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Full Length Research Paper

The introduction of macro- and micronutrients on the yield and quality of *Rosa hybrida* cvs. Whisky and Cardinal Mac

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The quality and flower yield of roses are directly dependent on the balanced application of macro and micronutrients. In the present study, foliar application of macro- and micronutrients was done after every 15 days when new emerging leaves had sprouted after pruning. The results reveal that plants treated with foliar application of micronutrients along with NPK showed significant increase in the growth characteristic like plant height, number of flowers plant^{-1}, bud diameter, flower diameter, fresh and dry weight of flower, flower quality, flower stalk length compared to the application of NPK alone and untreated plants (control). Application of foliar fertilizer (NPK = 15:32:7 + micro power) and NPK (15:32:7) + chelated mix micronutrients gave the highest values compared to the other treatments in both cultivars. Cardinal responded well to micronutrients as compared to Whisky Mac in case of cultivars. Leaf total chlorophyll contents, vase life and the mineral contents (NPK) of leaves were significantly increased as a result of foliar application of micronutrients compared to the control treatment. It was concluded that application of micronutrients along with NPK could improve flower yield and quality of roses.

Key words: Chlorophyll content, NPK percentage, micronutrients, rose.

INTRODUCTION

Rose is known as foremost cut flowers in global floriculture industry. It is a symbol of friendliness, spirituality, motivation, sensuality, elegance and source of visual satisfaction for human beings. Roses were cultivated since the ancient times and they are indeed one of the antique ornamentals of gardens (Shafiq et al., 2006). Rose contains 200 species and more than 18,000 cultivars and has a family *Rosaceae* and genus *Rosa* (Gudin, 2000). Rose (*Rosa hybrida* L.) gives the 33% flower production compared with the total cut flower production in world (Kras, 1999). Cut flower production focus has moved to countries where the climates are better and production costs are low from traditional growers, such as the Netherlands, Germany and France (Zhao et al., 2008).

Flowers are the vibrant element in decorative flowering plants and they look awesome where we live (Tariq et al., 2012). Rose's intensification and excellence are affected by management of nutrients to a great extent (Savvas, 2002). Growers are not successful to produce best quality production due to the reason of very insufficient knowledge and technical skills regarding proper concentrations of different micronutrients. For the successful production of excellent cut rose flowers, genotypic variation and micronutrient application play a

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leading role (Khoshgoftarmanesh et al., 2008).

Most of the soils of Pakistan have high pH value (alkaline), which hinders the absorption of micronutrients (Ahsan et al., 2012). When nutrient shortage cannot be corrected through soil application then foliar nutrition is an alternate method to correct those problems (Halder et al., 2007; Sarkar et al., 2007; Cakmak, 2008). Due to high pH value of sandy desert soil, application of fertile-zers through foliar spray may be helpful in these conditions to keep away from the soil fixation of some micronutrients (El-Naggar, 2009).

Micronutrients such as Fe, Mn, B, Cu, Zn, Mo, Ni and Co are necessary in much lesser amount and essential for plant intensification than those of the primary nutrients (Brady and Ray, 2000). These are essential because of their immense connotation and involvement to enzyme system in metabolism (Massoud et al., 2005). Foliar application of micronutrients may be six to 20 times more efficient than soil application in increasing crop production and other growth parameters (Leiw, 1988).

Due to the important value of roses in world global cut flower business, a field experiment was envisaged to evaluate the impact of foliar application of macro and micronutrients with regard of growth, flower production and early blossoming of *R. hybrida* cvs. Cardinal and Whisky Mac.

MATERIALS AND METHODS

The experiment was carried out according to randomized complete block design (RCBD) with factorial arrangements with three replications in moderately controlled (temperature 28 ± 2°C and humidity 65%) green house at Rosa Project of Institute of Horticultural Sciences, University of Agriculture, Faisalabad (31°25' N, 73°09' E), Pakistan during 2010 to 2011. Two best cut flower cultivars that is, Cardinal and Whisky Mac of *R. hybrida* L. were selected for the experiment and allowed to grow in sand packed beds with measurement of 1.5, 1.0 and 0.6 m length, girth and depth, respectively. These beds were creased with polythene pieces between plants and rows spacing of 60 and 30 cm, respectively.

