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IMPACT OF TIME AND LEVEL OF PRUNING ON GROWTH, FLOWERING AND YIELD CHARACTERISTICS OF ROSE

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Abstract

The study aims to determine the ideal pruning time and level in order to attain excellent flowering response. The experiment consists of two treatments with four pruning time, *viz.* T1, T2, T3, T4 and four different levels, *viz*. L1, L2, L3 and L4. Results indicated that growth, flowering and yield characters were significantly influenced by pruning time and its levels. The pruning done in T2 was found better for plant height, shoot length, number of shoots per plant, number of buds per plant, number of flowers per plant, flowers yield per plant and longer flowering duration. Maximum flower diameter and average fresh weight were obtained in T4. Additionally, in T1 pruning resulted in early bud initiation (days) and flower emergence (days). Regardless of pruning time, the level kept at 30 cm (L4) exhibited favorable growth, flowering and yield characteristics. The study demonstrated that in order to obtain, maximum rose flowers yield, the plants should be pruned at 30 cm level during second fortnight of October interval.

Introduction

Rosa bourboniana L., species in North Indian plains. It grows flowers mostly three times in a year i.e. March-April, July-August and mid-December. Moreover, the primary flowering season lasts from the months of March to April (Sood and Nagar 2004). It is used in traditional markets for offering in temples as fresh petals and garlands. As per annual report (2021-2022), the state of Haryana is cultivating rose in 0.09 thousand hectares of land with production of around 0.96 thousand tons under loose flowers and 0.40 thousand tons under cut flowers (Singh *et al.* 2023).

Pruning intensity plays an important part in influencing rose flowers yield. It is mostly done to modify the developmental phases in order to promote new growth, which will produce robust and profuse flowering (Malhotra and Kumar 2000). Pruning is one of the considerable horticulture practices both from economical and practical point of view. This technique is done in a desired manner guiding lower branches for the uptake of sufficient light to make more food, altering it towards the development stages to encourage new axillary shoots and promotes bud development (Zekavati and Zadeh 2013). When pruning is done at right time, it helps plant preserve and divert energy to the pruned shoots. Ultimately, the rejuvenated old plant will yield a greater number of flowers with desired growth habit. This practice not only controls and improves morphological and yield parameters, but also fulfil commercial demand with time fluctuations to meet the specific requirement for roses especially during off season period. However, rose production is greatly dependent upon appropriate choice of its type and cultural practices.

The cultivation of rose loose flowers is gaining utmost priority in Haryana and its nearby regions due to ease in cultivation, nearby markets, quick transportation and enhanced demand. Hence, the present study addresses the impact of pruning time and its levels on vegetative and reproductive characteristics of rose plants.

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Materials and Methods

The experiment was conducted during October, 2022 to May, 2023 and October, 2023 to May, 2024 at the Experimental Farm under Department of Horticulture, CCSHAU, Hisar, Haryana. The meteorological weather data of Hisar district (Fig 1) is representing the mean minimum temperature ranges from 3.6 to 23.4 and 4.8 to 24.5°C, maximum temperature ranges from 14.6 to 39.8°C and 11.7 to 41.8 °C, relative humidity varies from 52 to 100% and 53 to 100% in the morning and 16 to 81% & 14 to 85 and 16 to 84% in the evening, and bright sunshine hours ranges from 2.3 to 9.7 hrs and 0.5 to 9.5 hrs in the year 2022-23 and 2023-24, respectively (Fig. 1).

