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Improved Quality and Quantity of Winter Flowering in Rose (*Rosa spp.*) By Controlling the Timing and Type of Pruning Applied in Autumn

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Abstract: The present work aimed to improve rose flowering during Winter where most flowers are disappeared and marketing is very profitable. Pruning experiments were carried out on the essential oil yielding hybrid tea rose cultivar (Eiffel tower) at the Floriculture Experimental Farm of Agriculture Faculty, Sohag University, Egypt during two successive years of 2007/2008 and 2008/2009. Four pruning types (light, medium, heavy and control without pruning) were applied at four different times during Autumn at three weeks intervals. Pruning in Autumn was essential to improve quantity and quality of rose flowering in Winter. The light pruning was the best type for increasing period, quantity and quality of flowers compared to other types. Beginning of Autumn or three weeks later were the best pruning times allowing the highest flowering rate and quality compared to the other tested times. The light prunings at these times were the best treatments increasing significantly all flowering measurements. The study of economical impact of both treatments showed that the light pruning of rose shrubs three weeks after beginning of autumn, the third week of October, is the best treatment for improving flowering in short time. Under this condition, flowers number per plant, flower weight and petals weight per flower were increased by 68.7%, 279.5% and 219.4% respectively compared to control. Flower-stem length was improved from 18.0 to 50.7 cm. Flowers and petals weight per feddan (0.42 hectares or 4200 m^2) were also increased by 540.4% and 439.0% respectively. An increment percentage of 735.4% was also obtained in essential oil content. The reported technique could provide 352.0 thousand flowers of 5.3 tons flowers, 3.8 tons petals and 11.3 liters essential oil per feddan during Winter. It presents a practical and economic solution for producers and commercials to meet out the shortage in rose flowers during this inactive period.

Key words: Rose · Ornamental · Medicinal · Aromatic · Pruning · Time · Severity · Growth · Flowering · Essential oil · Quality · Commercial · Economic

INTRODUCTION

Rosa (Rosaceae) is one of the most economically important genus of ornamental, aromatic and medicinal plants with about 200 species and 20,000 cultivars widely distributed all over the world [1, 2]. Roses are cultivated for ornamental purposes, perfumery industries and medical properties. They are used as garden plants, cut flowers or indoor plants. Rose essential oil, obtained by water distillation of petals, has a wide range of application in many industries for scenting and flavoring purposes, direct consumption or making various types of food products [3, 4]. Rose-water is also employed internally as an astringent or externally for affections of the eyes, either alone or with some ointment [5]. As a result of their multiple uses, rose flowers meet a great demand all the year. One of the main problems for rose producers is the low yield of flowers especially in Winter where most flowers are disappeared and marketing is very profitable. Using plant growth regulators as Alar, Kinetin, NAA, Cycocel and GA3 or light management to optimize growth and flowering of ornamental crops is costly or limited by protected houses [6, 7]. Pruning is an economical and practical technique not only for plant growth control but also for commercial reason as timing fluctuations in demand for roses during different seasons.

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This technique can be easily applied in open field to control quantity and quality of flowering. Roses usually require heavy pruning during Winter to renew growth and light pruning during the growing season. Many roses including hybrid teas only bloom on young wood that produces large and fine flowers. The production of roses out of season was well known from the ancient Romans to the present time. The Autumn was decidedly the best time for pruning where root with little top has the liberty to store up nutriment for a strong growth and flowering during the following season [5]. The influence of the severity and time of pruning on subsequent flower production and renew of shoots have previously been studied in greenhouse. Winter production was related to the degree of the plant cut-back during the Spring. Severe removal decreased Winter production of flowers and delay in Autumn cut-back decreased total Winter yield, but mid-Winter production was increased [8]. Pruning affected both morphological and yield parameters of *Rosa damascena* [9]. Its effect seemed to be related to some physiological effects under greenhouse conditions as reported by Calatayud *et al*. [10, 11]. Li *et al*. [12] also studied the effect of Summer pruning on carbohydrate balance in apple trees. Pruning of wild azalea plants had significantly affected its growth and flowering in the following year [13]. No available literature concerned study of pruning on quantity and quality of rose flowering during Winter under open field conditions. This objective was tried on the hybrid tea rose cultivar (Eiffel tower) which is the most economically flowering, fragrant and essential oil yielding crop in Egypt. The final goal is to produce rose flowers in good quantity and quality during the inactive and profitable period of Winter by the control of type and timing of pruning applied in Autumn.

