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Effect of pruning height on growth and cut flower production of rose (*Rosa hybrida* L.) variety 'White Success'

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ABSTRACT

Pruning is an inevitable practice in rose cultivation which stimulates the development, flowering and longevity of the cut roses. Optimum pruning height of rose var. 'White Success' was not identified yet. Thus, the present experiment was performed to estimate the consequences of diverse pruning heights on growth and flower production of rose var. 'White Success' at the Regional Agricultural Research and Development Centre, Bandarawela, Sri Lanka from January to April 2019. The experiment was arranged according to randomized complete block design with four replications. One-year-old budded rose plants were hard pruned at 15 cm from the ground level before the commencement of the experiment and allowed to grow for a period of one month. Eight treatments were defined based on different pruning heights. Analysis of variance was performed to decide the treatment effects on measurements. Results revealed that pruning was positively influenced the growth and flowering of roses than non-pruned plants. The highest performances in measured parameters were observed in pruning shoots from 15 cm above the bud union. According to the results of the present study, it could be concluded that growth and the flowering of roses could be increased by pruning practices. Pruning of new stems at 15 cm above the bud union is the best method to get higher production of quality flowers from "White success".

Keywords: *Flower production, Growth, Pruning height, Pruning, Vase life*

INTRODUCTION

Rose (*Rosa hybrida* L.) is a world-renowned ornamental cut flower species having high demand in the global market and commercial cultivation is limited to up country region in Sri Lanka (Rupasinghe *et al*., 2015). More than 25,000 varieties of modern roses have been cultivated throughout the world (Cairns, 2000). Rose is commonly known as 'Queen of the Flowers' and it is a symbol for love, genuineness, familiarity, romance, spirituality, and grace (Chuizhi and Robertson, 2003). Cut-roses are one of the most important woody perennials in addition to erect shrubs, bushes, and climbers which belong to the family Rosaceae (Khattak *et al*.,2011). Genus *Rosa* contains over 200 species and around 20,000 cultivars Younis *et al*., 2013).

Rose flowers play multiple roles in the society. They are used as attractive garden plants in landscapes and popular cut flowers. They are also utilized by industries for making a different kind of food products, essential oils and perfumes (Nybon, 2009). Most of the rose species are native to Asia (Notani *et al.*, 2014). Commercial cultivation of roses is carried out in the highlands of the central province of Sri Lanka (Dhanasekera, 1998). Commercial categories of roses are classified as Hybrid teas, floribunda, short-stemmed roses, spray roses and miniature roses in Sri Lanka (Krishnaraja and Wijesundara, 2016).

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Canopy management is an important practice in rose cultivation targeting a well-managed healthy plant. Chemical growth regulation has been and still is a crucial factor for the floricultural industry (Karl-Johan, 2017) and cannot widely be adopted by growers. Pruning can be considered as an economically feasible and pragmatic technique for canopy management. It not only promotes plant growth and development but also regulates flowering during different seasons. Pruning involves the removal of either shoot or root parts of a plant to manage plant structure and fruiting branches. The fundamental aims of pruning the shoot parts include creating an open bush to receive satisfactory light for food production, to induce the shape of the plant, to discharge the diseased offshoots of the plant, and to produce a healthy plant (Guleria, 2016).

Roses respond greatly to pruning and are accurately confided to be pruned every year frequently (Khattak *et al*., 2011). Pruning is done basically for amending the growth phases of rose to promote the new growth and make it abundant initiation of flower buds and vigorous, depending on the rose variety Khattak *et al*., 2011). Pruning is an important step because it improves the quality of cut flower and its growth including increased flower attributes, bigness, and color of flower (Younis *et al*., 2013).