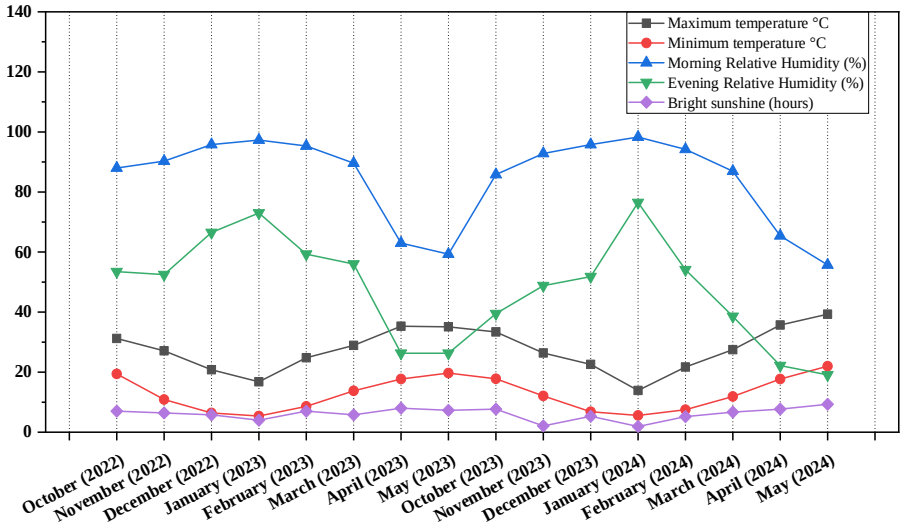

Fig 1. Temperature, relative humidity and bright sunshine hours during the course of experimentation.

The experiment was laid out in factorial randomized block design with three replications comprised of two treatments, *viz.* four pruning time at first fortnight of October (T1); second fortnight of October (T2); first fortnight of November (T3); second fortnight of November (T4) and four levels of pruning, *viz.* control (L1); 10 cm (L2); 20 cm (L3); 30 cm (L4). Three-year-old rose plants were pruned on 3rd October according to which pruning fortnight intervals was determined onwards. The rose plant was cultivated at distance of 90 cm for row to row and 60 cm for plant to plant. The rose shrubs taken under control treatment were reduced to height of 180 cm leaving five to seven main stems followed by thinning operation. While, the remaining plants were cut back to different levels with the help of secateurs. After pruning, cut ends were disinfected with copper oxychloride fungicide (Blitox @ 3g/l) to prevent infection. The plant height and plant spread were recorded at 60, 120- and 180-days interval after pruning. Meanwhile, number of buds per plant were counted at 30 days interval after pruning and up to 180 days. Total number of shoots per plant were recorded at the end of experiment. The data regarding days to first bud initiation, first flower opening, duration of flowering (days) were recorded. Fresh weight (g) of rose flowers was measured by with the help of electric weighing balance. Flower diameter (cm) was calculated with the help of vernier caliper. Number of flowers per plant were counted. Flower yield per plant (g) was represented as grams per plant by multiplying number of flowers per plant and average fresh weight of flowers (g). Resulted data was analysed via SPSS version 16.0 software (Okagbue *et al.* 2020) and OPSTAT, HAU, Hisar by Sheoran OP (Panse and Sukhatme

1995) and treatments means calculated were compared at 5% level of significance. Moreover, the correlation analysis was computed between vase life and various flowering characteristics with the help of R studio (Mendiburum and Simon 2015).

Results and Discussion

Growth, flowering and yield characteristics of rose plants revealed significant behavior towards pruning intensity at various levels and intervals as per pooled data.

The study reveals that T2 had significantly increased the plant height (cm) and shoot length (cm) at different stages of crop growth such as 60 days, 120 and 180 days after pruning (Table 1). Plant height and shoot length of treatment T2 had reached highest after 180 days of pruning with values of 120.2 and 110.1 cm, respectively. With respect to various pruning levels, pruning done at 30 cm level (L4) had also impacted both the morphological characters over other pruning levels. This may be due to the fact that low temperature and late pruning slowed down the overall growth since timely pruning is needed which help in longer branches (Abdullah *et al.* 2014). Meanwhile, early pruning would concentrate all the sources to increase the plant height (Almas *et al*. 2014).

The treatment combination of T2 and L4 had registered maximum plant height and shoot length (Fig. 2). It is clear from the pooled data that in comparison to other pruning intervals October pruned plants revealed tallest plants than November month treatments. Further, different levels of pruning were also found with more varied plant height in contrast to un-pruned plants. However, as time passes pruned plants attained their complete vegetative and reproductive growth and exceeded un-pruned rose plants. Hence, improvement in shoot length is associated with pruning intensity (Wiesman 2009).

Whereas, the reduced branches height in November month treatments was associated with insufficient time available for branches to elongate and support bud's development (Zekavati 2014). Light pruning performed three weeks after the onset of autumn were still better than pruning performed at the start of the season (Shyamalee *et al.* 2021). The number of shoots per plant were counted highest in T2 and it was statistically at par with T1 in both the respective years (Table 1 and Fig. 3). L4 exhibited highest number of shoots per plant, followed by L3 and L2 pruning level treatments. The results obtained are in agreement the findings of with Hassanein (2010) who reported that light pruning levels increased the shoots count.

