Research Article

Effect of Phosphorus and Potassium on the Production and Quality of Cut Rose Cultivars

Ammara Saeed* and Noor-ul-Amin

Department of Horticulture, Faculty of Crop Production Sciences, The University of Agriculture, Peshawar, Khyber Pakhtunkhwa, Pakistan.

Abstract | Phosphorus and potassium are macro nutrients that play major role in growth and development of plants. A Randomize Complete Block Design experiment was laid with split plot arrangement at Ornamental Horticulture Nursery, Department of Horticulture, The University of Agriculture Peshawar during 2014 and 2015. Cut flower rose cultivars were tested with treatments of 3 levels of phosphorus (30, 60 and 90 kg ha^{-1}) and potassium (20, 40 and 60 kg ha^{-1}) each as well as combined. Results showed that when plants were supplied with phosphorus at 60 kg ha^{-1} and potassium at 40 kg ha^{-1}, it significantly improved studied variables, such as early days to sprouting (11.5 days), days to flowering (35.0 days), maximum number of branches $plant^{-1}$ (11.4), number of leaves $branch^{-1}$ (19.0), flower stalk length (44.7 cm), flower diameter (7.7 cm), number of flower $plant^{-1}$ (12.2), flower persistence (11.6 days) and survival percentage (96.8 %). Results further showed that all the study attributes were recorded significantly best in 2015 compared to 2014. In cultivars, Gold Medal produced early sprouting (12.7 days), maximum number of branches (7.4), and number of leaves $branch^{-1}$ (15.3), survival percentage (87.1%), number of flowers (10.6) and flower persistence (9.2 days). While cultivar Cardinal produced highest flower stalk length (41.6 cm) and flower diameter (7.4 cm). The interaction between treatments and cultivars significantly affected number of branches $plant^{-1}$, number of leaves $branch^{-1}$, days to flowering, flower stalk length, flower diameter and flower persistence. It can be concluded that P @ 60 kg ha^{-1} with combination of K @ 40 kg ha^{-1} enhance production and quality of rose cultivar, especially in Gold Medal and Cardinal cultivars.

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***Correspondence** | Ammara Saeed, Department of Horticulture, Faculty of Crop Production Sciences, The University of Agriculture, Peshawar, Khyber Pakhtunkhwa, Pakistan; **Email:** ammarahorticulturist@gmail.com
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Keywords | Phosphorus, Potassium, Cut flower rose cultivar, Number of branches, Flower persistence, Gold medal, Cardinal cultivar

Introduction

Rose belongs to genus *Rosa* in the family Rosaceae and comprised of 200 species worldwide (Gudin, 2000). Roses were reported to be brought to Europe from China (Guoliang, 2003). Among the total genotypes of roses, only 20 are known for their high attractiveness in terms of flowers (Korban, 2007). As roses are used for interior decoration and igniting charm of many events such as marriage ceremonies, arrival of dignitaries, Valentine's Day and other similar occasions, ultimately boosting worldwide floriculture business (Butt, 2003). The largest producers of cut flowers are USA, Holland, Israel, Columbia, Kenyu, Japan and Zimbabwe (Usman et al., 2014).

The diverse agro climatic conditions in Pakistan suit all kind of ornamental plants, including cut flower and pot plants round the year. In Pakistan, growing cut flower especially roses, is a very profitable business, if

done on commercial basis. Cut flower major growing areas of Pakistan include Pattoki in Punjab, Peshawar in Khyber Pakhtunkhwa and Quetta in Baluchistan (Usman et al., 2014).

Favorable climate, proper nutrition and selection of cultivars according to the environmental conditions play pivotal role in the production and quality of cut roses. Among nutrients, phosphorus is considered a major element for plant growth and development. Normally plants need phosphorus for metabolic regulation, cellular bioenergetics and among the key component of essential bimolecular including DNA, RNA, ATP, phospholipids and sugar-phosphates (Plaxton and Hans, 2015).

On the other hand, potassium plays prime role in regulating the opening and closing of stomata, water retention, promote the growth of meristematic tissue and activation of enzymes (Bhandal and Malik, 1988). Potassium also helps in plants faster growth, efficient use of water and develops more resistant against drought, disease and pest and as a result plants grow stronger and produces high yield use of specific fertilizer at proper amount and time in floriculture industry is considered one of important tools which ensure proper growth and enhance yield. (Rhoades, 2016).

Cut flower rose production in Pakistan and particularly in Khyber Pakhtunkhwa is low, which can be related with lack of knowledge to select best cultivars according to the climate condition of the area and applying suitable fertilizer with specific level. Keeping these points in mind, an experiment was designed in Department of Horticulture, The University of Agriculture, Peshawar to study the effect of phosphorus and potassium on the production and quality of cut rose cultivars.

