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OPTIMIZING FERTIGATION FREQUENCY FOR *ROSA HYBRIDA* L.

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Abstract

The influence of two levels (500 ml and 250 ml) of NPK fertigation applied at 2, 4 and 6 days interval on plant growth and flowering in two rose (*Rosa hybrida* L.) cultivars Amalia and Anjleeq was studied as means of achieving better management, production and ascertaining NPK utilization by the rose plants. Plant height, number of branches, number of leaves, number of flowers plant^{-1}, number of petals flower^{-1}, leaf nitrogen, phosphorus and potassium percentage were maximum with fertigation @ 500 ml at 2 days interval whereas more number of days were taken by the plants for the emergence of first flower with fertigation @ 250 ml at 6 days interval. Although all treatments were effective in improving rose growth and yield in both cultivars as compared to control, however, the effect of fertigation @ 500 ml at 2 days interval was very pronounced particularly in improving vegetative as well as the reproductive growth as compared to other treatments.

Introduction

Optimal fertigation scheduling of greenhouse soil less crops is very important since it influences the rhizosphere environment, media water potential and salt accumulation, which in turn affect plant growth and consequently crop production and quality (Raviv & Blom, 2001).

Fertigation control involves the determination of both timing and quantity of fertilizer and water application. A better understanding of the effects of fertigation frequency on growth, flower production and quality of rose plants can help to propose optimal fertigation scheduling. Rose has gained great economic importance due to its high market value and great export potential. The demand for rose cut flowers has recently increased tremendously in Pakistan (Yusuf & Dennis, 1999).

Inadequate plant nutrition causes serious disorders in rose cultivation and may eventually lead to decline of plant vigor and ultimately reduction of yield. Flower production can be enhanced by increasing level of NPK (Young *et al.*, 1976, Umma & Gowda, 1986). Fertigation combines two main inputs required for plant growth and development i.e., water and nutrients. The right combination of water and nutrients is the key for high yield and quality. Fertigation has flexibility, cost effectiveness and the potential for improved seasonal fertilizer application efficiency over traditional fertilizer application methods (Jaynes *et al.*, 1992). Moreover, the fact that roses, unlike most other crops, are being constantly harvested and thereby exhibiting large fluctuation of the transpiring area must be taken into consideration when attempting to formulate fertigation schedule.

The influence of various levels and sources of N fertigation on flowering of cut rose cv. First Red was studied under protected conditions (Ashok *et al.*, 1999) and it was observed that Ammonium nitrate at 150 ppm resulted the highest values for bud circumference (6.09cm), flower diameter (7.33 cm), petal length (4.01cm), petal breadth (3.84 cm) and flower yield (153m^{-3}). Whereas, the effects of aqueous ammonia, nitric acid, ammonium nitrate and urea @ 50, 100 and 150 ppm were studied on rose cv. First

Red (Ashok & Rengasamy, 2000). Generally, higher N rate resulted in higher fresh weight and dry matter production. Ammonium nitrate @ 150 ppm recorded the longest shoots (67.36cm), maximum number of leaves (13.48) and number of petals (25-41). It was observed that combination of 175 ppm of K and N while P at 50 ppm produced the maximum number of flowers and plant height in roses (Gurav *et al*., 2002).

Optimal fertigation scheduling is very important to save water and nutrients, while efficient use of water by drip irrigation is becoming increasingly important. Accurate supply of nutrients and water will result in better water use efficiency, avoid stress situations and control production (Raviv & Blom, 2001). When stress occurs during leaf growth in the marketable stem, although it does not affect the stems quality, it causes a yield delay of 10-15 days (Caballero *et al*., 1996). It has also been reported (Chimonidou-Pavlidou, 1996, 1999) that drought stress was very damaging to rose plants development, affecting the quantity (up to 70% reduction in production) and quality (reduction in stem length and fresh weight) of the flowering shoots produced. On the other hand, excessive water in the substrate can also be injurious to roses by reducing substrate aeration and causing abnormal development of plants.

It was hypothesized that controlled application of fertilizer alongwith irrigation could not only improve the growth and yield of rose plants but also improve the absorption of nutrients by the plants. Thus, the primary objective of the present study was to optimize NPK fertigation for the better health and vigorous growth of rose plants to get maximum number of best quality cut flowers. A better understanding of the effects of fertigation frequency on growth, yield and nutrient uptake could help to develop optimal fertigation strategies for roses.

Materials and Methods

Present research work was conducted during 2005 in the greenhouse, Rose research area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad (latitude 31°30N, longitude 73°10E and altitude 213m) where the average maximum and minimum temperatures were 30±4°C and 15±3°C, respectively. The average maximum and minimum relative humidity were 75 and 36%, respectively. The plants of two *Rosa hybrida* L., cultivars Amalia and Anjleeq were raised in the departmental nursery and transplanted in trenches (formed in the greenhouse by digging soil) having a length, width and depth of 15.0, 1.0 and 0.6 m, respectively, lined with polythene sheet and filled with sand, at a spacing of 30cm between plants in 60cm spaced rows.