Amongst different pruning time, treatment T2 exhibited maximum number of buds per plant (15.78) and minimum in T3 (9.65) when recorded after 30 days of pruning (Table 1). Pruning practice with varied time and levels had influenced rose plants physiological and morphological growth which later led to more number of buds per plant exceeding the un-pruned plants as shown in Table 1 and Fig. 4. The determined results may also be due to meteorological factors such as maximum and minimum temperature, morning and evening relative humidity and bright sunshine hours. In this study, temperature and bright sun shine hours increased with respect to the following year, whereas, relative humidity increased during first flowering period while decreased in second flowering period. Due to such environmental variations, there will be fluctuation in stomatal function of rose plants causes disturbances in growth attributes (Mortensen and Fjeld 1995).

Among the tested pruning times, earliest bud initiation (24.08 days) and first flower opening (22.06 days) were appeared in T1 treatment, followed by T2 (Fig. 5A). While, rose full blooms lasted longer (41.52 days) in T2 followed by T1. The results were further corroborated by Pal *et al.* (2014).

Flowering of rose shrubs under various pruning levels was also found significant (Fig. 5B). The un-pruned rose plants (L1) took minimum number of days for bud initiation (9.88 days) and first flower appearance (23.94 days) followed by shortest flowering duration (31.57 days).

Table 1. Effects of pruning time and its levels on growth characteristics of rose (pooled mean of 2 years).

Treatments	Plant height (cm)			Shoot length (cm)			Number of shoots per plant	Number of buds per plant					
	60 days	120 days	180 days	60 days	120 days	180 days		30 days	60 days	90 days	120 days	150 days	180 days
Pruning time (T)													
T1	62.52^{b}	87.47^{b}	116.05^{b}	61.84^{b}	81.55^{b}	106.76^{b}	22.22^{a}	10.89^{b}	56.58^{b}	76.99^{b}	9.53^{b}	36.04^{b}	78.33^{b}
T2	70.07^{a}	91.03^{a}	120.23^{a}	67.75^{a}	87.16^{a}	110.13^{a}	22.51^{a}	15.78^{a}	68.87^{a}	78.65^{a}	11.14^{a}	40.74^{a}	84.13^{a}
T3	48.70^{c}	67.83^{c}	91.27^{c}	44.00^{c}	64.40^{c}	88.86^{c}	20.65^{b}	9.65^{c}	27.78^{c}	47.33^{c}	9.05^{c}	34.25^{c}	50.88^{c}
T4	47.50^{d}	66.99^{d}	90.02^{d}	41.49^{d}	62.81^{d}	87.27^{d}	20.02^{c}	10.59^{b}	27.39^{c}	42.23^{d}	8.95^{c}	33.24^{c}	47.71^{d}
SEm±	0.38	0.12	0.26	0.20	0.31	0.37	0.12	0.27	0.38	0.48	0.15	0.56	0.30
C.D.	1.10	0.36	0.75	0.59	0.90	1.08	0.33	0.78	1.09	1.38	0.44	1.61	0.86
Level of pruning (L)													
L1	44.65^{d}	73.84^{d}	97.00^{d}	40.45^{d}	69.01^{c}	91.43^{d}	14.86^{d}	31.93^{a}	60.65^{d}	41.03^{d}	21.08^{d}	38.79^{d}	52.50^{d}
L2	56.36^{c}	74.74^{c}	101.16^{c}	53.79^{c}	69.42^{c}	96.37^{c}	16.16^{c}	4.19^{c}	34.13^{c}	60.84^{c}	4.17^{c}	30.59^{c}	62.63^{c}
L3	61.92^{b}	79.22^{b}	106.57^{b}	58.12^{b}	75.53^{b}	100.20^{b}	24.50^{b}	4.83^{c}	40.28^{b}	67.83^{b}	5.91^{b}	34.34^{b}	68.84^{b}
L4	65.86^{a}	85.52^{a}	112.83^{a}	62.73^{a}	81.96^{a}	105.01^{a}	29.88^{a}	5.96^{b}	45.56^{a}	75.51^{a}	7.52^{a}	40.53^{a}	77.08^{a}
SEm±	0.38	0.12	0.26	0.20	0.31	0.37	0.12	0.27	0.38	0.48	0.15	0.56	0.30
C.D.	1.10	0.36	0.75	0.59	0.90	1.08	0.33	0.78	1.09	1.38	0.44	1.61	0.86

Mean values in each column with the same letters are statistically at par (not significantly differing) as per Tukey's HSD test at p=0.05 level of significance; SEm±, Standard error mean; C.D., Critical difference; Treatment details are already given in Materials and Methods.