Treatments

Foliar application of different commercial formulations of macro and micronutrients were prepared. Five treatments were applied that is: T_0, control; T_1, NPK (17:17:17); T_2, NPK (15:32:7) + micro power); T_3, NPK (15:32:7) + chelated mix micronutrients; and T_4, NPK (15:20:15) + Chelated mix micronutrients + VC-10 . Micro power contain N, 1%; K_2O, 1%; Zn, 2.5%; B, 1%; Fe, 1%; Mn, 1% and Cu, 2% nutrients and chelated mix micronutrients (CMM) also contained Zn, 1.5%; B, 2%; Fe, 2%; Mn, 2% and Cu, 1% nutrients. VC-10 is a commercial product that contains acidic solution and it maintained the soil pH level low (acidic). Each treatment had five healthy and vigorous plants of each cultivar that were replicated thrice. Both micronutrients (Micro power and chelated mix micronutrients) and macronutrients with all combinations were applied through foliar spray at 6 to 8 ml per 100 ml after two months interval from November 2010 to October 2011. Cultural and management practices like weeding, irrigation, hoeing etc. were similar for all treatments in all replications throughout the experiment.

Data collection

Data regarding different growth parameters as plant height (cm) and leaf area (cm^2) were taken by measuring tape and digital leaf area meter (Top YMJ-A), respectively. Number of flowers $plant^{-1}$ was noted and stalk length of flower (cm) was determined by measuring ribbon. Bud diameter (mm) and flower diameter (mm) were measured by digital vernier caliper. Fresh weight of flower (g) was taken by digital weighing balance and flower dried in the shade and then transferred into the oven at 65°C for 48 h to dry. Quality of flower (growth of bud, flower shape, size in diameter and color) were determined by scoring method illustrated by Dest and Guillard (1987) and Cooper and Spokas (1991). Leaf total chlorophyll percentage (mg g^{-1}) was measured by digital chlorophyll meter (CCM 200 plus) and at the end vase life of flower was counted in days.

Leaf analysis

Completely stretched and grown-up foliage from lower section of the plants was assembled, cleaned and air dried for 48 h. These were then oven dried at 55°C for 24 h. The dried foliage was compressed, grounded and stored in artificial bottles for analysis of N, P and K (Champan and Parker, 1961). Afterward one gram sample of dehydrated ground leaf matter was digested by means of H_2SO_4 and H_2O_2 (Yoshida et al., 1976). Nitrogen was determined by Kjeldhal's method (Markhan, 1942), while phosphorus was measured using the method of Jackson, 1962. Potassium determination was done using standard methods (Naheed et al., 2008).

Statistical analysis

Data were evaluated statistically by means of using analysis of variance procedure and at 5% level of significance (Steel et al., 1997).

RESULTS

For plant height, analysis of variance demonstrated extremely significant values for both varieties and treatments and also there were considerable difference with interaction between varieties and treatments. Cardinal produced more height as compare to Whisky Mac. Maximum plant height in Cardinal was 116.33 cm and minimum height 74.67 cm were recorded while in Whisky Mac 90.21 and 65.82 cm was maximum and minimum plant heights, respectively. In case of treatments, T_4 (NPK = 15:20:15 + chelated mix micronutrients + VC-10) produced utmost height in both varieties and T_0 (control) showed minimum height (Table 1).

For Leaf area, similar results were obtained as in plant height. Comparison of treatments illustrated that T_4 (NPK = 15:20:15 + Chelated Mix Micronutrients + VC-10) showed (Table 1) high value (20.66 cm^2) of leaf area while lowest value (6.42 cm^2) was obtained in T_0 (control). In Whisky Mac, there were no considerable differences among different treatments. Highest values of leaf area were obtained in T_2 (NPK = 15:32:7 + Micro power) with 15.21 cm^2 and lowest value was obtained by T_1 (NPK = 17:17:17) with 11.47 cm^2. Comparison of varieties indicated that Cardinal produced maximum leaf area as com-

Table 1. Effect of foliar application of macro and micronutrients on different plant characteristics.