Compound fertilizer having NPK @ 17:17:17 was used as source of fertilizer and it was applied @ 2 gL^{-1} of irrigation water (canal water having 0.4 dSm^{-1} EC and 6.9 pH). Fertigation was applied @ 250 and 500 ml per plant at 2, 4 and 6 days interval according to following schedule: T_1= 250 ml per plant after 2 days, T_2= 500 ml per plant after 2 days, T_3= 250 ml per plant after 4 days, T_4= 500 ml per plant after 4 days, T_5= 250 ml per plant after 6 days and T_6= 500 ml per plant after 6 days. This schedule was designed for cut rose flower production under minimum irrigation regimes in order to study the growth and flowering response of rose with limited water application. There were 10 plants in each treatment replicated thrice, all the treatments were randomized and the experiment was laid out in a completely randomized design with factorial arrangements. Plants were pruned to a uniform height, then allowed to grow and data for all attributes of the two rose cultivars were collected. Plant height (cm) was measured with the help of measuring tape. Number of branches $plant^{-1}$, number of leaves $plant^{-1}$, days for the emergence of first flower, number of flowers $plant^{-1}$ and number of petals $flower^{-1}$ were calculated by counting. Leaf nitrogen,

phosphorus and potassium contents were estimated by leaf analysis following standard procedure described by Wolf (1982) by using Kjeldhal apparatus for N, Spectrophotometer for P and Flame Photometer for K. Data collected were analyzed statistically by using the method described by Steel *et al*., (1997).

Results and Discussion

The observations recorded on plant height indicated that application of 500 ml of fertigation at 2 days interval resulted in maximum plant height (65.16cm). This treatment was statistically at par with application of 500 ml fertigation at 4 days interval and was significantly different from all other treatments. Application of 250 ml fertigation at 2 days interval and 500 ml fertigation at 6 days interval were statistically similar. Minimum plant height was observed when fertigation was applied @ 250 ml at 6 days interval. This treatment was statistically at par with the application of 250 ml fertigations at 4 days interval (Fig. 1). Comparison of varieties indicated that Anjleeq produced taller plants than did Amalia but statistically both varieties were at par with each other. Our findings were confirmed by the studies of Palai *et al.,* (2002) who observed desirable plant height in *Rosa hybrid acv*. Montezuma with the application of NPK fertilization @ 300 ppm. Similar results were also reported by Krishna *et al.,* (1999) who studied the effect of fertigation on growth and yield of carnation cultivars grown under polyhouse and observed significant plant height when fertigated with recommended compound fertilizer containing 80, 100 and 120 mg L^{-1} NPK, respectively.

As for as the number of branches $plant^{-1}$ was concerned, application of 500 ml fertigations at 2 days interval produced maximum number of branches (7.16) and these results were at par with those of 500 ml fertigation at 4 days interval and were significantly different from the results of 250 ml fertigation at 4 days interval. Application of 250 ml fertigation at 4 days interval and 250ml fertigation at 6 days interval were statistically similar. Application of 250 ml fertigation at 2 days interval produced significantly more branches (5.16) than application of 250 ml fertigation at 4 days interval (4.66) and 250 ml fertigation at 6 days interval producing only 4.33 branches (Fig. 2). Comparison between varieties depicted that 'Anjleeq' produced significantly higher number of branches $plant^{-1}$ (6.55) than were produced by 'Amalia' (4.77). Both the varieties were statistically different. Maximum branches $plant^{-1}$ were also reported by Patil *et al*., (1999) in *Polyanthes tuberosa* with the application of 250:200:200 kg NPK ha^{-1} and by Katsoulas *et al*., (2006) in *Rosa hybrida cv*. First Red by increasing irrigation frequency in a soilless growing medium.

Information procured on the number of leaves $plant^{-1}$ exhibited that application of 500 ml fertigation at 2 days interval produced maximum number of leaves per plant (7.16) and it is followed by application of 500 ml fertigation at 4 days interval as shown in Fig. 3. So both the treatments were statistically at par whereas application of 250 ml fertigation at 2 days interval was also statistically at par with application of 500 ml fertigation at 4 days interval. Application of 250 ml fertigation at 4 days interval was similar to application of 250 ml fertigation at 6 days interval. Application of 250 ml fertigation at 2 days interval and 500 ml at 6 days interval was statistically similar. As for as the varieties are concerned, Anjleeq produced significantly higher number of leaves (217) than Amalia (204). Maximum number of leaves $plant^{-1}$ were also reported by Ashok & Rengasamy (2000) who studied the effect of N fertigation at different levels and sources on growth of cut rose cv. First Red.

