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Response of potassium nitrate and urea phosphate on flowering, fruiting and yield of Cape gooseberry (*Physalis peruviana* L.)

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Abstract
The influence of potassium nitrate and urea phosphate on blooming, fruiting, and quality of cape gooseberry (*Physalis peruviana* L.) *viz.* Sel-VK-601 was investigated using a randomized block design with seven treatments and three replications. The treatments had a significant impact on plant height (147.67 cm), inter nodal length (18.66 cm), number of branches per plant (17.78), time span of appearance of 50% flowering (92.56), bud break to full bloom (11.56), and duration of fruit set to maturity (73.78) when sprayed with Urea phosphate @ 1.5 percent. With the application of KNO_3 @ 1.5 percent, plant girth (5.60 cm), number of flower per shoot (11.89), number of fruit set per plant (137.67), fruit weight (9.59 g), fruit length (27.36), fruit width (27.12), and number of fruit per plant (88.00) were measured. As a result of the overall findings of this study, it can be concluded that increasing the concentration with an adequate dose of urea phosphate and KNO_3 increases the vegetative development and yield of Cape gooseberry.

Keywords: Cape gooseberry, KNO_3, urea phosphate, quality, yield

Introduction
Cape gooseberry (*Physalis peruviana* L. Solanaceae) seems to be a minor fruit crop native to South America that was grown in South Africa during the 19th century, particularly in the Cape of Good Hope area. Cape gooseberry is known by a variety of names in different places, including "Poha" in Hawaii, "Golden Berry" in South Africa, and Rasbhari, Makoi, or Tepari on India's Asian continent (Gupta and Roy, 1980) [11]. The calyx is green in colour and consists of five sepals, each about 5 cm long, that completely cover the development of the fruit throughout the year. It can reach a height of 1.0 to 1.5 metres. However, with cultural training, it can reach a maximum height of 2.0 metres (Fischer, 2000) [8]. The calyx turns dark when the fruit is fully mature, indicating that the Physalis is ready to be harvested (Avila *et al*. 2006) [3]. The cape gooseberry has been grown on a small scale in India and is considered a minor crop, with most cape gooseberries being grown as a one-year crop on the plains of north India. It is commonly grown as a backyard crop and in Peri-urban areas, and it is marketed at exorbitant prices in populous cities. Cape gooseberry is a warm-climate crop that requires a long growing season to provide lucrative yields and production. Cape gooseberry is still cultivated on a limited scale by farmers with inadequate crop management practices, resulting in low yield and poorer quality fruits, making it difficult to sell for a good price. The mineral nutrition and biochemical features of fruit vary based on the cultivar, the growing region, the environment, the maturation time, cultural practice, and nutrition application. Because nutrients are given to plants at their beginning phage as well as essential phage, foliar application of nutrients is a quick technique to improve crop growth and development. When there is a lack of moisture in the soil due to rain, fertilizer applied as a foliar spray result in efficient absorption and consumption, which is more cost effective than alternative fertilizer application methods. Foliar spraying of nutrients is believed to be more efficient than fertilizer application, and because Urea has an uncharged behaviour and easily passes through the cuticle, it has become the most widely used fertilizer method in the field on horticultural crops (Gooding and Davies, 1992; Cheng *et al.* 2002) [9, 4]. Potassium and nitrogen are two nutrients that are commonly used in fertigation because of their great mobility in the soil. The key nutrients nitrogen and potassium are linked to an increase in output and play a critical role in crop yield and vegetative growth.

According to Aminifard *et al.* (2010) [2], nitrogen and potassium are primarily responsible for structural activities, and they play a role in the creation of numerous organic molecules that are vital to plants, such as proteins, proline, and amino acids (Parida and Das, 2005) [14]. Potassium is a macro element that is required in large amounts for normal plant growth and development. Potassium is involved in a variety of physiological processes, including water relations, photosynthesis, assimilation, transport, and enzyme activation, all of which have a direct impact on crop output. Whenever potassium fertilizers intake is less than the need of a fruit crop, foliar potassium spray is used to control vegetative growth, fruit set, and quality. Potassium is the most important nutrient for plants to execute a variety of functions, including the activation of enzymes involved in respiration, regulation of cell turgor pressure, and direct impact on CO_2 assimilation rate through the control of stomatal opening and shutting (Faquin and Andrade, 2004) [7]. Nitrogen and potassium are important macronutrients for high yield, and they play a key role in photosynthesis, protein synthesis, and oxidative metabolism, as well as serving as an activator for a variety of enzymes. They are also important in the translocation of photosynthates in to the sink organs, turgorscence maintenance, and water and nutrient transportation in the plant system. Application of nutrients refers to the provision of nutrients such as potassium nitrate and urea phosphate at an appropriate level for the cape gooseberry's survival by maximizing the advantages from all available sources, which is necessary for maintaining the soil's physical and biological qualities (Chundawat, 2001) [5]. Considering the potential commercial importance of cape gooseberry, the current study was undertaken to investigate "the influence of potassium nitrate and urea phosphate on blooming, fruiting, and quality of cape gooseberry (*Physalis peruviana* L.) *viz.* Sel-VK-601."

