The Effect of Biofertilizers on Growth, Yield and Quality of Cape Gooseberry (*Physalis Peruviana* L.) in PrayagrajAgro-climatic Conditions.

Abstract

The present investigation "The effect of biofertilizers on growth, yield and quality of Cape Gooseberry (*Physalis peruviana* L.) in Prayagraj agroclimatic conditions" was undertaken at Central Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (UP) during 2022. The experiment was laid out in a Randomized Block Design (RBD) with 10 treatment combinations viz, $\mathbf{T_0}$(Control), T1(100% RDF), $\mathbf{T_2}$(100% RDF+ Azotobacter) 10g, $\mathbf{T_3}$ (100% RDF + Azospirillium) 10g, $\mathbf{T_4}$ (100% RDF + Azotobacter)10g, $\mathbf{T_5}$ (75% RDF= Azotobacter) 10g, $\mathbf{T_6}$(75% RDF + Azospirillium) 10g, $\mathbf{T_7}$(75% RDF + Trichoderma) 10g, $\mathbf{T_8}$(75% RDF + Azotobacter + Azospirillium) 10g, $\mathbf{T_9}$(75% RDF + Azotobacter + Azospirillium + Trichoderma) 10g with three replications. The main objective of the experiment was to find out the effect of various biofertilizers on yield and quality of Cape Gooseberry and to estimate the economics of various treatments. From the present investigation treatment T9(75% RDF + Azotobacter + Azospirillium + Trichoderma) 10g performed best in terms of yield parameters, (fruit weight (10.39g), and quality parameters Acidity (0.14%), of Cape Gooseberry. However, highest B:C ratio was found in Treatment.

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Keywords: **Biofertilizers, Cape gooseberry, Growth, Yield, Quality.**

Introduction

Cape gooseberry is a minor fruit crop of the world and comes under Solanaceae family. It is known by different names in different parts of world like golden berry (South Africa and U.K.), giant ground cherry, Peruvian ground cherry and Peruvian cherry (U.S.), poha (Hawaii), jam fruit (India), uvilla (Ecuador) and uchuva (Colombia). It is a quick growing herbaceous crop easily propagated by seeds and cuttings. Cape gooseberry has a wide adaptability to different soil types and climatic conditions. It is basically a warm season crop and requires relatively long season to produce profitable yields. It can be cultivated in tropical, sub-tropical and temperate region also. Three types of cape gooseberry indigenous to Colombia, Kenya and South Africa are cultivated worldwide. Colombia is the world's largest producer of cape gooseberry followed by South Africa. The cape gooseberry is indigenous to South America but was cultivated in South Africa in the region of the Cape of Good Hope during the 19th century, imparting the common name, "cape gooseberry". The species *P. peruviana* was introduced in South Africa by the Spanish from where it spread to different countries where it is grown commercially (Mazorra, 2006).

Among growth regulators, Gibberellic acid plays a vital role in the development of morphological characters of plants and their fruits. The application of gibberellins along auxins (naphthalene acetic acid) are known to influence the seed germination, plant growth, development, flowering, and fruit characters. Gibberellic acid delays the senescence of fruits. Naphthalene acetic acid reduces the fruit drop and increases the number of fruits to be set (Alam and Khan, 2002). Though plant growth regulators have great potential to influence plant growth morphogenesis but its application have to be judiciously planned in terms of optimal concentration, which constitute the major impediments in plant growth regulators applicability. Since very little information is available in the effect of growth regulators on growth and yield of cape gooseberry, the present investigation was aimed to find out suitable growth regulators for increasing the yield potential and quality in cape gooseberry. Generally, the fruit of P. peruviana L. is consumed fresh as well as vegetable salads. The whole fruit can be used in syrup and dried as it becomes a "very nice raisin". The fruit is also used in sauces and glazes for meats and seafood. It can also be used for making jams and jellies (National Research Council, 1989). The juice of the ripe fruit is high in pectinase, reducing costs in the preparation of jams and other similar preparations (Corporation Colombia International, 2001). Although cape gooseberry is generally commercialized as fresh products, the fruits are also used in sauces, syrups, and marmalades or dehydrated (similarly to grape raisins) for use in bakeries, cocktails, snacks, and cereal breakfast.

P. peruviana is an economically useful crop as an exotic exported fruit, and is favoured in breeding and cultivation programs of many countries. P. peruviana fruits are marketed in the United States as goldenberry and sometimes Pichuberry, named after Macchu Picchu in order to associate the fruit with its cultivation in Peru.