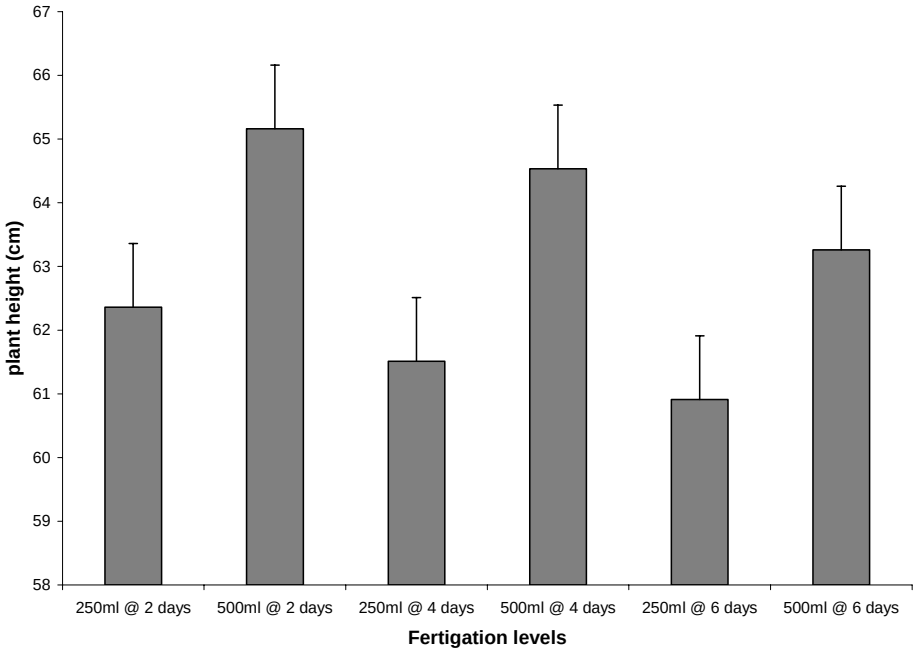

Fig. 1. Effect of NPK fertigation on plant height (cm).

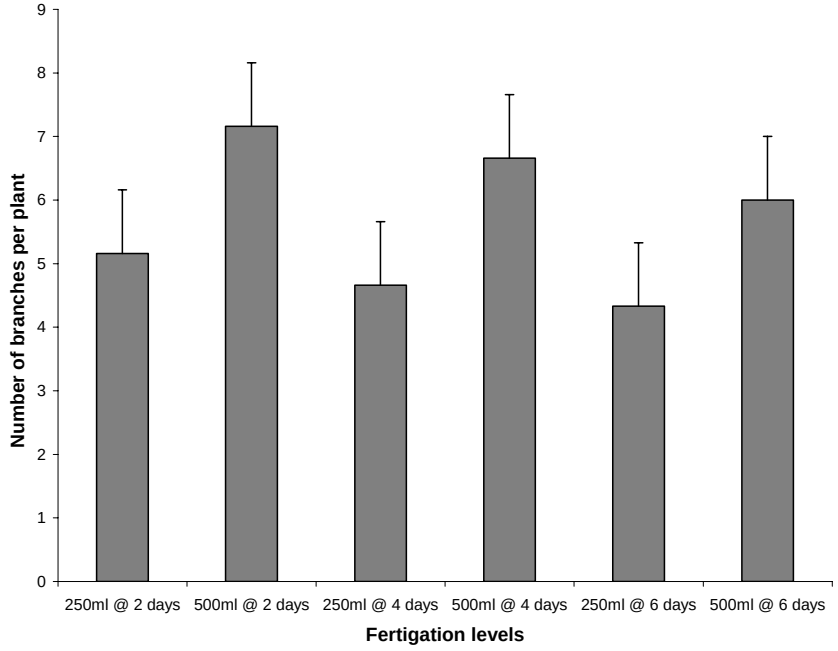

Fig. 2. Effect of NPK fertigation on number of branches per plant.

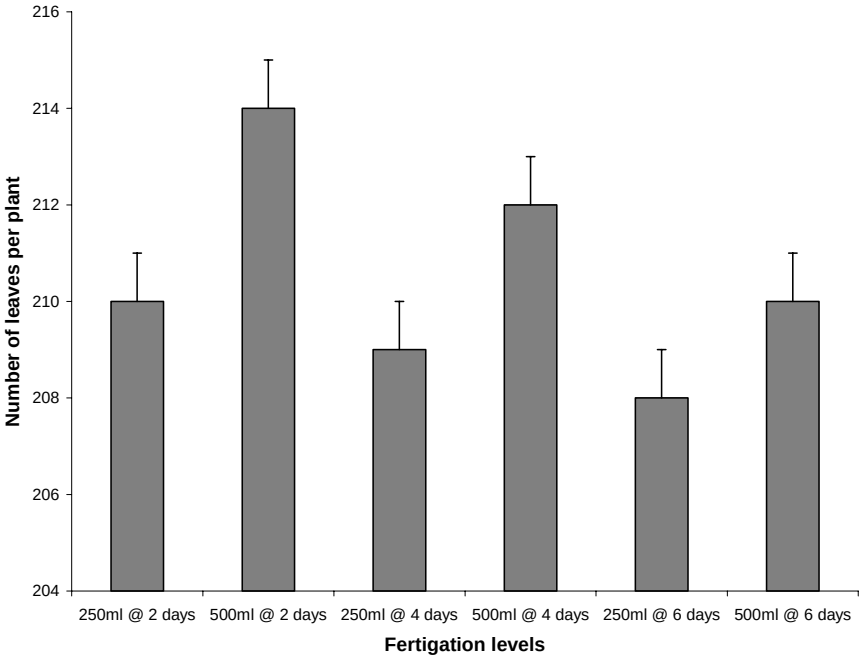

Fig. 3. Effect of NPK fertigation on number of leaves per plant.