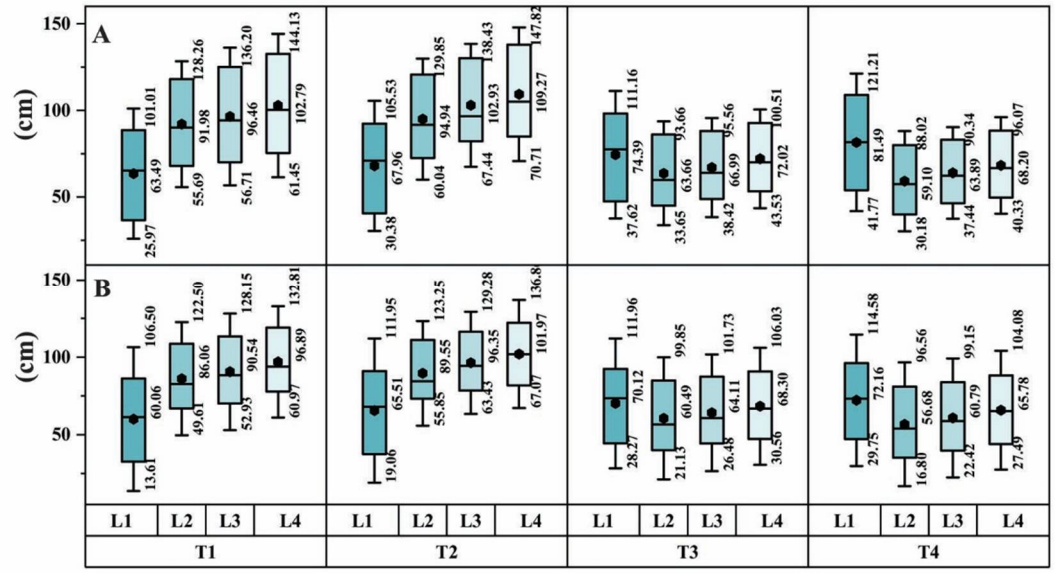

Fig. 2. Box plot represents interaction effects of pruning time and its levels on (A) plant height and (B) shoot length of rose plants (pooled mean of 2 years). The line represents median value and spot near or on the median line indicates mean value. While box represents 25th & 75th percentiles and whiskers represents minimum (at 60 days) and maximum (at 180 days).

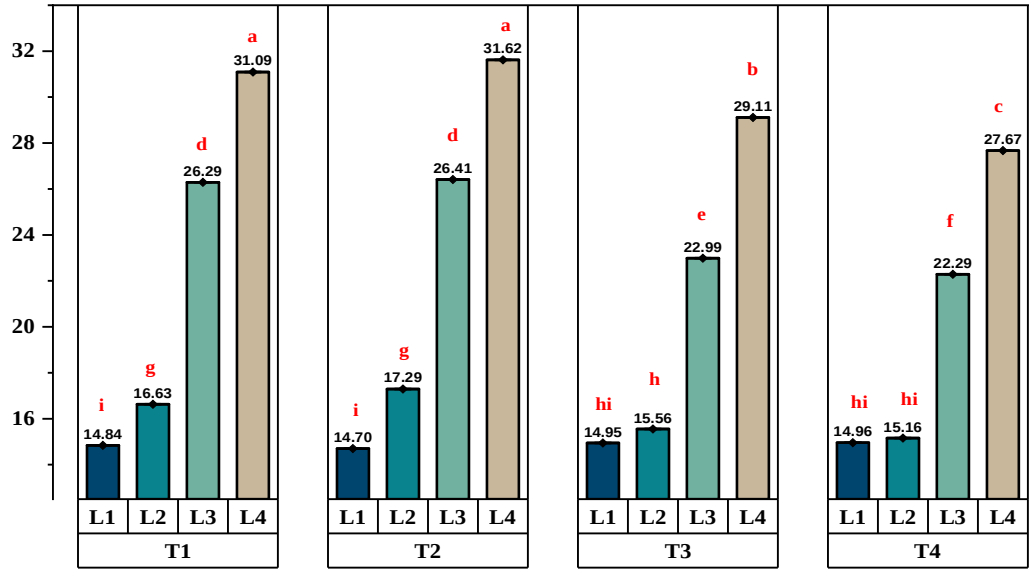

Fig. 3. Bar representing pruning time and its levels interaction effects on number of shoots per plant (pooled mean) of rose plants. Dissimilar alphabets are significantly different (p = 0.05).

