International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(7): 865-869
www.biochemjournal.com
Received: 04-04-2024
Accepted: 09-05-2024

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Effect of variety and different levels of nitrogen and potassium on flowering, quality and yield on rose (*Rosa hybrida* L.) through fertigation cv. gladiator and divine

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DOI: https://doi.org/10.33545/26174693.2024.v8.i7k.1614

Abstract
The present investigation was carried out at Lal Baugh Farm, College of Horticulture, Junagadh Agricultural University, Junagadh (Gujarat). During *rabi* season in the year 2023, in Randomized Block Design with factorial concept having twelve treatments. The result of experiment revealed that individual effect of variety Gladiator recorded maximum fresh weight of flower (17.69 g), dry weight of flower (3.14 g), vase life (7.67 days), *in-situ* shelf life (11.43 days), number of petals per flower (54.42) and days to first flower bud appearance (23.60 days) was recorded minimum. Meanwhile variety Divine recorded maximum flower diameter (8.94 cm), number of flowers per plant (34.00), number of flowers per plot (680.01) and number of flowers per hectare (15.11 lakh).
In case of nitrogen 60 g/plant recorded maximum fresh weight of flower (13.31 g), dry weight of flower (2.45 g), vase life (7.46 days), flower diameter (8.50 cm), number of petals per flower (47.47), number of flowers per plant (29.75), number of flowers per plot (595.01), number of flowers per hectare (13.22 lakh), whereas minimum days to first flower bud initiation (23.97 days) observed in nitrogen 20 g/plant.
Similarly, it was recorded that 40 g/plant of potassium gave maximum flower diameter (8.52 cm), fresh weight of flower (14.19 g), dry weight of flower (2.47 g), vase life (7.51 days), number of petals per flower (46.59), number of flowers per plant (29.78), number of flowers per plot (595.56), number of flowers per hectare (13.23 lakh), whereas minimum days to first flower bud initiation (24.41 days) observed in potassium 20 g/plant.

Keywords: Flowering, nitrogen, potassium, quality, rose, variety, yield

Introduction
Roses, belonging to the Rosaceae family (*Rosa hybrida* L.), are celebrated globally as the "Queen of flowers". They dominate the flower trade worldwide due to their beauty and versatility. Found across the Northern Hemisphere, from Alaska to Norway, roses are incredibly adaptable to various climates. They hold a rich cultural significance, used in worship, social gatherings, weddings, and everyday decor. Known by various names like "flower of old", "queen of flowers", and "perfume of god", roses have historically been the most extensively cultivated flower. Their enduring popularity underscores their role as a symbol of beauty and elegance across diverse cultures and contexts.
In the realm of cultivating high-quality flowers, proper fertilization stands as a cornerstone. Among the essential nutrients crucial for plant growth and development, nitrogen reigns supreme. While soils may naturally harbor nitrogen, which plants can absorb and convert into vital nutrients, supplementing nitrogen is often preferred to ensure optimal supply for plant health. Nitrogen plays a pivotal role in promoting vegetative growth in plants. It supports the development of leaves, stems, and overall plant vigor. Meanwhile, potassium serves a different yet equally vital function. It aids in the transportation of nutrients, water, and carbohydrates throughout the plant's tissues, ensuring efficient nutrient uptake and utilization. Together, nitrogen and potassium, among other nutrients, form the bedrock of effective fertilization practices that enable plants to thrive, producing robust and high-quality flowers.

Fertigation offers a dual benefit of enhancing yield potential while conserving water and maintaining its quality, resulting in a significant reduction of 45–50% in irrigation water use and a corresponding 40% increase in output. By integrating fertilizer inputs into irrigation systems, fertigation promotes plant growth and flowering, thereby enhancing overall yield. Fertigation involves the application of fertilizers during specific seasons, achieving higher efficacy at lower costs compared to conventional methods. However, the continuous picking of roses and their expansive transpiring surface necessitate careful timing of fertigation applications. Therefore, this study aims to explore optimal strategies for managing rose fertigation and its impact on output quality and growth.