Treatment	Plant height (cm)		Leaf area (cm^2)		Number of flowers $plant^{-1}$		Bud diameter (mm)	
	Cardinal	Whisky Mac	Cardinal	Whisky Mac	Cardinal	Whisky Mac	Cardinal	Whisky Mac
T_0	74.67±0.21^{d}	65.82±0.77^{d}	6.42±0.50^{d}	11.83±1.96^{a}	6.92±0.12^{e}	7.3±0.12^{e}	12.05±0.01^{d}	13.38±0.12^{d}
T_1	96.65±0.33^{c}	69.93±0.23^{c}	11.5±0.80^{c}	11.47±1.35^{a}	7.26±0.06^{d}	7.93±0.12^{d}	12.79±0.12^{c}	13.91±0.12b^{c}
T_2	118.32±0.40^{a}	82.21±0.52^{b}	17.69±1.8a^{b}	15.21±1.73^{a}	9.04±0.06^{c}	9.1±0.06^{c}	15.98±0.12^{a}	14.91±0.09^{a}
T_3	108.27±1.21^{b}	82.28±0.55^{b}	12.87±1.4b^{c}	13.57±1.74^{a}	11.85±0.12^{a}	12.1±0.03^{a}	15.87±0.12^{a}	14.21±0.06^{b}
T_4	116.33±0.49^{a}	90.21±0.58^{a}	20.66±1.9^{a}	13.46±1.15^{a}	10.56±0.12^{b}	10.3±0.06^{b}	14.63±0.12^{b}	13.87±0.06^{c}

Table 2. Foliar application of macro and micronutrients on different flower characteristics.

Treatment	Flower diameter (mm)		Fresh weight of flower (g)		Dry weight of flower (g)		Flower stalk length (cm)	
	Cardinal	Whisky Mac	Cardinal	Whisky Mac	Cardinal	Whisky Mac	Cardinal	Whisky Mac
T_0	66.93±1.15^{e}	56.3±0.58^{e}	10.54±0.12^{e}	10.32±0.12^{e}	1.66±0.06^{b}	1.30±0.03^{d}	28.27±0.58^{d}	24.13±0.58^{d}
T_1	85.23±1.15^{d}	75.7±1.73^{d}	12.3±0.12^{d}	10.9±0.09^{d}	1.62±0.06^{b}	1.44±0.03^{c}	34.16±1.15^{c}	30.63±1.15^{c}
T_2	96.63±1.45^{c}	88.5±1.15^{c}	15.83±0.17^{b}	12.8±0.06^{c}	2.23±0.29^{a}	1.60±0.03^{b}	44.95±0.58^{a}	41.84±0.58^{a}
T_3	100.67±0.58^{b}	92.9±1.15^{b}	18.3±0. 17^{a}	16.0±0.06^{a}	2.16±0.03^{a}	2.08±0.01^{a}	40.3±0.58^{b}	37.7±1.15^{b}
T_4	104.43±1.15^{a}	101.37±1.15^{a}	14.32±0.13^{c}	13.4±0.17^{b}	2.16±0.03^{a}	2.2±0.05^{a}	41.07±0.58^{b}	42.01±0.58^{a}

compared with the Whisky Mac.

Number of flowers $plant^{-1}$ in Cardinal was highest in T_3 (NPK = 15:32:7 + Chelated Mix Micronutrients) and minimum numbers of flowers were shown by T_1 (NPK = 17:17:17). There were very significant differences among all treatments and similar results were also observed in Whisky Mac where highest numbers of flowers were obtained by the same treatment as in Cardinal and lowest numbers of flowers were observed in T_0 (control). There was not any considerable difference between both varieties but Whisky Mac was slightly higher in this characteristic as shown in Table 1.

When treatments were compared with each other it illustrated that T_2 (NPK + Micro power) showed high value of bud diameter (15.98 and 14.91 mm) while the lowest bud diameter (12.05 and 13.87 mm) was obtained by T_0 (control) in Cardinal and Whisky Mac, respectively, (Table 1). When varieties were compared with each other, the results indicated (Table 1) that Cardinal produced maximum bud diameter as compared to the Whisky Mac.