Materials and Methods

The Experiment was conducted in Randomized Block Design (RBD) with one control and 09 treatments with the objective of growth, yield, quality and economics of cape gooseberry at the central research farm of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj during 2022-23, with the following treatments **T_0**(Control), T1(100% RDF), **T_2** (100% RDF+ Azotobacter) 10g, **T_3** (100% RDF + Azospirillium) 10g, **T_4** (100% RDF + Azotobacter)10g, **T_5** (75% RDF= Azotobacter) 10g, **T_6** (75% RDF + Azospirillium) 10g, **T_7** (75% RDF + Trichoderma) 10g, **T_8** (75% RDF + Azotobacter + Azospirillium) 10g, **T_9** (75% RDF + Azotobacter + Azospirillium + Trichoderma) 10g with three replications.

Results and Discussion

Themaximumheight(72.51cm)wasrecordedinthetreatmentT_9(75%RDF+Azotobacter +Azospirillium+Trichoderma(10g).Minimumheight(48.2cm)wasobservedinthetreatmentT_0(control).The application of biofertilizer might have improved the soil physical and chemical properties and leading to the adequate supply of nutrients to the plants which might have promoted the maximum vegetative growth while the minimum plant growth was due to non-availability of nutrients. Similar findings were reported by **Sivaiah*et al.* (2013); Meena*et al.* (2015); Kumar*et al.* (2016); Singh*et al.* (2018)**

The maximum Number of branches per plant (11.88) was observed in the treatment T_9 (75%RDF+Azotobacter+Azospirillium+Trichoderma (10g).TheminimumNumberofbranchesper plant(6.33)was observed in treatment T_0(Control).It was noticed that number of branches per plant increased with increasing plant height successively with the increasing levels of nutrients Similar findings were reported by **Sivaiah*et al.* (2013).**

The maximum number of leaves per plant (92.34) was observed in the treatment T_9 (75%RDF + Azotobacter + Azospirillium + Trichoderma (10g). The minimum numbers of leaves49.22)wereobserved intreatment T_0(Control).It was noticed that number of leaves per plant increased with increasing plant height successively with the increasing levels of micronutrient. Combination of inorganic manure and application of micronutrients also recorded maximum plant height and number of leaves also which helped the plants in better photosynthesis to attain vigor. The findings of the present investigation are in conformity with the reports of **Sivaiah*et al.* (2013); Meena*et al.* (2015); Kumar*et al.* (2016);**

Themaximumleafarea(69.34cm^2)wasobservedinthetreatmentT_9(75%RDF+Azotobacter + Azospirillium + Trichoderma (10g). The minimum leaf area (51.88 cm^2) wasobservedfrom the treatment T_0(Control).

The maximum number of days to first flowering (64.67 days) was recorded in the treatmentT_0 (Control). The minimum number of days to first flowering (64.67days) was recorded inthetreatment T_9(75%RDF+Azotobacter + Azospirillium + Trichoderma (10g).

The maximum number of days taken to first fruiting (73 days) was recorded in the treatmentT_0 (Control). The minimum number of days to first flowering (55.42 days) was recorded inthetreatment T_9(75%RDF+Azotobacter + Azospirillium + Trichoderma (10g).

The maximum number of flowers (96.33days) was recorded from thetreatment T_0 (Control).The minimum numbers of flowers (74.62days) was recorded from the treatment T_9 (75%RDF+Azotobacter +Azospirillium + Trichoderma(10g). Maximum number of flowers might be due to increased number of flowers which might have formed into fruits due to adequate availability of major and minor nutrients during its growth and development. Minimum number of fruits yield per plant in T_1(Control) might be due to non-availability of nutrients during its development. Similar findings were reported by **Sathyamurthy*et al.* (2017);Reddy*et al.* (2018).**

The maximum number of fruits (82.52) was observed from the treatment T_9 (75% RDF +Azotobacter + Azospirillium + Trichoderma (10g). The minimum numbers of fruits (61.67)wereobservedfrom thetreatment T_0(Control). Maximum number of flowers might be due to increased number of flowers which might have formed into fruits due to adequate availability of major and minor nutrients during its growth and development. Minimum number of fruits yield per plant in T_1(Control) might be due to non-availability of nutrients during its development. Similar findings were reported by **Sathyamurthy*et al.* (2017);Reddy*et al.* (2018).**

Themaximumaveragefruitweightwithhusk(10.89g)andwithouthusk(9.68g)wasobserved from the treatment T_9 (75% RDF + Azotobacter + Azospirillium + Trichoderma(10g). The minimum average fruit weight with husk (7.01 g) and without husk (6.08g) wasobservedfrom the treatment T_0(Control).Biofertililzers play an important role in improving productivity and quality of horticultural crops. Added dose of biofertilzers along with RDF and other essential nutrients increased the vigor of plants, assimilating area, size of fruit, thereby resulting into higher weight of fruit. These results are in close conformity with the findings of**Ali*et al.* (2015); Haleema*et al.* (2017).**