Materials and Methods

This experiment was conducted during 2023 at Lal Baugh Farm, College of Horticulture, Junagadh Agricultural University, Junagadh (Gujarat) during the *rabi* season. The trial used a factorial Randomized Block Design, in which 18 treatments combinations involved where, Factor A had two variety *i.e.* Gladiator and divine, Factor B had three levels of nitrogen (N) *i.e.* N_1: 20 g/plant, N_2: 40 g/plant and N_3: 60 g/plant. Additionally, two levels of potassium (K) i.e. K_1: 20 g/plant and K_2: 40 g/plant were applied. Following the pruning process farm yard manure was applied 20 t/ha. Application of fertigation was done in 4 splits 1st after 15 days of pruning, then given in monthly interval. Nitrogen was applied in the form of urea and potassium was applied in form of MOP.

Results and Discussion

The effect of variety and different levels of nitrogen, potassium their interaction effect on flowering, quality and yield are depicted in Tables 1, 2, 3 and 4.

Flowering and Quality Parameters

Effect of variety

Effect of variety showed significant difference in the various flowering and quality parameters such as days to first flower bud initiation, fresh weight, dry weight, vase life, *in-situ* shelf life, flower diameter and number of petals per flower.

Minimum number of days to first flower bud initiation (23.60) was recorded in variety Gladiator. The flowering characters in different varieties are dependent on proper amounts of stored carbohydrates, which are necessary for inducing the plant vegetative phase to flowering (Kosegarten and mengel, 1995) [8]. Similar findings were recorded by Kanamaadi and Patil (1993) [6] in chrysanthemum.

Maximum fresh weight (17.69 g) & dry weight (3.14 g) of flower, vase life (7.67 days), *in-situ* shelf life (11.43 days), flower diameter (8.94 cm) and number of petals per flower (54.42) was observed in variety Gladiator. It means Gladiator variety was found best as it gave superior response for flowering and quality attributes as compared to Divine variety. These findings are in corroboration to Raghava *et al.* (1988) [14], Ranpise *et al.* (2002) [16] and Dattatraya (2006) [2] in China aster.

Effect of nitrogen

Effect of nitrogen showed significant difference in the various flowering and quality parameters such as days to first flower bud initiation, fresh weight, dry weight, vase life, flower diameter and number of petals per flower.

Minimum number of days to first flower bud initiation (23.97) was observed in treatment N_3 (60 g/plant), which was at par with treatment N_4 (60 g/plant). The reason for earlier flower bud initiation might be due to the reason that nitrogen helps in accumulation of certain energy reserves like proteins and carbohydrates, which are essential for flower bud initiation. These results were in close conformity to that of Singh *et al.* (2015) [20] in carnation and Fayaz *et al.* (2016) [3] in gerbera.

Table 1: Effect of variety and different levels of nitrogen and potassium on flowering and quality parameters of rose (*Rosa hybrida* L.)

Treatments	Days to 1st flower bud initiation (days)	Fresh weight (g)	Dry weight (g)	Vase Life (days)	*In-situ* vase life (days)	Flower diameter (cm)	Number of petals per flower
Factor A – Variety							
V_1: Gladiator	23.60	17.69	3.14	7.67	11.43	7.40	54.42
V_2: Divine	26.50	8.25	1.61	6.57	10.22	8.94	34.47
S.Em. ±	0.406	0.253	0.046	0.129	0.197	0.145	0.901
C.D. at 5%	1.19	0.74	0.13	0.38	0.58	0.43	2.64
Factor B – Nitrogen							
N_1 : 20 g/plant	23.97	12.30	2.25	6.88	10.66	7.64	42.02
N_2: 40 g/plant	25.31	13.29	2.43	7.03	10.86	8.38	43.85
N_3: 60 g/plant	25.76	13.31	2.45	7.46	10.96	8.50	47.47
S.Em.±	0.497	0.310	0.056	0.158	0.242	0.178	1.103
C.D. at 5%	1.46	0.91	0.16	0.46	NS	0.52	3.24
Factor C – Potassium							
K_1 : 20 g/plant	25.69	11.75	2.28	6.73	10.55	7.83	42.30
K_2 : 40 g/plant	24.41	14.19	2.47	7.51	11.10	8.52	46.59
S.Em.±	0.406	0.253	0.046	0.129	0.197	0.145	0.901
C.D. at 5%	1.19	0.74	0.16	0.38	NS	0.43	2.64