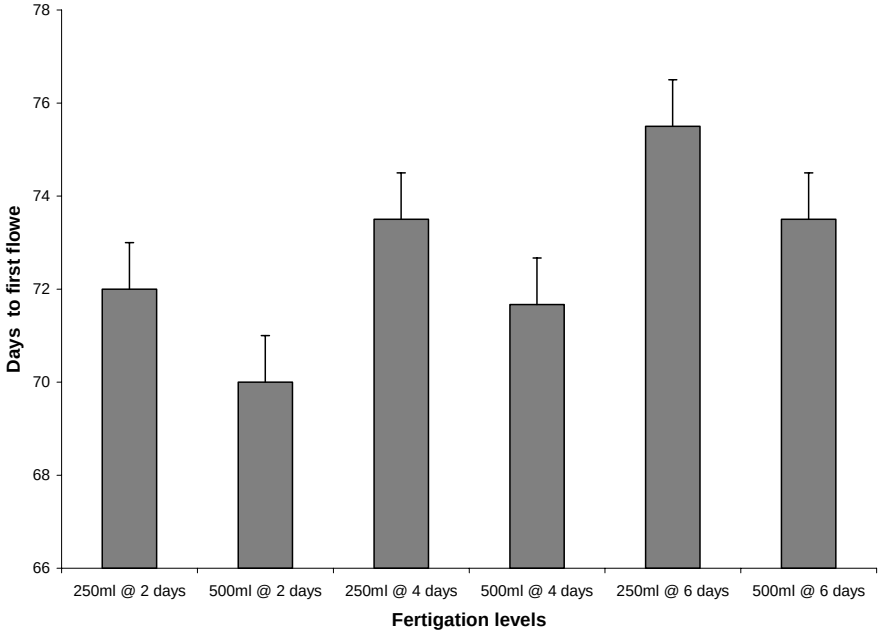

Fig. 4. Effect of NPK fertigation on days to first flower.

Data regarding days for emergence of first flower indicated that in case of application of 250 ml fertigation at 6 days interval, flower emergence was delayed. It took maximum days to flower and significantly differed from other treatments. In case of application of 500 ml fertigation at 2 days interval, flower emergence took minimum days and is at par with 500 ml at 4 days interval. Application of 250 ml fertigation at 4 days interval and 500 ml fertigation at 6 days interval were statistically similar (Fig. 4). Similarly comparison between varieties revealed that Amalia took 71.55 days for emergence of first flower than Anjleeq (73.83). Results indicate that high frequency irrigation enhanced photosynthetic rate which increases carbohydrate reserves of the plants which resulted in early flower emergence. Early flower emergence in roses in response to NPK @ 300 ppm was also observed by Palai *et al*., (2002).

Results obtained on number of flowers plant^{-1} indicated that in case of application of 500 ml fertigation at 2 days interval and 500 ml fertigation at 4 days interval, the number of flowers plant^{-1} were maximum and the treatments effects were statistically at par. Similarly application of 250 ml fertigation at 2 days interval and 500 ml fertigation at 6 days interval produced significantly higher number of flowers plant^{-1} and were statistically similar whereas application of 250 ml fertigation at 4 days interval and 250 ml fertigation at 6 days interval were statistically similar to each other as shown in Fig. 5. 'Anjleeq' produced more flowers plant^{-1} (6.61) than 'Amalia' (5.61). Significant increase in number of flowers plant^{-1} was observed by Palai *et al*., (2002) in rose cv. Montezuma when fertigated with NPK @ 300 ppm.

In case of application of 500 ml fertigation at 2 days interval, maximum number of petals flower^{-1} (28.50) was obtained and it was followed by application of 500 ml fertigation at 4 days interval. Therefore, both treatments were statistically at par. Application of 250 ml fertigation at 2 days interval and 500 ml fertigation at 6 days interval were also statistically at par with each other. Minimum petals flower^{-1} (24.00) were observed in application of 250 ml fertigation at 6 days interval and it was statistically similar to application of 250 ml fertigation at 4 days interval. Application of 500 ml fertigation at 4 days interval exhibited same number of petals flower^{-1} as observed in application of 500 ml fertigation at 2 days interval. So, application of 500 ml fertigation at 4 days interval is the best fertigation level at which maximum petals flower^{-1} were produced (Fig. 6). More petals were produced by high frequency irrigation and this increase may be due to more number of branches produced by this treatment which resulted in more carbohydrate synthesis which increased number of petals. Maximum number of petals (25.41) in rose cv. First Red was also reported by Ashok & Rengasamy (2000) who studied the effect of fertigation with ammonium nitrate @150 mg L^{-1}.

Leaf nitrogen percentage was maximum (3.53%) in case of application of 500 ml fertigation at 2 days interval and 500 ml fertigation at 4 days interval, which are statistically similar. Both of these treatments also presented significantly higher nitrogen percentage than application of 500 ml fertigations at 6 days interval. Application of 250 ml fertigation at 2 days interval and 250ml fertigation at 4 days interval were at par statistically. Application of 250 ml fertigation at 6 days interval exhibited minimum nitrogen percentage (2.38%) as presented in Fig. 7. 'Amalia' and 'Anjleeq' were at par with each other in response to leaf nitrogen percentage. Increase in leaf N contents of tuberose was also reported by Amarjeet *et al*., (2000) with increasing NPK fertilizer application.

