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Effect of canopy architecture management on growth and yield of grape cv. Sharad seedless

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Abstract
Effect of canopy architecture management on growth and yield of grape cultivar Sharad seedless was studied during the year 2020-2021 and 2021-2022 at the Horticulture Garden, Department of Horticulture, University of Agricultural Sciences, Raichur. At 45 days after pruning growth parameters length of the fruiting shoot (cm), diameter of the fruiting shoot (mm), internodal length of fruiting shoot (cm), number of leaves per vine, leaf area per vine (m^2) and LAI was not affected significantly by canopy architecture management practices during the present study in grape cultivar Sharad seedless. At 90 days after pruning significantly maximum length of fruiting shoot (108.67 cm), fruiting shoot diameter (6.56 mm), internodal length (5.54 cm) and minimum number of leaves (2977), leaf area (20.31 m^2) and leaf area index (4.51) was noticed in ST (T_2) canopy management practice. While significantly minimum fruiting shoot length (81.30 cm), fruiting shoot diameter (5.34 mm), internodal length (4.62 cm) and higher number of leaves (4494), leaf area (39.01 m^2) and leaf area index (8.67) was observed in control (T_1). Number of bunches per cane and number of bunches per vine was not effected significantly but numerically more number of bunches per cane (1.16) and number of bunches per vine (40.67) was recorded in LR_1 (T_4). Significantly maximum bunch length (17.83 cm), bunch breadth (11.56 cm), bunch weight (359.1 g) and bunch volume (336.5 cm^3) in canopy management practices ST+LR_1 (T_7) and fruit yield per vine (14.00 kg) and fruit yield tonne per hectare (31.11 t ha^{-1}) was observed in LR_1 (T_4) canopy architecture management practice.

Keywords: Canopy, management, growth, yield

Introduction
Grape (*Vitis vinifera* L.) belongs to the family Vitaceae which is divided into two sub-genera, *Euvitis Planch* (2n = 38) and *Muscadinia Planch* (2n = 40). Most commercial grapes belong to genus *Vitis* which contains about 60 species (Olien, 1990). Grape (*Vitis vinifera* L.) is an important commercial fruit crop in India. The majority of grapes production is used for fresh consumption. Table grapes are used for fresh consumption. They should have attractive appearance, bold and elongated berries, and crisp pulp with thin and soft skin. Seedless-ness is another desirable character for table grapes. Sharad Seedless is an impotent commercial variety. It is a clonal selection from the Russian variety Kishmish Chernyi (Black Sultana). The berries of Sharad seedless are bluish black with crisp pulp, oblong to elliptical in shape. Canopy management plays an important role in healthy foliage with high photosynthetic efficiency to maximize the solar radiation use efficiency and enough space for air circulation inside the canopy. Canopy management plays an important role in grape which affects yield and quality of grapes. Canopy architecture management is considered the most important practice through which grape production and quality can be improved (Fawzi *et al*., 2010) [12]. The grapevine canopy and vine vigour can be managed through shoot thinning. Sunlight intensity received at different zones in the vine canopy is known to strongly influence fruit composition, such as sugars, acids, and other secondary metabolites Myers *et al*. (2008) [18]. It is important to consider the microclimate inside the main canopy and at the fruit zone when choosing how and when to conduct canopy management practices. Canopy density affects the exposure of leaves of the inner and outer canopy influencing the photosynthetic efficiency of the leaves.

Materials and methods
A field experiment on "Effect of canopy architecture management on growth and yield of grape cultivar Sharad seedless" was conducted during the year 2020-2021 and 2021-2022 at

the Horticulture Garden, Department of Horticulture, UAS, Raichur, Karnataka, India. The experiment was laid out by adopting Randomized Block Design with three replications at two vines per treatment. The observations were recorded from the two vines in each treatment (in each vine five shoots) which were tagged for recording various growth and yield characters at different stages of vine growth *i.e.* 45 and 90 days after pruning. The mean values of each of the three replications calculated in this way were subjected to statistical analysis and results were interpreted for the characters.

Treatment details

T_1 - control
T_2 - ST (shoot thinning)
T_3 - SP (shoot positioning)
T_4 - LR_1 (leaf removal 15 cm from the base of the shoot)
T_5 - LR_2 (removal of two leaves before bunch and two leaves after bunch)
T_6 - ST + SP
T_7 - ST + LR_1
T_8 - ST+LR_2
T_9 - SP+LR_1
T_{10} - SP+LR_2
T_{11} - LR_1+LR_2
T_{12} - ST+SP+LR_1+LR_2

Imposition of the treatments

LR_1: Leaf removal after fruit set by removing in a 15 cm zone of leaves from the base of the shoot, only on the east side of the canopy to avoid exposing clusters to western sunlight, particularly at mid-day.

