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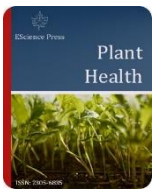

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Effect of Pruning Heights on Vegetative and Reproductive Response of Rosa *Gruss-an-teplitz*

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ABSTRACT

Rosa Gruss-an-teplitz, belongs to *Rosaceae* family, commonly known as 'Desi Rose', is one of the beautiful red roses of the old garden rose section and produces flowers almost throughout the year. Roses are pruned regularly every year for regulating growth and flowering. This enhances the number, size, and quality of the flowers. Therefore, response of *Gruss-an-teplitz* to pruning heights at (Control, 01, 1.5, 02, 2.5, 03, 3.5 ft.), was evaluated in an experimental field. Pruning at 2.5 ft. had significant effects on studied parameters, including vegetative and reproductive plant growth, flower yield and gaseous exchange. This experiment was laid out under Randomized Complete Block Design (RCBD) using three replications per treatment. Pruning at (2.5 ft.) significantly improved growth, in terms of higher leaf area (129.55 cm^2), plant height (77.01 cm), number of flowers (658.02), flower weight (4.51 g) and flower diameter (7.86 cm) with respect to other treatments. Chlorophyll a (1.57 mg/g), Chlorophyll b (2.73 mg/g), stomatal conductance (gs) (68.62) and photosynthetic rate (3.06) were also increased by pruning at (2.5 ft.). Pruning application at 2.5 ft. improved biomass, water preservation, pigments, enzymatic activity, leaf gaseous exchange, and flower yield of *Gruss-an-teplitz*.

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INTRODUCTION

Gruss-an-teplitz belongs to *Rosaceae* family is famous among roses with high demand in the local and international markets. It is an important variety of Rosa species which produces red color fragrant flowers, used for ornamental purposes and essential oil extraction (Akhtar *et al*., 2021). Known for high demand throughout the year due to extensive use of its flowers in different occasions like marriage ceremony, death ceremony, Eid festival etc. This industrially important floricultural crop is extensively used for medical, pharmaceutical and food industries. Moreover, it is commonly used as bedded or potted plant in lawns (Gulzar *et al.,* 2019). *Gruss-an-teplitz* could be propagated asexually using grafting, cutting and budding. Scientists are trying to enhance flowering of floricultural crops by different factors like environment, genetics, nutrition and plant growth regulators. Positive role of plant growth regulator and plant extracts for enhancing vegetative and reproductive growth in

various ornamental crops have been reported by different scientists (Pervez *et al*., 2017).

Canopy management in rose cultivation is to produce a well-managed, healthy plant. Pruning can be viewed as a practical and economically viable canopy management approach; pruning boosts the metabolic sinks, turgor pressure, and photosynthetic light reaction in rose plants (Ahmad *et al*., 2019). In addition to encouraging plant growth and development, it controls flowering at different times of the year (Nadeem *et al*., 2017). In order to control a plant's structure and flowering branches, pruning entails the removal of either a plant's shoot or root components. Main purpose of pruning the shoot parts are to make a healthy plant, encourage the shape of the plant and discharge the sick offshoots of the plant (Guleria, 2016).

Pruning also has an impact on the morphological and yield characteristics of roses (Shyamalee *et al*., 2021). Pruning can boost physical characteristics like the number of leaves and flowers per plant. Like in all ornamental roses, in aromatic roses regular pruning has been found to positive impact. In short, pruning has a key role in modifying the vegetative and yield contributing factors of roses. Nitrogen cycle is also influenced by the height and type of pruning (Hassan and Fetouh, 2019). However, according to their species, variation, and ecological conditions, roses require varying types, levels, and timing of pruning (Mahajan and pal, 2020). The plant becomes robust enough to produce more flowers with higher weight by employing the absorbed food when nutrients are more readily available during the entire growing period. Results for flower diameter closely resemble those for the rose cultivar "*Gruss-an-teplitz*," where the largest flower diameter was measured after applying more nitrogen. Additionally, it had been noted that marigold flowers grew to their largest size at reduced plant densities (Pratibha *et al*., 2018).

