



Performance comparison of *Rosa hybrida* varieties under Pothwar climate

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Abstract

Roses nature beautiful creation, response differential in newly adopted area. it is necessary to evaluate the exotic varieties response for adoptability in Pothwar climate of Pakistan. In this study, the twenty-one *Rosa hybrida* varieties were grown to evaluate their performance in open field. The aesthetic beauty of varieties, adoptability and morphological performance was assessed under the Pothwar agro climatic condition. Data was collected on plant height (cm), primary branches, number of flowers, flower diameter (cm), number of flowers petals, number of prickles per 10 cm area and flower persistence life (days). Data was analyzed by using factorial design with LSD level 0.05. Results shows that plant growth with respect of number of flowers increases up to month of May. As temperature increase above 37 °C, number of flowers decrease but increasing trend in growth and number of primary branches observed up to October until growth ceased. Significant Interaction was observed in yield traits and months. The maximum plant height (91.15 cm) was observed in variety Medistrich (V6) and maximum number of primary branches (14.82) was counted in Variety Gruss an teplitz (V21). As number of flowers concerned in all varieties, Angel face (V16) flowering performance was significant. Minimum variation was observed in diameter of flower throughout the season from March to October. The flower persistence life in field varied from 6.16 to 13.50 days among varieties. Overall significant variation was observed in each variety for overall performance. It is concluded that variety Medistrich, Gruss an teplitz performance remain better in Pothwar climate of Rawalpindi.

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Introduction

The roses are popular and most favorite ornamental flower among Rosaceae family. The natural aesthetic beauty associated with color geometry makes the roses “Queen of Flowers” (Bale *et al.*, 2012). Production and growth of roses in new adopted area mainly influenced by climatic fluctuation and associated edaphic factors (light, humidity and temperature). Roses shows differential response to temperature in relevance to time of flowering, usually low temperature leads to dormancy of roses which effect bud break period and flowering, but it may be minimal depends upon the cultural practices. The temperature requirement for growth and production varies between day(20-25°C) and night(13-16°C) with sunlight (8 hours) availability (Shin *et al.*, 2001). Roses needs 1210.94 mm irrigation water in open field of sub-humid climatic condition and 999.51 mm greenhouse production (Singh *et al.* 2016). The results of different survey studies indicated that roses commercial adoptability is boosting in various cities of the Punjab. The flower farming under Roses, Gladiolus, tuberose and jasmine is estimated around 9000 acres with productivity of 10-12 thousand tons (Riaz *et al.*, 2007). Pakistan has potential of productivity throughout the year which can meet the global markets demands by gulf countries e.g. United Arab Emirates (UAE), Saudi Arabia (KSA), Russian Federation and European countries (Aftab *et al.*, 2007). Production, growth and flowering may be increased by adopting suitable pruning practices, Growth regulators and light management which also increase production cost (Saffari *et al.*, 20014; Blom and Zheng, 2009). The selected rose varieties are successfully adopted in our country in open field conditions for cut flower and loose flower purposes. Roses flower has multipurpose usage, but main problem is the low production of flowers especially in winter. Selection of roses is important factor especially in arid and semi-arid areas due to high soil salinity, poor quality or less irrigation water (harvested rain water irrigation), temperature and rainfall fluctuation (Qian *et al.*, 2005). However, a limited research work is done to know the performance of outdoor rose varieties. The cultivation

of rose under open condition is gaining importance in Punjab due to its relative ease in cultivation, high returns, increasing market demand and modern cultural practices. The aim of present study was to evaluate locally adopted exotic varieties grown for commercial importance in response to Pothwar climatic condition of Rawalpindi.

Material and methods

Location and meteorological data

Present research work was performed at experimental field area University research farm Koont (latitude 33° 11' N, longitude 73° 01' E) PMAS Arid Agriculture University Rawalpindi during the year 2016-2017. The description of varieties (Beales, 1999) grown in Pothwar climate of Pakistan (Table 1). The meteorological data of the research site (SAWCRI, 2016-17) for two years study (Fig. 2).

Field preparation

Field was prepared by plugging, hoeing and followed by planking. The plants of each varieties were planted with the gap of 3 feet. During the experiment, All the cultural practices such as irrigation, weed eradication, hoeing, insects and pest preventive measures were given uniformly to all the varieties (Sarwar and Butt, 2015). The water used for irrigation in experimental field was harvested rain water (Fig. 1).

Data collection

The plant height (cm) was taken on monthly basis with three replications by using meter rod. The average was computed for statistical analysis. The number of primary branches, number of flowers, flower diameter (cm) was computed on monthly basis with three replications. Number of petals, flower stem length, number of prickles per 10 cm of branch and flower persistence life were analyzed with three replications during the month of March and April.

Experimental Design

The present research work was planned in Randomized Complete Block Design involving plants of twenty-one varieties of rose with three replications (Table 1). Data was analyzed by factorial design using

standard ANOVA technique by statistics 8.1. The resulted means values for each variety were separated to evaluate significance by using LSD test at $P = 0.05$ (Steel and Torrie, 1984).

Results and discussion

Plant height

The data regarding plant height of varieties was observed on monthly basis for two years 2016-2017. The analyzed data shows that the plant height of rose bush differ significantly in varieties with comparison to different months. The interaction effect of month and year in respect to plant height (cm) varied significantly (Table 2).