LR_2: Leaf removal during version stage by removing two leaves above and two below the cluster to expose bunches.

ST: Shoot thinning at the time of flowering by selecting unfruitful or weak shoots arising from the same node.

SP: Shoot positioning manually by positioning the vertically growing shoots to a downward orientation twice; one immediately after fruit set and again a week later.

Results and Discussion

Growth parameters

The data on effect of canopy architecture management on growth parameter was recorded at 45 and 90 days after pruning and presented in Table 1. At 45 days after pruning all growth parameters like length of the fruiting shoot (cm), diameter of the fruiting shoot (mm), internodal length of fruiting shoot (cm), number of leaves per vine, leaf area per vine (m^2) and LAI was not affected significantly by canopy architecture management practices during the present study in grape cultivar Sharad seedless. However, numerically maximum length of fruiting shoot (57.40 cm), fruiting shoot diameter (5.46 mm), internodal (4.61 cm) and minimum number of leaves (2100), leaf area (12.16 m^2) and leaf area index (2.70) was noticed in ST (T_2) canopy management practice. While numerically minimum fruiting shoot length (52.85 cm), fruiting shoot diameter (4.76 mm), internodal (3.91 cm) and higher number of leaves (2552), leaf area (17.19 m^2) and leaf area index (3.82) was observed in control (T_1).

Fruiting shoot length (cm)

Among all the treatments at 90 days after pruning, significantly longest length of fruiting shoot was observed in ST (T_2) (108.67 cm) which was on par with ST + LR_1 (T_7) (103.85 cm) flowed by ST + LR_2 (T_8) (101.12 cm), ST + SP (T_6) (99.92 cm) and ST + SP + LR_1 + LR_2 (T_{12}) (98.49 cm) and significantly least fruiting shoot length was observed in control (T_1) (81.30 cm).

It was clear from the results that, fruiting shoot length was increased by shoot thinning and its combination with other canopy management treatments and it was less in control. Increase in shoot length might be due to the encouragement of translocation of photosynthetic products towards the remaining shoots by removing the un-fruited faster growing shoots which consumes the photosynthetic products Abd El-Ghany *et al*. (2005) [1]. The obtained results were in line with those of Zhuang *et al*. (2014) [32] on "Cabernet Franc" grapevine and Naor *et al*. (2002) [19] they reported that, shoot density at 14 and 44 shoots/ vine companied with two crop levels (one and two clusters per shoot) on "Sauvignon Blanc" grapevine resulted in greater main shoot length, lateral shoot length, shoot diameter, leaf area per shoot and specific leaf weight with the lower shoot density (14 shoots per vine) as compared to the higher one (44 shoots per vine) for three years.

Fruiting shoot diameter (mm)

Significantly maximum fruiting shoot diameter was recorded in ST (T_2) (6.56 mm) which was on par with ST+SP (T_6) (6.44 mm), ST+LR_1 (T_7) (6.42 mm), ST+LR_2 (T_8) (6.40 mm) and ST+SP+LR_1+LR_2 (T_{12}) (6.33 mm) whereas lowest fruiting shoot diameter was observed in control (T_1) (5.34 mm).

From the result it was found least diameter of fruiting shoot was recorded in control. It was may be due to the presence of more number of shoots per vine which might have led to higher competition for the absorption of food material resulting in weaker shoots. Whereas it was maximum in shoot thinning treatment alone and its combination with leaf removal treatments it might be due to the reduction in number of shoots per vine reduced the sink and allowed greater allocation of assimilates. The results are similar with Somkuwar *et al*. (2014) [28] in Tas-A-Ganesh grapes. Considerable growth was induced by shoot thinning and leaf removal. Increase in shoot diameter may be due to consolidation of food material in shoots supported by photo synthetically active leaves. The results are in conformity with the findings of Ameer (2013) [2] in Flame Seedless, Bravdo *et al*. (1985) [9] in Cabernet Sauvignon.

