Original Research Article

Optimization of pruning interval and height for better growth and loose flower production in Rose (*Rosa gruss-an-teplitz*) under open field conditions.

ABSTRACT

Aims: The present research was conducted in order to optimize the effect of pruning height and the time on the growth and flowering in rose under open field conditions.
Study design: The experiment was conducted using the factorial randomized block design (FRBD). It was laid out with 10 treatments using two pruning heights combined with five pruning times.
Place and Duration of Study: Department of Floriculture and Landscaping, Punjab Agricultural University, Ludhiana during 2021-23.
Methodology: Two years old plants were used for the experiment. They were planted at spacing of 90 x 70 cm. They were pruned at two different heights (45 and 90 cm) and at five different pruning times (15th September, 15th October, 15th November, 15th December and 15th January) as per the treatments.
Results: During both years of trial, it was found that plants pruned at 90 cm height on 15th September exhibited better vegetative growth in terms of plant height (144.08 and 147.78 cm) and number of branches per plant (44.00 and 46.75) as well as earlier flowering in terms of minimum days to bud appearance (31.17 and 32.00 days) and to flower opening (45.16 and 47.00 days). The maximum flower diameter (7.27 and 7.31 cm) and flower weight (5.59 and 5.38 g) were obtained in plants pruned at height of 90 cm on 15th November. However, number of flowers per plant (362.33 and 366.00) and flower yield (1715.60 and 1719.90 g/plant) were recorded maximum at pruning time of 15th November at 45 cm pruning height.

Conclusion: The pruning done at 45 cm height on 15th November showed a significant influence in improving the flower yield of *Rosa gruss-an-teplitz* under open field conditions of Punjab.

Keywords: *Rose(Rosa gruss-an-teplitz)***,** *Pruning time, Pruning height, Flowering, Flower yield*

1. INTRODUCTION

Rose is most favored flower due to its aroma and beauty and it is also referred to as "Queen of Flowers"[1]. Rose attains higher popularity in flower industry due to its different color, shape and form. As a cut flower, rose is used for making bouquets, and other decorating motive; as loose flower to make garlands and for other worshipping occasions. Rose fruit is useful for extraction of vitamin C and is used to make into jam, jelly, and marmalade. Rose hip seed oil is used in several cosmetics and skin care items[2].

Rosa gruss-an-teplitz, commonly known as '*Desi Rose '* is one of the most beautiful and fragrant red roses of the garden rose section as it produces intense red flowers. It is mainly grown for loose flower production to make garlands for different Indian festivals and marriage. Now-a-days, its commercial cultivation is being adopted by small and marginal farmers for loose flower production under Punjab conditions. As it has extraordinary flower color with long blooming phase, ease in cultivation and market demand during the whole year. Thus, it has the immense potential to generate generous income particularly for farmers with less land holdings surrounding cities[3].

The practice of pruning plays an important role in flower production of *Rosagruss-an-teplitz*. Pruning is economical and practical process which is done to regulate growth of plant and also for commercial use as per the need of loose rose flowers in market. Pruning is performed to maintain the quantity and quality of flowers. Floribunda and hybrid tea roses, which bloom often, require extensive annual pruning[1] whereas *desi gulab* blooms throughout the year due to which there is need to optimize pruning time and pruning heightto provide fuel for the initiation of flowering by sufficient ventilation that leads to low incidence of diseases to plants. The style of pruning affects the nutrient

cycle[4]. The minimal number of days needed for flower initiation may be caused by pruning's ability to increase C: N ratio, which promotes blooming and boosts plant vigour when done at an appropriate level[5]. An attempt has been made to find out optimum pruning time and height for better economic yield.