Materials and Methods

Randomized complete block design (RCBD) with split plot arrangement experiment was carried out at Ornamental Horticulture Nursery, Department of Horticulture, The University of Agriculture Peshawar during 2014 and 2015. Cut flower rose cultivars were tested with treatments of 3 levels of phosphorus (30, 60 and 90 kg ha^{-1}) and potassium (20, 40 and 60 kg ha^{-1}) each as well as combined. Five cultivars of cut rose Cardinal, Red Meshal, Whisky Mac, Gold Medal and Indian Chief were planted randomly into sub plots. Plot was selected in area where plants were fully exposed to sunlight and irrigation facility was available.

Field was ploughed with the help of cultivator at the depth of 15cm and removed all inert materials to make field clean and porous. Pits were prepared in depth of 60 cm and rose plants were planted with each plant to plant distance and row to row distance of 30 and 60 cm distance, respectively. After plantation, top of the pants was cut to encourage new growth and to have proper root shoot ratio. All cultural practices such as hoeing, weeding, pinching and irrigation were carried out throughout the experiment as per need. Irrigation was done after three days interval. General pruning was practiced each year in the month of January. Aphid attack was occurred on some plant which was controlled by using appropriate insecticide. Prior to fertilizer application, a representative sample of soil was collected at a depth of 1-15 cm and analysis was carried out at Soil and Environmental Department, The Agricultural University of Peshawar for chemical analysis.

Single super phosphate and Potassium sulphate were used as a source for phosphorus and potassium respectively, while urea was used as a basal dose @ 20 Kg ha^{-1}. Treatments (P and K) were applied to main plot.

Parameter studied

The data were collected of various morphological plant characteristics on randomly five plants in each treatment in all replication parameters.

Statistical analysis

Statistical analysis was performed across both years for cut rose agronomical data with two factorials in randomized complete block design (RCBD) (Steel and Torrie, 1997). The means were separated by the least significant difference (LSD) test using MSTATC (Michigan State University, East Lansing, MI).

Results and Discussion

The mean squares for days to sprouting, number of branches $plant^{-1}$, number of leaves $branch^{-1}$ and survival percentage are displayed in Table 1. Highly significant variation was observed regarding number of branches $plant^{-1}$ for years, treatments, cultivars and interaction between year with cultivars and cultivars with treatments. However, the interactive effect

with regard to year with treatment and between year treatment and cultivars was found non-significant. The variation regarding number of leaves branch^{-1} were significant observed on years, highly significant for cultivars, treatments and interaction among years with cultivars and treatment with cultivars. Moreover, the interaction of years with treatment and between year's treatment and cultivar were found non-significant.

Table 1: *Mean squares for days to sprouting, number of branches plant^{-1}, number of leaves branch^{-1} and survival %age.*

S.V	DF	Days to sprouting	No. of branches plant^{-1}	No. of leaves branch^{-1}	Survival %age
Year (Y)	1	3876**	68.2**	210.6*	13125.2*
Reps w/n (Y)	4	38.8	2.77	22	876.46
Treatments (T)	15	180.5**	77.9**	212.8**	3805.2**
Cultivars (C)	4	281.4**	33.9**	364.0**	7986.6**
Y × T	15	24.42^{NS}	3.88^{NS}	3.17^{NS}	395.4^{NS}
Error 1	60	23.42	2.46	1.73	256.9
Y × C	4	21.55^{NS}	7.04**	5.33**	517.9**
T × C	60	26.21^{NS}	4.04**	4.67**	170.0^{NS}
Y × T × C	6	21.54^{NS}	1.15^{NS}	0.79^{NS}	155.9^{NS}
Error 2	256	22.0	0.99	0.77	129.4

*,** = *Significantly different at 5 % probability level, respectively;* **NS:** *Non-significant.*

As indicated in Figure 1, the application of P and K treatments had shown better results compared to control plants. The minimum days to sprouting (23.2 days), and highest number of branches (11.4) plant^{-1}, number of leaves (15.83) branch^{-1} and survival percentage (94.6 %) was recorded for treatment with P @ 60 kg/ha and K @ 40 kg/ha.