Table 1. List of Rosa hybrida varieties with their parentage and characters grown in Pothwar climate of Pakistan.

Varieties	Parentage and year	Overall characters
Doreen johnson (V1)	'Great Venture × Fort Vancouver' × Memoriam. 1977.	Light pink hybrid tea, double flowered/ solitary with mild fragrance
Helen naude (V2)	Unknown. 1996.	White, pink blend hybrid tea, solitary/centered bloom form slight fragrance
Mr waqar (V3)	Local selection	White, hybrid tea, solitary bloom with strong fragrance
Eye paint (V4)	MACyeleve × Picasso. 1969.	Modern, cluster-Flowered/Floribunda, Red Blend white centered, Repeat-Flowering with mild fragrance
Fragrant plum (V5)	Shocking Blue× [Blue Nile × (Ivory Tower x Angel face)]. 1990.	Modern, large flower/Grandiflora, MAUVE, repeat flowering with strong fruity fragrance
Medistrich (V6)	Brandy × Freisensohne. 1992.	Modern, Large-Flowered/ Hybrid Tea, Deep Yellow, Repeat-Flowering with strong fragrance.
Elina (V7)	Nana mouskouri × Lolita. 1984.	Modern, large flower/hybrid tea, light yellow (lemon white), repeat flowering with slight fragrance.
Jude-the-obscure (V8)	Abraham darby× Windrush. 1989.	modern, solitary clustered flowered, medium yellow, repeat flowering with strong fragrance.
Ana-maritharsline (V9)	Sutter's Gold× (Demain x Peace). 1968.	Modern, Large-Flowered/ Hybrid Tea, Deep orange Pink, Repeat-Flowering.
Magic lantern (V10)	Sport of Gold medal. 1993.	Modern, Grandiflora/hybrid tea, solitary in small cluster with orange gold, apricot blend reflexed bloom form, repeat flowering with strong fragrance
First prize (V11)	Seedling of enchantment × seedling of Golden masterpiece. 1967.	hybrid tea, large flowered/solitary, cluster form, pink, repeat flowering with moderate fragrance
Bridal pink (V12)	Seedling of Summertime × Seedling of Spartan. 1967.	Modern Floribunda, Medium pink, repeat flowering with strong fragrance.
Morstylo (V13)	Local selection	Modern Floribunda, solitary bloom, red and creamy white blend, repeat flowering
Bora bora (V14)	Unknown. 1998.	Hybrid Tea, double flower, Mild-fruity fragrance, high-centered bloom form, repeat flowering with mild fruity fragrance
Pat Austin (V15)	Graham thomas × Abraham darby. 1995.	Modern, Hybrid tea shrub, solitary, orange red, repeat flowering with sharp fruity fragrance
Angel face (V16)	(Circus x Lavender pinocchio) × Sterling silver. 1968.	Floribunda, cluster flowered, heat tolerant, deep mauve purple blend, repeat flowering with strong fragrance
Hot cocoa (V17)	(Playboy × Altissimo) × Livin easy. 2002.	Floribunda, medium to large/cluster flower, rain tolerant, Smokey chocolate-orange, repeat flowering with fruity fragrance
Candy stripe (V18)	Sport of Pink peace. 1962.	Hybrid tea, solitary flower with pink blend stripe, repeat flowering with strong fragrance
Broceliande (V19)	Unknown. 2000.	Hybrid Tea, large/solitary bloom, red and white stripe, repeat flowering with strong fragrance
Scentimental (V20)	Playboy × peppermint Twist. 1996.	Modern, cluster flowered/Floribunda, bushy free flowering, burgundy red striped-cream white, sweet fragrance
Gruss an teplitz (V21)	Sir Joseph Paxton × Fellenberg) × Papa Gontier. 1897.	Bourbon/china, old garden rose, Crimson red, loosely double flowered, repeat flowering with moderate sweet fragrance

The Pothwar environment is different from other area of Pakistan. This area is only dependent on rainfall, soil water is scarce or not fit for irrigation. Water requirement of varieties varies in respect to their growing condition. Data analysis shows that maximum plant height (109.58 cm) was observed in month of December 2017 (Fig. 3).

The height of plants varied among varieties with respect to month. The maximum plant height (91.15 cm) was observed in variety Medistrich (V6) closely

followed by height (89.87 cm) of variety Fragrant plum (V5). The minimum plant height (75.24 cm) was observed in First prize (V11). The varieties Gruss an teplitz (V21), Helen naude (V2), Anamaritharsline(V9) and Doreen johnson(V1) remained at par with each other in plant height (84.42 cm, 84.42 cm, 84.33 cm and 84.25 cm respectively). The varieties First prize (V11), Candy stripe (V18), Jude-the-obscure (V8) growth performance in respect to plant height and related parameters was not satisfactory in the Pothwar condition (Table 2).

Table 2. Description of growth parameters plant height(cm), number of vegetative buds, no of flowers, flower size(cm), number of petals per flower, number of prickles per 10 cm and flower persistence life during the years 2016-2017 under Pothwar climate of Pakistan.