For flower diameter of Cardinal (Table 2), T_4 (NPK = 15:20:15 + chelated mix micronutrients + VC-10) showed highest value (104.43 mm) while the lowest flower diameter (66.93 mm) was obtained by T_0 (control). There was significant difference between the highest and lowest values of flower diameter. In Whisky Mac, T_4 (NPK = 15:20:15 + chelated mix micronutrients + VC-10) was also at the top followed by T_3 (NPK = 15:32:7 + chelated mix micronutrients) with 101.37 and 92.91 mm, respectively. Comparison of varieties indicated that Cardinal showed more effective response to macro and micrntrients as compare to Whisky Mac.

When treatments were compared (Table 2) in both varieties with each other, it illustrated that T_3 (NPK = 15:32:7 + chelated mix micronutrients) showed highest value of fresh weight of flower (18.33 and 15.95 g in Cardinal and Whisky Mac, respectively) and presented significant difference against all other treatments while lowest values (10.54 and 10.32 g) were found in T_0 (control). But in case of dry weight of flower T_3 (NPK = 15:32:7 + Chelated Mix Micronutrients) and T_4 (NPK = 15:20:15 + Chelated Mix Micronutrients + VC-10) shown same results with the values 2.16 g of each treatment and lowest values were observed in T_0 (control) in Cardinal. In case of Whisky Mac T_4 (NPK = 15:20:15 + Chelated Mix Micronutrients + VC-10) was best with the value of 2.22 g followed by T_3 (NPK = 15:32:7 + chelated mix micronutrients) with 2.08 g while lowest dry weight was observed in T_0 (control) with 1.30 g. Comparison of varieties indicated that Cardinal attained more fresh and dry weight of flower as compared to Whisky Mac. So, Cardinal responded well in this character also as shown in Table 2.

In case of flower stalk length, T_2 (NPK = 15:32:7 + Micro power) showed high value of flower stalk length (43.41 cm) and presented considerable dominance against other treatments (Table 2) while lowest flower stalk length (26.2 cm) was obtained with T_0 (control). Comparison of varieties indicated that Cardinal produced maximum value of flower stalk length (44.95 cm) as compared to the Whisky Mac (42.01 cm), so Cardinal showed better results.

Data suggested (Table 3) that in Cardinal, highest leaf total chlorophyll contents were observed in T_3 (NPK = 15:32:7 + Chelated Mix Micronutrients) with 62.33 mg g^{-1} followed by T_4 (NPK = 15:20:15 + chelated mix power) with 62.53 and 61.27 mg g^{-1}, respectively, and minimum value was observed in T_0 with 55.56 mg g^{-1}. But in case

Table 3. Foliar application of macro and micronutrients on different quality characteristics.

Treatment	Leaf total chlorophyll content (mg g^{-1})		Flower quality		Vase life (days)	
	Cardinal	Whisky Mac	Cardinal	Whisky Mac	Cardinal	Whisky Mac
T_0	55.56±2.89^{d}	54.4±3.46^{c}	3.76±0.06 e	5.03±0.58^{c}	4.92±0.03e	5.06±0.06e
T_1	59.48±2.89^{c}	59.6±3.46^{bc}	4.7±0.12^{d}	5.43±0.09^{c}	5.39±0.06^{d}	5.4±0.06^{c}
T_2	61.27±2.89^{b}	74.61±3.46^{a}	6.7±0.17^{b}	6.86±0.08^{ab}	7.18±0.05^{a}	6.8±0.06^{b}
T_3	62.9±2.89^{a}	65.50±2.83^{b}	7.21±0.17^{a}	7.11±0.06^{a}	7.1±0.06^{b}	7.11±0.06^{a}
T_4	62.53±3.48^{a}	61.56±0.93^{bc}	6.2±0.06^{c}	6.2±0.06^{b}	6.27±0.06^{c}	6.43±0.06^{c}

