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Anamika Sajwan
 Department of Horticulture,
 Ph. D Research Scholar, G.B.
 Pant University of Agriculture
 and Technology, Pantnagar,
 Uttarakhand, India

VK Rao
 Department of Horticulture,
 Faculty, G.B. Pant University
 of Agriculture and Technology,
 Pantnagar Uttarakhand, India

Ajit Kumar Kapoor
 Department of Horticulture,
 Faculty, G.B. Pant University
 of Agriculture and Technology,
 Pantnagar Uttarakhand, India

Rajeew Kumar
 Department of Agronomy,
 Faculty, G.B. Pant University
 of Agriculture and Technology,
 Pantnagar Uttarakhand, India

Gurdeep Bains
 Department of Plant
 Physiology, Faculty, G.B.
 Pant University of Agriculture
 and Technology, Pantnagar,
 Uttarakhand, India

Harshita Bora
 Department of Horticulture,
 Ph. D Research Scholar, G.B.
 Pant University of Agriculture
 and Technology, Pantnagar,
 Uttarakhand, India

Corresponding Author:
Anamika Sajwan
 Department of Horticulture,
 Ph. D Research Scholar, G.B.
 Pant University of Agriculture
 and Technology, Pantnagar,
 Uttarakhand, India

Effect of nano-potassium on vegetative growth of Damask rose under Tarai region of Uttarakhand

Anamika Sajwan, VK Rao, Ajit Kumar Kapoor, Rajeew Kumar, Gurdeep Bains and Harshita Bora

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Abstract

The present investigation was undertaken at the Model Floriculture Centre, G. B. Pant University of Agriculture and Technology, Pantnagar during 2022-23 and 2023-24. The experiment was laid in RBD with eight treatments and three replications. Treatments include: T₀: Control (No K), T₁: Recommended dose of potassium (K) @ 60 kg ha⁻¹ after pruning as basal dose, T₂: Nano K, single spray @ 100 ppm at 10-12 leaf stage after pruning, T₃: Nano K, single spray @ 150 ppm at 10-12 leaf stage after pruning, T₄: Nano K, single spray @ 200 ppm at 10-12 leaf stage after pruning, T₅: Nano K, double spray @ 100 ppm 6-8 leaf stage after pruning and 10-12 leaf stage after pruning, T₆: Nano K, double spray @ 150 ppm 6-8 leaf stage after pruning and 10-12 leaf stage after pruning, T₇: Nano K, double spray @ 200 ppm 6-8 leaf stage after pruning and 10-12 leaf stage after pruning. During 2022-23 and 2023-24, among all the treatments plant height (84.81 cm and 83.83 cm), number of branches (19.32 and 17.35), plant spread (81.26 cm² and 76.45 cm²) and numbers of flower per cluster (12.50 and 11.75) was recorded highest in T₇, respectively. However, there was non-significant effect on numbers of petals per flower.

Keywords: Potassium, nano K, pruning, height, branches, plant spread

Introduction

Damask rose (*Rosa damascena* Mill.) is an ornamental and aromatic plant that is primarily grown for products such as rose oil and rose water, which are widely used in the cosmetic, food and pharmaceutical industries. Damask rose essential oil, also known as attar and otto, is produced through steam distillation of Damask rose flowers and is often referred to as "liquid /fluid gold" due to its exorbitant price (Kumar *et al.*, 2016) [6]. It is a key base material in the flavor and fragrance industry. It is used to treat anxiety, depression, stress, chest pains, abdominal and digestive disorders, menstrual bleeding and used as a cardiogenic agent. (Mahboubi, 2016) [7].