Varieties	Plant height (cm)	Number of primary branches	No of flowers	Flower diameter (cm)	Number of flower petals	Number of prickles	Flower persistence life
Doreen johnson (V1)	84.25± 1.3 fg	11.65 ± 0.5 h	7.27 ± 0.8 ij	7.65 ± 0.2 cd	28.40 ± 0.6 e-h	15.50 ± 0.5 h	8.16 ± 0.3hij
Helen naude (V2)	84.42± 1.6 fg	11.21 ± 0.5 hij	8.62 ± 1.2 fgh	7.67 ± 0.5 cd	26.20 ± 0.2 fgh	13.94 ± 0.4 ijk	9.16 ± 0.3 fg
Mr waqar (V3)	84.65± 1.3 f	11.07 ± 1.04 ij	6.89 ± 1.1 j	6.24 ± 0.2 h	25.96 ± 0.2 fgh	21.33 ± 0.4 f	9.16 ± 0.3 fg
Eye paint (V4)	89.08± 0.9 bc	12.32 ± 0.5 fg	9.43 ± 0.8 def	5.77 ± 0.5 j	17.24 ± 0.2 i	40.50 ± 1.2 b	8.83 ± 0.5 fgh
Fragrant plum (V5)	89.87± 1.3 ab	11.56 ± 0.5 h	8.04 ± 0.8 g-j	7.74 ± 0.5 abc	16.90 ± 0.1i	11.33 ± 0.5 m	8.83 ± 0.5fgh
Medistrich (V6)	91.15± 1.3 a	13.36 ± 0.6 c	10.33 ± 0.7 cde	7.97 ± 0.5 a	19.57 ± 0.1 i	11.05 ± 0.1 m	9.50 ± 0.6ef
Elina (V7)	80.06± 1.0 i	11.57 ± 0.6 h	10.47 ± 1.5 cd	7.73 ± 0.4 bc	36.85 ± 0.1b	21.00 ± 0.5 f	13.50 ± 0.3 a
Jude-the-obscure (V8)	79.91± 0.7 i	10.79 ± 0.6 jk	8.97 ± 0.5 fg	6.08 ± 0.4 hi	29.87 ± 0.1 def	18.05 ± 0.2 g	7.83 ± 0.5ij
Ana-maritharsline (V9)	84.33 ± 2.8 fg	14.41 ± 0.4 ab	10.83 ± 0.7 bc	7.95 ± 0.3 ab	24.25 ± 0.1h	33.44 ± 0.2 c	12.16 ± 0.3 b
Magic lantern (V10)	85.22 ± 1.9 ef	10.21 ± 0.7 lm	8.06 ± 1.3 g-j	7.35 ± 0.3 ef	29.51 ± 0.3 d-g	10.33 ± 0.4 m	7.33 ± 0.2j
First prize (V11)	75.24 ± 2.5 j	9.98 ± 0.6 m	7.12 ± 0.6 ij	7.18 ± 0.5 f	18.11 ± 0.1i	29.11 ± 1.0 d	10.16 ± 0.3de
Bridal pink (V12)	84.94 ± 3.5 ef	13.11 ± 0.5 cd	8.70 ± 1.2 fgh	7.27± 0.3 ef	24.98 ± 0.0 gh	14.50 ± 0.9 hij	8.50 ± 0.3ghi
Morstylo (V13)	85.16 ± 1.3 ef	12.74 ± 0.3 def	9.54 ± 1.3 def	5.90 ± 0.3 ij	35.55 ± 0.2 bc	26.11 ± 0.9 e	8.83 ± 0.5fgh
Bora bora (V14)	87.81 ± 1.9 cd	14.61 ± 0.4 ab	12.31 ± 1.1 a	7.91 ± 0.3ab	34.53 ± 0.3bc	8.00 ± 0.4n	10.83 ± 0.5cd
Pat Austin (V15)	83.85 ± 1.8 fgh	12.17 ± 0.4 g	9.14 ± 0.8efg	6.18 ± 0.3h	48.40 ± 0.2a	12.83 ± 0.3kl	7.50 ± 0.3 j
Angel face (V16)	86.73 ± 1.1 de	14.34 ± 0.6 b	12.37 ± 1.59a	5.43 ± 0.4k	25.57 ± 0.2fgh	8.38 ± 0.1n	10.16 ± 0.8de
Hot cocoa (V17)	82.30 ± 2.1 h	13.00 ± 0.3 cde	8.14 ± 0.7g-j	6.17 ± 0.3h	25.57 ± 0.1 fgh	47.83 ± 0.6a	9.16 ± 0.3 fg
Candy stripe (V18)	79.33 ± 1.1 i	10.45 ± 0.3 kl	5.58 ± 1.2k	7.46 ± 0.4de	31.40 ± 0.4cde	14.94 ± 0.4hi	6.16 ± 0.3k
Broceliande (V19)	87.36 ± 1.3 cd	12.65 ± 0.5 ef	7.66 ± 0.5 hij	6.60 ± 0.3g	34.77 ± 0.3bc	12.66 ± 0.4l	11.50 ± 0.3bc
Scentimental (V20)	82.77 ± 1.2 gh	11.33 ± 0.5 hi	8.31 ± 0.7f-i	5.35 ± 0.2k	33.26 ± 0.6 bcd	13.38 ± 0.3jkl	10.16 ± 0.3de
Gruss an teplitz (V21)	84.42± 1.0 fg	14.82 ± 0.5 a	11.89 ± 1.9ab	4.72± 0.2 l	28.55 ± 0.2e-h	6.72 ± 0.5 o	8.50 ± 0.3ghi

Similar kind of variation in plant height was reported by Hussain and Khan (2004) and Manjula (2005). The cultivars with maximum plant height results longer flower stalk length (Shafiq *et al.*, 2011). The resulted variation among cultivars depends on genetic associated factor, environmental consensus, varying

management and cultural practices. Environmental factors and light intensity (irradiance) physiologically control flowering attributes (Zieslin,1990). These finding also correlate with the findings of khan *et al.* (2011) in which number of flowers, size of flowers, petals per flower and height of plant increase with the

effluent amount of treated water instead of fresh water.