MATERIALS AND METHODS

Plant Materials and Treatments: The study was conducted on ten years old shrubs of the hybrid tea rose cultivar (Eiffel tower) of medium pink (mp) and fragrant flowers, cultivated at one meter culture spacing, at the Floriculture Experimental Farm of Agriculture Faculty, Sohag University, Egypt from September to Mars of two successive years of 2007/2008 and 2008/2009. To improve quantity and quality of rose flowering during Winter, two factors were studied. The first one was the timing of pruning where rose shrubs were pruned at one of the following four times during Autumn, at three weeks intervals: beginning of Autumn at the last week of September (the first time), the third week of October (the second time), the second week of November (the third time) and the first week of December (the fourth time). The second factor was the type of pruning where the following four types of pruning were studied in each time as shown in Figure 1. (A) the control type with no pruning, (B) the heavy type where only five principal branches symmetrically distributed on rose shrub were selected and cut at 25 cm from the soil, (C) the medium type where five auxiliary branches were selected from the five principal branches and cut at 25 cm from the first branching [50 cm from the soil] and (D) the light type where five secondary branches were selected from the five auxiliary branches and cut at 25 cm from the second branching [75 cm from the soil]. All other branches were removed and only selected branches and leaves were left. Experiments contained sixteen treatments, four pruning types in each pruning time. Each treatment contained five replicates of three rose shrubs, 15 shrubs per treatment. Experiments were repeated twice from September to Mars of 2007/2008 and 2008/2009. The average of

Fig. 1: Rose control plant (A) and the three studied pruning types including heavy (B), medium (C) and light (D) pruning

temperature in Winter were (8-19°C) and (9-16°C) for both studied seasons respectively [14]. All standard agricultural practices of rose production were done similarly as recommended.

Quantity and Quality of Flowering Measured Parameters: Several parameters were recorded from all treatments during Winter, from the last week of December to the third week of Mars. Renewal shoots of more than 25 cm in length per plant were counted at the flowering stage of each treatment to record number of branches per plant. The date of the first flowering was also recorded for each treatment. Flowering buds were counted for all treatments at the end of Winter to record number of flowering buds per plant. Flowers at the suitable stage of cutting were recorded then removed weekly at 25 cm from branching starting from the first flowering until the end of Winter to record the weekly and the total number of cut flowers per plant. The total number of flowers per plant was calculated as the sum of cut flowers and flowering buds. Flower-stem length (cm) was recorded on fifteen flowers selected at random from the five replicates during the flowering stage. Those flowers were used to measure their characteristics as flower weight (g), petals number per flower, petals weight per flower and weight of 100 petals. Essential oil was also extracted for three hours by water distillation of 100 g petals collected at early morning to record essential oil content (ml per 100 g petals) as previously described by Hassanein and Salman [14]. The economical impact of improvement in rose flowering during Winter under the best pruning conditions was studied in comparison with control.

Experimental Design and Statistical Analysis: To determine the effect of both studied factors (type and timing of pruning) and their interaction, factorial analysis was carried out on the whole experiment including two factors of four levels with five replicates. To eliminate the time effect, the four pruning times were also analyzed independently as four simple experiments including four pruning types with five replicates. Simple and factorial analysis were carried out on the average of the combined data of the two studied years, 2007/2008 and 2008/2009. All data was subjected to analysis of variance (ANOVA) to determine significant differences followed by comparison of means at significant level of 5% using S-Plus V. 6 (Professional Release 1; 1988–2001).