Internodal length of fruiting shoot (cm)

Significantly lengthiest internodal length of fruiting shoot was recorded in treatment ST (T_2) (5.54 cm) flowed by ST+LR_1 (T_7) (5.21 cm), ST+LR_2 (T_8) (5.13 cm), ST+SP (T_6) (5.03 cm), ST+SP+LR_1+LR_2 (T_{12}) (5.00 cm) and LR_1 (T_4) (4.90 cm). While the shortest internodal length of the fruiting shoot was observed in control (T_1) (4.62 cm). It was obvious from the results that, shoot thinning and its combination with leaf removal from the base of the shoot and leaf removal above and below the bunch increase vigour of the fruiting shoot. It might be due to the diversion of more metabolites to the shoot or in shoot thinned vine. The limited number of shoots per vine might have received required quantity of nutrient and water which helps in maximum internodal length whereas, higher number of shoots have competed with each other for water and available nutrients. These findings are in agreement with the findings of Singhort *et al*. (1977) [27] in Thompson seedless grapes, Bates (2008) [8] in Concord grapes and Miller *et al*. (1996) [16] in potted grapevines.

Number of leaves per vine

Significantly lowest number of leaves was recorded in treatment ST+LR$_2$ (T$_8$) (2977) which was on par with ST+LR$_1$ (T$_7$) (3009), ST+SP+LR$_1$+LR$_2$ (T$_{12}$) (3041), ST (T$_2$) (3070), ST+SP (T$_6$) (3175), LR$_1$+LR$_2$ (T$_{11}$) (3219), LR$_1$ (T$_4$) (3242) and LR$_2$ (T$_5$) (3312). While control (T$_1$) has resulted in significantly maximum (4494) number of leaves per vine. It was obvious from the recorded data that, there are significant differences among the treatments. The highest values on number of leaves per vine were obtained from the treatment control flowed by shoot positioning it might be due to the more number of shoots per vine and more number of leaves per shoot as no leaf removal treatments were applied in these treatments. Sabry *et al*. (2020) [24] reported that, the working definition of a balanced shoot is that it has a sufficient amount of leaves, given that the leaves are well exposed to sunlight, to ripen two clusters completely. The similar result was also reported by Silvestroni *et al*. (2018) [26] where, the reduction in leaf layers in the fruiting zone was observed with the St (shoot thinning) treatment. These results are in accordance with Archer and Hunter (2004) [26] and Zamboni *et al*. (1997) [31] in Pinot Noir Sauvignon grapes.

Leaf area per vine (m^2)

Canopy management ST+LR$_2$ (T$_8$) has resulted in significantly lower leaf area (20.31 m^2) which was found on par with ST+LR$_1$ (T$_7$) (20.44 m^2), ST+SP+LR$_1$+LR$_2$ (T$_{12}$) (21.26 m^2), ST (T$_2$) (21.46 m^2), ST+SP (T$_6$) (23.07 m^2) and LR$_1$+LR$_2$ (T$_{11}$) (23.83 m^2). Whereas, significantly highest leaf area was observed in control (T$_1$) (39.01 m^2) in first year, second year and pooled data of two years respectively. Many researchers have studied the effect of shoot thinning, leaf removal and shoot positioning on total leaf area. According to Kliewer and Weaver (1971) [15], appropriate leaf area is required for the production of high-quality grapes, raisins, and wine. Satisha *et al*. (2000) [25] discovered a relation between yield per vine, photosynthetic rate, and leaf area per vine. When fifteen leaves were left on each cane, the berry diameter was at its highest. Silvestroni *et al*. (2018) [26] was also found that, the canopy density was lower in St (shoot thinning) treatment than the other canopy management treatments. Further, total leaf area was lower in shoot thinning along with pre-veraison defoliation. Also leaf removal treatment resulted in a significant reduction in canopy total leaf area and was 26 (%) lower than the control treatment reported by Anic *et al*. (2021) [4].