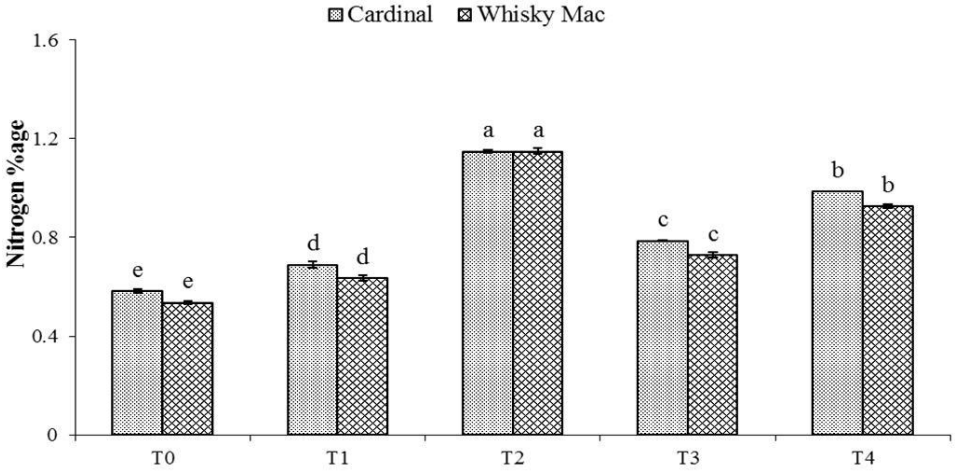

Figure 1. Foliar application of macro and micronutrients on nitrogen percentage.

of Whisky Mac, T_2 (NPK = 15:32:7 + Micro power) was highest with 74.61 mg g^{-1} and T_0 (control) was lowest with 54.41 mg g^{-1}. T_3 (NPK = 15:32:7 + Chelated Mix Micronu-trients) and T_4 (NPK = 15:20:15 + Chelated Mix Micronu-trients + VC-10) also contained significant chlorophyll contents with value of 65.50 and 61.56 mg g^{-1}, respect-tively. When varieties were compared with each other, the data illustrated that Whisky Mac attained more chlo-rophyll contents than the Cardinal.

For flower quality in case of Cardinal, when treatments were compared with each other it illustrate that T_3 (NPK = 15:32:7 + Chelated Mix Micronutrients) showed high value of flower quality (7.21) while lowest value of flower quality (4.39) was obtained in T_0 (control). But in Whisky Mac, the data illustrated that there were no significant difference among treatments. Maximum scores were obtained by T_3 (NPK = 15:32:7 + Chelated Mix Micronutri-ents) followed by T_2 (NPK = 15:32:7 + Micro power) and T_4 (NPK = 15:20:15 + Chelated Mix Micronutrients + VC-10) while minimum scores (5.03) were obtained by T_0 (control). Comparison of varieties indicated that Cardinal produced maximum value of flower quality as compared with the Whisky Mac, but on average basis Whisky Mac was good and there was very little difference in case of scores among treatments (Table 3).

When vase life of both varieties was checked, the data showed that vase life of T_2 (NPK = 15:32:7 + micro power) and T_3 (NPK = 15:32:7 + chelated mix micronutrients) was similar with 7.18 and 7.14 days, respectively, in Cardinal (Table 3). Minimum vase life was recorded in T_0 (control) with 4.92 days. In case of Whisky Mac T_3 (NPK = 15:32:7 + chelated mix micronutrients) created maximum vase life of 7.11 days followed by T_2 (NPK = 15:32:7 + Micro power) and T_4 (NPK = 15:20:15 + Chelated Mix Micronutrients + VC-10) with 6.83 and 6.43 days, respectively, while T_0 (control) with 5.06 days of vase life was lowest amongst all other treatments (Table 3).

For leaf nitrogen percentage, there were very significant results for varieties, treatments and with interaction of variety and treatments. When treatments were compared with each other in Cardinal, it illustrate that T_2 (NPK = 15:32:7 + Micro power) showed high value of leaf nitrogen (1.15%) while the lowest value of leaf nitrogen (0.58%) was obtained with T0 (control). Comparison of varieties indicated that Cardinal produced maximum value of leaf nitrogen percentage as compared to the Whisky Mac as shown in Figure 1.