Pruning is based on scientific principles of increasing the growth and performance of rose plants (Nantakumar and Balakrishnan, 1998). It greatly facilitates the rehabilitation of old rose plants (Lokhande *et al*., 2015). The nutrient cycle of the plant is accomplished by the style of pruning of cut roses. Pruned plants have superior flower buds, N-P-K level, and also carbohydrate level (Hossain and Mizutani, 2008). Findings revealed that pruning influence both morphological and yield parameters in cut roses (Paul *et al*., 1995). The appropriate type of pruning done at right time provides several benefits to roses. However, the type and frequency of pruning vary with the cultivar of roses. Hence the present study was conducted to identify the appropriate pruning height to enhance the growth and flowering of rose var. ‘White Success’.

MATERIALS AND METHODS

Site description

An open field experiment was carried out from January to April 2019 at the Regional Agriculture Research and Development Centre (RARDC), Bandarawela (6.8259° N, 80.9982° E), Sri Lanka. The experimental site is located in the IU3c (Up-Country Intermediate Zone) agro-ecological region. The average elevation of the site is 1400m above mean sea level. The maximum and minimum temperatures are 29 ℃ and 8℃, respectively. The annual rainfall is 1600 mm while the humidity ranges from 50 to 70%. The soil type of the experimental area is Red Yellow Podsolic. Nearly one-year-old budded plants of rose variety ‘White Success’ grown in the experimental field were used for the pruning study.

Experimental design

The experimental design was a Randomized Complete Block Design with eight treatments (Table 1). Each treatment was replicated four times. Experimental unit consists of one year old four healthy, well developed and uniform rose plants. All the experimental plants were hard pruned to uniform height (5 – 6 inches above the ground level) to facilitate uniform growth of plants before the commencement of the experiment. Shoots were pruned with the help of sharp secateurs. Cut ends of the shoots were dressed with fungicide solution (Thiophanate Methyl - Topsin®) to protect the plants from dying back. Dead, infested, weak crisscrossed branches and suckers

emerged from the rootstock were completely removed to maintain a strong and healthy frame of rose plants. Then plants were allowed to grow for a particular height. This height ranged from 15 to 20 cm from a hard pruning level.

Table 1. Description of Treatments

Treatments	Description
T1	Removal of terminal or flower buds
T2	Pruning of shoots 3 leaves above the bud union
T3	Pruning of shoots 4 leaves above the bud union
T4	Pruning of shoots 6 leaves above the bud union
T5	Pruning of shoots 5cm from the bud union
T6	Pruning of shoots 10cm from the bud union
T7	Pruning of shoots 15cm from the bud union
T8	Control (No pruning)

Measurements

Plant height was measured at weekly intervals. The number of shoots per plant, number of leaves in flower stem, flower bud length, number of flowers, and dry weight of flower buds were taken at seven weeks after pruning. Non - destructive sampling was practiced and samples were randomly selected from every treatment. For the longevity estimation, stems of picked cut flowers were dipped in the water bucket to maintain the water column throughout the stem. The flower stalks were then cut at 20 cm length in water and the cut flowers with top two leaves were put in a conical flask containing sterilized water and kept inside the laboratory at 26°Ctemperature and 50-60% relative humidity. The endpoint of vase life of cut roses was determined by the appearance of symptoms such as absent drop neck, wilting, or fading of petals. The longevity was assessed in number of days from the date of yield harvest.

Statistical Analysis

Analysis of the variance test (ANOVA) was conducted to assess the effects of the treatments on the measured parameters ($p=0.05$). Collected data were analyzed using SAS statistical software.

RESULTS AND DISCUSSION

Plant height

Significant differences ($p<0.05$) were observed between the treatments in height of the plant at the weekly interval after pruning (Figure 1). The highest plant height was recorded in T7 (Pruning of shoots 15 cm from bud union) in 6 and 7 weeks after pruning (WAP). Also 6^{th} week plant height of T1, T4, T6 and T7 was not significantly different from each other and a similar trend was observed between T5 and T8. Hence, statistically the lowest plant height was recorded in the T5 and T8 at $6^{th}$and 7^{th} WAP.