The maximum polar diameter with husk (4.23 cm) and without husk (2.78 cm) was recordedfrom the treatment T_9 (75% RDF + Azotobacter + Azospirillium + Trichoderma (10g). Theminimumpolardiameterwithhusk(3.11cm)andwithouthusk(1.88cm)wasobservedfromthetreatment T_0(control).Biofertililzers play an important role in improving productivity and quality of horticultural crops. Added dose of biofertilzers along with RDF and other essential nutrients increased the vigor of plants, assimilating area, size of fruit, thereby resulting into higher weight of fruit. These results are in close conformity with the findings of**Ali*et al.* (2015); Haleema*et al.* (2017).**

Themaximumradialdiameterwithhusk(3.78cm)andwithouthusk(2.88cm)wasrecorded from the treatment T_9(75% RDF + Azotobacter + Azospirillium + Trichoderma(10g).The minimum radial diameter with husk (2.95 cm) and without husk (2.25 cm) wasobservedfrom the treatment T_0 (control).Biofertililzers play an important role in improving productivity and quality of horticultural crops. Added dose of biofertilzers along with RDF and other essential nutrients increased the vigor of plants, assimilating area, size of fruit, thereby resulting into higher weight of fruit. These results are in close conformity with the findings of**Ali*et al.* (2015); Haleema*et al.* (2017).**

The maximum yield kg per plant (3.64kg) was observed from the treatment T_9(75% RDF +Azotobacter+Azospirillium+Trichoderma(10g).The minimumyieldkgperplant(1.20kg) was observed from thetreatment T_0(control).Biofertililzers play an important role in improving productivity and quality of horticultural crops. Added dose of biofertilzers along with RDF and other essential nutrients increased the vigor of plants, assimilating area, size of fruit, thereby resulting into higher weight of fruit. These results are in close conformity with the findings of**Pandiyan *et al.* (2018); Singh *et al.* (2018) and Shnain*et al.* (2021).**

The maximum Total soluble solids (12.52 ^{0}Brix) were observed from the treatment T_9

(75%RDF + Azotobacter + Azospirillium + Trichoderma (10g). The minimum total soluble solids(8.5 ^{0}Brix) wererecordedfrom the treatment T_0(control). The maximum TSS might be due to increased availability of major as well as minor nutrients specially nitrogen and potassium supplied by biofertilizers, because they play vital role in enhancing the quality. The minimum TSS in T_1(Control) might be to lack of availability of nutrients. Similar findings were also reported by**Ali*et al.*** **(2015); Kumar*et al.*** **(2017).**

The maximum acidity (0.42%) was observed from the treatment T_0 (control). The minimumacidity(0.14%)wasrecordedfromthetreatmentT$_9$(75%RDF+Azotobacter+Azospirillium+ Trichoderma(10g). The maximum acidity % might be due to increased availability of major as well as minor nutrients specially nitrogen and potassium supplied by biofertilizers, because they play vital role in enhancing the quality. The minimum acidity % in T_1(Control) might be to lack of availability of nutrients. Similar findings were also reported by**Ali*et al.*** **(2015); Kumar*et al.*** **(2017).**

Themaximumascorbicacid(47.52mg/100g)wasobservedfromthetreatmentT$_9$(75%RDF + Azotobacter + Azospirillium + Trichoderma (10g). The minimum ascorbic acid (19.53mg/100g) was recordedfrom the treatment T_0(control). The maximum ascorbic acid might be due to increased availability of major as well as minor nutrients specially nitrogen and potassium supplied by biofertilizers, because they play vital role in enhancing the quality. The minimum ascorbic acid in T_1(Control) might be to lack of availability of nutrients. Similar findings were also reported by**Ali*et al.*** **(2015); Kumar*et al.*** **(2017).**

Conclusion

On the basis of present investigation, it is concluded that the Treatment T9 (75% RDF + Azotobacter + Azospirillium + Trichoderma (10g) was found to be the best treatment combination with respect to growth (plant height, number of branches per plant, number. of leaves per plant, leaf area) ,yield(no. of fruits, average weight of fruits, polar and radial diameter), yield (kg/plant) and quality(acidity, T.S.S, ascorbic acid) and the highest benefit cost ratio (0.54) was found in T9 (75% RDF + Azotobacter + Azospirillium + Trichoderma (10g).

Future Scope

The future of agriculture lies in the widespread adoption of biofertilizers. These natural, eco-friendly alternatives enhance soil fertility, promote plant growth, and reduce environmental impact. By harnessing beneficial microorganisms and organic compounds, biofertilizers increase nutrient availability, leading to sustainable yields. With growing concerns over synthetic fertilizers' negative effects on ecosystems and human health, biofertilizers offer a promising solution for enhancing agricultural productivity while maintaining ecological balance. Their potential to improve soil health, increase crop resilience, and reduce chemical dependency positions them as a pivotal component of future agriculture, ensuring food security and environmental sustainability.