2. MATERIAL AND METHOD

The experiment was laid out at the Research Farm, Department of Floriculture and Landscaping, College of Horticulture and Forestry, Punjab Agricultural University, Ludhiana, Punjab, India during 2021-2023. The experimental site has a subtropical, semi-arid climate. In that area, winters are exceedingly cold with occasional ground frost between December and January. Summers are extremely hot and dry with desiccating winds during the months of April to June. The area receives an average annual rainfall of 800 mm, the majority of which is by SW monsoon and the remaining by western disturbances. The experiment site has slightly alkaline soil with pH 8.2 and has 80% sand, 10.5 % silt and 6.4 % clay. The experiment was executed using the Factorial Randomized Block Design. It was laid out with 10 treatments which were combinations of two pruning heights (45 and 90 cm) and five pruning times (15th September, 15th October, 15th November, 15th December and 15th January). 2 years old plants were used which were planted at spacing of 90 x 70 cm. After pruning, days to visible bud appearance and days to opening of first flower were recorded. At flowering, plant height number of branches, flower weight, flower diameter, number of flowers per plant and flower yield were recorded.

3. RESULTS AND DISCUSSION

3.1 PLANT HEIGHT (cm)

In *Rosa gruss-an-teplitz*, the different pruning heights and intervals significantly influenced the plant height. The data recorded of plant height during flowering was presented in Table 1. The maximum plant height (144.08 cm) was recorded in plants that were pruned at height of 90 cm from ground level on 15th September. The same treatment resulted in maximum plant height (147.78 cm) at flowering in the second year of trial. The obtained results of plant height at flowering after pruning is because of the pruning treatments as the plants pruned at height of 45 cm usually have minimum plant height than those of pruned at height of 90 cm. The minimum plant heights (67.58 cm and 70.00 cm) during both years were obtained in plants pruned at 45 cm on 15th November. Early pruning would concentrate all the resources to increase the plant height because the lateral branches are already present[6]. Also due to the aspect that during September month temperature and day length is more which results in more vegetative growth. Similar results also reported regarding vegetative parameters like plant height as it was maximum in plants that were pruned at height of 75 cm from ground level than those plants pruned at lower height[7].

Table 1. Effect of pruning height and time on plant height (cm) at flowering in *Rosa gruss-an-teplitz*

Pruning time	2021-2022			2022-2023		
	Pruning height			Pruning height		
	PH_1 (45 cm)	PH_2 (90 cm)	Mean	PH_1 (45 cm)	PH_2 (90 cm)	Mean
PT_1 (15 September)	94.58^{BCDE}	144.08^{A}	**119.33^{a}**	96.78^{E}	147.78^{A}	**122.28^{a}**
PT_2 (15 October)	87.42^{CDE}	120.67^{ABC}	**104.04^{ab}**	86.89^{F}	119.00^{C}	**102.95^{b}**
PT_3 (15 November)	67.58^{E}	109.92^{ABCD}	**88.75^{b}**	70.00^{H}	113.89^{CD}	**91.94^{c}**
PT_4 (15 December)	76.75^{DE}	105.00^{ABCDE}	**90.88^{b}**	77.57^{GH}	109.45^{D}	**93.51^{c}**
PT_5 (15 January)	80.08^{DE}	128.08^{AB}	**104.08^{ab}**	84.12^{FG}	131.90^{B}	**108.01^{b}**
Mean	**81.28^{b}**	**121.55^{a}**		**83.07^{b}**	**124.40^{a}**	

Mean values in each column with the same letters are not significantly different according to Tukey's HSD test at $P < 0.05$.

Superscripted uppercase letters depict the interaction effect while the lower case letters depict the individual treatment effect.

3.2 NUMBER OF BRANCHES/PLANT

The data pertaining number of branches per plant during flowering was presented in Table 2. The maximum number of branches (44.00 and 46.75) were observed in plants pruned at height of 90 cm on 15th October during both years respectively. It is evident from the results that pruning maximizes the number of branches which might be due to the favorable climatic conditions. Such results are obtained because pruning assisted in reducing apical dominance, resulting in a greater number of lateral branches. Similar results of maximum number of branches were reported under light pruned plants (75 cm) than heavy (25 cm from ground level) and medium height (50 cm from ground level) pruned rose plants in October month[8].