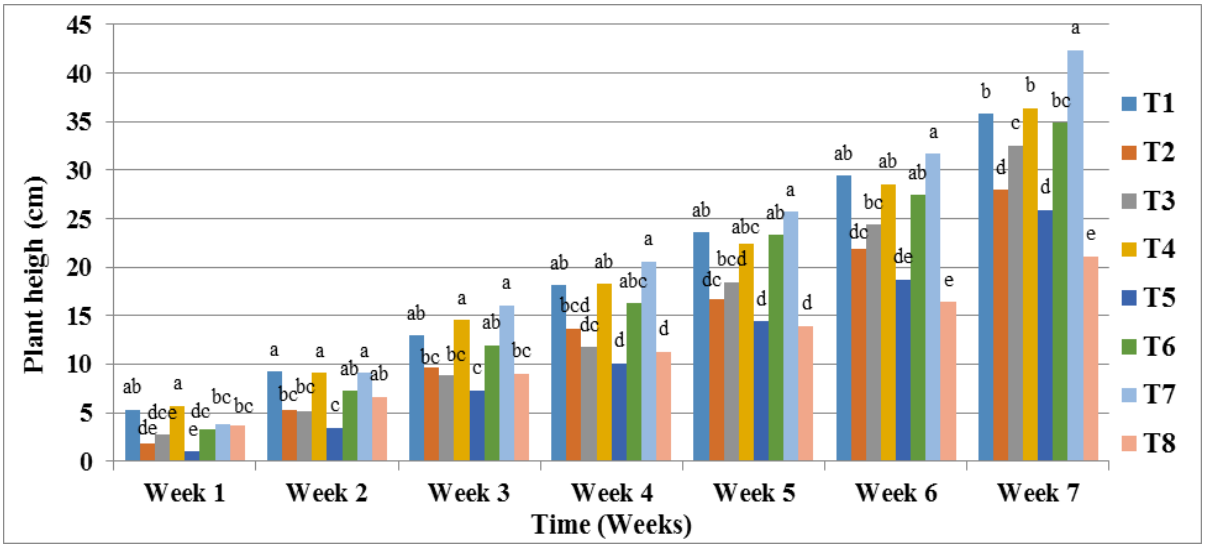

Figure 1. Treatment effect on plant height of rose var. 'White success' at weekly interval. Bars with the same letter within the same week were not significantly different ($\alpha = 0.05$).

Plant height is one of the important morphological characters of plants. Notani *et al*. (2014) have found that plant height of rose is generally influenced by the type and timing of pruning. Pruning has a beneficial effect on plant height. At 7 WAP the highest (42 cm) plant height was recorded in T7. Pruning improves the length of the shoots (Wiesman, 2009). Pruning leads to the accumulation of metabolites in the plants. These were utilized by plants to increase the growth of shoots (Notani *et al*., 2014). Plants belong to the control treatment produced the shortest plants. An increase in plant height is an indicator of good plant growth. Pruning of roses induces the assimilative system for biomass production (Silva *et al*., 2018).

Paul *et al*. (1995) reported that pruning practice influences not only morphological but also yield parameters in roses. Notani *et al*., (2014) stated that an unpruned rose bush becomes slender and unproductive with crooked stems of life and deadwood. Therefore, it could be suggested that pruning is an essential practice in rose cultivation and it is essential to increase the plant height.

Shoots per plant

Number of shoots per plant was significantly different among treatments ($p<0.05$). The highest number of shoots per plant was recorded in T7 and T1 while the lowest numbers of shoots were recorded in T8, T5, and T2 (Figure 2).