Materials and Methods

The present investigation entitled "Effect of potassium nitrate and urea phosphate in flowering, fruiting and yield of cape gooseberry (*Physalis peruviana* L.)" held atpermanent research farm of Horticulture Garden, Bihar Agricultural College, Sabour, Bhagalpur ($87^0$2'42" E, $25^0$15'40" N) at an altitude of 46 m above mean sea level in the heart of vast Indo-Gangatic plains of north India. This location's climate is subtropical in nature, with dry summers, moderate rainfall, and frigid winters. The coldest months are often January and February, with average temperatures as low as 10.4 °C. Sel-VK-601 is a single genomic constituent of Cape gooseberry (*Physalis peruviana* L.) used in this study. The genotypes were taken from the Bihar Agriculture College's experimental garden in Sabour, Bhagalpur. In the first month of October, micro seeds are sown in a protray that consists of coco peat, vermicompost, and sand in a 2:1:1/2 ratio. After 3-4 weeks, these saplings were ready for transplanting, and transplanting took only one month. The uniform seedlings were planted at a distance of 60 x 60 cm in the last week of November. Seedlings were planted in the evening to increase their chances of survival. After transplantation, the field was immediately irrigated. A dose of 5 kilogrammes of farmyard manure, 40 kilogrammes of nitrogen, 40 kilogrammes of phosphorus, and 20 kilogrammes of potash per square metre was administered. At the time of bed preparation, half of the nitrogen, as well as the complete amount of phosphate, potash, and farm yard manure, were appropriately mixed in the soil, and the remaining half dose of nitrogen was applied one month after planting. From the second day following transplanting, the plants were carefully monitored. The appearance of irreversible wilting in seedlings and the emergence of fresh growth were regarded as characteristics of mortality and survival, respectively. After transplanting, we only needed to fill in a few gaps because we had chosen healthy, disease-free, and well-developed seedlings of around the same age in each plot with the same line, and we took proper care of them until they were properly established in the plot. However, such gap filling procedures performed after transplantation were not studied in depth. After seedlings were established in the field, similar cultural operations were carried out on a regular basis for each experimental block to keep the plants healthy. During the experiment, control measures for insects, pests, and disease occurrence were taken on a regular basis. T_1 (KNO_3@ 0.5 percent), T_2 (KNO_3@ 1.0 percent), T_3 (KNO_3@ 1.5 percent), T_4 (Urea Phosphate @ 0.5 percent), T_5 (Urea Phosphate @ 1.0 percent), T_6 (Urea Phosphate @ 1.5 percent), and T_7 (Urea Phosphate @ 1.5 percent) were the seven treatments used in the experiment (Control). 30 days, 60 days, 90 days, and 120 days following transplantation ANOVA using Opstat software was used for the statistical analysis.