Table 2. Effect of pruning height and time on number of branches per plant at flowering in *Rosa gruss-an-teplitz*

	2021-2022			2022-2023		
Pruning time	**Pruning height**			**Pruning height**		
	PH_1 (45 cm)	**PH_2 (90 cm)**	**Mean**	**PH_1 (45 cm)**	**PH_2 (90 cm)**	**Mean**
PT_1 (15 September)	29.08^{ABC}	38.33^{AB}	**33.70^{a}**	27.25^{C}	41.00^{B}	**34.13^{b}**
PT_2 (15 October)	43.91^{A}	44.00^{A}	**43.95^{a}**	45.15^{A}	46.75^{A}	**45.95^{a}**
PT_3 (15 November)	12.25^{C}	22.66^{BC}	**17.45^{b}**	11.29^{G}	21.00^{E}	**16.15^{d}**
PT_4 (15 December)	20.00^{C}	23.00^{BC}	**21.50^{b}**	20.45^{E}	24.14^{D}	**22.30^{c}**
PT_5 (15 January)	12.00^{C}	16.41^{C}	**14.20^{b}**	13.78^{F}	20.91^{E}	**17.35^{d}**
Mean	**23.45^{b}**	**28.88^{a}**		**23.59^{b}**	**30.76^{a}**	

Mean values in each column with the same letters are not significantly different according to Tukey's HSD test at $P < 0.05$.
Superscripted uppercase letters depict the interaction effect while the lower case letters depict the individual treatment effect.

3.3 DAYS TO BUD APPEARANCE AND FIRST FLOWER OPENING

It is clear from the results that during both years of trial, earlier bud appearance (31.17 and 32.00 days) and first flower opening (45.16 and 47.00 days) occurred in plants that were pruned at 90 cm height from ground level on 15th September (Fig. 1). However, maximum days to bud appearance and first flower opening were taken by the plants pruned on 15th November at 45 cm height. This may be the result of increased photosynthesis due to the plant's accelerated vegetative development, which may have been used to produce flowers of higher quality. The minimal number of days needed for flower initiation may be caused by pruning's ability to increase C:N ratio, which promotes blooming and boosts plant vigour when done at an appropriate level. Also, lesser days taken for bud appearance were due to the climatic conditions as during high temperature conditions, more vegetative and reproductive growth take place which results in early bud appearance that's why in September month pruned plants, bud formation takes place early. Hence, earlier flower opening and flowering. In *Jasminum sambac*' similar results were obtained in case of pruning height that plants pruned at more height took lesser number of days for visible bud appearance[9].