Maximum fresh weight (13.31 g) & dry weight (2.45 g) of flower was noted in N_3 (60 g/plant). The increase in fresh weight might be due to an increase in plant height, plant spread and the number of branches per plant. These observations are in accordance with the findings of Rajan *et al.* (2019) [15] in chrysanthemum and Savaliya *et al.* (2019) [19] in golden rod. Maximum vase life (7.46) was observed in treatment N_3 (60 g/plant). The probable reason for good vase life might be that nitrogen is necessary for production of amino acids, which are building blocks of protein. Proteins are important for maintaining the quality and appearance of cut flowers. These findings were similar to

that of Aremsungla and Topno (2022) [1] in zinnia. Maximum flower diameter (8.50 cm), number of petals per flower (47.47) was observed in treatment N_3 (60 g/plant). The probable reason for this is sink-source relationship, the growth of sink tissue and organ (In present case, the flowers) can be limited by supply of photosynthesis from source leaves. The result was in close conformity with Mantur (1988) [11] in China aster, Geetha *et al*. (2004) [4] in rose.

Effect of potassium

Effect of potassium showed significant improvement in the flowering and quality parameters such as days to first flower bud initiation, fresh weight, dry weight, vase life, flower diameter and number of petals per flower.

Minimum number of days to first flower bud initiation (24.41) was observed in treatment K_2 (40 g/plant). The reason associated with this might be that potassium helps in the formation and transport of carbohydrates, which are required for flower bud initiation and flower formation. It also helps in the activation of enzymes involved in energy metabolism, needed during flowering period. These results were in close conformity Fayaz *et al*. (2016) [3] in gerbera.

The fresh weight (14.19 g) & dry weight (2.47 g) of flower, vase life (7.51 days), number of petals per flower (46.59) was observed in treatment K_2 (40 g/plant). The findings suggest that applying higher dose of water soluble fertilizer (presently potassium) can lead to improvements in flowering and quality results were in close conformity to that of Geetha (2004) [4] in rose, Reshma (2018) [17] in gomphrena and Savaliya *et al.* (2019) [19] in golden rod.

Interaction effect of V and N

Significantly maximum fresh weight (18.74 g) & dry weight (3.29 g) was noted in Gladiator with N_3 (60 g/plant) treatment combination. This might be due to the reason that application of higher level of nitrogen increased the vegetative growth of gladiator, so ultimately higher photosynthetic activity occurred and more photosynthates might be produce at the source that are used at the sink and increased flowering attributes. These findings were similar to that Singh (1998) [21] in tuberose and Hammed and sekar (1999) [5] in marigold.

Interaction effect of N and K

Maximum vase life (8.21 days) was noted in (60:40 NK g/plant) treatment combination, which was at par with treatment Gladiator (40 N g/plant). This might be due to the reason that in terms of flower keeping quality, both these nutrients play an important role. Hence, this combination was found to be ideal for vase life. These results were in close conformity to that of Singh *et al*. (2013) [22] in gladiolus and Fayaz *et al*. (2016) [3] in gerbera.

Maximum flower diameter (8.59) and number of petals (53.17) per flower was noted in (60:40 NK g/plant) treatment combination. This might be due to the reason that nitrogen helps in accumulation of energy reserves during flowering period, which also result in increase in flower size, thereby increasing the flower weight ultimately, increase number of petals and potassium is an important element which regulates water uptake and retention. These results were in close similarity to that of Qasim *et al*. (2008) [13] in rose and Madhuri and Barad (2018) [9] in carnation.

Table 2: Interaction effect of variety and different levels of N on fresh weight & dry weight of rose (*Rosa hybrida* L.)