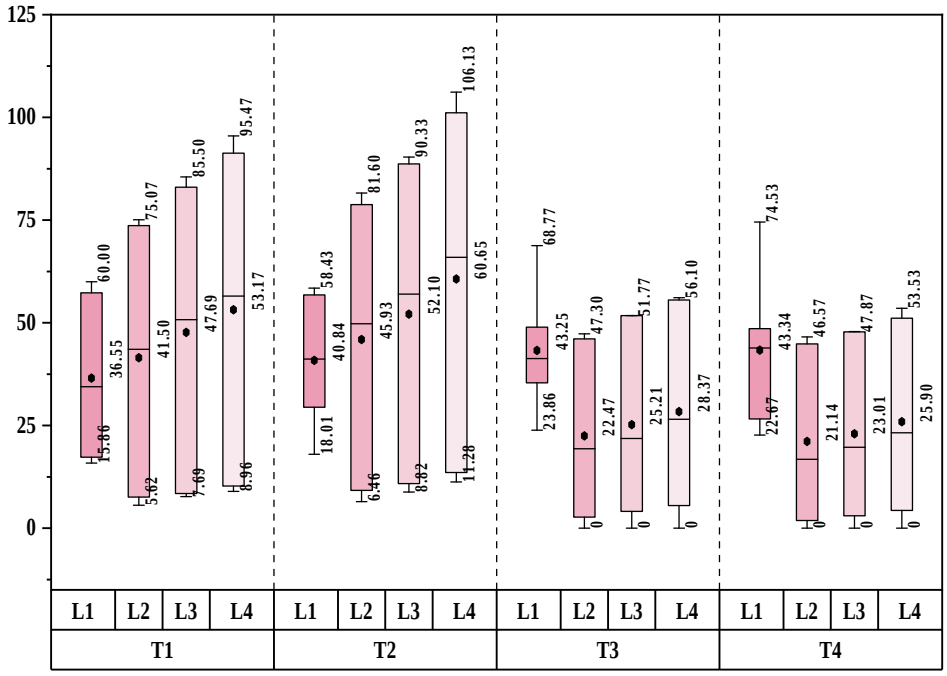

Fig 4. Box plot represents interaction effect of pruning time and its levels on number of buds per plant of rose plants (pooled mean of 2 years). The line represents median value and spot near or on the median line indicates mean value. While box represents 25th & 75th percentiles and whiskers represents minimum (at 30 days) and maximum (at 180 days).

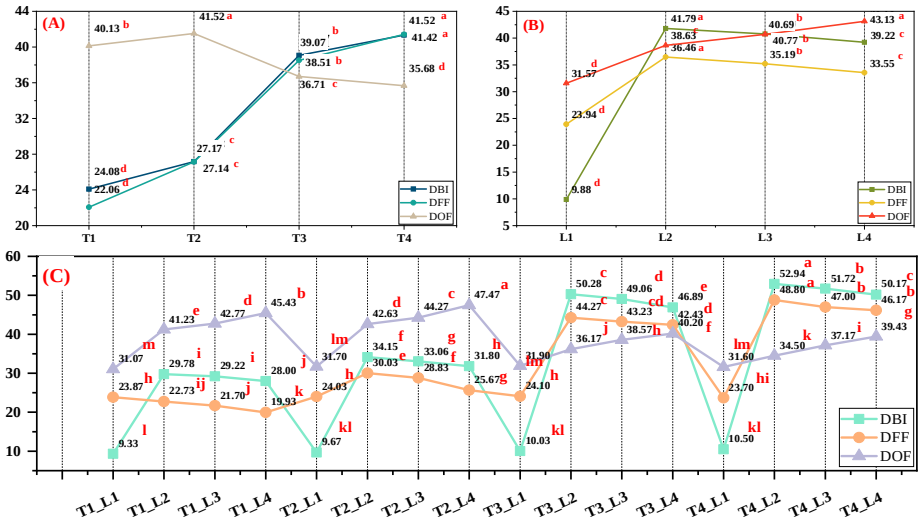

Fig. 5. Line and scatter representation of pruning time and its levels effect on flowering characters of rose plants (A) Pooled mean of pruning time (B) Pooled mean of pruning levels (C) Interaction effect. Dissimilar alphabets are significantly different (p=0.05). DBI, Days to bud initiation; DFF, Days to first flower opening; DOF, Duration of flowering.