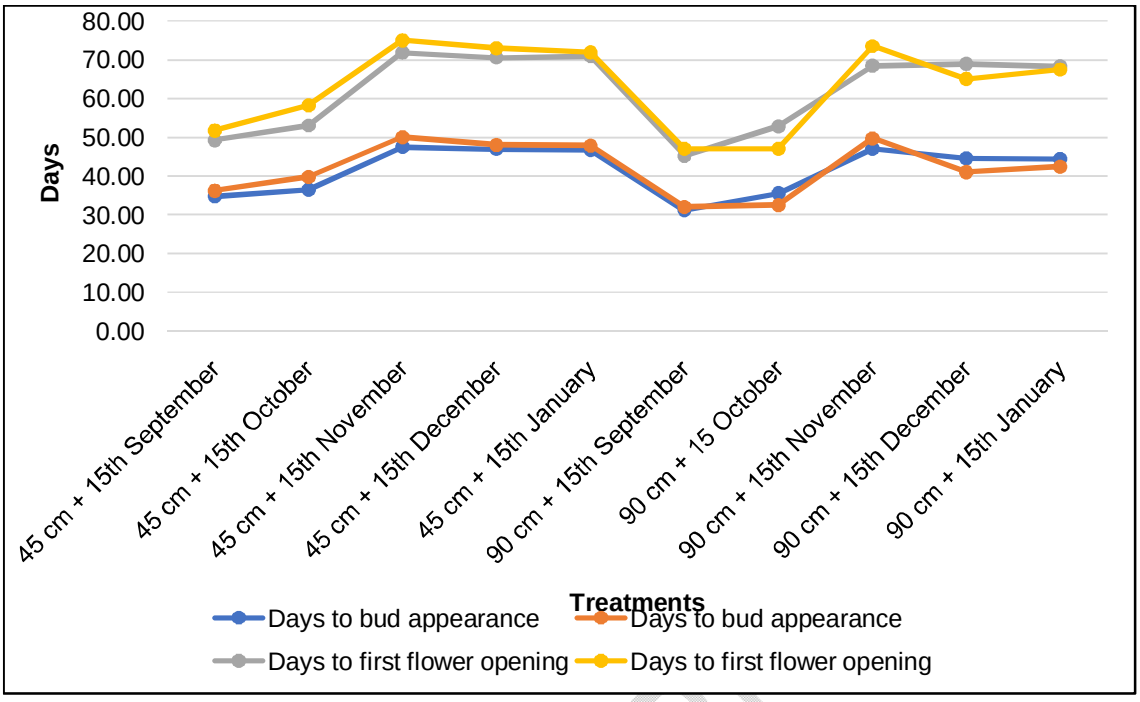

Fig. 1: Effect of pruning height and time on days to bud appearance and first flower opening in *Rosa gruss-an-teplitz*

3.4 FLOWER DIAMETER (cm)

The data pertaining flower diameter after pruning was presented in Table 3.Recorded data of flower diameter was significantly influenced by different pruning heights and pruning time. During the first year of experiment, the maximum (7.27 cm) and minimum (6.64 cm) flower diameter were found in flowers of plants pruned on PT_3 (15th November) and on PT_1 (15th September) at PH_2 (90 cm) and PH_1 (45 cm) height respectively. In the second year, the maximum flower diameter (7.31 cm) was obtained in the same treatment as in first year which was at par with other pruning times at 90 cm pruning height. While the minimum flower diameter (6.15 cm) was obtained in the treatment of pruning height of 45 cm done on 15th October. These outcomes may be attributable to the proper positioning of pruning, which boosted light absorption within the canopy and maintained an adequate number of metabolic sinks and the higher stem water potential which was beneficial to increase flower size and number.Also, pruning mostly boosts the new growth with higher amount of plant reserved food materials, which are accorded with diameter and food materials are reserved in plants that are pruned late at adequate level of pruning due to which in November month pruning maximum flower diameter is recorded. Plants pruned during low temperature conditions also result in more diameter of flower as compared to plants pruned at high temperature. Pruning at more height (90 cm) during November month resulted in more flower diameter than lower height pruned plants was reported in *Rosa damascene* also[10].

3.5 WEIGHT OF FLOWER (g)

The data recorded of flower weight at flowering was presented in Table 4.Pruning height and time significantly affected the individual flower weight. In both years, maximum flower weights (5.59 g and 5.38 g) were observed in pruning height treatment PH_2 (90 cm) done on PT_3 (15th November) while minimum flower weights (3.51 and 3.78 g) were obtained with treatment PH_1 (45 cm)+ PT_1 (15 September). Pruning at different heights and time shows variation in flower weight. In case of flower number, it is evident from the results that pruning at more height results in more flower weight which might be due to the increased flower diameter as recorded in the experiment. Also, when plants pruned in November, temperature remains low till flowering due to which also weight of flowers was increased. Similar results of increased flower weight by pruning during November month were obtainedin *Rosa indica*[11]. It was also reported in *Jasminum sambac* that pruning performed at more height results in increased flower weight[5].