In case of leaf phosphorus percentage in Cardinal, T2 (NPK = 15:32:7 + micro power) contained highest value of 0.112% phosphorus in leaves followed by T3 (NPK = 15:32:7 + Chelated Mix Micronutrients) with 0.083%

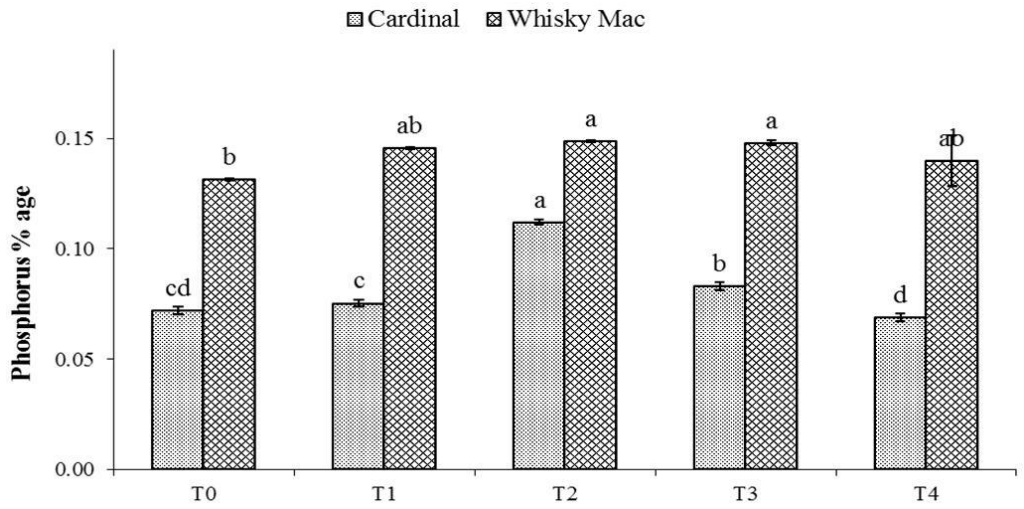

Figure 2. Foliar application of macro and micronutrients on phosphorus percentage.

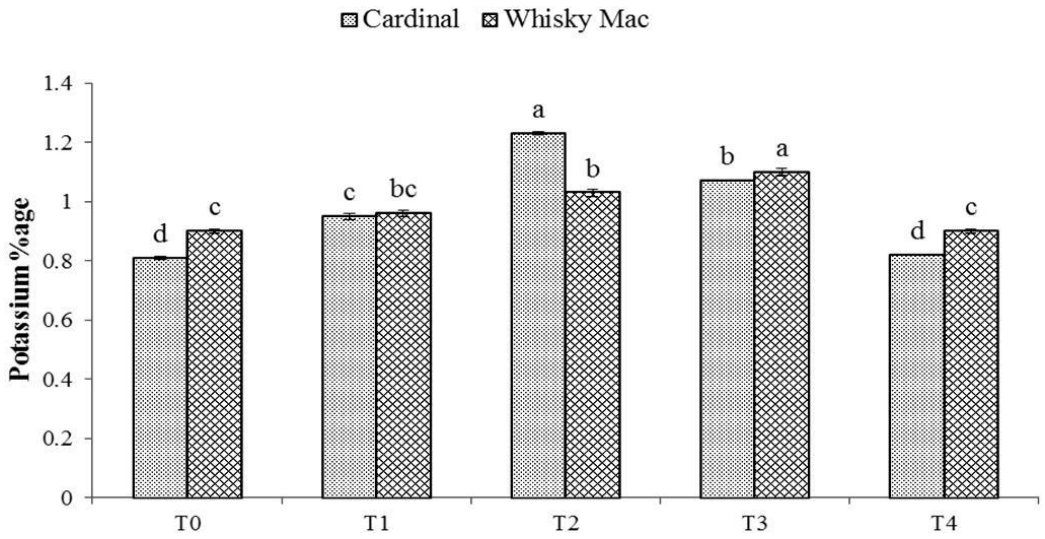

Figure 3. Foliar application of macro and micronutrients on potassium percentage.