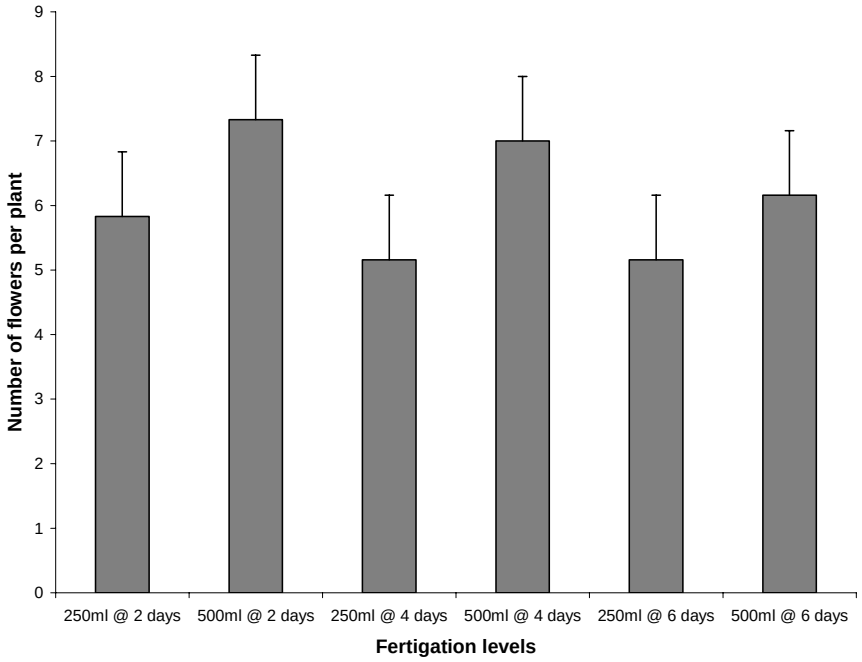

Fig. 5. Effect of NPK fertigation on number of flowers per plant.

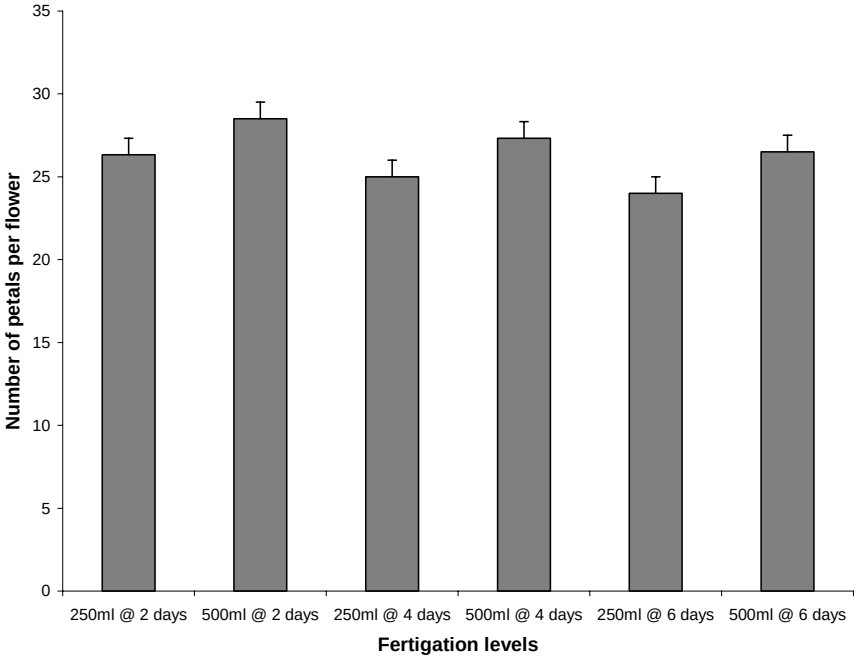

Fig. 6. Effect of NPK fertigation on number of petals per flower.

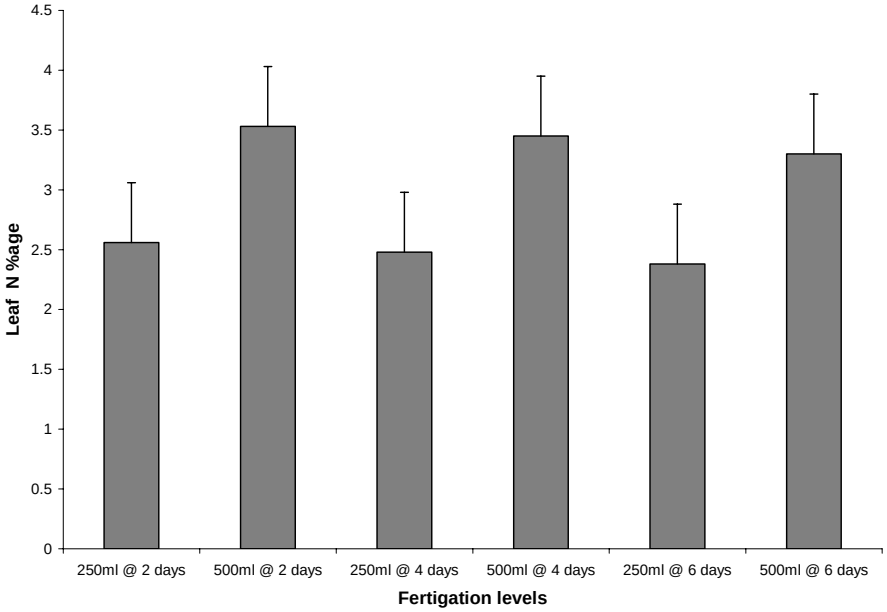

Fig. 7. Leaf N % age as influenced by various fertigation levels.