No of primary branches

The results of analysis regarding number of primary branches per plant indicate that varieties showed

significant difference among each other. The analyzed data shows number of primary branches in varieties varies significantly with respect to months.

The interaction effect of month and year varied significantly.



Fig. 1. Experimental field during the month of March (A) start of flowering in Rosa hybrida varieties in Pothwar climate of Pakistan (B).

The maximum number of primary branches (14.86) were observed in the month of December 2016 (Fig. 4). The variety Gruss an teplitz (V21) possess maximum number of primary branches (14.82) closely followed by the varieties Bora bora (V14) and Ana-maritharsline (V9). The minimum number of primary branches (9.98) were observed in variety

First prize (V11) (Table 2).

The vegetative buds start to appear in month of February in the Pothwar condition. Vegetative growth remained active up to month of May. The growth and flowering influenced by the increase in temperature in the month of May (Fig. 4).

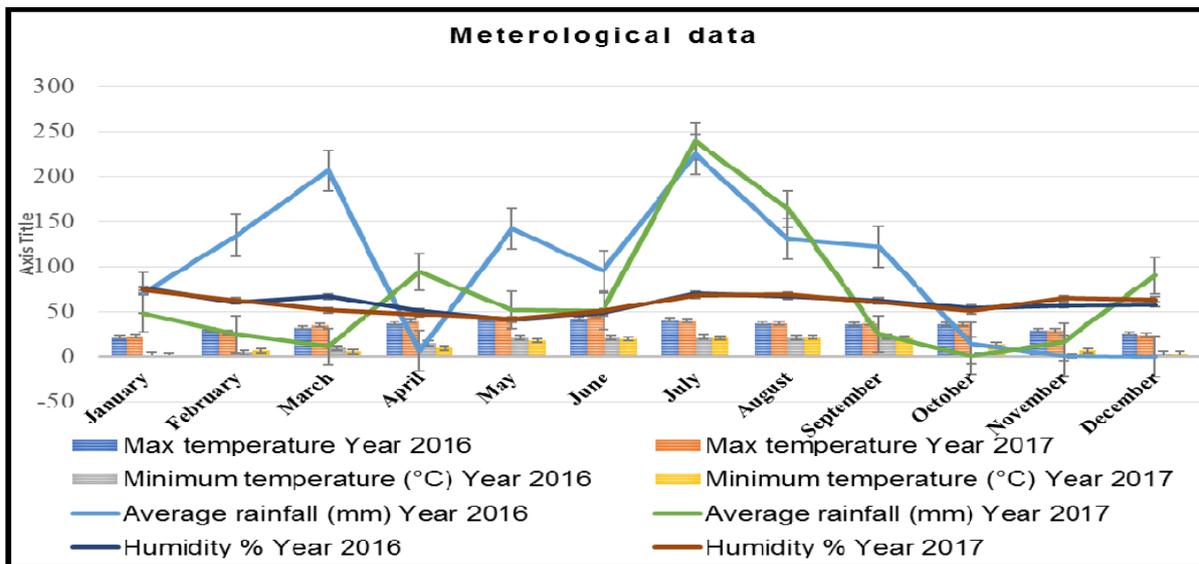


Fig. 2. Description of meteorological data for minimum/maximum temperature (°C), average rainfall (mm) and humidity percentage (%) of the years 2016-2017 of experimental site in Pothwar climate of Pakistan.

Primary shoots produced the flower in spring season which later on converted into vegetative growth. The Rose genotype produced flower bud at the terminal of primary shoots and floral bud emergence first time during 6–8 weeks after sprouting (Shubin *et al.*,

2015). Qasim *et al.* (2008) reported that the cultivar Anjeeeq with maximum plant height (65.16 cm), number of branches per plant (6.55) and maximum number of leaves (217) as compared to Amalia.