Leaf area Index

Canopy management practice ST+LR$_2$ (T$_8$) has resulted in significantly lowest (4.51) leaf area index and it was on par with [ST+LR$_1$ (T$_7$), ST+SP+LR$_1$+LR$_2$ (T$_{12}$), ST (T$_2$), ST+SP (T$_6$), LR$_1$+LR$_2$ (T$_{11}$), LR$_1$ (T$_4$) and LR$_2$ (T$_5$) respectively] (4.54, 4.72, 4.77, 5.13, 5.30, 5.50 and 5.55 respectively). Whereas, significantly higher was observed in control (T$_1$) (8.67). Penetration of light into the canopy and effective absorption of sunlight by leaves is very important aspect in improving the photosynthetic efficiency of leaves. In the present study, as expected, shoot thinning, leaf removals and their combinations significantly reduced the leaf area and leaf area index over the growing season, lower LAI means fewer leaves within the canopy and increased light penetration. According to Ames *et al*. (2016) [3] shoot thinning decreased LAI 20 per cent during the year (2013) and 22 per cent during the year (2014) compared to non-shoot thinned vines in (Blanc Du Bois) win grapes the results was also in line with the findings of Somkuwar *et al*. (2014) [28] in Tas-A-Ganesh grapes. Similarly, Hunter and Visser (1990) [13] found partial defoliation significantly reduced leaf area.

Yield parameters

Number of bunches per cane

The data on number of bunches per cane was recorded and presented in Table. 2. No significant difference was observed on number of bunches per cane in the present study. However, numerically maximum number of bunches per cane was observed in LR$_1$ (T$_4$) (1.16) while lowest was recorded in ST+LR$_2$ (T$_8$) (1.02). Reduction in number of bunches per cane might be due to the reduced number of shoots per cane.

Number of bunches per vine

No significant effect was observed due to the different canopy management practices on number of bunches per vine (Table. 2). However, numerically more number of bunches per vine was recorded in LR$_1$ (T$_4$) (40.67) and minimum in ST+LR$_2$ (T$_8$) (35.67). It mainly due to the more number of bunches per cane in LR$_1$ (T$_4$) treatment and less numbers in ST+LR$_2$ (T$_8$) treatment so ultimately higher number of bunches per vine will be notice in LR$_1$ (T$_4$) and lower in ST+LR$_2$ (T$_8$).

Bunch length

Significantly maximum bunch length was recorded in ST+LR$_1$ (T$_7$) (17.83 cm) which was at par with {ST+LR$_2$ (T$_8$), LR$_1$ (T$_4$), LR$_2$ (T$_5$), LR$_1$+LR$_2$ (T$_{11}$), ST+SP+LR$_1$+LR$_2$ (T$_{12}$), ST (T$_2$) and ST+SP+LR$_1$+LR$_2$ (T$_{12}$) respectively} (17.56, 17.14, 16.94, 16.76 and 16.42 cm respectively). While control (T$_1$) has resulted in significantly shortest (14.42 cm) bunch length. Maximum bunch length in shoot thinned vines may be due to the increased in higher photosynthetes accumulation in the developing clusters. This was strongly supported by the findings of Jogaiah *et al*. (2013) [14].

Bunch Breadth

There was significant difference for canopy architecture management practices on bunch breadth in grape cultivar Sharad seedless (Table. 2.). Canopy management practice ST+LR$_1$ (T$_7$) has resulted in significantly maximum (11.56 cm) bunch length which was on par with {ST+LR$_2$ (T$_8$), LR$_1$ (T$_4$), LR$_2$ (T$_5$) and LR$_1$+LR$_2$ (T$_{11}$) respectively} (11.35, 11.06, 10.99 and 10.89 cm respectively). While significantly minimum bunch breadth was recorded in control (T$_1$) (9.08 cm). Cluster length and breadth are very important attributes for table grapes quality. Significantly high bunch breadth was noted in shoot thinning and its combination with leaf removals. While significantly lowest bunch breadth was in control vines. High bunch breadth in shoot thinning and its combination with leaf removal might be due to the well exposed shoots which leads to the improve vine performance as compare to the dense canopy and helps in increasing the bunch size. Results are in agreement with findings of Jogaiah *et al*. (2013) [14] who reported that, diversion of photosynthates to available bunches by reduced number of shoots resulted in increased cane thickness, which attributed to bunch size. Similar results were also reported by, Porika (2013) [21].

Bunch weight

Weight of the bunch significantly affected by different canopy management practices in the present investigation among which ST+LR_1 (T_7) has resulted in significantly highest (359.1 g) which was on par with ST+LR_2 (T_8) (350.2 g), LR_1 (T_4) (345.8 g), LR_2 (T_5) (339.9 g) and LR_1+LR_2 (T_{11}) (329.3 g) while significantly lowest was observed in control (T_1) (252.4 g). It was obvious from the results weight of the bunch was significantly affected by canopy management practices among the different canopy management practices shoot thinning along with leaf removal recorded highest bunch weight whereas lower was observed in control vines. It might be due to the diversion of photosynthates to the bunch by reducing the number of shoots and leaves. Similar result was also reported by Jogaiah *et al*. (2013) [14] in Norton grapes, shoot thinning increased the total photosynthetic capacity of leaf by better light interception to the vine which results in higher photosynthates accumulation in developing clusters. Bunches developed on control/ no cane regulated vines showed inferior bunch characters Ashwini *et al*. (2017) [7]. These findings are close agreement with those reported earlier by Clingeleffer (1989) [10], Reynolds *et al*. (1994) [23], Somkuwar *et al*. (2012) [29].