Table 3. Effect of pruning height and time on flower diameter (cm) in *Rosa gruss-an-teplitz*

Pruning time	2021-2022			2022-2023		
	Pruning height			Pruning height		
	PH_1 (45 cm)	PH_2 (90 cm)	Mean	PH_1 (45 cm)	PH_2 (90 cm)	Mean
PT_1 (15 September)	6.64^{C}	6.85^{ABC}	**6.74^{C}**	6.45^{B}	7.14^{A}	**6.80^{ab}**
PT_2 (15 October)	6.75^{BC}	6.89^{ABC}	**6.82^{BC}**	6.15^{B}	6.95^{A}	**6.55^{b}**
PT_3 (15 November)	7.06^{ABC}	7.27^{A}	**7.16^{A}**	7.00^{A}	7.31^{A}	**7.16^{a}**
PT_4 (15 December)	6.91^{ABC}	7.18^{AB}	**7.04^{AB}**	7.05^{A}	6.94^{A}	**7.00^{a}**
PT_5 (15 January)	6.78^{ABC}	7.01^{ABC}	**6.90^{ABC}**	6.89^{A}	6.90^{A}	**6.90^{ab}**
Mean	**6.83^{B}**	**7.04^{A}**		**6.71^{a}**	**7.05^{a}**	

Mean values in each column with the same letters are not significantly different according to Tukey's HSD test at $P < 0.05$.
Superscripted uppercase letters depict the interaction effect while the lower case letters depict the individual treatment effect.

Table 4. Effect of pruning height and time on weight of flower (g) in *Rosa gruss-an-teplitz*

Pruning time	2021-2022			2022-2023		
	Pruning height			Pruning height		
	PH_1 (45 cm)	PH_2 (90 cm)	Mean	PH_1 (45 cm)	PH_2 (90 cm)	Mean
PT_1 (15 September)	3.51^{B}	3.82^{B}	**3.67^{b}**	3.78^{D}	4.34^{C}	**4.06^{b}**
PT_2 (15 October)	5.21^{A}	5.49^{A}	**5.35^{a}**	5.17^{AB}	5.27^{AB}	**5.22^{a}**
PT_3 (15 November)	5.24^{A}	5.59^{A}	**5.42^{a}**	5.00^{AB}	5.38^{A}	**5.19^{a}**
PT_4 (15 December)	5.12^{A}	5.42^{A}	**5.27^{a}**	5.03^{AB}	5.18^{AB}	**5.11^{a}**
PT_5 (15 January)	5.07^{A}	5.42^{A}	**5.24^{a}**	4.90^{B}	5.08^{AB}	**4.99^{a}**
Mean	**4.83^{b}**	**5.15^{a}**		**4.78^{a}**	**5.05^{a}**	

Mean values in each column with the same letters are not significantly different according to Tukey's HSD test at $P < 0.05$.
Superscripted uppercase letters depict the interaction effect while the lower case letters depict the individual treatment effect.

3.6 NUMBER OF FLOWERS/PLANT

It was found that interaction treatments had significant influence on the of number of flowers per plant from pruning to six months (Table 5). The maximum (362.33 and 366.00) number of flowers were found under treatment PH_1+ PT_3 (45 cm + 15thNovember) during both years. While treatment PH_2+ PT_5 (90 cm + 15th January) recorded minimum (126.33 and 129.67) number of flowers per plant from pruning to six months. It is obvious from the data that maximum number of flowers per plant were recorded in plants pruned at lower height. It can be explained by the beneficial effect of pruning at lower height above ground level which results in production of more rose flowers per plant. The increase in number of flowers per plant recorded in 45 cm height pruned plants may be due to pruning done at optimum height which increased the light interception within canopy, maintained adequate amount of metabolic sinks and improved stem water potential that could have caused increased number of flower per plant. This might be due to more vigorous growth and productive shoots also. In case of pruning time, September month pruned plants recorded more number of flowers per plant followed by October, November, December and January month pruned plants. It might be due to the

fact that September month pruned plants get more time to flowering because of early pruning. The above obtained results are with close conformity with the findings in *Jasminum samba*c of maximum number of flowers under less height pruned plants[7].