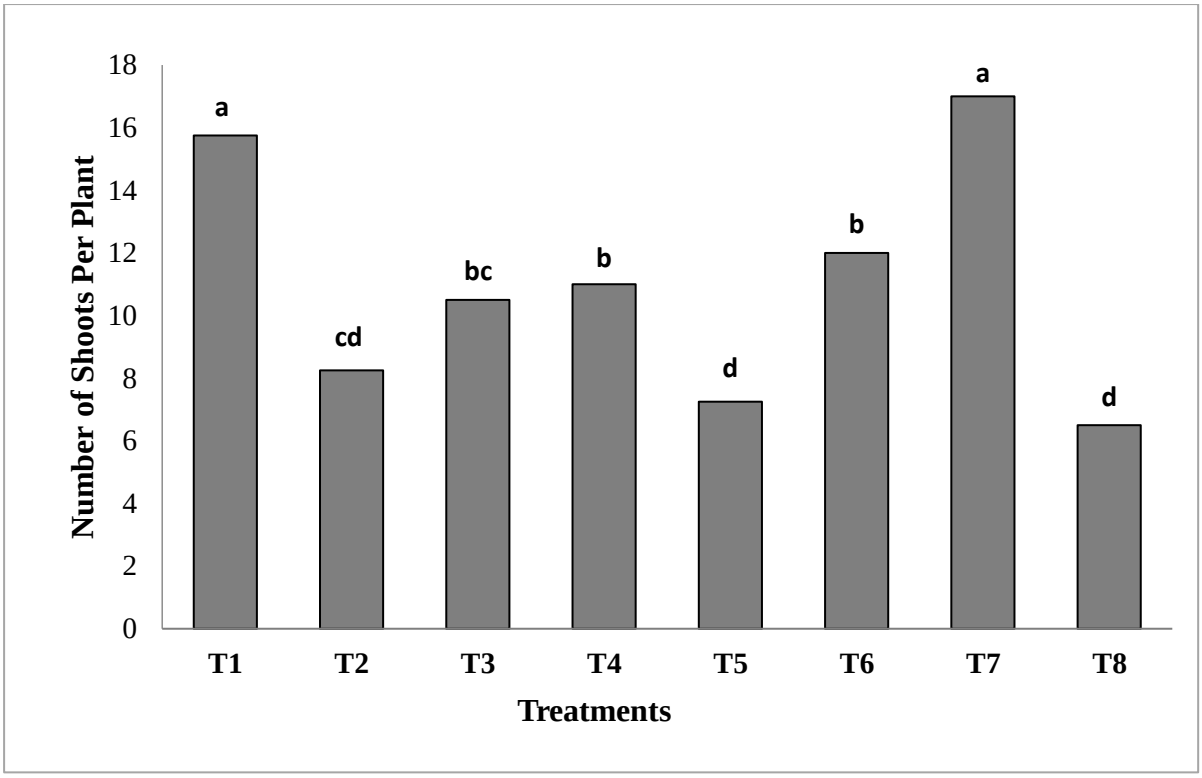

Figure 1. Effect of pruning height on the number of shoots per plant of rose var. 'White success' at 7 WAP. Bars with the same letter are not significantly different ($\alpha = 0.05$).

Pruning is a vital practice since it induces the vegetative growth of roses (Gibson, 1984; Anderson, 1991). In roses, vegetative growth is vital as it considerably influences the flower yield (Guleria, 2016). Degeyter (1975) found that pruning can increase the shoot number of rose plants. Pruning practice ensures the production of strong and healthy shoots in a higher number, which will bear flowers and improve the quality of blooms compared to older shoots (Mundhe *et al*., 2018).

There is a positive correlation between number of shoots and flower buds of the plant. Number of flower buds in a plant increases due to increasing the number of shoots per plant and length of shoots (Adhikari *et al*., 2014). Results of this experiment revealed that pruning increased the number of shoots per plant in roses. Kaith *et al*., (2011) reported that an increase in shoot number and shoot length would increase the yield per plant. Therefore, pruning is a beneficial practice in rose cultivation.

Number of leaves on the flower stem

It was noticed that there was a significant difference ($p<0.05$) among the treatments for the number of leaves on the flower stem. The highest number of leaves on the flower stem was recorded in T7 whereas the lowest was measured in T8 and T5 (Figure 3).