Bunch volume (cm^3)

There were significant differences among the different canopy management on volume of bunch. Significantly maximum volume of the bunch was observed in ST+LR_1 (T_7) (336.5 cm^3) which was on par with ST+LR_2 (T_8) (327.5 cm^3), LR_1 (T_4) (320.3 cm^3), LR_2 (T_5) (317.9 cm^3) and LR_1+LR_2 (T_{11}) (307.0 cm^3), where significantly lowest volume of bunch was noticed in control (T_1) (236.3 cm^3). It may be due to the higher bunch size in shoot thinning followed by leaf removal treatment and lowest bunch size in control treatment. Similar results were also reported by Somkuwar *et al*. (2012) [29].

Fruit yield per vine (kg)

Influence of canopy architecture management on yield per vine of Sharad seedless was recorded and presented in Table 2. Significantly highest yield was recorded in LR_1 (T_4) (14.00 kg) yield per vine which was on par with LR_2 (T_5) (13.72 kg), ST+LR_1 (T_7) (12.86 kg), LR_1+LR_2 (T_{11}) (12.66 kg) and ST+LR_2 (T_8) (12.50 kg). While, significantly lowest was observed in SP (T_3) (9.99 kg) which was closely on par with control (T_1) (10.16 kg). High yield in LR_1 and LR_2 might be due to the more number of bunches along with slight higher bunch weight and in their combination with shoot thinning may be due to the higher bunch weight, even though number of bunches was non-significant in present study and numerically it was high in control and shoot positioned treatment but yield per vine was low it may be due to the lower bunch and berry weight in these treatments. Similar findings were reported by (Morris *et al*., 2004**;** Naor *et al*., 2002; Reynolds *et al*., 2005; Sun *et al*., 2012) [17, 19, 22, 30].

Fruit yield (t ha^{-1})

Yield per hectare (t) significantly affected by different canopy management practices among which LR_1 (T_4) has resulted in significantly highest (31.11 t) yield per hectare which was on par with LR_2 (T_5) (30.50 t), ST+LR_1 (T_7) (28.59 t), LR_1+LR_2 (T_{11}) (28.13 t) and ST+LR_2 (T_8) (27.78 t). While, significantly lowest was observed in SP (T_3) (22.20 t) which was closely on par with control (T_1) (22.57 t). The impact of increase or decrease in yield per hectare is generally visible directly on yield per vine, number of bunches and bunch weight. The increase in yield may be due to the high number of bunches and the increasing in bunch weight in above mentioned treatments. Similar result was also reported by Fawzi *et al*. (2015) [11] in Superior grapevine. The minimum number of shoot density and leaf density increases the light penetration percentage in fruit zone. The results are similar with Antognozzi and Palliotti (1993) [5]. The present study is in confirmation to the many of the earlier studies. Jogaiah *et al*. (2013) [14] in Norton grapes; Ashwini *et al*. (2017) [7] in wine grape cultivars; Ames *et al*. (2016) [3] in Blanc Du Bois grapes.

Table 1: Effect of canopy architecture management on growth parameters at different growth stages of grape cultivar Sharad seedless (Pooled data of two years)