The interactions between both the treatments was also significantly affecting the bud initiation, first flower emergence and flowering duration (Fig 5C). The treatment combination of T1L1 had exhibited earliest bud development followed by T2L1, T3L1 and T4L1. However, first flower opening was observed in T1L4 (19.93 days) followed by T1L3 (21.70 days). While, treatment combination T2L4 revealed highest flowering duration (47.47 days) followed by T1L4. The results are in close agreement with Santhoshini (2014).

The data pertaining to Table 2, Figs 5 and 6 is focusing on flowering and yield characteristics which differed significantly with respect to pruning time and its levels. Resulted pooled mean of flower diameter and average fresh weight were appeared maximum in November month fortnights treatments and minimum in October month fortnights treatments. Amongst different pruning time, rose plants pruned as per treatment T3 were concluded better in terms of maximum flower diameter (6.76 cm) and average fresh weight (6.41 g) which were also found statistically at par (6.72 cm and 6.39 g) with treatment T4, respectively (Table 2). While, pruning performed at distinct levels was resulted in smaller plants for November month treatments and tallest plants for October month treatments which ultimately help them to divert the nutritional energy more towards flowers development (Pal *et al.* 2014). According to Younis *et al.* (2013), the different rose pruning period studied had also exhibited similar results. However, pruning done in treatment T2 revealed minimum flower diameter (6.39 cm) which was statistically at par with treatment T1 (6.42 cm) in both the years, respectively. Meanwhile, an average fresh weight of rose flowers was recorded minimum in first fortnight of October (6.07 g) which was statistically at par with second fortnight of October (6.14 g). Irrespective of different pruning time, the rose shrubs planned reduction to different levels had significantly improved the flowering characteristics over un-pruned rose plants as shown in Figs 6A and B. As light pruning at 30 cm level (L4) was appeared better in terms for above flowering characters. Hassanein (2010) stated the fact that distribution of plant nutrition due to heavy pruning may contribute towards longer shoots with reduced flower size, fresh weight and vice-versa.

Table 2. Effects of time and level of pruning on growth, flowering and yield characteristics of rose.

Treatments	Flower diameter (cm)	Fresh weight (g)	Number of flowers per plant	Flowers yield per plant (g)
Pruning time (T)				
T1	6.39^{b}	6.07^{b}	138.52^{b}	848.8^{b}
T2	6.42^{b}	6.14^{b}	146.92^{a}	914.6^{a}
T3	6.76^{a}	6.41^{a}	97.54^{c}	631.15^{c}
T4	6.72^{a}	6.39^{a}	93.34^{d}	599.85^{d}
SEm±	0.02	0.03	0.86	5.55
C.D.	0.05	0.09	2.45	16.04
Level of pruning (L)				
L1	6.04^{d}	5.57^{d}	90.12^{d}	501.85^{d}
L2	6.57^{c}	6.20^{c}	114.02^{c}	703.05^{c}
L3	6.71^{b}	6.51^{b}	126.94^{b}	817.65^{b}
L4	6.96^{a}	6.74^{a}	145.24^{a}	971.80^{a}
SEm±	0.02	0.03	0.86	5.55
C.D.	0.05	0.09	2.45	16.04

Same as Table 1.

The October month treatments were dominating over the November month treatments in terms of number of flowers and yield per plant (Table 2). Treatment T2 showed excellent improvement in number of flowers and yield per plant characters over other pruning treatments. Moreover, rose shrubs which were reduced to 30 cm height (L4) had also found with highest number of flowers and yield per plant in comparison to un-pruned plants (L1). So, more early the pruning performed and at optimum height, longer will be time available in autumn for development of green stature, increase in light perception and ultimately more nutrient storage which will further led to enhanced yield with improved quality (Pawar *et al*. 2019).