Table 5. Effect of pruning height and time on number of flowers per plant in *Rosa gruss-an-teplitz*

Pruning time	2021-2022			2022-2023		
	Pruning height			Pruning height		
	PH_1 (45 cm)	PH_2 (90 cm)	Mean	PH_1 (45 cm)	PH_2 (90 cm)	Mean
PT_1 (15 September)	329.67^{AB}	204.33^{BC}	**267.00^{a}**	331.33^{B}	210.00^{D}	**270.67^{c}**
PT_2 (15 October)	329.33^{AB}	241.67^{ABC}	**285.50^{a}**	332.67^{B}	242.00^{C}	**287.34^{b}**
PT_3 (15 November)	362.33^{A}	240.00^{ABC}	**301.17^{a}**	366.00^{A}	243.33^{C}	**304.67^{a}**
PT_4 (15 December)	198.33^{C}	168.00^{C}	**183.17^{b}**	197.00^{E}	172.33^{F}	**184.67^{d}**
PT_5 (15 January)	194.00^{C}	126.33^{C}	**160.17^{b}**	191.00^{E}	129.67^{G}	**160.34^{e}**
Mean	**282.73^{a}**	**196.07^{b}**		**283.60^{a}**	**199.47^{b}**	

Mean values in each column with the same letters are not significantly different according to Tukey's HSD test at $P < 0.05$.
Superscripted uppercase letters depict the interaction effect while the lower case letters depict the individual treatment effect.

Table 6. Effect of pruning height and time on flower yield per plant (g) in *Rosa gruss-an-teplitz*

Pruning time	2021-2022			2022-2023		
	Pruning height			Pruning height		
	PH_1 (45 cm)	PH_2 (90 cm)	Mean	PH_1 (45 cm)	PH_2 (90 cm)	Mean
PT_1 (15 September)	1270.30^{AB}	917.90^{BC}	**1094.10^{bc}**	1383.48^{B}	1056.05^{E}	**1219.77^{c}**
PT_2 (15 October)	1685.10^{A}	1109.00^{BC}	**1397.10^{ab}**	1656.65^{A}	1129.80^{D}	**1393.23^{b}**
PT_3 (15 November)	1715.60^{A}	1325.50^{AB}	**1520.60^{a}**	1719.90^{A}	1275.34^{C}	**1497.62^{a}**
PT_4 (15 December)	1033.00^{BC}	939.70^{BC}	**986.40^{c}**	990.91^{F}	892.67^{G}	**941.79^{d}**
PT_5 (15 January)	984.60^{BC}	684.20^{C}	**834.40^{c}**	935.90^{G}	658.73^{H}	**797.32^{e}**
Mean	**1337.70^{a}**	**995.20^{b}**		**1337.37^{a}**	**1002.52^{b}**	

Mean values in each column with the same letters are not significantly different according to Tukey's HSD test at $P < 0.05$.
Superscripted uppercase letters depict the interaction effect while the lower case letters depict the individual treatment effect.

3.7 FLOWER YIELD/PLANT (g)

The maximum flower yield (1715.60 and 1719.90 g/plant) recorded in pruning time 15th November with 45 cm of pruning height (Table 6) which was at par with plants pruned at same height on 15th October. The reason explaining the more flower yield per plant might be due to the pruning done at optimum time at proper level from ground level which leads to the proper vegetative growth that ultimately enhanced the reproductive growth by producing more flowers. Both October and November month pruned plants recorded more flower yield as compared to other treatments because during these months maximum flower weight were recorded. However, minimum flower yield (684.20 and 658.73 g/plant) was obtained in plants pruned on 15th January at 90 cm height.

4. CONCLUSION

On the basis of results obtained in present investigation, it is concluded that optimum pruning height 45 cm during October -November had a significant impact in improving flower yield of *Rosa gruss-an-teplitz*under open field conditions of Punjab.

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