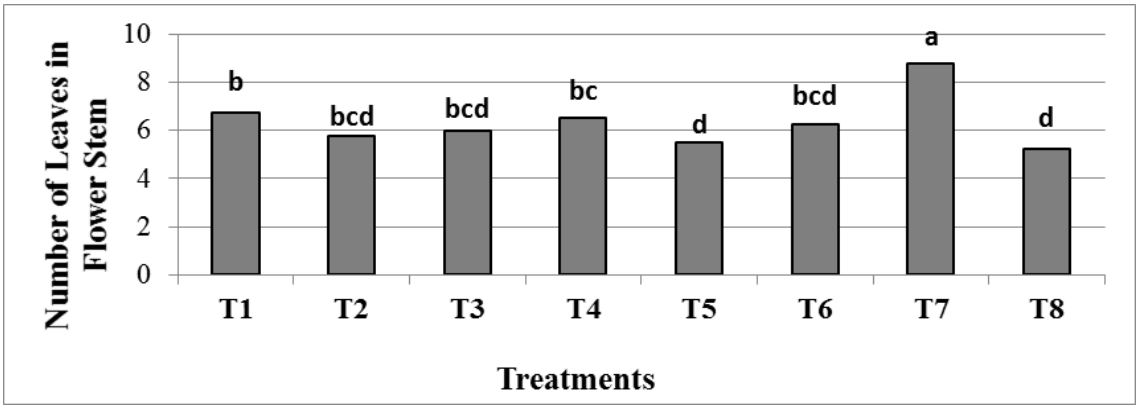

Figure 2. Effect of pruning height on the number of leaves in flower stem of rose var. 'white success' at 7 WAP. Bars with the same letter are not significantly different ($\alpha = 0.05$).

The number of leaves in flower stem is an important quality parameter in rose marketing. Pruning has a significant influence on the number of leaves in the flower stem. The highest number of leaves in the flower stem was recorded in T7. Therefore, the pruning of rose plants enhanced the number of leaves in flower stem over the control. Pruning influences the quantity of leaves and leaf area per flowering shoot (Guleria, 2016).

Pruning increases the reception of solar radiation by the plants (Saifuddin *et al*., 2010). Tsegaye and Struik (2000) reported that the light penetration and allocation are enhanced by shoot pruning. Pruned plants contain higher sink capacity than non-pruned plants. Jorquera-Fontena *et al*., (2014) stated that severely pruned plants have limited sink capacity. Increased exposure to solar radiation might increase the number of sources (leaves) in pruned plants as they have more sinks.

Length of flower bud

Different pruning levels has a significant ($p<0.05$) effect on the average flower bud length of roses. The longestbuds was recorded in T7, T4, and T6compared to other treatments, while the shortest buds was observed in T8 (control) (Figure 4).