Table 1: Effect of Biofertilizers on Plant height (cm), no. of branches, no. leaves, leaf area (cm^2), Days to flowering and Days to fruiting.

Treatment	Plant Height			No. of Branches		No. of leaves			Leaf area			Days to Flowering	Days to fruiting
	20 DAT	40 DAT	60 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT		
T_0	12.20	27.35	48.20	2.83	6.33	5.83	29.44	49.22	22.29	38.46	51.88	64.67	73.00
T_1	24.26	42.18	62.51	3.16	6.67	6.17	34.73	65.96	22.34	45.80	64.58	62.00	71.67
T_2	30.35	44.37	70.69	3.33	7.67	6.83	34.58	76.41	23.23	42.11	62.29	61.00	70.67
T_3	26.33	48.76	63.46	4.16	8.00	7.00	32.81	65.51	23.62	42.75	52.48	59.67	69.00
T_4	24.72	42.28	64.74	4.67	10.00	7.17	40.70	74.09	23.95	45.59	66.67	58.33	67.67
T_5	22.25	36.1	63.29	4.67	9.16	8.16	39.36	80.11	24.14	48.72	70.77	56.33	65.33
T_6	23.08	37.75	58.88	5.33	10.50	8.33	36.48	81.17	24.25	52.01	70.86	53.00	62.33
T_7	21.38	35.61	59.23	5.5	10.83	8.67	41.35	85.73	24.89	49.67	66.18	50.66	60.67
T_8	27.01	38.62	58.51	5.67	11.50	9.17	44.87	91.58	25.32	49.18	68.83	47.33	56.67
T_9	30.44	46.18	72.51	5.82	11.80	9.82	45.23	92.34	25.89	49.57	69.34	46.54	55.42
F Test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
SE (d)	**12.2**	**27.35**	**48.2**	**1.101**	**1.984**	**1.15**	**4.82**	**12.70**	**1.147**	**4.227**	**6.968**	**6.30**	**6.24**
CD	**1.654**	**1.958**	**2.152**	**0.348**	**0.627**	**0.36**	**1.52**	**4.02**	**0.362**	**1.336**	**2.203**	**1.99**	**1.97**

Table 2: Effect of Biofertilizers on days to flower bud initiation, days to fruiting, average weight of fruit, polar diameter, radial diameter, yield/plant, acidity %, ascorbic acid (mg/100g), tss, ascorbic acid and b:c ratio.

Treatment	**Days to Flower bud initiation**	**Days to fruiting**	**Average weight of fruit**		**Polar Diameter**		**Radial Diameter**		**Yield/plant (kg)**	**Acidity %**	**TSS**	**Ascorbic Acid**	**B:C Ratio**
			With Husk	**Without Husk**	**With Husk**	**Without Husk**	**With Husk**	**Without Husk**					
T_0	96.33	61.67	7.01	6.08	3.11	1.88	2.95	2.25	1.20	0.42	8.50	19.53	0.55
T_1	93.67	63.00	7.00	6.50	3.33	1.96	3.17	2.25	1.44	0.39	9.00	37.43	0.81
T_2	91.67	63.66	8.25	7.40	3.4	1.98	3.20	2.30	1.82	0.38	9.63	40.14	0.94
T_3	81.67	66.50	8.33	7.50	3.41	2.03	3.21	2.48	2.10	0.34	10.00	41.07	1.36
T_4	79.33	66.83	8.75	7.67	3.43	2.05	3.28	2.48	2.26	0.3	10.30	42.81	1.42
T_5	78.00	68.50	9.33	8.33	3.45	2.1	3.35	2.53	2.44	0.29	10.77	44.38	1.48
T_6	77.00	77.83	9.66	8.67	3.5	2.15	3.36	2.55	2.64	0.27	11.13	44.45	1.54
T_7	76.67	78.50	10.06	9.03	3.53	2.2	3.38	2.60	2.89	0.23	11.67	45.13	1.63
T_8	75.83	81.83	10.16	9.33	3.65	2.25	3.42	2.68	3.23	0.17	12.03	47.1	1.74
T_9	74.62	82.52	10.89	9.68	4.23	2.78	3.78	2.88	3.64	0.14	12.52	47.52	1.88
F Test	**S**	S	**S**	**S**	**S**	**S**	S	S	**S**	**S**	S	**S**	
SE (d)	**8.18**	**8.18**	**1.27**	**1.20**	**0.291**	**0.252**	**0.21**	**0.20**	**0.768**	**0.093**	**0.09**	**8.15**	
CD	**2.59**	**2.59**	**0.40**	**0.38**	**0.092**	**0.079**	**0.07**	**0.06**	**0.243**	**0.029**	**0.03**	**2.577**	

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