Results and Discussion

Vegetative growth, Flowering and fruiting behaviour

Table 1 summarizes the data on vegetative development, flowering, and fruiting behaviour under various treatments. There was a substantial variation in the treatment when different doses and characteristics were used. T_6 (Urea phosphate @ 1.5%) had the highest plant height (147.67 cm), which was comparable to treatments T_3 (KNO_3 @ 1.5%) and T_2 (KNO_3 @ 1.0%), which had plant heights of (136.89 cm) and (134.00 cm), respectively. This is due to the fact that nitrogen aids plant development by playing an active role in cell division and cell elongation. Increased growth with greater nitrogen levels could be due to increased availability of nitrogen in various areas of the plant. The results obtained by Dong *et al*. are consistent with the current findings (2005) [6]. Foliar treatments of urea have been shown to boost plant growth, N reserves, and fruiting (Rosecrance *et al.*, 1998; Sanchez *et al.*, 1990) [16, 17]. Plant height increases with potassium treatment, according to Adel and Thomas (1994) [1], and plants cannot complete a regular life cycle without enough potassium. They discovered that rising potassium levels were linked to increases in vegetative growth, net photosynthetic rate, NPK content, and chlorophyll content. Plant girth, on the other hand, is a measurement of the distance around the base of a plant measured perpendicular to the plant's axis. While T_3 (KNO_3 @ 1.5%) had the largest plant girth (5.60 cm), it was statistically equal to T_2 (KNO_3 @ 1.0%) and T1 (KNO_3 @ 0.5%), which had plant girths of (5.22 cm) and (5.19 cm), respectively. Our findings were corroborated by Guneri *et al*., (2016) [10], who discovered that potassium and phosphorus administrations boosted seedling girth. The maximum plant girth at increased nitrogen as well as potassium levels were due to enhanced potassium uptake and accumulation in leaf tissues, which improved photosynthetic efficiency, resulting in increased carbohydrate synthesis, translocation, and accumulation. Other features, such as inter nodal length, were determined to be nonsignificant between the variation (18.66 cm) and (15.74 cm) when urea phosphate @ 1.5 percent was applied and under control conditions. whereas, a close analysis of the results found a significant treatment effect on the time of appearance of 50% flowering, also with maximum duration being (92.56 days) with T_6 (Urea phosphate @1.5 percent), and it was comparable to treatments T_5 (Urea phosphate @1.0 percent), T_2 (KNO_3 @ 1.0 percent), T_4 (urea phosphate @ 1.0 percent), and T_1 (KNO_3 @ 0.5 percent) with flowering periods of (90.00 days). While the highest number of flowers per shoot recorded was (11.89) in treatment T_3 (KNO_3 @ 1.5 percent), it was at par with T_3 (KNO_3 @ 1.5 percent), T_5 (Urea phosphate @1.0 percent), and T_2 (KNO_3 @1.0 percent) with flowering durations of (10.78 days, (10.44 days), and (10.44 days) respectively. The effect of chemicals and photoperiod conditions on plant vegetative growth, which may be the cause of variation in plant growth. When plants were treated with potassium nitrate, the number of blooms and inflorescences rose; Khayat *et al*., (2010) [12] showed comparable results for 'Selva' strawberries, and our outcomes were consistent with earlier research (Rahemi and Asghari, 2004) [15]. Because the element K plays crucial regulatory roles both within and outside of plant cells, it's reasonable to assume that providing plants with access to a readily available K source will improve plant growth and, as a result, allow them to flower more frequently. The other measure, maximum fruit set per plant (137.67), was identified with T_3 (KNO_3 @ 1.5%), and it was comparable to T_2 (KNO_3 @ 1.0%), T_5 (Urea phosphate @1.0%), and T_6 (Urea phosphate @1.5%). There were (117.33), (119.44), and (121.78) fruit sets per plant, respectively. This could be related to the production of Cape gooseberry, that was affected by climatic conditions as well as chemical treatment. Sudha *et al.*, (2012) [19] observed that foliar spraying potassium nitrate at a dosage of 2% resulted in the highest number of flowering/shoots (68.7%), fruit set (17.0%), number of fruits (146) per plant, and fruit production (43.8 kg/plant). In the other observation, T_6 (Urea phosphate @1.5 percent) had the longest fruit set to maturity (73.78 days), while the other treatments (T_1 (KNO_3 @ 0.5 percent), T_2 (KNO_3 @ 1.0 percent), T_3 (KNO_3 @ 1.5 percent), T_4 (Urea phosphate @ 0.5 percent), T_5 (Urea phosphate @1.0 percent), T_4 (Urea phosphate @ 0.5 percent), and T_5 (Urea phosphate @1.0 percent). Shulman *et al*. (1987) [18] evaluated the reaction of grapes *cv*. Sultana (Thompson Seedless) and discovered that Gibberellic acid combined with urea phosphate @ 1% increased berry size and delayed maturity in grapes. while as other data, the maximum fruit weight (9.59 g) was recorded in treatment T_3 (KNO_3 @ 1.5%) which was at par with fruit weight (8.99 g), (9.39 g), (8.55 g), (9.17 g) and (9.42 g) with T_1 (KNO_3 @ 0.5%),T_2 (KNO_3 @ 1.0%), T_5(Urea phosphate @1.5%) and T_6 (Urea phosphate @1.5%),maximum fruit length (27.36 mm) was recorded with T_3 (KNO_3 @1.5%) at par with the fruit length (25.02 mm), (25.06 mm), (24.80 mm) and (25.14 mm) were recognized with the plant treatment T_1 (KNO_3 @ 0.5%),T_2 (KNO_3 @ 1.0%), T_5(Urea phosphate @1.5%) and T_6 (Urea phosphate @1.5%)respectively, Other parameters examined high fruit breadth (27.12 mm) were found to be similar to the fruit breadth values (25.35 mm), (24.41 mm), (24.45 mm), (25.16 mm), and (26.12 mm) with T_3 (KNO_3 @1.5 percent). T_1 (KNO_3 @ 0.5 percent), T_2 (KNO_3 @ 1.0 percent), T_4 (urea phosphate @ 0.5 percent), T_5 (Urea phosphate @1.5 percent), and T_6 (Urea phosphate @1.5 percent) were the treatments used. While our findings are consistent with those of Kour and Bakshi (2006), who observed that the largest fruit weight was found in Aligarh genotype (12.20 g.) so under control condition, followed by Farrukhabad genotype (11.90 g.). Following that, Vijay *et al.*, (2016) [20] found that in sweet orange *cv*. Jaffa, use of KNO_3 @ 4 percent resulted in the greatest average fruit weight (157.62 g), followed by weight (153.02 g) with application of K_2SO_4 @ 3 percent. It can be determined that potassium administration enhanced fruit weight above the control. While T_3 (KNO_3 @ 1.5 percent) had the highest number of fruits per plant (88.00), T_5 (Urea phosphate @ 1.0 percent) and T_6 (Urea phosphate @ 1.5 percent) had the lowest number of fruits per plant (82.00) and (77.41), respectively. Our findings matched those of Nahar *et al*. (2010) [13], who investigated the effects of $KClO_3$, KNO_3, and urea on mango flowering and fruiting and discovered that foliar application of KNO_3 At 4 percent produced the most fruits (581) per plant.