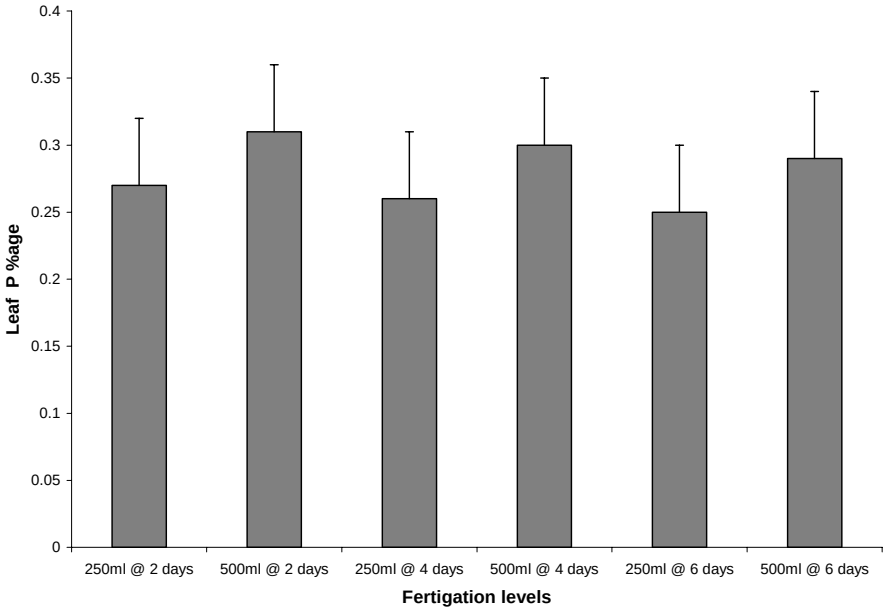

Fig. 8. Leaf P % age as influenced by various NPK fertigation levels.

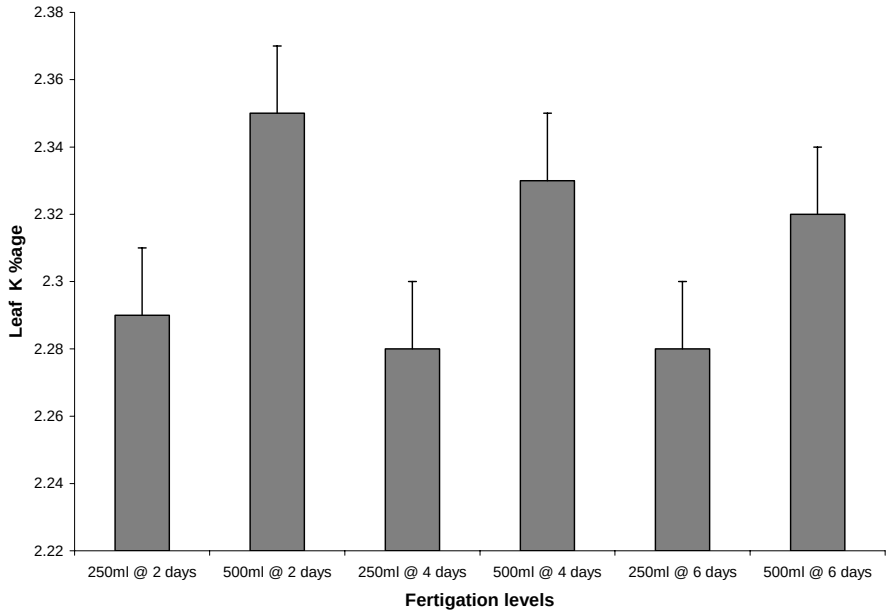

Fig. 9. Leaf K % age as influenced by various levels on NPK fertigation.