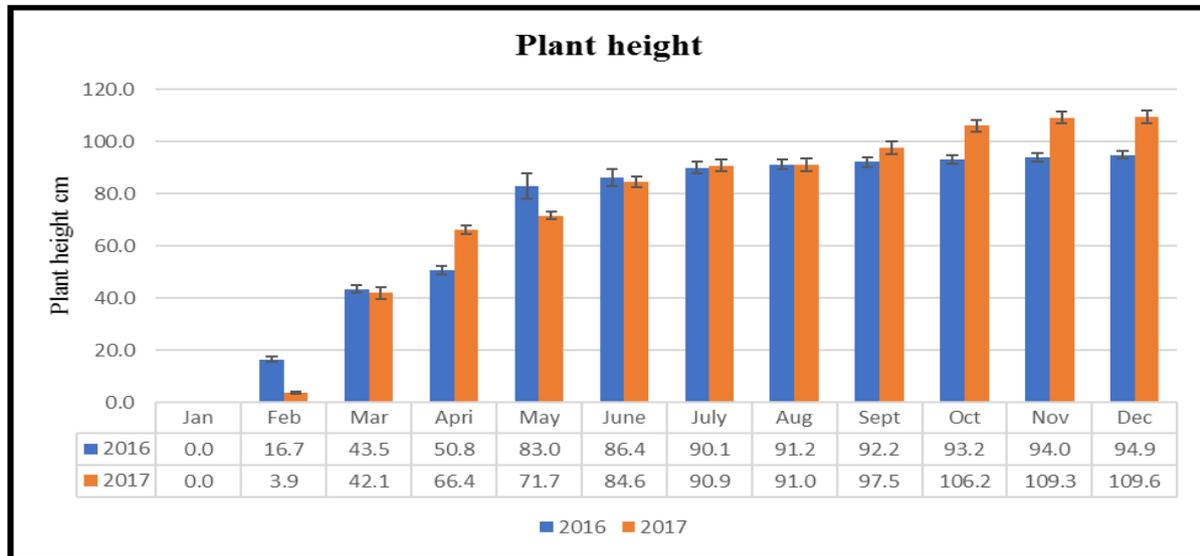


Fig. 3. Description of plant height (cm) from January to December month for years 2016-2017 in Pothwar climate of Pakistan.

The flowering attributes in roses is known to be sovereigns dependent on growth temperature, light intensity and not by photoperiod (Zieslin and Halevy, 1975; Zieslin and Mor, 1990; Mortensen *et al.*, 1992). Data regarding Increase in number of branches also correlate with the finding of Silberbush and Lieth

(2004). The studied a stimulation model for to predict role of nutrient uptake with successive flower-cutting cycles in roses. Flowering branches were trimmed consecutively at flower maturity result in new shoot growth.

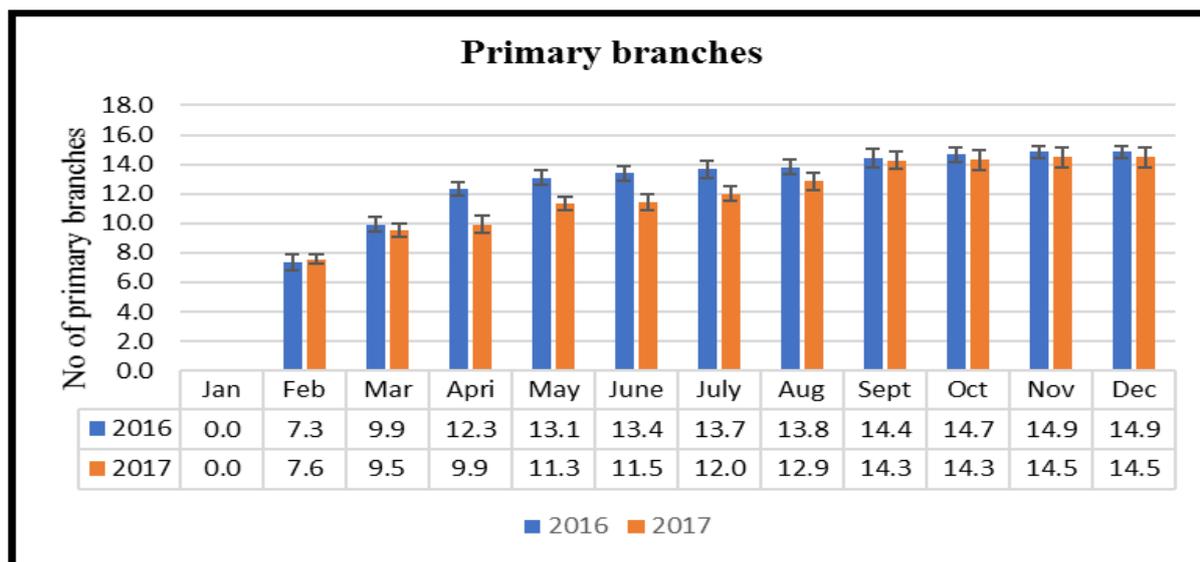


Fig. 4. Description about increase in number of primary branches of Rosa hybrida varieties from January to December for years 2016-2017 in Pothwar climate of Pakistan.

Number of flowers

The results for number of flowers of collected data on monthly basis for each variety varied significantly. The interaction effect of number of flowers in respect

to month and year varied significantly. The maximum number of flowers (29.06) were obtained in the month of April 2017 (Fig. 5).