It is grown throughout the world, including Iran, Bulgaria, Turkey, Morocco, China, southern France, southern Italy, Russia, Libya, Ukraine and India. Concrete, absolute and Damask rose oil have a global annual demand of 45 tonnes each. Bulgaria and Turkey are the two largest producers of rose oil, accounting for 80-90% of global output (Anonymous, 2024) [1]. In India, it is grown on approximately 2500-3000 ha of land in Rajasthan, Uttar Pradesh, Haryana, Jammu and Kashmir and some areas of Himachal Pradesh and Uttarakhand to produce 0.2 MT of rose essential oil and a large amount of rose water each year (Kumar *et al.*, 2016) [6]. The essential oil of Damask rose is of global economic importance; its demand and price are constantly rising on the national and international markets and global rose oil production accounts for roughly half of total demand, representing a significant upstream business opportunity for the agricultural sector globally. This necessitates focusing on increasing Damask rose production to meet future demand. A variety of factors contribute to increase flower yield, including genetic make-up, environmental factors, pre-harvest factors, etc. (Danyaie *et al.*, 2011) [3]. Nutrient management can be the potential factor to significantly affect economic yield positively.

Potassium is a key cationic macronutrient. It regulates several physiological processes in plants, including plant growth, photosynthate movement, pest and disease resistance, water status regulation and drought tolerance (Zorb *et al.*, 2014) [14].

Inside the cell, it is in a charge of enzyme activation activity, such as the essential oil synthesis enzyme (*Chrysargyris et al.*, 2017) ^[2], ion homeostasis, protein synthesis, osmoregulation and membrane potential regulation (Marschner, 2012) ^[8]. Despite the abundance of potassium in the soil, only a dissolved fraction of potassium is available to plants and the use of chemical fertilizers remains a major barrier for achieving reasonable sustainability due to limited nutrient use efficiency and environmental constraints. Nanofertilizers can be an alternative to chemical fertilizer by lowering production cost and increasing crop yield and quality with increased nutrient use efficiency. Because of its large surface area and ability to hold large amounts of nutrients, nanoparticles can release those nutrients gradually and steadily, facilitating crop uptake of nutrients that meet requirements without having any negative side effects from specialized fertilizer inputs (Preetha and Balakrishnan, 2017) ^[11]. In literature limited data is available on the effect of nano- potassium on Damask rose thus, the objective of study was to evaluate the effect of nano- potassium on vegetative growth of Damask rose.

Materials and Methods

The experiment was carried out at the Model Floriculture Centre of the G.B. Pant University of Agriculture and Technology, Pantnagar, District Udham Singh Nagar (Uttarakhand), during the year 2022-23 and 2023-24 from December to May. It is located in the *Tarai* region of Uttarakhand. The soil at Pantnagar comes under mollisols. The experimental material used for the study was Damask rose (*Rosa damascena*) variety named Ranisahiba. The experiment was performed in Randomized Block Design with 8 treatments and three replications. The treatments include: T₀: Control (No K), T₁: Recommended dose of potassium (K) @ 60 kg ha⁻¹ after pruning as basal dose, T₂: Nano K, single spray @ 100 ppm at 10-12 leaf stage after pruning, T₃: Nano K, single spray @ 150 ppm at 10-12 leaf stage after pruning, T₄: Nano K, single spray @ 200 ppm at 10-12 leaf stage after pruning, T₅: Nano K, double spray @ 100 ppm 6-8 leaf stage after pruning and 10-12 leaf stage after pruning, T₆: Nano K, double spray @ 150 ppm 6-8 leaf stage after pruning and 10-12 leaf stage after pruning, T₇: Nano K, double spray @ 200 ppm 6-8 leaf stage after pruning and 10-12 leaf stage after pruning. Pruning was done in last week of December and immediately after pruning a spray of copper oxychloride was done. Cultural operations like hoeing, weeding and irrigation were done as per the crop requirement. The observations such as plant height, number of branches, plant spread was taken at 135 days after pruning (DAP) while, numbers of petals per flower and numbers of flower per cluster were taken at flowering stage.