RESULTS

Potential of Flowering During Winter: Flowering curve presented in Figure (2) shows behavior of rose plants during Winter as a result of pruning type applied at different times during Autumn. Achievement of pruning at the beginning of Autumn or three weeks later allowed the fastest and longest flowering of pruned plants compared to the other pruning times. Under these conditions, rose plants started flowering three weeks before Winter recording a flowering period of 15 weeks until the end of Winter compared to just 5 and 3 weeks for the third and fourth time of pruning respectively (Figure 2). The light pruning showed the best flowering rate compared to control and other pruning type regardless time of pruning. It was also the fastest type in renewing shoots and producing buds and flowers in the contrary of heavy type. The light pruned plants gave the highest accumulative number of flowers during Winter with an average of 55.5 flowers per plant compared to 30.4 – 38.8 for control and other pruned plants. The best flowering rate during Winter was obtained from plants pruned lightly at the beginning of Autumn followed by those pruned three weeks later, 88 and 79 flowers per plant respectively. Delaying of pruning after mid-Autumn or pruning plants at heavy level showed the smallest flowering rate.

Growth and Flowering Quantity: Data presented in Table (1) shows the effect of timing and type of pruning applied in Autumn on growth and flowering of rose during Winter. Among the tested times, the second time of rose pruning achieved three weeks after the beginning of Autumn, gave significantly the highest number of renewal shoots and flowering buds per plant followed by the first time achieved at the beginning of Autumn. However, the first time of pruning gave significantly the highest cut flowers and subsequently the highest total number of flowering during Winter followed by the second one. Both times were similarly the best ones enhancing flower-stem length. Flowering of rose plants under different types of pruning are shown in Figure (3). The light pruning of rose shrubs was the best pruning type for flowering where it significantly increased number of flowers and flowering buds per plant compared to control and other types. All pruning types showed significantly higher flower-stem length compared to control. The heavy one was the best type showing

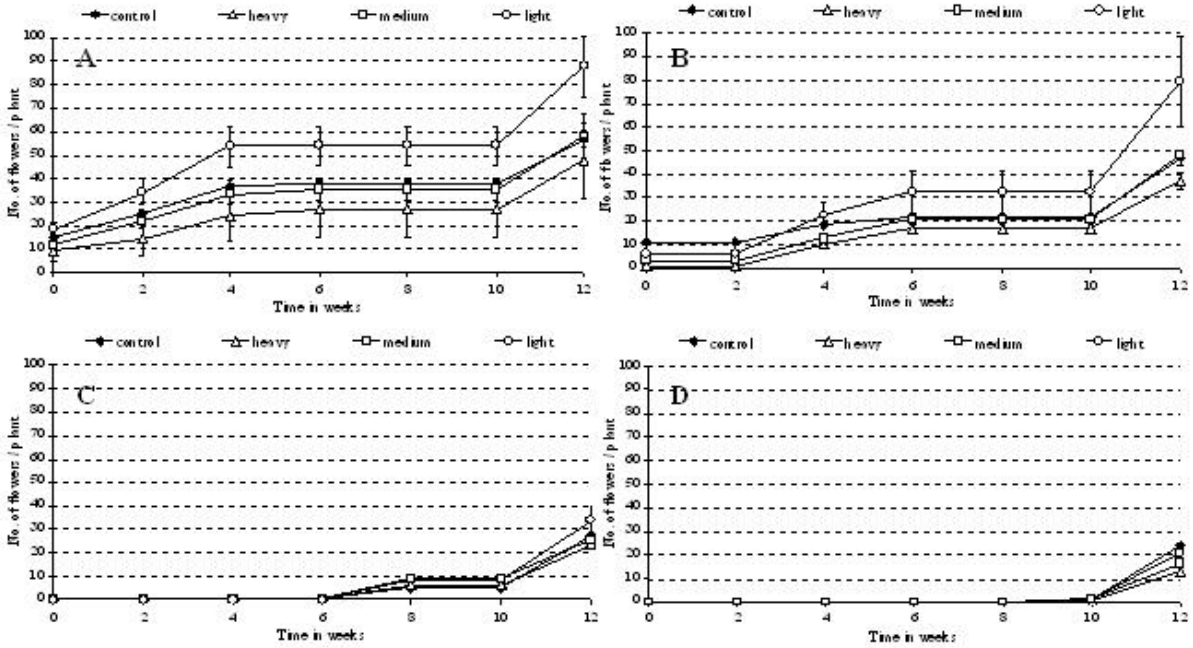

Fig. 2: Accumulative flowering of rose plants during Winter for the four tested types of pruning carried out at four different times (A, B, C and D) from beginning of Autumn at three weeks intervals, average of two seasons (2007/2008 and 2008/2009) with confidence interval at p= 0.05