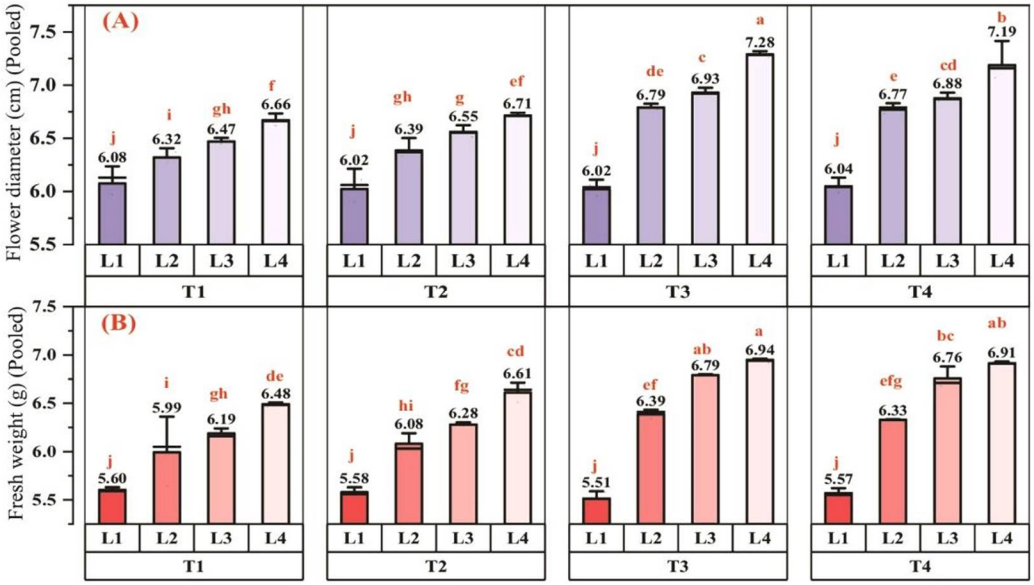

Fig. 6. Bar representing pruning time and its levels interaction effect (pooled mean) on (A) flower diameter (B) fresh weight of rose plants; Dissimilar alphabets are significantly different (p=0.05). Treatment details are already mentioned in Materials and Methods.

In control plants old shoots were incapable of producing sufficient number of flowers while pruned plants showed better response towards photosynthetic light reaction due to well-developed stature and maintained growth after pruning treatments (Mundhe *et al*. 2018).

The number of flowers and yield per plant were found steadily increasing with respect to October month pruning done at different levels in pooled data of Figs 7A and B). Since, more the number of buds more will be flower count, ultimately contributing towards yield of rose plants (Fig 7B). In addition, the number of flowers produced per plant were significantly varied with different pruning treatments effect on total number of shoots per plant. The plants pruned to 30 cm height (light pruning) were significantly better in vegetative growth than un-pruned plants.

Estimation of correlation coefficients had been done to determine the interrelationship between flowers yield per plant and other components is given in Fig. 8. Results showed that yield per plant is positively correlated with duration of flowering (r=0.95), number of flowers per plant (r=0.98), number of buds per plant (r=0.95), shoot length (r=0.84), plant height (r=0.80) and number of shoots per plant (0.81) at p<0.001. However, yield per plant was positively correlated to flowers fresh weight (r^2= 0.45) at p<0.01 and flower diameter (0.32) at p<0.05. While there was

non-significant correlation with days to bud initiation and days to first flower opening. A highly positive correlation was also obtained for number of flowers per plant with respect to number of buds per plant (0.99), shoot length (r=0.92), plant height (r=0.88), and number of shoots per plant (0.71) at p<0.001. While it was negatively correlated to days to first flower opening (r=-0.43) at p<0.01 and non-significantly correlated with average fresh weight, flower diameter and days to bud initiation. Such scenario, where a few numbers of traits significantly contributed in improving the flowers yield were documented by Tabaei-aghdaei *et al.* (2005). These positive and negative strong inter-relationship among different characteristics with respect to yield per plant would be useful in improving rose flowers quantity.