Results and Discussion

Plant height (cm)

During the year 2022-23, highest plant height (84.81 cm) at 135 DAP was found in T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) followed by T₁ (Recommended dose of K @ 60 kg ha⁻¹) with plant height 81.30 cm. While, lowest plant height was observed in control (55.71 cm). In 2023-24, the maximum plant (83.83 cm) was observed in T₇ (Nano K, double spray

@ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) which was statistically at par with T₁ (Recommended dose of K @ 60 kg ha⁻¹) (80.46 cm) and minimum was found in control (53.02 cm). As per the pooled data of both years, maximum plant height (84.49 cm) was observed in T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) and the minimum plant height was recorded in control (54.36 cm). The increase in plant height may be attributed to the close relationship between potassium and the growth of meristem tissues as potassium activates and regulates ATPase in the plasma membrane to produce acid inducement, which then subsequently catalyzes cell wall loosening and activates the hydrolysing enzyme (Oosterhuis *et al.*, 2014) ^[9].

Numbers of branches per plant

During 2022-23, at 135 DAP highest number of branches (19.32) were recorded in T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) which was significantly at par with T₁ (Recommended dose of K @ 60 kg ha⁻¹) with 18.19 branches and the minimum number of branches were recorded in T₀ (Control) 11.65. Whereas, in the year 2023-24, the maximum number of branches (17.35) at 135 DAP were observed in T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) followed by T₁ (Recommended dose of K @ 60 kg ha⁻¹) with 16.29 branches and the minimum number of branches (9.36) were observed in T₀ (Control). As per the pooled analysis of both years, maximum number of branches (18.33) were observed in T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) whereas, minimum number of branches (10.51) were recorded in T₀ (Control). The increase in number of branches at different stages might be due to the role of potassium in improved nutrient uptake (Sustr *et al.*, 2019) ^[13], increased level of transport and distribution of photosynthetic products and cell enlargement (Rady *et al.*, 2023) ^[12]. These findings are in line with Hassani *et al.* (2015) ^[4] in peppermint.

Plant spread (cm)

During the year 2022-23, at 135 DAP highest plant spread (81.26 cm) was recorded in T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) followed by T₁ (Recommended dose of K @ 60 kg ha⁻¹) with 75.86 cm plant spread and minimum plant spread (56.50 cm) was recorded in T₀ (Control). In the year 2023-24, the maximum plant spread (76.45 cm) at 135 DAP was found in T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) followed by T₁ (Recommended dose of K @ 60 kg ha⁻¹) with 70.56 cm plant spread and the minimum plant spread (55.10 cm) was observed in T₀ (Control). The pooled data of both years indicated that the highest plant spread (78.86 cm) was observed in the treatment T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) and lowest plant spread (55.80 cm) was found in T₀ (Control), respectively. The increase in plant spread might be due to an increase in the number of branches by the enhanced supply of photosynthates, increased nutrient availability in plants treated with nano-potassium. The above results conform with the findings of Palavalasa (2016) ^[10] in garland chrysanthemum.

Numbers of petals per flower

The data related to the effect of nano- K on number of petals per flower is given in Table 2. It is demonstrated that in both the years (2022-23 and 2023-24), various treatments do not have any significant effect on numbers of petals per flower. However, the maximum number of petals per flower (61.17 and 62.58) in 2022-23 and 2023-24 respectively, was recorded in T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) whereas, minimum numbers of petals per flower (54.33 and 52.00) was recorded in T₀ (Control). As per the pooled data of both years, there was no significant effect of Nano K on number of petals per flower. Though the highest number of petals per flower (61.88) was obtained in T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) and lowest number of petals per flower (53.17) was observed in T₀ (Control).