phosphorus while lowest value was observed in T_0 (control) with 0.072% phosphorus. In Whisky Mac, all treatments (T_2, T_3, T_4 and T_1) contained similar quantity of phosphorus with little difference (0.1487, 0.148, 0.146 and 0.145%, respectively) except T_1 (NPK = 17:17:17) which contained lowest quantity 0.131% of phosphorus as compare to others treatments. Data showed that Whisky Mac contained more phosphorus as compare to the Cardinal (Figure 2).

Data revealed that potassium were in highest quantity in T_2 (NPK = 15:32:7 + Micro power) with 1.23% followed by T_3 (NPK = 15:32:7 + chelated mix micronutrients) and T_1 (NPK = 17:17:17) with 1.07 and 0.95%, respectively, and T_0 was lowest with 0.81% in Cardinal. In case of Whisky Mac, maximum concentration was observed in T_3 (NPK = 15:32:7 + Chelated Mix Micronutrients) with 1.10% followed by T_2 (NPK = 15:32:7 + Micro power) with 1.03% potassium (Figure 3). When varieties were compared with each other, data reveled that Whisky Mac contained slightly higher potassium contents than Cardinal.

DISCUSSION

Improvement in growth characters such as plant height and leaf area by the application of micronutrients may exist due to enhanced photosynthetic and other metabolic activity which leads to an increase in various plant metabolites responsible for cell division and elongation as opined by Hatwar et al. (2003). The photosynthesis enhanced in presence of B and Zn was also reported by Rawat and Mathpal (1984). It was noted from this experi-

ment that mixture of macro and micronutrients with VC-10 produced maximum plant height related to all other treatment combinations. Similar explanation was reported by Deshmukh and Wavhal (1999), which argued that to facilitate with the application of macro and micronutrients like B and Zn increased in leaf area and plant height in aster was obtained. In Whisky Mac, leaf area was less as compare to Cardinal that may be due to genetic character of the plant and highest leaf area was observed when macronutrients were with the ratio of 15:32:7 + Micro power were applied. Results presented above were also in line by the conclusion of Prabhat et al. (2002), whose results showed to facilitate foliar application of 0.2% ferrous sulphate alone or in different grouping give maximum value of plant height and also increase leaf area. El-Naggar (2009) reported that the fertilizers application by orthophosphoric acid singly or combination of boric acid with this stimulated leaf area in *Dianthus caryophyllus* cv. white William Sim (carnation plant).

It was observed from this experiment that NPK (15:32:7) + chelated mix micronutrients had profound effect on increasing number of flowers than any other treatment combinations. Ahmad et al. (2010) also reported that micronutrients application followed by only B application give early and maximum flowering/plant as compare with other treatment combinations. There was 14% greater numbers of flowers produced with nutrients application compared with the control plants (Sajid et al., 2009). Prabhat et al. (2002) also showed to facilitate foliar application of 0.2% ferrous sulphate alone or in different grouping produced highest value of number of leaves branch^{-1} of gladiolus. The results were also in line with the conclusion of Singh and Bhattachajee (1997) from which it was concluded that foliar sprays of $ZnSO_4$, $CuSO_4$, $MnSO_4$ and $FeSO_4$ applied two times followed by pruning to roses *cv*. Raktagandha (3 years older), significantly increased number of flowers plants^{-1} and other quality and quantity parameter.

Maximum bud diameter was observed when NPK (15:32:7) were mixed with Micro power and foliar spray was applied on the plants. Joshi et al.(2002), also favored our argument and declared that maximum value of bud and flower diameter of *Rosa damascena* was produced with the application of Zn, Mn and other essential micronutrients and B was concerned with a number of cellular actions like flower fertilization, raise in the length of pollen tubes, cell division, growth, development and process of respiration. It was also observed in this experiment and it was also cleared that extra figure of flower diameter were produced in contrast with other application of treatments. Deficiency of B and Zn resulted in small leaves and improper reproductive development.