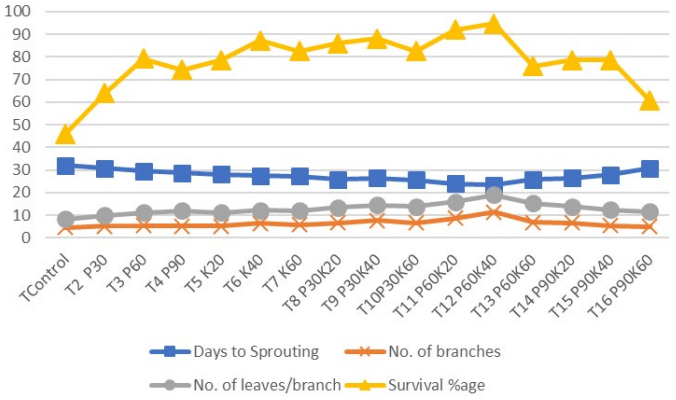

Figure 1: *Effect of different concentrations of phosphorus and potassium on mean days to sprouting, No. of branches, No. of leaves per branch and survival %age in cut flower.*

Similarly, based on two year means data regarding cut rose flowers as shown in Figure 2, minimum days to sprouting were recorded in all cultivars except for Whisky mac in 2015. The number of branches per plant, number of leaves per branch and survival percent in second year for all the cultivars had been recorded significantly (P<0.05) higher compared to first year.

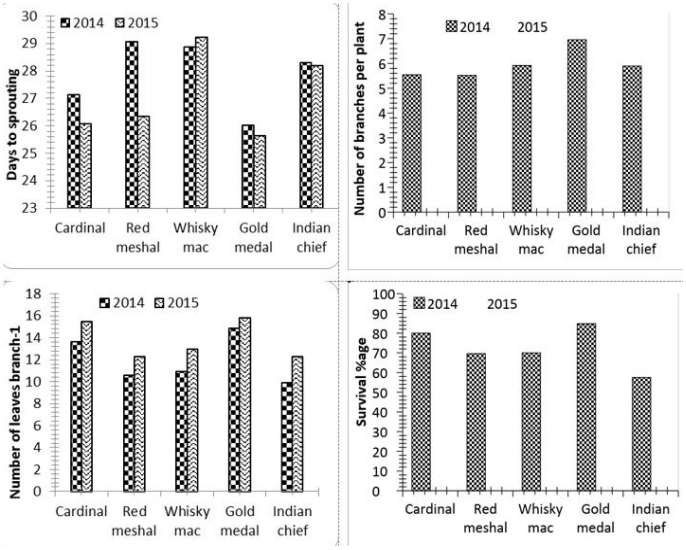

Figure 2: *Response of cultivars and year on days to sprouting, number of branches per plant, number of leaves per branch and survival percentage of cut rose flowers.*

The mean squares for days to flowering bud, flower stalk length (cm), diameter of flower (cm), persistence of flower and number of flowers per plant are displayed in Table 2. Highly significant (P<0.01) variation were observed for diameter of flower and number of flowers per plant with respect to yearly, treatments, cultivars and their interactions. Significant (P<0.05) variation were recorded within the yearly data and interaction between treatment and cultivar (T × C) for remaining attributes including days to flowering, flower stalk length and flower persistence.

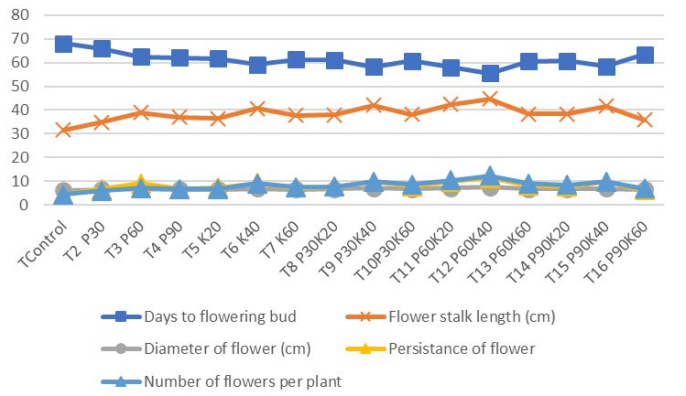

Figure 3: *Effect of different concentrations of P and K on mean days to flowering bud, flower stalk length (cm), diameter of flower (cm), persistence of flower and number of flower per plant in cut flower.*

Table 2: *Source of variation for days to flowering, flower stalk length, diameter of flower, no. of flower plant^{-1} and flower persistence.*