Table 1: Growth and flowering of rose during Winter as affected by timing and type of pruning during Autumn, presented as the average of two seasons, 2007/2008 and 2008/2009

Pruning timing	Pruning type	Branches no. per plant	Flowering buds no. per plant	Cut flowers no. per plant	Total flowers no. per plant	Flower-stem length (cm)
First time	---	23.2 b	31.2 b	31.6 a	62.8 a	50.2 a
Second time	---	32.2 a	40.3 a	12.7 b	52.9 b	46.0 a
Third time	---	23.8 b	18.9 c	8.9 c	27.5 c	19.8 b
Fourth time	---	21.2 b	15.7 c	3.0 d	18.7 d	22.4 b
LSD 0.05*		2.90	3.90	2.50	6.10	4.20
---	Control	38.8 a	26.5 b	12.3 bc	38.8 b	13.5 d
---	Heavy	16.1 c	20.4 c	10.0 c	30.4 c	48.2 a
---	Medium	16.6 c	23.6 bc	13.6 b	37.2 b	41.5 b
---	Light	28.8 b	35.2 a	20.3 a	55.5 a	35.2 c
	LSD 0.05*	2.90	3.90	2.50	6.10	4.20
LSD 0.05 of interaction*		5.80	7.70	5.00	12.20	8.30
First time	Control	35.0 a	29.0 b	28.0 bc	57.0 b	19.0 c
First time	Heavy	17.0 c	26.3 b	21.3 c	47.7 b	67.4 a
First time	Medium	14.3 c	27.7 b	30.7 b	58.3 b	62.6 ab
First time	Light	26.3 b	41.7 a	46.3 a	88.0 a	51.9 b
LSD 0.05**		5.20	9.90	8.70	18.60	12.70
Second time	Control	52.0 a	36.0 b	11.0 b	47.0 b	18.0 b
Second time	Heavy	21.7 c	29.3 b	7.7 b	37.0 b	56.7 a
Second time	Medium	22.3 c	36.0 b	12.3 b	48.3 b	58.7 a
Second time	Light	32.7 b	59.7 a	19.7 a	79.3 a	50.7 a
LSD 0.05**		6.70	11.00	5.40	16.00	8.80
Third time	Control	35.0 a	19.0 ab	8.0 bc	27.0 ab	9.0 c
Third time	Heavy	14.3 b	16.7 b	7.3 c	24.0 b	31.2 a
Third time	Medium	16.0 b	16.0 b	9.3 ab	25.3 b	20.8 b
Third time	Light	29.7 a	22.7 a	11.0 a	33.7 a	18.3 b
LSD 0.05**		6.70	5.60	1.70	6.80	5.00
Fourth time	Control	33.0 a	22.0 a	2.0 b	24.0 a	8.0 c
Fourth time	Heavy	11.5 b	9.3 c	3.7 ab	13.0 c	37.5 a
Fourth time	Medium	13.6 b	14.7 b	2.0 b	16.7 bc	23.9 b
Fourth time	Light	26.7 a	16.7 b	4.3 a	21.0 ab	20.1 b
LSD 0.05**		5.90	3.90	1.70	4.70	5.90

* Factorial analysis, ** Simple analysis. Means with the same letter in the same column of each section are not significantly different at $p = 0.05$

Fig. 3: Flowering of rose plants during Winter under control (A) and the three studied pruning types including heavy (B), medium (C) and light (D) pruning.