Table 1: Effect of potassium nitrate and urea phosphate on vegetative Growth, flowering and fruiting behaviour of Cape gooseberry.

Treatments	Plant height (cm)	Plant girth (cm)	Inter nodal length (cm)	Number of branches per plant	Period of appearance of 50% flowering (days)	Period of bud break to full bloom (days)	Number of flowers /shoot	Number of fruit set per plant	Duration of fruit set to maturity (days)	Fruit weight (g)	Fruit length (mm)	Fruit breadth (mm)	Number of fruits per plant
T_1	134.00	5.19	16.27	15.56	87.00	9.22	9.11	102.44	72.33	8.99	25.02	25.35	63.90
T_2	136.89	5.22	17.75	16.11	88.22	10.44	9.89	117.33	70.22	9.39	25.06	25.41	75.03
T_3	141.67	5.60	18.14	16.44	85.56	10.78	11.89	137.67	69.11	9.59	27.36	27.12	88.00
T_4	129.56	4.72	16.42	14.00	87.56	9.44	10.22	113.33	70.78	8.55	23.99	24.45	68.75
T_5	131.78	4.79	16.61	15.44	90.00	10.44	10.56	119.44	72.00	9.17	24.80	25.16	82.00
T_6	147.54	5.04	18.66	17.78	92.56	11.56	11.22	121.78	73.78	9.42	25.14	26.12	77.41
T_7	118.56	4.37	15.74	12.67	79.56	7.22	7.78	66.89	62.55	6.79	22.34	21.23	60.24
S.Em(±)	4.24	0.18	----	0.50	1.86	0.38	0.49	7.62	2.05	0.27	0.84	1.00	4.29
CD(P=0.5)	13.06	0.55	NS	1.55	5.73	1.18	1.50	23.49	6.33	0.83	2.58	3.09	13.21
CV	5.47	6.17	----	5.63	3.70	6.72	8.36	11.87	5.07	5.28	5.85	6.96	10.09

Conclusion

Based on the effects of potassium nitrate and urea phosphate sprays on cape gooseberry flowering, fruiting, and yield (*Physalis peruviana* L.). Urea phosphate and potassium nitrate produced the best results, respectively. As a result, the application of urea phosphate and KNO_3 at a sufficient dose are very useful chemicals that increase the flowering, fruiting, and yield of cape gooseberry by delaying the ripening process, as well as the quality parameters that provide very useful information to agricultural researchers as well as nutritional and medicinal researchers.

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