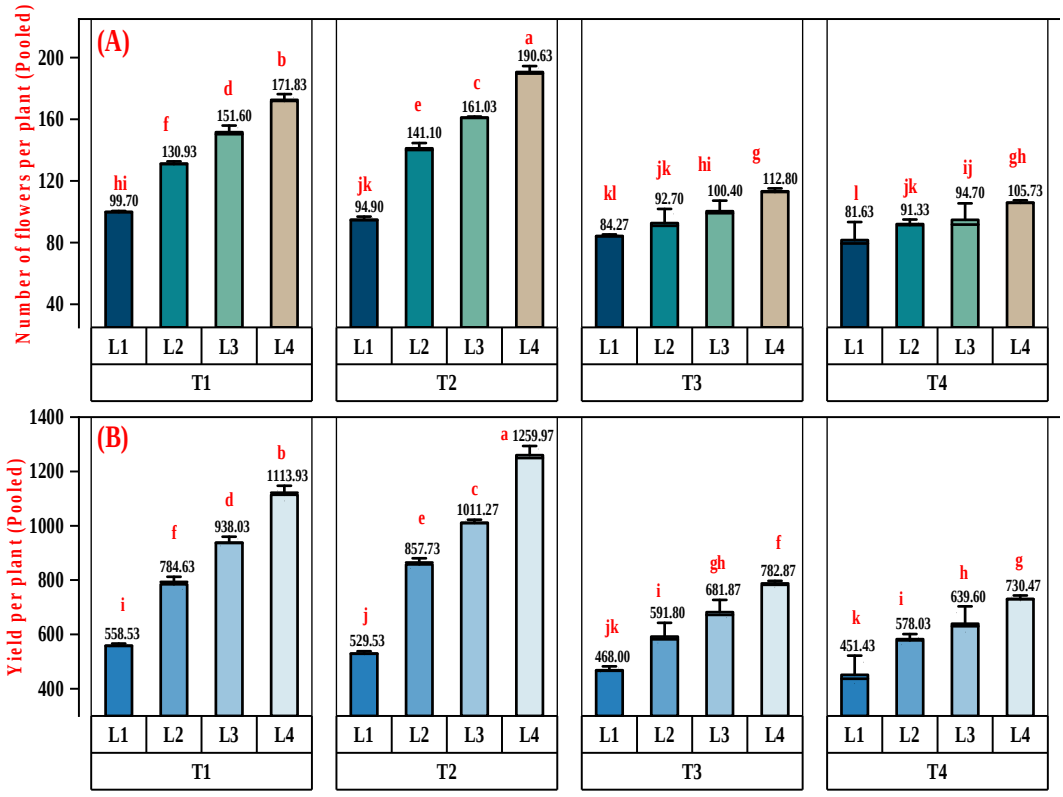

Fig. 7. Bar representing pruning time and its levels interaction effect (pooled mean) on (A) number of flowers per plant (B) flower yield per plant (g) of rose plants; Same alphabets are not significantly different (p=0.05)**.** Treatment details are already mentioned in materials and methods.

The results obtained from this experiment revealed valuable insights into the substantial effects of time of pruning and its level on various growth, flowering and yield parameters in second fortnight of October month pruning done at 30 cm level for obtaining good flower yield per plant. While, November month pruning time could improve the flower appearance in context to size and fresh weight. However, further research regarding range of pruning time and severities is required for more improvement in rose flowering characteristics.

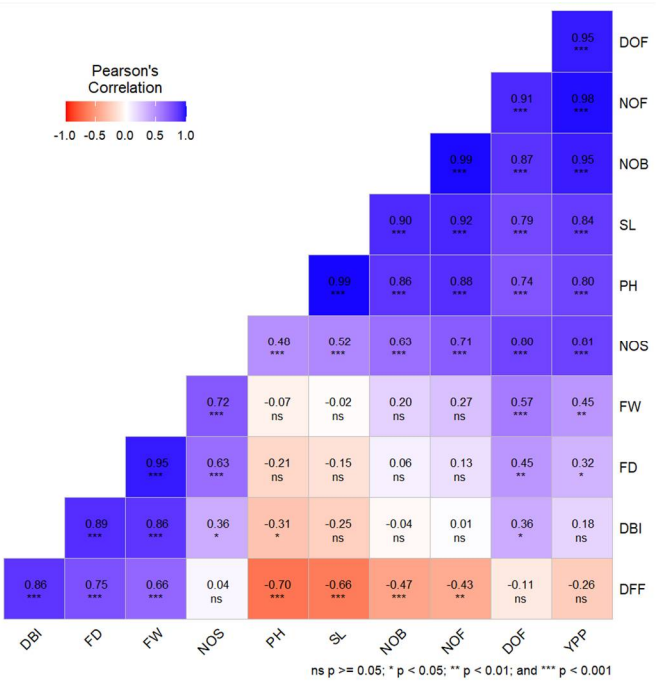

Fig. 8. Correlation coefficient analysis among quantitative traits of rose plants. The coloured bar revealing the positive correlation while moving towards dark blue colour and negative correlation when moving towards dark red colour. PH: Plant height (cm); SL: Shoot length (cm); NOS: Number of shoots per plant; NOB: Number of buds per plant; DBI: Days to bud initiation; DFF: Days to first flower opening; DFF: Duration of flowering; FD: Flower diameter (cm); FW: Average fresh weight (g); NOF: Number of flowers per plant; YPP: Yield per plant (g/plant); ns: non-significant.

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