Top-pruning is an effective technique in the growth pattern of oil-bearing roses. To boost flower quantity and quality, as well as to make agronomic procedures and the harvesting process easier, the upper portions of rose bushes are clipped using this method in the early spring months (Oliveira *et al*., 2021). Pruning must be done at the proper time to avoid harming the plants and still yield the desired results (Riedel *et al*., 2019). As a result, it is important to regularly monitor the climate of the growing location and prune rose plants at the appropriate time. The yield and quality of flowers were significantly affected by top pruning of oil rose plants. With the changing interval for the international standard (ISO 9842), it had a particular impact on the chemicals found in rose oil (Pal and Mahajan, 2017). Delaying the pruning from 15 date of March to 15 April dramatically improved the total flower output and essential oil content. The bushes of the plants that weren't pruned produced the most flowers. To cut pruning costs and boost flower yield, top trimming might be suspended for a few years. Plant height to moderate top pruning generally enhanced flowers production and flowers essential oil content, whereas extreme pruning lowered both. By removing old twigs and replacing them with fresh, healthy ones, this procedure helps to increase bloom production (Suchocka *et al*., 2021). Therefore, it is necessary to increase flower production and to improve plant growth.

Keeping in view value of the crop, presented research was aimed at improving vegetative and reproductive growth as well as to improve yield of rose (*Rosa Gruss-an-teplitz*) through pruning at different heights.

MATERIAL AND METHODS

Experiment Site Location and Condition

The study was carried out in field area, Horticultural Research Sub-Station for Floriculture and Landscaping, Multan (31°30′ N, 73°10′ E, elevation 213 m). Two-years-old *Gruss-an-teplitz* plants were pruned in October 2022-23 at different pruning heights.

Experiment Design and Methodology

Experimental treatments were set according to (RCBD) Randomized Complete Block Design. In this experiment, seven (07) different treatments were selected for pruning of rose plants with different pruning heights during winter season year 2022-23. Each treatment was replicated three times. Experimental units were consisting of one-year-old, healthy uniform raised plants. T_0 (control) No pruning, T_1 (Pruning at 1 feet height), T_2 (Pruning at 1.5 feet height), T_3 (Pruning at 2 feet height), T_4 (Pruning at 2.5), T_5 (Pruning at 3 feet height), T_6 (Pruning at 3.5 feet height), All standard cultural practices like irrigation, weeding, fertilization, hoeing, plant protection measures etc. of rose production were done similarly as recommended in all treatments. Then data was recorded vegetative growth parameters plant height (cm), number of leaves and branches plant $^{-1}$, shoot length (cm), stem diameter (cm),

leaf area cm^2, Reproductive parameters number of days to flower bud opening and flowering duration, number of flowers $palnt^{-1}$, flower diameter (cm^2), Flower weight (gm), total yield $plant^{-1}$, flower fresh/dry weight (gm),dry meter %age, Chlorophyll A and B (mg/g FW), physiological parameters like stomatal conductance (gs) (μmol H_2O $m^{-2}s^{-1}$), respiration rate CO_2 (mg kg^{-1} h^{-1}). The above set of observations recorded regarding the growth, yield and quality of *Rosa Gruss-an-teplitz* were recorded using standard protocols and procedures.

Statistical Analysis

The experimental data obtained through observation were statistically analyzed by analysis of variance (ANOVA) using 8.1 statistical software and least significance difference (LSD) test at 5% probability level.