Treatments	Fresh weight (g)		Dry weight (g)	
	V_1	V_2	V_1	V_2
N_1	16.22	8.39	2.89	1.61
N_2	18.12	8.47	3.24	1.62
N_3	18.74	7.89	3.29	1.63
S. Em.±	0.438		0.079	
C. D. @ 5%	1.28		0.23	
C. V. %	8.27		8.12	

Table 3: Interaction effect of different levels of NK on vase life, flower diameter and number of petals of rose (*Rosa hybrida* L.)

Treatments	Vase life (days)		Flower diameter (cm)		Number of petals per flower	
	K_1	K_2	K_1	K_2	K_1	K_2
N_1	6.67	7.08	6.80	8.48	41.08	42.96
N_2	6.80	7.25	8.29	8.47	44.05	43.65
N_3	6.71	8.21	8.40	8.59	41.77	53.17
S. Em.±	0.223		0.251		1.560	
C. D. @ 5%	0.65		0.74		4.58	
C. V. %	7.66		7.53		8.60	

Yield Parameters

Effect of variety

Effect of variety showed significant difference in the yield parameters such as number of flowers per plant, number of flowers per plot and number of flowers per hectare.

Significantly maximum number of flowers per plant (34.00), number of flowers per plot (680.01) and number of flowers per hectare (15.11 lakh) was recorded in Divine variety. As it gave superior response for flowering and yield attributes of flower. This could be the result of genetic variations between kinds. The results are in full conformity with the result of Raghava *et al.* (1988) [14] and Ranpise *et al*. (2002) [16] in China aster.

Table 4: Effect of variety and different levels of nitrogen and potassium on yield parameters of rose (*Rosa hybrida* L.).

Treatments	Number of flowers per plant	Number of flowers per plot	Number of flowers per hectare (Lakh)
Factor A – Variety			
V_1: Gladiator	23.22	464.43	10.32
V_2: Divine	34.00	680.01	15.11
S.Em.±	0.578	11.559	0.25
C.D. at 5%	1.70	33.90	0.75
Factor B – Nitrogen			
N_1 : 20 g/plant	27.17	543.33	12.07
N_2: 40 g/plant	28.92	578.32	12.85
N_3: 60 g/plant	29.75	595.01	13.22
S.Em.±	0.708	14.157	0.31
C.D. at 5%	2.08	41.52	0.92
Factor C – Potassium			
K_1 : 20 g/plant	27.44	548.89	12.20
K_2 : 40 g/plant	29.78	595.56	13.23
S.Em.±	0.578	11.56	0.26
C.D. at 5%	1.70	33.90	0.75

Effect of nitrogen

Maximum number of flowers per plant (29.75), number of flowers per plot (595.01) and number of flowers per hectare (13.22 lakh) was observed in N_3 (60 g/plant). This might be due to the reason that nitrogen promotes the formation of amino acids and other compounds that are involved in flower formation. These results were in close similarity to that of Kejkar *et al*. (2014) [7] in spider lily and Sahu *et al*. (2021) [18] in chrysanthemum.

Effect of potassium

Significantly more number of flowers per plant (29.78), number of flowers (595.56) per plot and number of flowers per hectare (13.23 lakh) was observed in treatment K_2 (40 g/plant). This might be due to the reason that potassium promotes flower bud development, thereby increasing the number of flowers per plant, per plot and per hectare. These results were in close similarity to that of Singh *et al*. (2017) [23] in China aster and Sahu *et al*. (2021) [18] in chrysanthemum.

Conclusion

From the result of the field experiment, it appears reasonable to infer that there were notable differences in the outcomes of various treatments for flowering, quality and yield parameters. In terms of parameters like flower diameter and yield parameters, variety (Divine) performed better. In contrast, the Gladiator variety performed better in flowering and quality parameters. Results of flowering parameters and yield parameters were found maximum with 60 g N/plant whereas, minimum days to first flower bud initiation (23.97 days) observed in 20 g N/plant and with K (40 g/plant) flowering parameters and yield parameters were found maximum. Thus, for better growth, yield and highest net realization, the rose variety Divine should be shown. Similarly, for better net realization, rose plants should be nourished at 40 g N/plant. Application of potassium at 20 g/plant also gave a higher net realization in rose plants.

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