Table 2: Characteristics of rose flowers as affected by timing and type of pruning during Autumn, presented as the average of two seasons, 2007/2008 and 2008/2009

Pruning timing	Pruning type	Flower weight (g)	Petals no. per flower	Petals weight per flower (g)	100 petals weight (g)	Essential oil content*** (ml/ 100 g)
First time	---	11.7 a	26.7 a	8.3 a	30.6 b	0.26 a
Second time	---	11.5 a	25.0 ab	8.6 a	34.4 ab	0.26 a
Third time	---	11.6 a	22.0 c	8.9 a	38.9 a	0.26 a
Fourth time	---	10.4 b	22.9 bc	7.4 b	31.6 b	0.23 b
LSD 0.05*		1.00	2.80	0.80	4.60	0.01
---	Control	4.8 d	16.3 c	3.5 d	21.6 c	0.20 c
---	Heavy	9.8 c	23.6 b	7.8 c	34.4 b	0.25 b
---	Medium	14.1 b	25.4 b	10.4 b	42.3 a	0.28 a
---	Light	16.4 a	31.2 a	11.5 a	37.3 b	0.28 a
	LSD 0.05*	1.00	2.80	0.80	4.60	0.01
LSD 0.05 of interaction*		2.00	N. S.	1.60	N. S.	0.01
First time	Control	6.1 b	19.2 b	4.0 c	21.3 b	0.22 c
First time	Heavy	12.6 a	27.6 a	8.5 b	31.7 a	0.26 b
First time	Medium	13.5 a	27.6 a	9.7 ab	35.5 a	0.29 a
First time	Light	14.6 a	32.4 a	10.9 a	34.0 a	0.28 a
LSD 0.05**		2.20	6.70	1.60	5.80	0.02
Second time	Control	4.4 c	16.2 c	3.6 c	23.0 b	0.20 c
Second time	Heavy	10.0 b	24.6 b	8.3 b	34.9 a	0.25 b
Second time	Medium	15.0 a	25.6 b	11.0 a	44.9 a	0.30 a
Second time	Light	16.7 a	33.4 a	11.5 a	34.8 a	0.31 a
LSD 0.05**		2.20	6.70	1.70	11.60	0.02
Third time	Control	3.7 c	14.5 c	3.0 d	20.9 b	0.21 c
Third time	Heavy	5.9 c	18.8 c	7.1 c	39.1 a	0.25 b
Third time	Medium	15.3 b	24.6 b	11.5 b	49.3 a	0.28 a
Third time	Light	21.3 a	29.9 a	13.8 a	46.6 a	0.29 a
LSD 0.05**		2.20	5.00	1.80	13.70	0.02
Fourth time	Control	4.9 c	15.4 c	3.2 c	21.3 c	0.17 c
Fourth time	Heavy	10.7 b	23.5 b	7.3 b	31.7 b	0.22 b
Fourth time	Medium	12.8 a	23.7 b	9.3 a	39.5 a	0.25 a
Fourth time	Light	13.1 a	29.2 a	9.8 a	34.0 ab	0.26 a
LSD 0.05**		2.00	5.40	1.50	5.60	0.01

* Factorial analysis, ** Simple analysis, *** Volume of essential oil (ml) in a weight of flowers petals (g). Means with the same letter in the same column of each section are not significantly different at $p = 0.05$

the longest flower-stem. However, number of renewal shoots on pruned plants during Winter didn't reach to the number of branches previously found on control plants. Interactions effect was significant for all measurements. Control followed by the light pruning showed the highest number of branches for all tested times. The light pruning of rose plants at beginning of Autumn or three weeks later allowed the best flowering of 88 flowers per plant. However, control and all pruning types at the last time of pruning gave the least flowering of 13-24 flowers per plant. The heavy pruning of rose at the beginning of Autumn showed the longest flower-stem length of 67.4 cm. Control plants showed the smallest flower length of 8-19 cm in any tested times. Simple analysis of pruning

Fig. 4: Characteristics of rose flowers during Winter under control (A) and the three studied pruning types including heavy (B), medium (C) and light (D) pruning