RESULTS

Effect of Different Pruning Height on Vegetative Growth

Composed data concerning at different pruning height to rose plant were collected and subjected to the statistical analysis illustrated significant effect on the pruning heights on plant vegetative growth parameters in Rosa *Gruss-an-teplitz* are given in Table 1. Analysis of variance revealed that top-pruning practice had highly-significant effects on plant height. Treatment averages were evaluated by using the LSD test and the results are provided in the table 1. Tallest plant was recorded in T_5 (77 cm) while minimum plant height recorded in T_3 (62 cm). Evaluation of means regarding number of leaves $plant^{-1}$ T_1 performed well in this character (541.70) leaves with maximum shoot length (116.49cm) while minimum leaves $plant^{-1}$ recorded in T_6 (361.50) with shoot length (35.80cm). T_3 performed well for mean number of branches $plant^{-1}$ with (108.34 branches) while minimum was recorded in T_0 (35.71 branches).

Maximum stem diameter was recorded in T_4 (0.87cm) with average leaf area (129.55mm^2) while minimum in T_0 (0.23cm) with average leaf area (105.11mm^2). Current results were synonymous to the findings of Saffari *et al*., (2004) who concluded that pruning during early winter season increases the plant height and other vegetative characteristics of plants. Pruning in winter increase the number of branches in rose plants, which is unswerving with the results of Pal *et al*. (2017). More number of branches resulted more flower yield as the number of flowering bud increases.

Table 1. Effect of pruning heights on vegetative growth of *Rosa Gruss-an-teplitz*.

Pruning Treatments	Plant Height (cm)	No of leaves	No. of branches	Shoot length	Stem diameter	Leaf area
T0	57.30 E	430.13 B	35.71 F	30.40 G	0.23 E	105.11 E
T1	70.48 C	541.70 A	72.30 D	116.49 A	0.60 C	114.18 D
T2	72.38 BC	428.16 C	108.34 A	50.48 E	0.72 B	118.48 BC
T3	62.45 D	427.55 C	85.51 C	40.45 F	0.67 BC	119.20 C
T4	74.20 B	364.60 CD	90.55 B	75.47 B	0.87 A	129.55 A
T5	77.01 A	361.50 C	72.93 D	60.51 C	0.63 C	125.71 B
T6	70.48 C	361.49 C	68.83 E	35.80 G	0.41 CD	110.43 BC

Values are mean ± SE and letters represent significant difference at P≤0.05 according to LSD.

Effect of different Pruning Height on Reproductive Growth

Evaluation of mean regarding minimum number of days to flower bud sprouting (26.32days) number of days to flowering (38.54days), maximum flowering duration (330.08days) was recorded in T_0 while maximum was recorded in T_1. Maximum number of flowers $plant^{-1}$ was recorded in T_0 (658.02) followed by T_5 (652.28) while minimum was recorded in T_2 (468.50). Maximum single flower weight and diameter was recorded in T_4 (4.51gm), (7.86cm^2) while minimum were recorded in T_1 (2.73gm), (5.90 cm^2). Increased flower numbers (FN, FW, FD and BED) attributes showed plant response to pruning heights that may be due to improved different pruning heights (Mahajan and pal, 2020).

Table 2. Effect of pruning heights on reproductive growth of *Rosa Gruss-an-teplitz*,

Pruning Treatments	No. of days to bud sprout	No. of days to flowering	Flowering duration (Days)	No. of flowers	Singal Flower weight (gm)	Flower Diameter cm^2
T0	26.32 E	20.91 F	330.08 A	468.50 F	3.78 CD	6.03 E
T1	32.50 A	50.50 A	327.50 B	546.00 D	2.73 E	5.90 F
T2	30.25 B	48.25 B	316.75 F	550.55 DE	3.02 D	6.50 E
T3	29.24 BC	45.24 BC	320.76 DE	628.05 C	3.24 D	7.60 B
T4	27.08 C	42.08 CD	322.92 CD	658.02 A	4.51 A	7.86 A
T5	28.46 BC	40.30 E	324.50 D	652.28 B	4.25 B	7.56 C
T6	28.30 D	41.74 D	326.78 C	546.10 DE	3.56 C	7.43 D

Values are mean ± SE and letters represent significant difference at P≤0.05 according to LSD.