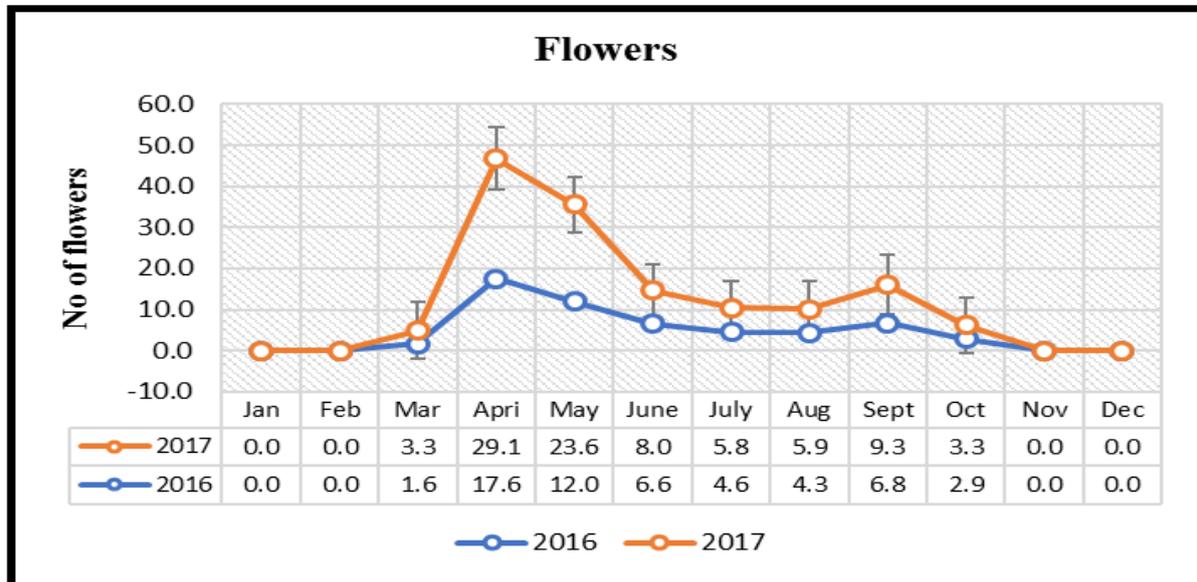


Fig. 5. Description about number of flowers of *Rosa hybrida* varieties in different months for years 2016-2017 in Pothwar climate of Pakistan.

The maximum number of flowers (12.37) were obtained by variety Angel face (V16) closely followed by the varieties Bora bora (V14) and Gruss an teplitz (V21). The minimum number of flowers (5.58) were obtained by variety Candy stripe (V18) (Table 2). Semeniuk (1971) study proposed that blooming is controlled genetically by a single recessive gene to differentiate into Recurrent blooming and perpetual blooming.

The variation in number of flowers per plant is related to recurrent blooming habit due to their genetic makeup (Debener and Mattiesch, 1999). our finding correlate with the finding of Khattak *et al.* (1995) as temperature increased humidity decreased in the month of July which ultimately decrease flower number. Highest number of flowers in months of March and April as compared to June and July. Production of flower either in late autumn or early spring under favorable temperature (Duchesne, 1766; DeVries, 1976). Productivity might be attributed to increase in plant height, leaves and leaves area. Higher the leaf area, more the photosynthetic rate

results in excessive dry matter accumulation (production of more number of flowers/plant). Variation in production of flower in rose studied already by Sindhu and Ramesh Kumar, 2004; Mantur *et al.*, 2005. The favorable growing environment and climatic factors have also contributed for expressing their maximum yield potential in high yielding varieties (Talia *et al.*, 2003).

Flower diameter

Data regarding flower diameter collected on monthly basis revealed that varieties and month show non-significant difference throughout the flowering season. The results of analysis showed that interaction effect of flower diameter (cm) of varieties varied significantly in respect to month and year. Interaction effect of flower bud diameter in comparison to month varied non-significantly (Fig. 6). The maximum flower diameter (7.59 cm) was observed in month of April. Statistical analysis of the collected data shows that comparison of flower diameter in respect to variety varies significantly among each other (Table 2). The maximum flower

diameter (7.97 cm) was observed in variety Medistrich (V6) followed by varieties Anamaritharsline (V9) and Bora bora (V14) with the values of 7.95 cm and 7.91 cm respectively. The minimum flower diameter (4.72 cm) was observed in variety Gruss an teplitz (V21). The flower diameter of

varieties Mr waqar (V3), Broceliande (V19) and Hot cocoa (V17) was statistically at par with each other (6.24 cm, 6.18 cm and 6.17 cm). Hessayon (1988) observed that varying flower diameters in different rose cultivars showed similar results as founded.