Treatment	Fruiting shoot length (cm)	Fruiting shoot diameter (mm)	Internodal length of fruiting shoot (cm)	Number of leaves per vine	Leaf area per vine (m^2)	Leaf area Index
	45 DAP					
T_1: control	52.85	4.76	3.91	2552	17.19	3.82
T_2: ST	57.40	5.46	4.61	2147	12.16	2.70
T_3: SP	53.75	4.88	4.23	2488	16.34	3.63
T_4: LR_1	55.13	4.99	4.35	2319	14.56	3.24
T_5: LR_2	54.67	4.95	4.26	2336	14.54	3.23
T_6: ST+SP	56.10	5.14	4.46	2284	13.62	3.03
T_7: ST+LR_1	56.75	5.41	4.60	2100	12.43	2.76
T_8: ST+LR_2	56.28	5.33	4.57	2123	12.41	2.76
T_9: SP+LR_1	53.52	4.87	4.11	2383	15.05	3.34
T_{10}: SP+LR_2	53.12	4.86	4.06	2424	15.36	3.41
T_{11}: LR_1+LR_2	53.77	4.92	4.24	2243	13.77	3.06
T_{12}:ST+SP+LR_1+LR_2	55.45	5.09	4.40	2138	12.89	2.86
S. Em.±	2.47	0.170	0.155	181.6	1.28	0.28
C.D. at 5%	NS	NS	NS	NS	NS	NS
	90 DAP					
T_1: control	81.30	5.34	4.62	4494	39.01	8.67
T_2: ST	108.67	6.56	5.54	3070	21.46	4.77
T_3: SP	86.09	5.54	4.82	3686	31.08	6.91
T_4: LR_1	90.09	5.96	4.90	3242	24.76	5.50
T_5: LR_2	87.37	5.78	4.86	3312	24.96	5.55

T_6: ST+SP	99.92	6.44	5.03	3175	23.07	5.13
T_7: ST+LR_1	103.85	6.42	5.21	3009	20.44	4.54
T_8: ST+LR_2	101.12	6.40	5.13	2977	20.31	4.51
T_9: SP+LR_1	84.92	5.58	4.71	3616	30.31	6.74
T_{10}: SP+LR_2	82.94	5.38	4.61	3738	30.65	6.81
T_{11}: LR_1+LR_2	86.02	5.57	4.81	3219	23.83	5.30
T_{12}:ST+SP+LR_1+LR_2	98.49	6.33	5.00	3041	21.26	4.72
S. Em.±	2.04	0.157	0.105	123.9	1.47	0.33
C.D. at 5%	6.02	0.463	0.309	365.8	4.34	0.97

ST: Shoot thinning, SP: Shoot positioning, LR_1: Leaf removal 15cm from the base of the shoot, LR_2: Removal of two leaves before bunch and two leaves after bunch

Table 2: Effect of canopy architecture management on yield parameters of grape cultivar Sharad seedless (Pooled data of two years)

Treatment	Number of bunches per cane	Number of bunches per vine	Bunch length (cm)	Bunch Breadth (cm)	Bunch weight (g)	Bunch volume (cm^3)	Fruit yield per vine (kg)	Fruit yield (t ha^{-1})
T_1: control	1.15	40.17	14.42	9.08	252.4	236.3	10.16	22.57
T_2: ST	1.06	37.25	16.46	10.64	302.1	281.0	11.23	24.96
T_3: SP	1.12	39.08	14.48	9.43	257.0	240.2	9.99	22.20
T_4: LR_1	1.16	40.67	17.14	11.06	345.8	320.3	14.00	31.11
T_5: LR_2	1.15	40.25	16.94	10.99	339.9	317.9	13.72	30.50
T_6: ST+SP	1.04	36.33	16.25	10.36	285.9	266.0	10.44	23.19
T_7: ST+LR_1	1.03	35.83	17.83	11.56	359.1	336.5	12.86	28.59
T_8: ST+LR_2	1.02	35.67	17.56	11.35	350.2	327.5	12.50	27.78
T_9: SP+LR_1	1.10	38.33	15.46	9.87	276.6	257.4	10.64	23.63
T_{10}: SP+LR_2	1.07	37.58	15.63	9.58	274.7	249.6	10.25	22.77
T_{11}: LR_1+LR_2	1.10	38.58	16.76	10.89	329.3	307.0	12.66	28.13
T_{12}:ST+SP+LR_1+LR_2	1.05	36.83	16.42	10.22	290.3	270.8	10.71	23.81
S. Em.±	0.04	1.35	0.45	0.28	12.72	10.03	0.52	1.14
C.D. at 5%	NS	NS	1.34	0.82	37.54	29.61	1.53	3.37

ST: Shoot thinning, SP: Shoot positioning, LR_1: Leaf removal 15cm from the base of the shoot, LR_2: Removal of two leaves before bunch and two leaves after bunch

Conclusion

From the present investigation it can be concluded that, among the different canopy management practices shoot tinning (T_2), shoot thinning followed by leaf removal from 15 cm base of the shoot (T_7) and leaf removal from 15 cm base of the shoot (T_4) was best practices to get optimum growth with higher fruit yield.

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