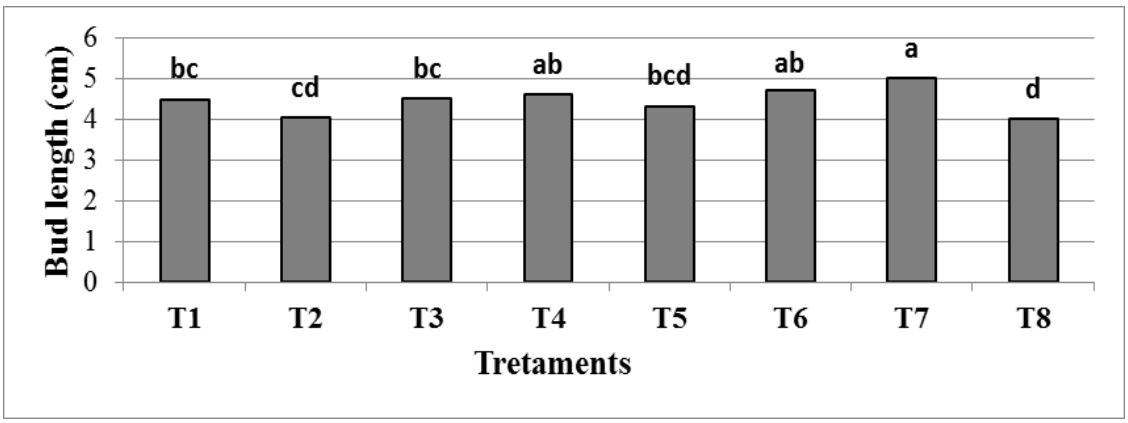

Figure 3. Effect of pruning height on bud length of rose var. 'white success' at 7 WAP. Bars with the same letter are not significantly different ($\alpha = 0.05$).

Pruning has a significant influence on the bud size of roses. The lowest bud length was observed in the control treatment (no pruning). It showed that pruning is essential

to obtain larger blooms in roses. According to Hassanein (2010), the pruning technique is essential for improving rose flower quantity and quality.

In unpruned plants, old shoots might be inefficient in producing a greater number of flowers. Further, few nutrients must have been distributed among too many shoots of control plants. These nutrients might be insufficient for producing larger blooms. Therefore, non-pruned plants might be under nutrient stress which led to reduce growth and flowering (Hassanein, 2010). It could be the reason for the lowest bud length in the control treatment. Pruning can increase bud size in roses. Pruned plants have a higher capacity for photosynthesis process, an amplified number of metabolic sinks, and elevated turgor pressure compared to unpruned plants (Hassanein, 2010). All these factors contribute to increased bud size in pruned plants. These might be the reasons for higher bud length in pruned plants.

The dry weight of flower buds

There was a significant difference ($p<0.05$) observed among the treatments for the dry weight of flower buds. The highest dry weight of flower bud was recorded in T7, T4, and T1 compared to other treatments. The lowest dry weight of flower buds was recorded in T8, T5, and T2 (Figure 5).

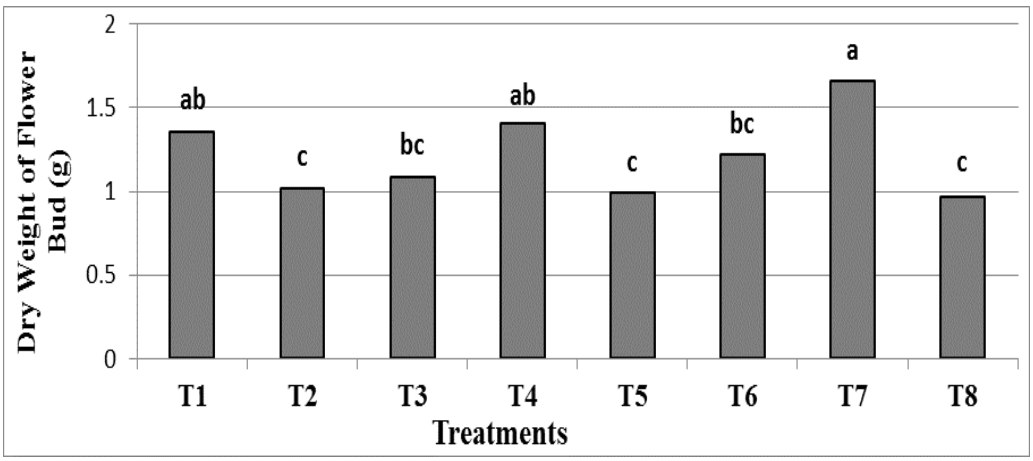

Figure 4. Effect of pruning height on the dry weight of flower buds of rose var. 'white success' at 7 WAP. Bars with the same letter are not significantly different ($\alpha = 0.05$.