Table 3: Economical impact of improvement in rose flowering during Winter under the best pruning conditions compared to control, the average of 2007/2008 and 2008/2009 seasons

Economical impact	Control without pruning (A)		Light pruning (B)		Increment (B – A)		Increment % (B-A)/Ax100	
Pruning timing	First	Second	First	Second	First	Second	First	Second
Flowers no. per plant	57.00	47.00	88.00	79.30	31.00	32.30	54.4	68.7
Flower-stem length (cm)	19.00	18.00	51.90	50.70	32.90	32.70	173.2	181.7
Flower weight (g)	6.10	4.40	14.60	16.70	8.50	12.30	139.3	279.5
Petals weight per flower (g)	4.00	3.60	10.90	11.50	6.90	7.90	172.5	219.4
Essential oil (ml / 100 g)	0.22	0.20	0.28	0.31	0.06	0.11	27.3	55.0
Flowers weight per plant (g)	347.70	206.80	1284.80	1324.30	937.10	1117.50	269.5	540.4
Petals weight per plant (g)	228.00	169.20	959.20	912.00	731.20	742.80	320.7	439.0
Flowers no. (1000 per feddan*)	228.00	188.00	352.00	317.20	124.00	129.20	54.4	68.7
Flowers weight per feddan* (kg)	1390.80	827.20	5139.20	5297.20	3748.40	4470.00	269.5	540.4
Petals weight per feddan* (kg)	912.00	676.80	3836.80	3647.80	2924.80	2971.00	320.7	439.0
Essential oil per feddan* (Liter)	2.01	1.35	10.74	11.31	8.74	9.95	435.4	735.4

* Feddan (0.42 hectares or 4200 m^2) is an area cultivated by 4000 rose shrubs at 1 m^2 culture spacing, First: Pruning at beginning of Autumn (the last week of September), Second: Pruning three weeks after Autumn (the third week of October)

type effects at different times during Autumn are shown in Table (1). Pruning of rose plants at the beginning of Autumn showed that light pruning was significantly the best type for flowering compared to control and other types. No significant difference was found between control and both other types in flowering. All pruning types significantly increased flower-stem length compared to control. However, renewal shoots on pruned plants were less than old branches of control plants. Similar results were found when pruning was achieved at the second time, three weeks later. Achievement of pruning at the third time showed no significant effect between the light pruning and control in number of branches, number of flowering buds and total flowers but significantly higher number of cut flowers was obtained from pruned plants. All types also showed significantly longer flower-stem compared to control and the heavy one was the best type. At the fourth time of pruning, three weeks before Winter, the light pruning also gave the greatest number of cut flowers but no significant difference was found between this type and control in total flowers and branching. The other types gave less flowers with longer flower-stem compared to control.

Flowers Quality and Essential Oil Content: Characteristics of flowers produced from control and pruned plants during Winter after pruning at different times during Autumn are shown in Table (2). Timing of pruning had significant effects on quality of flowers and essential oil content. The three first times were similarly better than the fourth one for flower weight, petals weight per flower and essential oil content. The first time showed the highest petals number per flower and the third one showed the highest weight of 100 petals. Pruning of rose plants at any type significantly improved all flowers characteristics compared to non pruned control plants (Table 2 and Figure 4). The light type was significantly the best pruning type for improving quality of rose flowers including weight of flower, number and weight of petals per flower and essential oil content. The medium one was

also good for improving petal weight per flower and essential oil content. Interaction effects were significant for flower weight, petals weight per flower and essential oil content. The light pruning of rose shrubs at the third time showed the highest weight of flower and its petals followed by the second time which also gave the greatest essential oil content. Non pruned control plants showed the least quality of flowers in all tested times. Simple analysis of pruning type effect on quality of flowers in different times is shown in Table (2). Pruning of rose shrubs at the beginning of Autumn significantly improved flowers quality and essential oil content compared to control. The light and medium pruning were better than the heavy pruning in petals weight per flower and essential oil content respectively. The second time of pruning showed similar effects where, all pruning types were significantly better than control. The light type was the best pruning for improving number of petals per flower. The light and medium pruning were better than the heavy pruning for flower weight, petals weight per flower and essential oil content. At the third time of pruning, all types improved flower quality and essential oil content but no significant difference was found between heavy pruning and control in flower weight and number of petals per flower. The light pruning was the best pruning type for improvement of rose flowers quality and essential oil content. The fourth date also showed significantly better results for all pruning types compared to control in all parameters. The light and medium types were also better than the heavy type.