Effect of different Pruning Height on Flowering Parameters

Maximum flower fresh/dry weight was recorded in T_0 (2257.90gm) and (950.30gm) while minimum was recorded in T_1 (1478.40gm) and (546.70gm). Maximum leaves fresh/dry weight was recorded in T_4 (478.86gm) and (95.77gm) minimum leaves fresh/dry weight was recorded in T_0 (294.26gm) and (67.50gm). Maximum dry matter %age was recorded in T_2 and T_4 (20.00 %age) while minimum dry matter %age was recorded in T_0 and T_6 (19.98 %age).

Physiological parameters

Highest chlorophyll a and b contents were recorded in T_2 (1.57) and (2.62) while lowest was recorded in T_0 (1.20) and (2.20). Maximum Gas attributes (gs) was recorded in T6 (68.66) while minimum was recorded in T_0 (52.67). Maximum photosynthetic efficiency rate was recorded in T_4 (2.93) while minimum photosynthetic rate was recorded in T_0 (1.95).Higher water transpiration rate was recorded in T_4 (2.56) while lowest was recorded in T_0 (1.53). Higher chlorophyll pigments in the present study showed increased photosynthetic activity that significantly increased plant biomass of *Gruss-an-teplitz*. Similar correlation of increased chlorophyll with improved growth in bent grass was recorded by Geng *et al*. (2020).

Table 3. Effect of pruning heights on flowering characteristics of *Rosa Gruss-an-teplitz*.

Pruning Treatments	Fresh flower weight / plant (gm)	flower dry weight (gm)	Leaves fresh weight (gm)	Leaves dry weight (gm)	Leaves dry matter (%age)
T0	1478.40 G	295.68 F	294.26 F	67.50 F	19.98±0.12 B
T1	1497.80 F	299.56 G	357.53 D	83.85 C	19.99±0.20 B
T2	1884.10 E	376.82 E	426.59 B	85.32 B	20.00±1.29 A
T3	1938.00 D	387.60 D	348.41 E	69.68 E	19.99±0.18 B
T4	2257.90 A	451.58 A	478.86 A	95.77 A	20.00±0.17 A
T5	2005.50 B	401.10 B	397.45 C	79.49 CD	20.00±0.12 A
T6	1956.00 C	391.20 C	383.18 CD	76.63 D	19.98±0.13 C

Values are mean ± SE and letters represent significant difference at P≤0.05 according to LSD

Table 4. Effect of pruning heights on physiological and pigments components of *Rosa Gruss-an-teplitz*.

Treatments	Chl a	Chl b	Gs	Photosyntatic activity	Transpiration rate
T0	1.10 E	2.20 E	52.67 E	1.50 F	1.53 D
T1	1.53 B	2.62 B	54.33 D	2.33 E	1.64 C
T2	1.57 A	2.73 A	58.67 CD	2.56 D	1.57 D
T3	1.33 C	2.36 D	65.08 C	2.36 D	2.06 B
T4	1.50 B	2.53 C	68.62 A	2.93 B	2.56 A
T5	1.46 BC	2.51 C	67.33 B	2.84 C	2.43 A
T6	1.31 D	2.49 D	68.66 A	3.06 A	2.36 B

Values are mean ± SE and letters represent significant difference at P≤0.05 according to LSD

DISCUSSION

Pruning is very important horticultural practice to maintain the health and shape of the plant. By proper timing at standard height of pruning, one can increase the yield and quality of flowers. Rosa *Gruss-an-teplitz* flowers bump into a great mandate all over the year especially during winter season where most flowers are extinct and more chances of profitable marketing (Sharma *et al*., 2021). Pruning is a useful technique used for restarting growth and stimulating flowering of rose plants since antique times. Maximum number of leaves recorded at pruning height 1feet (541 leaves). Pruning height had noteworthy effects on plant growth and quality of flower production (Suchocka *et al*., 2021).