Pruning had a significant influence on the dry weight of flower buds of experimental plants over the control treatment (no pruning). At 7 WAP, the highest dry weight of flower bud was recorded in T7, T4, and T1. Therefore, pruning could be used to increase reproductive growth and yield performances of rose plants. Various levels of pruning significantly improved the characteristics of the flower of roses compared to non-pruned (control) plants. The old shoots of control plants might be ineffective to produce more flowers and little nutrients content distributed on many shoots of control plants might be insufficient for manufacturing good flowers (Hassanein, 2010). Therefore, Hassanein and Dorion (2006) reported that non-pruned control plants are in nutrient stress and they show a reduction in growth and flowering. It could be the reason for the lowest dry weight of flower buds observed in the control treatment.

Pruned plants had a higher capacity for better photosynthetic light reaction, a large number of metabolic sinks, and a higher turgor pressure than non-pruned plants (Calatayud *et al*., 2007). It provides favorable effects on roses and increases the

quantity and quality of the flowers compared to the non-pruned plants. Pruning may allow the production of more renewal green covering and subsequently more nutrients storage before the dormant period. This also encourages more yield and high-quality flowers. Pruning is essential for improving the quality of rose flowers such as flower weight and the quantity of petals per flower (Hassanein, 2010).

Number of flowers per plant

Number of flowers per plant was significantly influenced by the treatment ($p<0.05$).

The highest number of flowers per plant was harvested from T7 compared to other treatments. The lowest number of flowers was harvested from T8 and T5 (Figure 6).

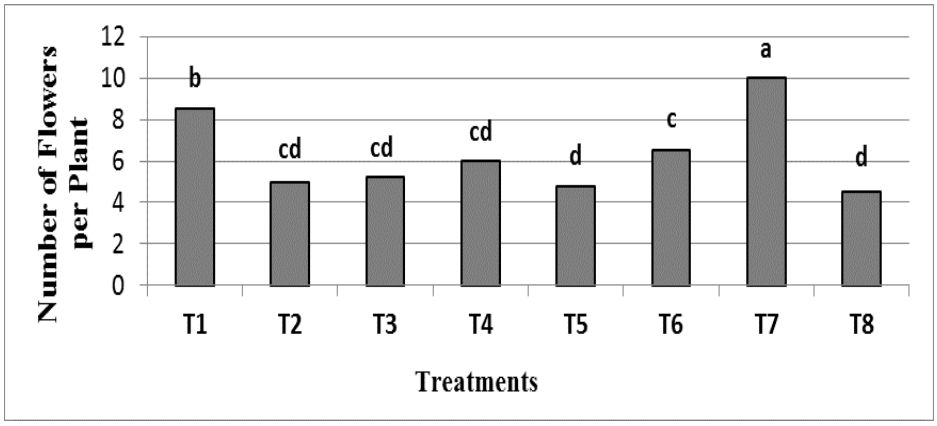

Figure 5. Effect of pruning height on the number of flowers per plant in rose var. 'white success' at 7 WAP. Bars with the same letter are not significantly different ($\alpha = 0.05$).

The number of flowers produced by plants is an important yield parameter in rose cultivation. Pruning has a significant influence on flower production. The highest number of flowers was harvested from T7. Therefore, the pruning of rose plants amplified the number of flowers per plant. Guleria (2016) reported that pruning can increase the number of flowers per plant and flowering cycle. Pruned plants have more photosynthetic capacity. As reported by Mundhe *et al.* (2018), it could be due to cytokinin accumulation in the flower producing shoots as a pruning effect and this could increase the flowering rate per plant.

Pruned plants have more sinks and sources than non- pruned plants. Therefore, the availability of nutrients is comparatively higher in pruned plants. Jorquera-Fontena *et al*. (2014) reported that yield per plant significantly increased with decreasing pruning severity and yield was controlled by sink potential when plants were exposed to severe pruning. Therefore, mild pruning could increase yield. Pruning improves the length of the shoots and plant growth (Wiesman, 2009). Pruning leads to the accumulation of metabolites in the plants. These were utilized by plants to increase the growth and flower number (Notani *et al.*, 2014). Hence pruning increases flower number in roses.