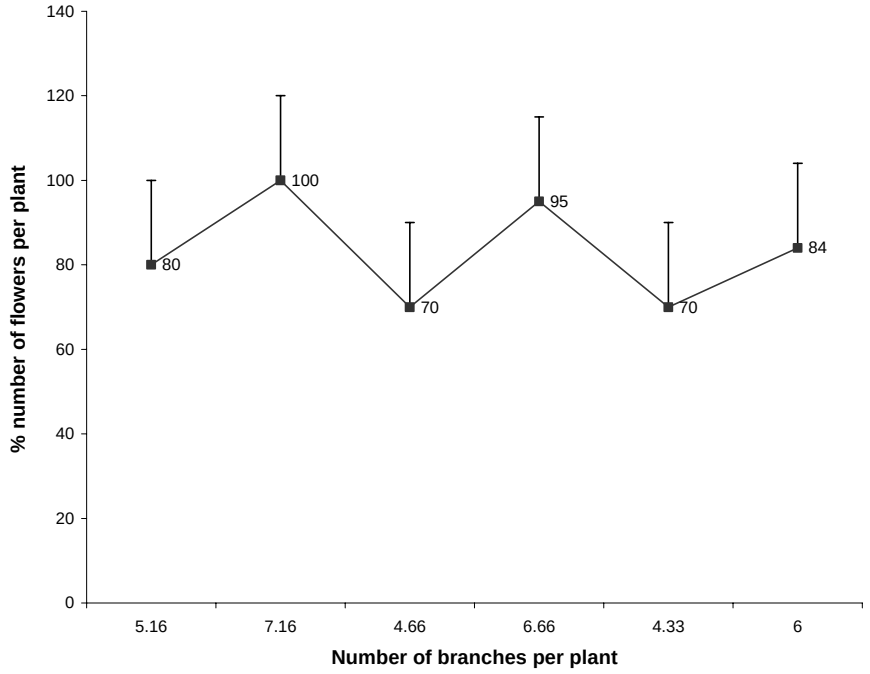

Fig. 10. Correlation between number of branches per plant and number of flowers per plant.

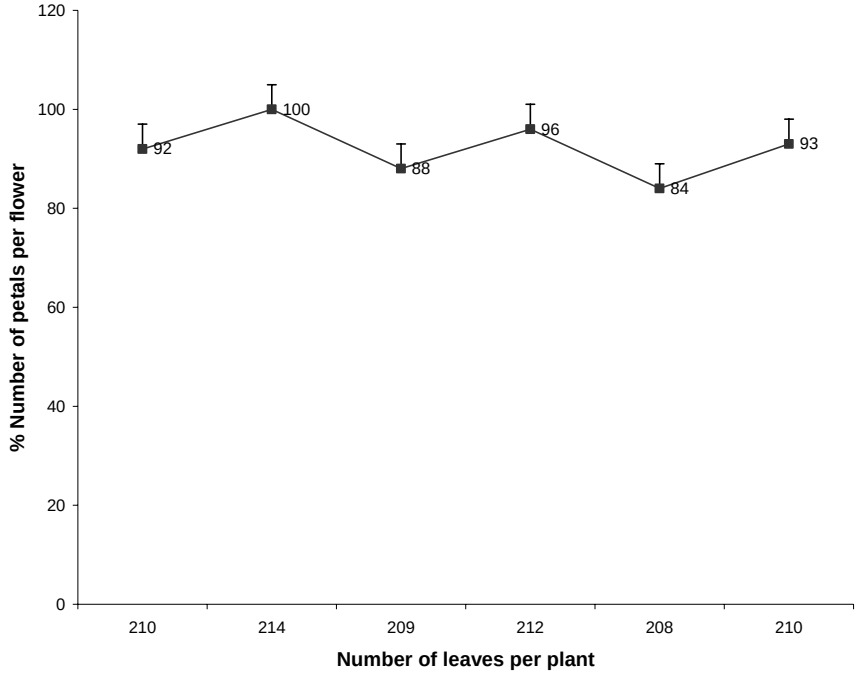

Fig. 11. Correlation between number of leaves per plant and number of petals per flower.

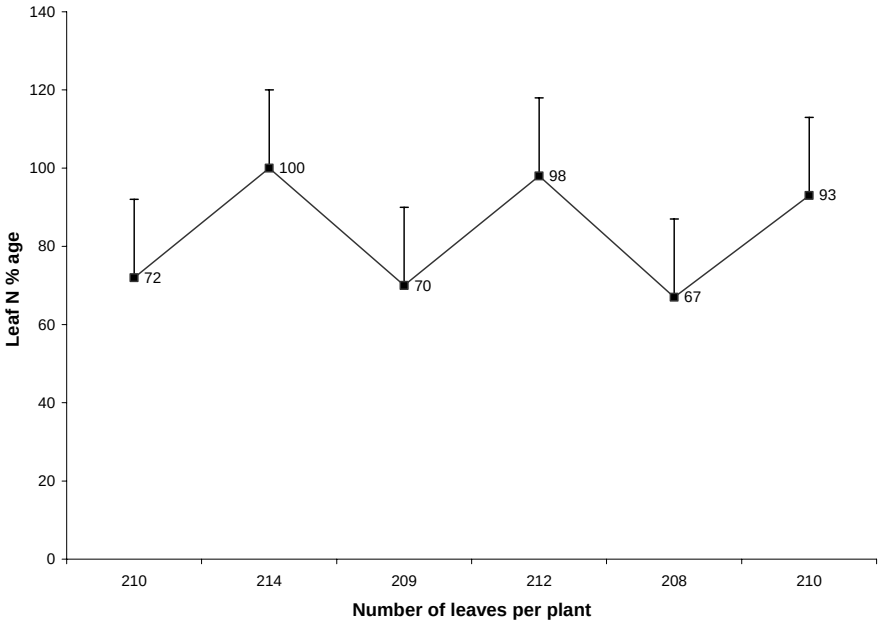

Fig. 12. Correlation between number of leaves per plant and leaf N % age.