S.V	DF	Days to flowering	Flower stalk length	Diameter of flower	No. flower plant^{-1}	Flower persistence
Year (Y)	1	252.3*	32.5*	7.38**	910.2**	145.2*
Reps w/n (Y)	4	30.0	2.07	0.25	2.96	16.8
Treatments	15	262.8**	303.7**	3.85**	93.7**	89.4**
Cultivars (C)	4	851.0**	465.5**	28.6**	145.8**	67.1**
Y × T	15	15.48^{NS}	1.13^{NS}	0.12^{NS}	0.08^{NS}	3.16^{NS}
Error 1	60	10.41	1.66	0.14	0.66	2.36
Y × C	4	10.35*	8.20**	0.10^{NS}	8.54**	4.93**
T × C	60	5.77*	3.93**	0.17**	1.88^{NS}	1.36**
Y × T × C	60	3.85^{NS}	0.88^{NS}	0.05^{NS}	0.10^{NS}	0.69^{NS}
Error 2	256	3.74	1.45	0.05	1.38	0.63

*,** = *Significant at 5 % probability level, respectively;* **NS:** *Non-significant.*

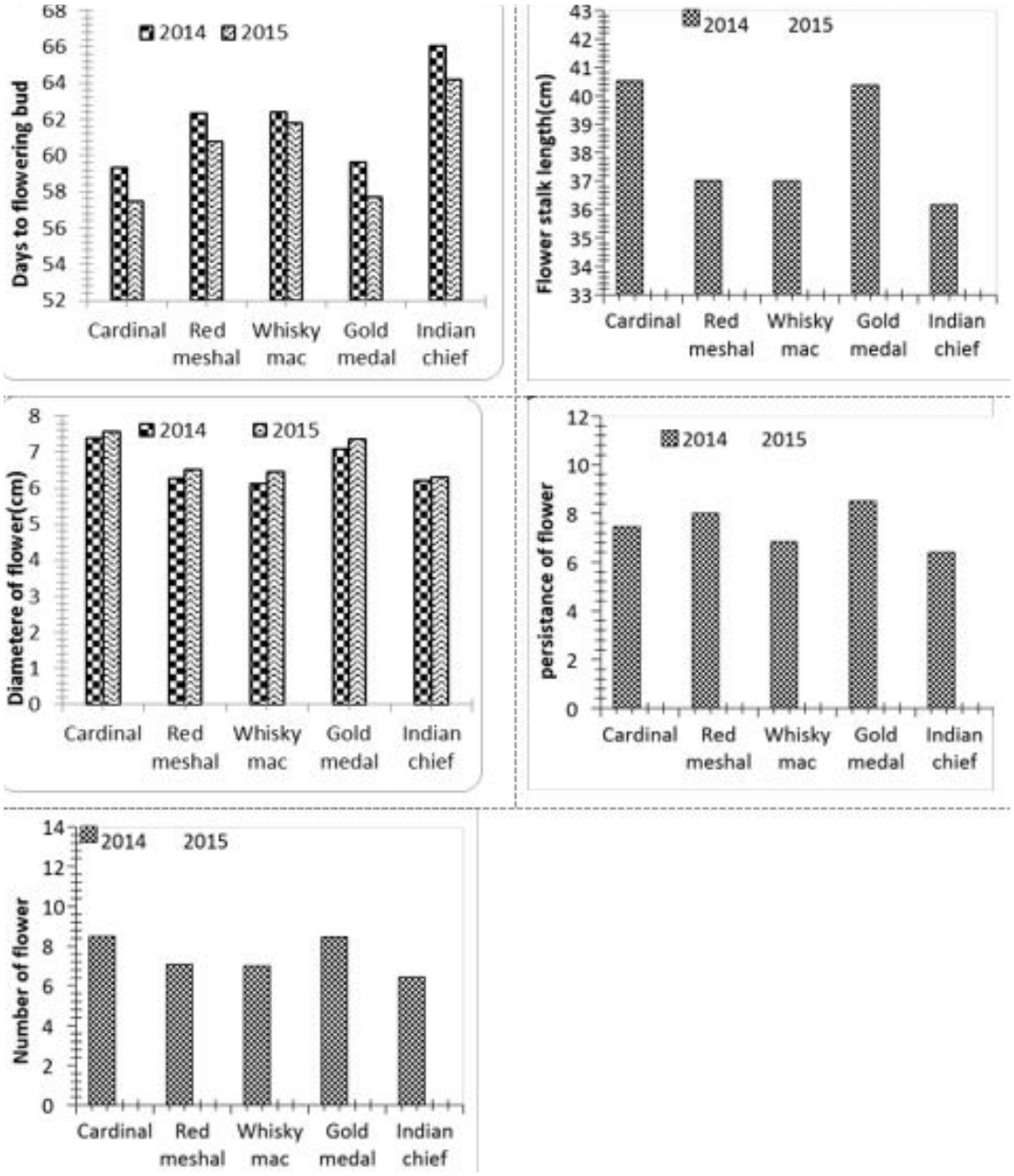

Figure 4: *Response of cultivars and year on days to flowering bud, flower stalk length (cm), diameter of flower (cm), persistence of flower and number of flower per plant in cut flower.*

Links Researchers

As indicated in Figure 2, the application of P and K treatments had shown better results compared to control plants. The minimum days to flowering bud (55.5 days), and highest flower stalk length (44.7 cm), diameter of flower (7.5 cm), persistence of flower (11.4) and number of flowers per plant (12.3 flowers) was recorded for treatment with P @ 60 kg/ha and K @ 40 kg/ha.