Number of flowers per cluster

In the year 2022-23, T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) showed significantly greater number of flowers per cluster (12.50) than all other treatments followed by T₁ (Recommended dose of K @ 60 kg ha⁻¹) and T₆ (Nano K, double spray @ 150 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) with 11.50 and 10.70 flowers per cluster. However, the

minimum number of flowers per cluster (7.50) were found in T₀ (Control). In the year 2023-24, the maximum number of flowers per cluster (11.75) were recorded in T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) which was followed by T₁ (Recommended dose of K @ 60 kg ha⁻¹) and T₁ was statistically at par with T₆ (Nano K, double spray @ 150 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) with 11.00 and 10.50 flowers per cluster. The minimum number of flowers per cluster (6.80) was spotted in T₀ (Control). As per the pooled analysis of both the years, plants treated with T₇ (Nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) exhibited the highest number of flowers per cluster (12.13) followed by T₁ (Recommended dose of K @ 60 kg ha⁻¹) and T₆ (Nano K @ 150 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning) with 11.25 and 10.60, respectively. While, the minimum number of flowers per cluster (7.15) was observed in T₀ (Control). The increase in number of flowers per cluster may be because of potassium role in activating the enzymes responsible for protein composition, sugar conversion, photosynthesis, nitrogen and carbon metabolism, thereby enhancing plant productivity and quality (Oosterhuis *et al.*, 2014)^[9]. The current findings find support from Kamaluddin *et al.* (2022)^[5] in kalanchoe.

Table 1: Effect of nano- potassium on plant height (cm), number of branches and plant spread (cm²) in Damask rose

Treatments	Plant height (cm)			Number of branches per plant			Plant spread (cm)		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
T ₀ : Control (No K)	55.71	53.02	54.36	11.65	9.36	10.51	56.50	55.10	55.80
T ₁ : Recommended dose of K (60 kg ha ⁻¹)	81.30	80.46	80.47	18.19	16.29	17.24	75.86	70.56	73.21
T ₂ : Nano K @ 100 ppm (Single spray)	59.75	57.26	58.51	12.08	11.23	11.66	58.14	56.81	57.48
T ₃ : Nano K @ 150 ppm (Single spray)	67.00	60.21	63.61	13.65	11.88	12.77	59.64	57.67	58.66
T ₄ : Nano K @ 200 ppm (Single spray)	76.50	71.29	73.90	15.69	13.45	14.57	66.15	65.18	65.66
T ₅ : Nano K @ 100 ppm (Double spray)	73.00	66.52	69.76	13.78	12.87	13.33	62.14	61.25	61.70
T ₆ : Nano K @ 150 ppm (Double spray)	78.75	75.73	77.24	15.94	14.67	15.30	70.30	69.37	69.84
T ₇ : Nano K @ 200 ppm (Double spray)	84.81	83.83	84.49	19.32	17.35	18.33	81.26	76.45	78.86
SE(m)±	1.02	1.51	0.83	0.49	0.42	0.42	0.74	0.67	0.42
C.D. (p=0.05)	3.12	3.51	2.55	1.52	1.29	1.29	2.28	2.04	1.29

Table 2: Effect of nano- potassium on numbers of petals per flower, number of flowers per cluster in Damask rose

Treatments	Number of petals per flower			Number of flowers per cluster		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
T ₀ : Control (No K)	54.33	52.00	53.17	7.50	6.80	7.15
T ₁ : Recommended dose of K (60 kg ha ⁻¹)	59.58	58.08	58.83	11.50	11.00	11.25
T ₂ : Nano K @ 100 ppm (Single spray)	55.50	52.92	54.21	8.00	7.50	7.75
T ₃ : Nano K @ 150 ppm (Single spray)	55.83	53.17	54.50	8.50	8.10	8.30
T ₄ : Nano K @ 200 ppm (Single spray)	56.75	55.75	56.25	9.75	9.60	9.68
T ₅ : Nano K @ 100 ppm (Double spray)	56.25	53.83	55.04	8.88	8.50	8.69
T ₆ : Nano K @ 150 ppm (Double spray)	57.42	58.25	57.83	10.70	10.50	10.60
T ₇ : Nano K @ 200 ppm (Double spray)	61.17	62.58	61.88	12.50	11.75	12.13
SE(m)±	2.73	2.48	1.82	0.08	0.19	0.09
C.D. (p=0.05)	NS	NS	NS	0.25	0.58	0.28