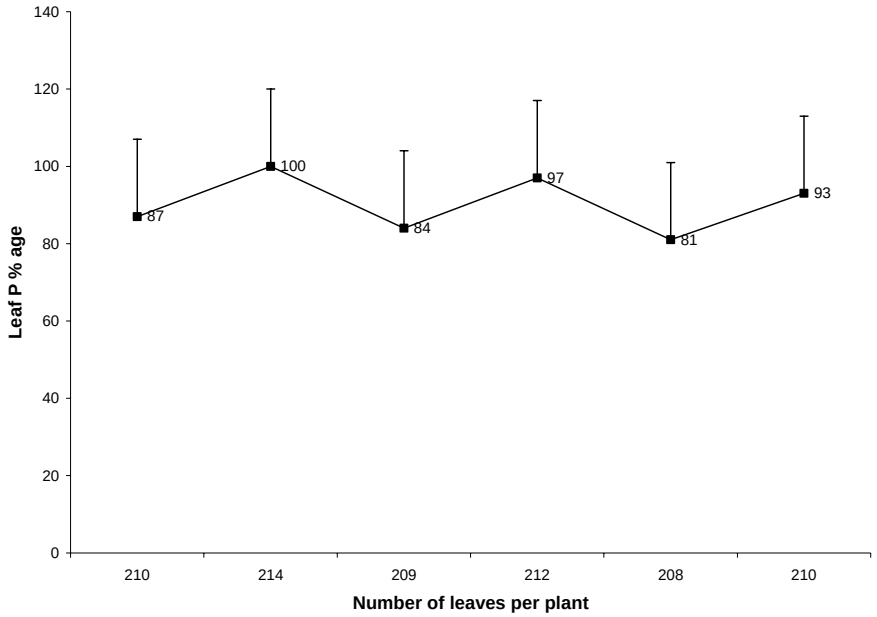

Fig. 13. Correlation between number of leaves per plant and leaf P % age.

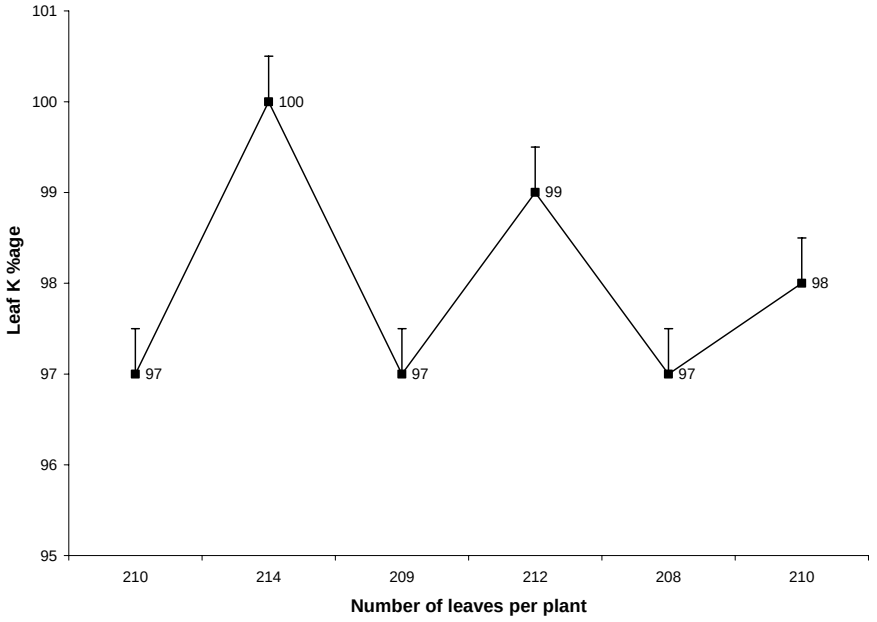

Fig. 14. Correlation between number of leaves per plant and leaf K % age.

Leaf phosphorus percentage was maximum (0.31%) in case of application of 500 ml fertigation at 2 days interval as shown in Fig. 8. It was statistically at par with application of 500 ml fertigation at 4 days interval and different from all other treatments. Application of 500 ml fertigation at 4 days interval and 500 ml fertigation at 6 days interval were also statistically similar, while different from application of 250 ml fertigation at 2 days interval. Application of 250 ml fertigation at 4 days interval and 250 ml fertigation at 6 days interval were at par statistically. Amalia showed significantly higher leaf phosphorus percentage (0.29%) as compared to Anjleeq (0.27%).

Maximum leaf potassium percentage (2.35%) was observed in case of application of 500 ml fertigation at 2 days interval. Application of 500 ml fertigation at 4 days interval and 500 ml fertigation at 6 days interval were at par statistically. Application of 250 ml fertigation at 4 days interval and 250 ml fertigation at 6 days interval were also at par statistically with each other and produced minimum leaf potassium percentage (2.28%) as compared to application of 250 ml fertigation at 2 days interval (Fig. 9). Slightly higher leaf potassium percentage (2.31%) was found in Anjleeq as compared to 'Amalia' (2.30%), however, both varieties were statistically at par with other.

Conclusion

NPK Application in the form of fertigation enhanced various growth indices and increased flower yield of *Rosa hybrida* L. cvs. 'Amalia' and 'Anjleeq'. High frequency of fertigation (500 ml at 2 days interval) increased plant height, number of branches, number of leaves, number of flowers plant^{-1}, number of petals flower^{-1}, leaf nitrogen, phosphorus and potassium percentage. Whereas, number of days for the emergence of first flower was maximum with low frequency of fertigation @ 250 ml at 6 days interval. Therefore, optimum use of compound fertilizer (NPK) at high frequency proved better towards vigorous growth and maximum flower production in rose.

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