15.14 | 2.64 |
| $T_7$ | 3.54 | 3.56 | 3.55 | 20.08 | 16.60 | 16.36 | 23.79 | 97.10 | 11.78 | 15.86 | 58.14 | 5.05 | 4.24 | 16.79 | 2.31 |
| $T_8$ | 2.87 | 2.82 | 2.80 | 15.24 | 16.09 | 16.33 | 56.08 | 40.53 | 29.61 | 37.39 | 27.28 | 12.69 | 16.01 | 12.17 | 3.59 |
| $T_9$ | 2.76 | 2.71 | 2.69 | 13.59 | 14.32 | 14.18 | 59.97 | 44.25 | 22.27 | 39.98 | 28.78 | 9.54 | 17.67 | 11.31 | 10.14 |
| $T_{10}$ | 2.52 | 2.49 | 2.46 | 15.28 | 16.39 | 16.35 | 70.04 | 36.88 | 27.84 | 46.69 | 25.23 | 11.93 | 22.40 | 15.63 | 3.30 |
| $T_{11}$ | 2.89 | 2.79 | 2.77 | 16.26 | 15.32 | 15.18 | 72.15 | 40.22 | 29.25 | 48.10 | 27.09 | 12.53 | 17.23 | 14.75 | 3.47 |
| $T_{12}$ | 3.14 | 3.08 | 3.04 | 17.15 | 15.24 | 15.11 | 90.75 | 74.82 | 37.01 | 60.50 | 48.01 | 15.86 | 23.52 | 21.25 | 4.35 |
| $T_{13}$ | 3.43 | 3.36 | 3.33 | 18.16 | 16.21 | 16.07 | 104.07 | 84.31 | 51.56 | 69.38 | 55.26 | 22.10 | 23.68 | 21.52 | 8.10 |
| $T_{14}$ | 3.48 | 3.44 | 3.41 | 18.41 | 16.30 | 16.14 | 93.51 | 81.28 | 39.17 | 62.34 | 52.55 | 16.79 | 24.22 | 13.66 | 6.72 |
| $T_{15}$ | 2.51 | 2.46 | 2.44 | 11.23 | 10.34 | 10.16 | 29.25 | 15.84 | 6.14 | 19.50 | 10.24 | 2.63 | 7.62 | 3.25 | 1.09 |
| $T_{16}$ | 2.53 | 2.48 | 2.46 | 12.03 | 10.44 | 10.10` | 32.34 | 17.73 | 7.57 | 21.56 | 11.34 | 3.24 | 8.07 | 4.35 | 1.38 |
| $T_{17}$ | 2.53 | 2.52 | 2.49 | 12.27 | 11.08 | 10.98 | 33.08 | 18.49 | 7.46 | 22.06 | 11.80 | 3.20 | 8.20 | 4.69 | 1.48 |
| $T_{18}$ | 2.30 | 2.25 | 2.26 | 21.25 | 18.59 | 17.36 | 88.08 | 63.28 | 32.23 | 58.72 | 41.24 | 13.81 | 24.92 | 6.70 | 1.81 |
| S. Em.± | 0.06 | 0.06 | 0.06 | 0.21 | 0.19 | 0.31 | 1.12 | 1.26 | 0.67 | 1.14 | 1.12 | 0.47 | 0.39 | 0.28 | 0.12 |
| C.D. at 5 % | 0.19 | 0.19 | NS | 0.61 | 0.53 | NS | 3.17 | 3.57 | 1.90 | 3.23 | 3.18 | 1.32 | 1.12 | 0.81 | 0.36 |

**Table 3:** Effect of half shoot pruning and paclobutrazol on yield distribution (kg/tree) in spring flush in lemon

| Treatments | Yield distribution (kg/tree) in spring flush | | | | |
|---|---|---|---|---|---|
| | 30 May | 17 June | 12 July | 30 July | 5 August |
| $T_1$ | 5.604 | 7.006 | 3.503 | 9.341 | 2.480 |
| $T_2$ | 5.475 | 6.843 | 3.422 | 9.125 | 2.647 |
| $T_3$ | 5.329 | 6.661 | 3.330 | 8.881 | 2.310 |
| $T_4$ | 5.165 | 6.456 | 3.228 | 8.608 | 3.187 |
| $T_5$ | 2.926 | 3.657 | 1.828 | 4.876 | 1.541 |
| $T_6$ | 1.960 | 2.450 | 1.225 | 3.267 | 0.962 |
| $T_7$ | 0.825 | 1.031 | 0.516 | 1.375 | 0.460 |
| $T_8$ | 3.188 | 3.985 | 1.992 | 5.313 | 1.378 |
| $T_9$ | 3.375 | 4.219 | 2.109 | 5.625 | 2.305 |
| $T_{10}$ | 4.408 | 5.510 | 2.755 | 7.347 | 2.288 |
| $T_{11}$ | 3.478 | 4.348 | 2.174 | 5.797 | 1.392 |

| | | | | | |
|---|---|---|---|---|---|
| $T_{12}$ | 4.675 | 5.844 | 2.922 | 7.792 | 2.190 |
| $T_{13}$ | 4.701 | 5.877 | 2.938 | 7.836 | 2.137 |
| $T_{14}$ | 4.751 | 5.939 | 2.969 | 7.918 | 2.345 |
| $T_{15}$ | 1.508 | 1.885 | 0.942 | 2.513 | 0.574 |
| $T_{16}$ | 1.583 | 1.978 | 0.989 | 2.638 | 0.456 |
| $T_{17}$ | 1.609 | 2.011 | 1.005 | 2.681 | 0.509 |
| $T_{18}$ | 0.000 | 4.087 | 2.725 | 12.262 | 5.691 |
| S. Em.± | 0.109 | 0.104 | 0.080 | 0.098 | 0.059 |
| C.D. at 5 % | 0.315 | 0.299 | 0.232 | 0.282 | 0.172 |

## Conclusion

From the study, it was concluded that the early half shoot pruning of tree after spring crop harvesting in October-November and paclobutrazol application @2.5 ml/tree in lemon were vital for regulating tree size spread, volume, more number of hermaphrodite flower and high yield per tree and advancing fruit yield harvest in lemon. The spring crop is regulated by early pruning and paclobutrazol application. The harvesting period can be early in date i.e. May-June under *Tarai* condition of Uttarakhand by proper manipulation of early half shoot pruning and application of paclobutrazol.

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