Maximum plant height was recorded when pruning at 3 feet whereas minimum was recorded at 1feet pruning was done. Current results were synonymous to the findings of Pal *et al*., (2017) who concluded that pruning at 2.5 feet during early winter season increases the plant canopy and other vegetative characteristics of plants. Pruning in winter increase the number of branches in rose plants, which is unswerving with the results of (Mahajan and pal, 2020). More number of branches resulted more flower yield as the number of flowering bud increases. Thus, it appears that flower yield depends on number of branches. Pruning also has an impact on the morphological and yield characteristics of roses. For example, if pruning is done 15 cm above the bud union, it can improve the quality and yield of roses. Pruning can boost physical characteristics like the number of leaves and flowers per plant (Shyamalee *et al*., 2021).

Reproductive growth of number of flowers, flower diameter, flower weight and flowering duration were recorded maximum of pruning at 2.5 ft. These reproductive growth parameters increased by pruning at 2.5 ft. because more number of branches produced which increase number of leaves. By increasing number of flowers, photosynthetic rate is increase by increasing chlorophyll molecules in leaves which resulted in maximum reproductive growth i-e increase flower yield. Physiological parameters i-e stomatal conductance, respiration rate and photosynthetic rate are also increase by increasing in chlorophyll pigments. The physiological processes and growth phases are altered by pruning operations to promote the beginning of new axillary buds. In stems that have been trimmed, flower initiation begins soon after the axillary bud development (Dora, 2000). Pruning normally done to alter the shape of the plant to make it easier to cultivate and collect roses. Further, it has been claimed that pruning boosts the metabolic sinks, turgor pressure, and photosynthetic light reaction in rose plants (Calatayud *et al*., 2007).

Due to pruning in early winter thickness of flower can appear that affects the stem length of rose flowers. Result showed that when plants pruned at height of 3 feet produce earlier flower bud formation with minimum days taken to flowering while maximum flowering duration recorded when pruning at 1.5feet. Our result are accordance with the result of Martinez and Wool (2003) who observed that when Pistacia shrub pruned on mid of winter season then earlier bud production take place. Pruning must be done at the proper time to avoid harming the plants and still yield the desired results. To prevent winter and spring frosts, oil-bearing roses shouldn't have their tops cut too early. On the other hand, plants may lose an excessive number of twigs and buds if they are clipped too late (Baydar *et al*., 2008).

Pruning mostly boosts the new growth with higher amount of plant reserved food materials, which are accorded with diameter. That might be the most conceivable reasons (Ranganathan *et al*., 2017). The results were according to the conclusion of Maguire (Mahajan and Pal, 2020) who concluded that pruning in winter season produce maximum flower diameter. Flower weight significantly influenced by the pruning time and the plants which pruned at the start of winter produce maximum fresh weight of flowers. These results are in accordance with the result of Saffari *et al*. (2004) who concluded that plants pruned in winter season produced maximum fresh weight of flowers.

Pruning date had noteworthy effects on plant growth and quality of flower production (Riedal *et al*., 2019). Maximum growth occurred when all cultural practices (i.e. pruning, weeding, fertilization etc.) were applied at proper time and stage of growth and development. Our results coordinated with the findings of (Mahajan and pal, 2020) who concluded that rose plants pruned on start of winter produce maximum growth. These conclusions also matched with the results of (Alam *et al*., 2022) who observed rose growth were excellent when pruned in early winter.

CONCLUSIONS

From the above results of this experiment, it is concluded that pruning at 2.5 ft. during end of December

in winter season was best for producing highest vegetative growth of plant and to develop flowers with improved quality and quantity of Rosa *Gruss-an-teplitz*. Pruning at 2.5 ft. showed best result in flower production.

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