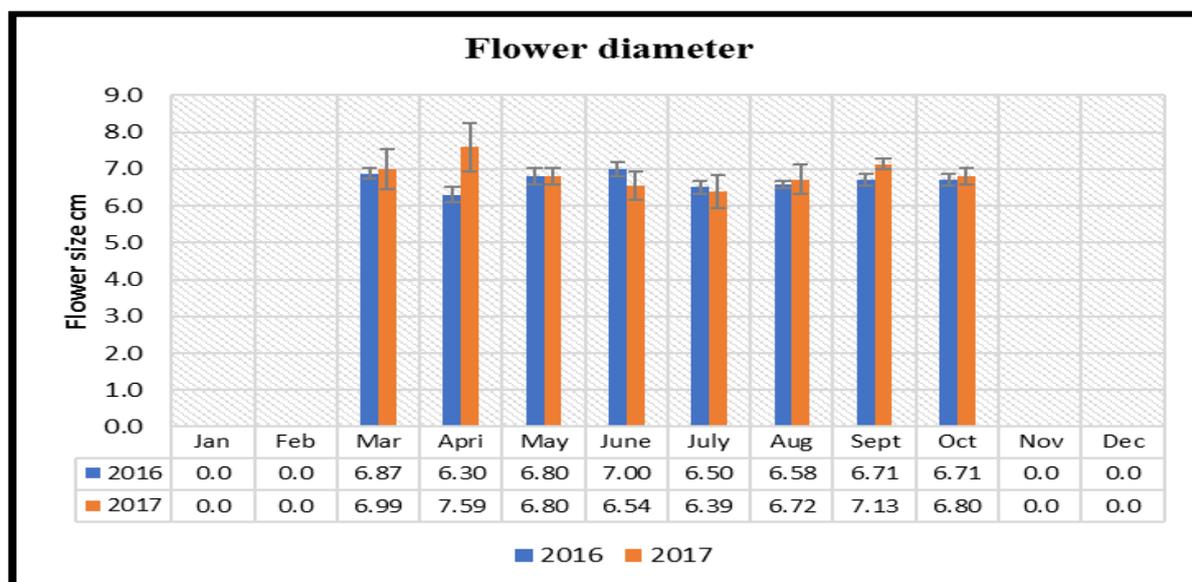


Fig. 6. Description about flower diameter (cm) of *Rosa hybrida* varieties in different months for years 2016-2017 in Pothwar climate of Pakistan.

Number of flower petals

Statistical analysis of collected data regarding number of flower petals for each variety varied significantly (Table 2). The maximum number of petals (48.40) were observed in variety Pat austin (v15). The number of petals in varieties Angel face(V16) and Hot cocoa (V17) were same (25.74). The minimum no of petals (16.90) were observed in variety Fragrant plum(V5) closely followed by the number of petals (17.24) in variety Eye paint (V4). The large size petals counting conducted accurately (Raufe *et al.*, 2006). The increased number of petals/flower can also be attributed to the availability of high organic matter percentage in irrigation water which ultimately improve soil physiology and availability of nutrients (Brady and Weil 2008).

Number of prickles (in 10 cm length)

Highly significantly difference in number of prickles per 10 cm area among varieties was observed. The data shows that maximum number of prickles (47.83)

were found in variety Hot cocoa (V17) and minimum number of prickles (6.72) were found in variety Gruss an teplitz (V21) (Table 2).

Flower persistence life

The statistical analysis of data shows that flower persistence life in the field vary significantly among all varieties (Table 2). The maximum flower persistence life (13.50 days) in the field was observed in variety Elina (V7). The minimum flower persistence life (6.16 days) was observed in variety in Candy stripe(V18). The cut flowers with tight bud open slowly and uniformly have appealing effect due to their longer vase life and fresh appearance. These variations could be because of varietal characters or may be time taken from bud initiation to full bloom stage in rose (Bhattacharjee *et al.*, 1993).

Conclusion

The variety Medistrich, Fragrant plum, Gruss an teplitz, Helen naude, Ana-maritharsline and Doreen

johnson growth performance was satisfactory as compared to other varieties used in this study. The varieties First prize, Candy stripe, Jude -the-obscure performance was not satisfactory. In the present study, varieties performance regarding all traits show decreasing trend as temperature and humidity decrease. The selection of tight flower bud varieties which open slowly with uniformity has appealing beauty then loose flower varieties for future.

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References

- Aftab M, Shabbir G, Mahmood A.** 2007. Production of high quality bulbous flowers in Pothwar. Prospects of Horticulture Industry in Pakistan, International symposium. University of Agriculture Faisalabad 221-223.
- Bale S, Durham R, Phillips T, Townsend L, Ward NA.** 2012. Rose. Kentucky: University of Kentucky College of Agriculture.
- Beales P.** 1999. Botanica's roses: the encyclopedia of roses. 2nd Revised edition. Publisher: Welcome Rain.
- Bhattacharjee SK, Singh VC, Saxena NK.** 1993. Studies on vegetative growth, flowering, flower quality and vase life of roses. Singapur Journal of Primary Industries **21(2)**, 67-71.
- Blom TJ, Zheng Y.** 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.
<http://dx.doi.org/10.1016/j.scienta.2008.07.014>
- Brady NC, Weil RR.** 2008. The Nature and Properties of Soils. 14th Edition, Pearson Education, Inc, New Jersey, ISBN: 0135133874, 504-517.
- Debener T, Mattiesch L.** 1999. Construction of a genetic linkage map for roses using RAPD and AFLP markers. Theoretical and Applied Genetics **99**, 891–899.
<http://dx.doi.org/10.1007/s001220051310>
- DeVries DP.** 1976. Juvenility in hybrid tea-roses. Euphytica **25**, 321-328.
<http://dx.doi.org/10.1007/bfo0041563>
- Duchesne N.** 1766. Histoire Naturelle Des Fraisiers, Didot Panckoucke, C.J. Paris.
- Hessayon DG.** 1988. The Rose expert. Pub, Britanica House, Waltham Cross, Herts, England. 2003.
- Hussain A, Khan MA.** 2004. Effect of growth regulators on stem cutting of Rosa bourboniana and Rosa gruss-an-teplitz. International journal of agriculture biology **6**, 931-32.
- Khan MA, Shaukat S, Shahzad A, Ahmed W.** 2011. Application of waste stabilization pond's effluent on cultivation of roses (Rosa damascena mill) Pakistan journal of botany **43(4)**, 1919-1923.
- Khattak AM, Mohammad M, Jala-ud-Din B.** 1995. Environmental response of some exotic rose cultivars to D.I Khan conditions. Pakistan journal of botany **27**, 299-03.
- Mantur SM, Bagali AN, Patil SR.** 2005. Influence of bending and pruning on different varieties of roses under naturally ventilated Polyhouse. Karnataka Journal of Agriculture Sciences **18(2)**, 474-77.
- Mortensen LM, Gislerod HR, Mikkelsen H.** 1992. Effects of different levels of supplementary lighting on the year-round yield of cut roses. Gartenbauwissenschaft **57**, 198–202.
- Qasim M, Ahmed I, Ahmed T.** 2008. Optimizing fertigation frequency for Rosa hybrida. Pakistan journal of Botany **40(2)**, 533-45.
- Qian YL, Fu JM, Klett J, Newman SE.** 2005.