Economical Impact: The obtained results showed a good impact for pruning on the quantity and quality of rose flowering during Winter (Table 3). Under the best conditions, light pruning at the beginning of Autumn or three weeks later, 79.3 – 88.0 flowers were obtained per plant versus 47.0 – 57.0 for control. So, a number of 317.2 – 352.0 thousand flowers can be produced from lightly pruned plants per feddan (0.42 hectares or 4200 m^2) versus 188.0 – 288.0 for control plants with increment percentage of 54.4 – 68.7% over control. Those flowers were of good quality where their flower-stem was 50.7 – 51.9 cm versus 18.0 – 19.0 cm for control flowers. The weight of flower was also improved by 139.3– 279.5%, which make it possible to obtain 5.1 – 5.3 tons of flowers per feddan of lightly pruned plants versus 0.8 – 1.4 tons for control plants. A weight of 3.6 – 3.8 tons of petals can be also obtained from pruned plants with an increment percentage of 320.7 – 439.0% compared to control. The essential oil content in petals was also improved where 10.7 – 11.3 liters can be produced from pruned plants per feddan versus 1.4 – 2.0 liters for control. The light pruning of rose shrubs at the second time of pruning, at the third week of October, was better than that achieved at the beginning of Autumn for increment percentage of all measurements.

DISCUSSION

Rose flowers meet a great demand throughout the year specially in Winter where most flowers are disappeared and marketing is very profitable. Pruning is a practical technique used for renewing growth and promoting flowering of plants since ancient times [5]. In this study, this economical technique was applied on rose plants growing under open field conditions during Autumn to improve rose flowering during Winter. Generally, pruning applied in Autumn was found to be essential for improving rose flowers quantity and quality in Winter when compared to control plants. This result is in agreement with those previously reported on rose plants growing under greenhouse conditions [8, 9]. The old shoots of control plants might be incapable to produce more flowers and little nutrients content distributed on many shoots of control plants might be insufficient for producing good flowers. So, non pruned control plants may be submitted to stress which led them to the reduction of growth and flowering as reported by Hassanein and Dorion [15]. It was also reported that pruned plants had a higher capacity for better promoting the photosynthetic light reaction, a large number of metabolic sinks and a higher turgor than non-pruned plants [11]. The obtained results revealed the important role of pruning timing where applying pruning early, at beginning of Autumn or three weeks later, showed a favorable effect on rose flowers quantity and quality compared to the late pruning. The longer time available in Autumn after early pruning may allow the production of more renewal green covering and subsequently more nutrients storage before the dormant period, this should encourage more yield and high quality respectively. The cold may also inhibit the good growth for the producing flowering buds. The decrease in total Winter yield as a result of the delay of Autumn cut-back was previously reported on rose growing in greenhouse [8]. Pruning type was also an effective factor affecting significantly rose flowers quantity and quality where the light pruning was the best type. This result can be explained by the higher buds and foliage still after the light pruning promoting more renewal shoots and/or

flowers and better flowering compared to other types. The heavy type decreased flowers production which may be resulted from the removal of the photosynthetic area causing reduction in number of producing flowers. Similar result was previously reported on rose under greenhouse conditions [8]. The higher flower-stem length under heavy pruning resulted from the distribution of nutrients content on little number of flowers. Similar result was found by Wang [13] on azalea plants. The light pruning of rose plants at the beginning of Autumn or three weeks later significantly increased flowers yield and improved characteristics of flowers compared to control and other interaction treatments. The essential oil content was also improved as a result of Autumn pruning in the contrary of results obtained by Saffari *et al*. [6] applying pruning during Spring in protected house. It was found that Autumn pruning induce an increase in starch and soluble sugar levels [16]. On the economic level, the light pruning three weeks after beginning of Autumn was better than that achieved at the beginning of Autumn (Table 3). This result can be explained by the shorter time needed for maximum yield and quality besides the higher improvement percentage under this condition.