The vase life of flowers

Different pruning levels significantly influenced ($p<0.05$) the vase life of roses. The highest vase life was recorded in flowers belong to T7 and the lowest vase life were recorded in flowers belongs to T1, T2, T3, T5 and T8 (Figure 7).

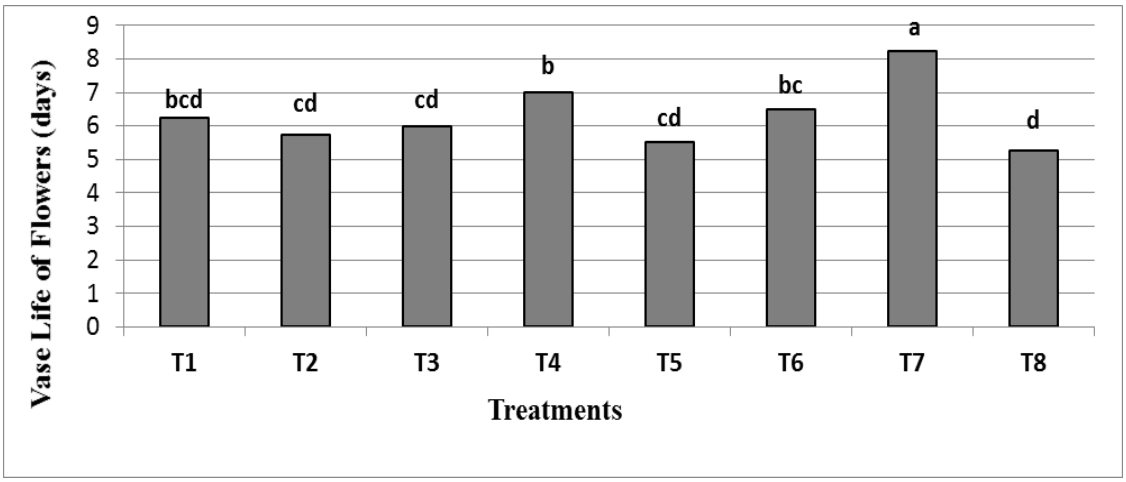

Figure 6. Effect of pruning height on vase life of flowers of rose var. 'white success' at 7 WAP. Bars with the same letter are not significantly different ($\alpha = 0.05$).

The increased longevity of cut flowers is advantageous in cut flower production and marketing. It is an essential quality trait preferred by retailers and customers (Banjaw *et al*., 2017). Pruning has a considerable influence on the vase life of rose flowers. The lowest period of vase life was observed in flowers in the control treatment (no pruning) and T2, T3, T5. It showed that pruning practice increases the vase life of rose flowers. Guleria (2016) found that pruning can increase the lifespan of rose flowers.

The energy content of flowers plays a major role in vase life. Van Doorn (2004) suggested that the vase life of cut flowers is closely associated with the petal carbohydrate composition. Unpruned plants might be in a nutrient deficiency due to a large number of sinks over sources. Available nutrients might be insufficient for producing larger blooms. According to Hassanein, (2010) non-pruned plants might be under nutrient stress which led to reduce growth and flowering. Therefore, the energy content of the cut flowers produced by unpruned rose plants might be lower than those produced by pruned plants. It could be the reason for the lowest vase life in the control treatment.

The highest vase life was recorded in T7 treatment than non-pruned. As reported availability of nutrients is comparatively higher in pruned plants. Therefore, the energy content of the flowers produced by pruned rose plants might higher than those produced in non-pruned plants. Therefore, the vase life of flowers might be higher in pruned plants.

CONCLUSIONS

Light pruning had a positive effect on the growth and cut flower production of roses than un-pruned and severely pruned plants. un-pruned plants produced a smaller number of flowers with poor quality. Therefore, pruning is the best method to get the maximum number of high-quality flowers from var. 'White success' and pruning of new stems at 15 cm above bud union is the best to get maximum production from rose variety 'White Success'.

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