Based on two year means data regarding cut rose flowers as shown in Figure 4, minimum days to flowering bud for all cultivars was recorded in second year i.e. 2015. The flower stalk length (cm), diameter of flower (cm), persistence of flower and number of flower per plant in cut flower in second year for all the cultivars had been recorded significantly ($P<0.05$) higher compared to first year.

The availability of such nutrients in adequate amount in the soil help the plants to grow vigorously as well as promotes functional characteristics. Potash requires for wide range of functions in plant cell such as activation of numerous enzymes and up take of nutrients which give plant vigorous growth (Sultenfuss and Doyle, 1999; Marschner, 2012; Britto and Kronzucker, 2008). Pal and Ghosh (2010) stated that potassium at 200 kg ha^{-1} influence both primary and secondary branches in marigold. Hussan et al. (2011) reported that maximum survival percentage in *Fressia cormel* was obtained at application of high level of K @ 60 kg ha^{-1}. Similarly, Phosphorus provides energy for the movement of nutrient within plant in the form of adenosine tri-phosphate and adenosine di-phosphate (Sultenfuss and Doyle, 1999; Gangwar et al., 2012). Shoram et al. (2012) examined high application of phosphorus on Jasmine which resulted in better plant height, number of branches, flower diameter, flower weight, flowers numbers per plant, flowers yield flower shelf life and minimum days taken for flower initiation. Pimple et al. (2006) reported that vase life of gerbera flowers was enhanced under lower level of nitrogen and higher level of phosphorous 5g N + 15 g P2O5 g/m^2. Number of inducing mechanisms within plant is enhanced by the application of P and K (Malik, 1994). According to Jayamma et al. (2014), biofertilizers with addition of 50 % NPK can increase plant quality including a greater number of branches per plant.

Song et al. (2011) revealed that at 20:8:10 ratio NPK improved flower stalk length and stalk diameter, flower diameter and flower fresh and dry mass of chrysanthemum. According to Gurav et al. (2005) rose cv. First Red produces flower with longer stalk length when treated with NPK at 400:200:200 ppm $plant^{-1}week^{-1}$ under polyhouse condition. Terangpi and Paswan (2003) stated that in gerbera longest stalk of flower was recorded under application of P @ 10 g m^{-2} + K @ 30 g $^{-2}$ along with nitrogen and FYM. Similarly, Anamika and Lavania (1990) concluded that in combination of macro nutrients such as NPK at 25:20:15 g $plant^{-1}$ influenced best vegetative growth in rose in terms of plant spread, total leaf area and shoot diameter and plant height.

The variation with years and cultivars regarding days to sprouting on rose is due to the effect of temperature and age of plants (Khattak, 1991). Persistence of flowers is decreases with temperature increases above 30^0C, age of plant and their genetic makeup also result variation regarding persistence of rose flower (Younis et al., 2009).

The presented research findings were in line with the findings of Jamil et al. (2016), Bibi et al. (2016), Kalbhor et al. (2015), Shah et al. (2014), Baral et al. (2012), Mohapatra and Panda (2011), Yang et al. (2009), Qasim et al. (2008), Singh (2007), Renuka et al. (2005), Javid (2005), Baboo et al. (2005), Nagaraju et al. (2003), Ghaffoor et al. (2000), Bhujbal et al. (1992), Anuradha et al. (1990) and Gowda et al. (1988).

Thus, P and K applied at 60 and 40 kg ha^{-1} to rose plants for optimum production and quality was recommended. Cultivars Cardinal and Gold Medal were superior cut rose cultivars grown in Peshawar. Future research should be recommended by using other macro nutrient on quality and production of cut flower rose.

Novelty Statement

This study highlights the effects of phosphorus and potassium on the production and quality of cut rose cultivars. It can enhance the quality and production of cut flower rose cultivars under agro- climate condition of Peshawar.

Author's Contribution

Ammara Saeed: Conducted the experiments and field work, did data analysis and wrote the manuscript.
Noor-ul-Amin: Designed the study and supervised the project.

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