REFERENCES

1. Cuizhi, G. and K.R. Robertson, 2003. *Rosa Linnaeus,* Sp. Flora of China, 9: 339-381.
2. Ritz, C.M., H. Schmuths and V. Wissemann, 2005. Evolution by reticulation: European dogroses originated by multiple hybridization across the genus *Rosa.* J. Heredity, 96(1): 4-14.
3. Aslam Khan, M. and Shoaib-Ur-Rehman, 2005. Extraction and analysis of essential oil of *Rosa* species. International J. Agric. & Biol., 6: 973-974.
4. Nybon, H., 2009. Introduction to *Rosa*. In Plant genetics and genomics: genetics and genomics of *Rosaceae*, crops and models 6, Eds., Folta, K.M. and Gardiner, S.E. Springer Science + Business Media, LLC., pp: 339-351.
5. Parsons, S.B., 1956. The rose: its history, poetry, culture and classification. Wiley & Halsted, 351 broadway, New York, pp: 280.
6. Saffari, V.R., A. Khalighi, H. Lesani, M. Babalar and J.F. Obermaier, 2004. Effects of different plant growth regulators and time of pruning on yield components of *Rosa damascena* mill. International J. Agric. & Biol., 6: 1040-1042.
7. Blom, T.J. and Y. Zheng, 2009. The response of plant growth and leaf gas exchange to the speed of lamp movement in a greenhouse. Scientia Horticulturae, 119(2): 188-192.
8. Zieslin, N. and Y. Mor, 1981. Plant management of greenhouse roses. The pruning. Scientia Horticulturae, 14: 285-293.
9. Paul, T.M., M.A.A. Siddique and A.Q. John, 1995. Effect of severity and time of pruning on growth and flower production of *Rosa damascena* Mill. An important aromatic plant. Advnces in Plant Sci., 8: 28-32.
10. Calatayud, A., D. Roca, E. Gorbe and P.F. Martinez, 2007. Light acclimation in rose (*Rosa hybrida* cv. Grand Gala) leaves after pruning: Effects on chlorophyll A fluorescence, nitrate reductase, ammonium and carbohydrates. Scientia Horticulturae 111(2): 152-159.
11. Calatayud, A., D. Roca, E. Gorbe and P.F. Martinez, 2008. Physiological effects of pruning in rose plants *cv*. Grand Gala. Scientia Horticulturae, 116(1): 73-79.
12. Li, K., A.N. Lakso, R. Piccioni and T. Robinson, 2003. Summer pruning effects on fruit size, fruit quality, return bloom and fine root survival in apple trees. The Journal of Horticultural Science & Biotechnol., 78(6): 755-761.
13. Wang, T., 2008. Effect of pruning on flowering of *Rhododendron simsii* planch. Acta Horticulturae (ISHS), 769: 463-465.
14. Hassanein, A.M.A. and A.M.A. Salman, 2009. Susceptibility of rose (*Rosa spp*.) to infestation by the pubescent rose chafer, *Tropinota squalida* (Scop.) and its relationship with rose cultivars and climatic changes in southern Egypt. American-Eurasian J. Agricultural & Environmental Sciences, 6(6): 642-650.
15. Hassanein, A. and N. Dorion, 2006. Determining morphological and physiological parameters for the selection of drought-tolerant geraniums (*Pelargonium* x *hortorum* L. H. Bailey), The J. Horticultural Science and Biotechnol., 81(4): 707-713.
16. Clair-Maczulajtys, D., C. Sarthou and G. Bory, 1994. Effects of pruning on carbohydrate distribution in the trunk of sweet cherry (*Prunus avium* L.). Scientia Horticulturae, 59(1): 61-67.