Effects of long term recycled waste water irrigation on visual quality and ion concentrations of ponderosa pine. *Journal of Environmental Horticulture* **23**, 185-189.

<http://hrjournal.org/doi/pdf/10.24266/0738-2898-23.4.185>

Ramzan A, Hanif M, Tariq S. 2014. Performance of Rosa Hybrid cultivars under agroclimatic conditions of Islamabad. *Pakistan Journal of Agriculture Research* **52(1)**, 153-159.

Raufe S, Khan IA, Khan FA. 2006. Colchicine-induced tetraploidy and changes in allele frequencies in colchicine-treated populations of diploids assessed with RAPD markers in (*Gossypium arboreum*). *Turkish journal of Biology* **30**, 93-100.

Riaz T, Khan SN, Javaid A. 2007. Scenario of gladiolus production in Punjab, Pakistan. *Pakistan journal of botany* **39(7)**, 2389-2393.

Saffari VR, Khalighi A, Lesani, Babalar M, Obermaier JF. 2004. Effects of different plant growth regulators and time of pruning on yield components of Rosa damascena mill. *International Journal of Agriculture and Biology* **6**, 1040-1042.

SAWCRI. 2017. Soil and water conservation research institute Chakwal. Annual progress report, p 12-14.

Semeniuk P. 1971. Inheritance of recurrent blooming in Rosa wichuraiana. *Journal of heredity* **62(3)**, 203-220.

Shafique M, Maqbool M, Nawaz MA, Ahmed W. 2011. Performance of various snapdragon (*Antirrhinum majus* L.) cultivars as cut flower in Punjab, Pakistan. *Pakistan journal of botany* **43(2)**, 1003-10.

Shin H, Lieth JH, Kin S, Shin HK, Kim SH, Zieslin N. 2001. Effect of temperature on leaf area and flower size in rose. *Acta Horticulturae* **547**, 185-

91.

Shubin L, Ningning Z, Qing Z, Huijun Y, Hongying J, Qigang W, Min C, Xianqin Q, Hao Z, Shufang W, Shufa L, Kaixue T. 2015. Inheritance of Perpetual Blooming in Rosa chinensis 'Old Blush'. *Horticultural Plant journal* **1(2)**, 108-112.

<http://dx.doi.org/10.16420/j.issn.2095-9885.2016-0004>

Silberbush M, Lieth JH. 2004. Nitrate and potassium uptake by greenhouse roses (*Rosa hybrida*) along successive flower-cut cycles: a model and its calibration. *Scientia Horticulturae* **101**, 127-141.

<http://dx.doi.org/10.1016/j.scienta.2003.10.009>

Sindhu GS, Kumar R. 2004. Performance of rose cut flower varieties under unheated poly house condition. *Proceeding of National Symposium on Recent Trends and Future Strategies in Ornamental Horticulture*, Univ. Agric. Sci., Dharwad, Karnataka, India.

Singh VK, Tiwari KN, Santosh DT. 2016. Estimation of Crop Coefficient and Water Requirement of Dutch Roses (*Rosa hybrida*) under Greenhouse and Open Field Conditions. *Irrigation & Drainage Systems Engineering* **5**, 169.

<http://dx.doi.org/10.4172/2168-9768.1000169>

Tabassum R, Ghaffoor A, Waseem K, Nadeem MA. 2002. Evaluation of rose cultivars as cut flower production. *Asian Journal of Plant Sciences* **1(6)**, 668-669.

<http://dx.doi.org/10.3923/ajps.2002.668.669>

Talia, MAC, Cristiano G, Forleo LR, Lipari V, Noto G, Leonardi C. 2003. Evaluation of new anthurium cultivars in soilless culture. *Acta Horticulturae* **614**, 223-226.

<https://doi.org/10.17660/ActaHortic.2003.614.32>

Zieslin N, Halevy AH. 1975. Flower bud atrophy in Baccara' roses II. The effect of environmental factors.

Scientia Horticulturae **3**, 383–391.

[http://dx.doi.org/10.1016/0304-4238\(75\)90053-9](http://dx.doi.org/10.1016/0304-4238(75)90053-9)

Zieslin N, Mor Y. 1990. Light on roses: A review.

Scientia Horticulturae **43**, 1-1.

[http://dx.doi.org/10.1016/0304-4238\(90\)90031-9](http://dx.doi.org/10.1016/0304-4238(90)90031-9).