Increase in reproductive growth may take place because of application of all essential micronutrients in proper concentrations. NPK (15:32:7) + chelated mix micronutrients attained maximum fresh weight of flower followed by NPK (15:20:15) + chelated mix micronutrients + VC-10 and lowest fresh weight of flower were observed in control treatment of this experiment. Similar explanation was reported by Deshmukh and Wavhal (1999), who argued that with the application of essential micronutrients like B and Zn, fresh and dry weight of a flower increased in plants. B is straightly associated with fresh and dry weight of flowers and concerned with a number of cellular actions. It was also comprehensible that NPK combinations with micronutrients create extra value of fresh weight of a flower match up with all other treatments. El-Naggar (2009) reported that Sangral (foliar nourishment) of macro-elements and micro-elements Fe, Zn, Cu, Mn, B and Mo resulted in increase of dry weight of flowers.

Flower stalk length was recorded highest in NPK (15:32:7) + Micro power in this experiment. These results were due to response of micronutrients especially B which assist in movement of fundamental sugars in plant membranes and encourage appropriate cell division, cell wall growth and development and Zn that encourage seed/grain development, plant development and in protein, it acts as enzyme activator. Khoshgoftarmanesh et al. (2008) deliberated the response of extra contribution of Fe, Zn, Mn, and Cu on three *R. hybrida* cultivars Orange Juice, Aqua Fresh and Modern Girl. The results showed that there were significant variations among different cultivars of rose in increasing Zn, Fe, and Mn shortage signs and reaction of micronutrients application. All the treatments of micronutrients application presented maximum length of stalk of flower with increased width of Orange Juice and Modern Girl match up to the control treatment. Singh and Bhattacharjee (1997) also supported our urgings and also reported that micronutrients increase the flower diameter and quality characteristics of rose cv. Raktagandha.

It was observed from this experiment that plants which were treated with NPK (15:32:7) + micro power produces more chlorophyll content than all other treatments. The results of Mahgoub et al. (2010) were also in line with our results and noted that when plants were treated with 2.0 cm 3/L of Grow More followed by 1.0 cm 3/L, the highest values of quality parameters were found. Maximum values in the content of plants from Chlorophyll (a + b) and total Chlorophyll content was obtained when Grow More were spraying at the rate of 2.0 cm 3/L.

Results of this experiment presented above are in order by the conclusion of Prabhat et al. (2002) whose results showed to facilitate foliar application of 0.2% ferrous sulphate alone or in different grouping give maximum value of quality of flowers. Singh and Bhattacharjee (1997) concluded that foliar spray of $ZnSO_4$, $CuSO_4$, $MnSO_4$ and $FeSO_4$ two times subsequent to pruning of rose cv. Raktagandha, significantly increased quality characteristics of plants. Khoshgoftarmanesh et al. (2008) also showed that genotypic difference and enough micronutrient contribution were two solution factors in successful development of rose and he concluded that due to

application of micronutrients in proper quantity, major enhancement in plant development and quality of flower and micronutrient absorption of leaf as compared to control. El-Naggar (2009) also reported that Sangral (foliar nourishment) including macro-elements 20% nitrogen, 20% phosphorus, 20% potassium and micro-elements Fe, Zn, Cu, Mn, B and Mo (0.0, 0.2, 0.4, 0.6, 0.8 and 1.0%, respectively) resulted in major raised in carbohydrates, nitrogen, phosphorus, potassium, zinc and copper percentages founded in leaves compare with the control treatments in plants.

Conclusion

Keeping in view all the above growth, flowering and quality characteristics, T_2 (NPK+ micro power) and T_3 (NPK + chelated mix micronutrients) proved the best combination of macro and micronutrients while T_4 (NPK + chelated mix micronutrients +VC-10) due to addition of VC-10 which make the soil more acidic and more acidic conditions gave the less effective results in some growth, flowering and quality characteristics. Cardinal responded very well to micronutrients application and improvements in yield and quality of the flowers were also occurred as compare to Whisky Mac.

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