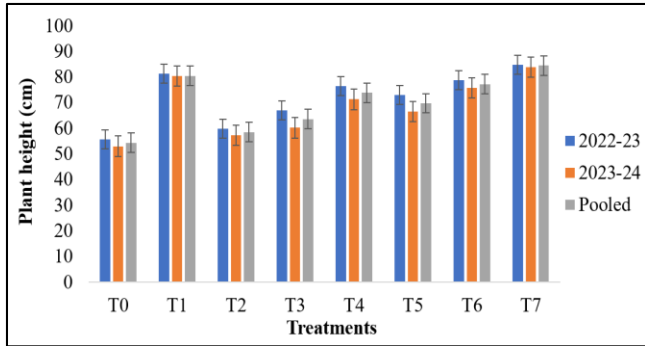


Fig 1: Influence of nano- potassium on plant height at 135 DAP in Damask rose

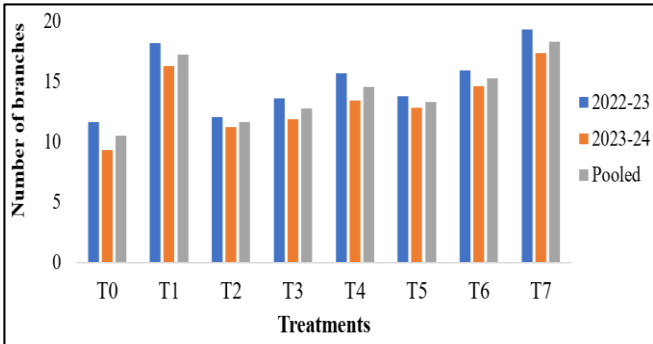


Fig 2: Influence of nano- potassium on number of branches at 135 DAP in Damask rose

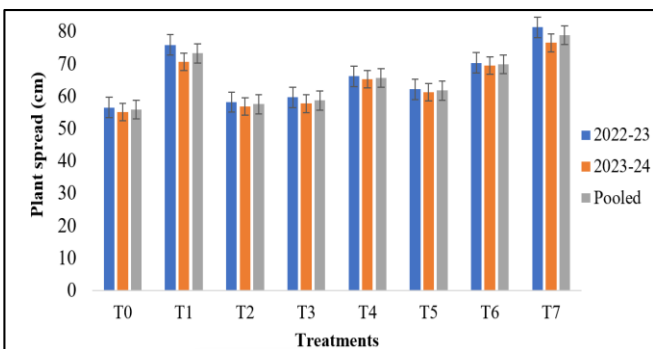


Fig 3: Influence of nano- potassium on plant spread at 135 DAP in Damask rose

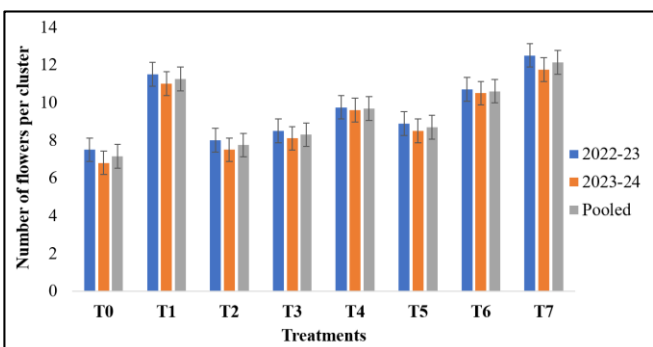


Fig 4: Influence of nano- potassium on the number of flowers per cluster in Damask rose

Conclusion

The result revealed that application of nano K, double spray @ 200 ppm at 6-8 leaf stage and 10-12 leaf stage after pruning (T₇) positively accelerate the plant height, number of branches, plant spread and numbers of flower per cluster. While, potassium fertilization does not have any effect on

number of petals per flower. Conversely, the minimum growth was observed in T₀ (Control).

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