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Effect of integrated nutrient management strategies on growth and yield of Cape gooseberry (*Physalis peruviana* L.)

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ABSTRACT

An investigation was undertaken during 2009-10 to study the impact of integrated nutrient management on growth and yield of Cape gooseberry genotype 'Aligarh'. Treatments consisted of application of biofertilizers (*Azotobacter, Azospirillium* and *Pseudomonas*) applied alone or in combination, with 75% and 100% NPK, plus full dose of FYM. The experiment was laid out in Randomized Block Design with twenty treatments replicated thrice. Seedlings inoculated with *Azotobacter* + 100% NPK + FYM gave maximum plant height, stem thickness, shoot number per plant and fruit yield per plant. Treatment of *Azotobacter* inoculation + 75% NPK +FYM gave maximum leaf area and minimum days to fruit picking. Biological routes to improving soil fertility and soil health for optimum crop production, therefore, form a vital component of integrated nutrient management.

Key words: Cape gooseberry, Aligarh, biofertilizers, NPK, FYM, growth, yield

INTRODUCTION

Cape gooseberry (*Physalis peruviana* L.), commonly known as Rasbhari, is a quick- growing herbaceous crop belonging to the family Solanaceae. The fruit resembles tomato in shape but is smaller in size. It is ideal as a jam-fruit owing to its rich pectin content. Apart from being rich in food value, plants of Cape gooseberry are high yielding and the crop is highly remunerative due to low production costs and a short juvenile period. This potential cash crop can also be grown as an intercrop. However, ultimately, its growth and yield depends upon orchard management practices, with Nutrient management being one of the prime considerations for higher yield.

Inorganic fertilizers are commonly used by most farmers because of relatively quick availability of nutrients to the plant, but their continuous use leads to damage to the ecosystem and soil health. Moreover, indiscriminate use of high amounts of chemical fertilizers results in deficiency of nutrients other than those applied. Thus, there is need to lay emphasis on management of natural resources like biofertilizers, etc. Biofertilizers are not a substitute but a supplement to chemical fertilizers for maximizing yield and also, to maintain a balance in the agro-ecosystem. There are reports of usefulness of these biofertilizers in other crops of Solanaceae family, such as tomato, but none in Cape gooseberry. With this in view, the present experiment was undertaken to work out an optimum combination of biological and chemical sources of nutrients in Cape gooseberry.

MATERIAL AND METHODS

The investigation on integrated nutrient management in Cape gooseberry was carried out at an experimental orchard and laboratory of Department of Horticulture, Khalsa College, Amritsar during 2009-10. For raising a nursery, seeds of Cape gooseberry genotype 'Aligarh' were sown on 15 June 2009 in raised nursery beds measuring 1m x 1m. Seedlings were transplanted a month after sowing i.e., in mid July (when these attained a height of 20cm) in well-prepared field beds measuring 2m x 3m. Plant-to-plant and row-to-row spacing was 1m x 1m. A unit of 6 plants/ plot comprised a single treatment. The experiment was laid out in Randomized Block Design. Twenty treatment combinations were replicated thrice.

Non-symbiotic biofertilizers (*Azotobacter*, *Azospirillium* and *Pseudomonas*), well known for their broad spectrum utility in various crops, were used in the experiment. These were applied as seedling treatment @ 1.5kg/ha and mixed proportionately in combined applications. Standard dose of NPK (10, 10 and 5g/plant) and FYM

(1kg/plant) was used as the control. Source of fertilizer applied was calcium ammonium nitrate (N 25%) for nitrogen, single super phosphate (P 16%) for phosphorus, and, muriate of potash (K 60%) for potassium. All of the phosphorus and potassium was applied during final preparation of the soil before making the beds, while, half of the nitrogen was applied 30 days after transplanting and the rest was applied after 25 days. Effect of different combinations of chemical and biological fertilizers on crop growth was recorded in terms of plant height, plant spread (N-S and E-W), stem thickness, shoot number per plant and leaf area, as per standard procedures. Apart from this, days to fruit picking from transplanting, and fruit-yield per plant, were also recorded. Total fruit yield was recorded on the basis of four pickings.

Treatment details

T_1 - *Azotobacter*
T_2 - *Azospirillium*
T_3 - *Pseudomonas*
T_4 - *Azotobacter* + *Azospirillium*
T_5 - *Azotobacter* + *Pseudomonas*
T_6 - *Azospirillium* + *Pseudomonas*
T_7 - *Azotobacter* + *Azospirillium* + *Pseudomonas*
T_8 - *Azotobacter* + 100% NPK
T_9 - *Azotobacter* + 75% NPK
T_{10} - *Azospirillium* + 100% NPK
T_{11} - *Azospirillium* + 75% NPK
T_{12} - *Pseudomonas* + 100% NPK
T_{13} - *Pseudomonas* + 75% NPK
T_{14} - *Azotobacter* + 100% NPK +FYM
T_{15} - *Azotobacter* + 75% NPK + FYM
T_{16} - *Azospirillium* + 100% NPK + FYM
T_{17} - *Azospirillium* + 75% NPK + FYM
T_{18} - *Pseudomonas* + 100% NPK + FYM
T_{19} - *Pseudomonas* + 75% NPK + FYM
T_{20} - Control (Recommended dose of NPK and FYM)

RESULTS AND DISCUSSION

Plant height and plant spread (N-S and E-W) increased significantly by biofertilization application compared to the control (Table 1). Maximum height was recorded in *Azotobacter* inoculation of seedlings + 100% NPK + FYM (T_{14}). Increase in height may be due to the fact that nitrogen is fixed by *Azotobacter* and, N being a constituent of protein and chlorophyll, plays a vital role in photosynthesis. It enhances accumulation of carbohydrates which, in turn, increase growth of plants (Mahmoud and Amara, 2000). The reason for increased plant height and plant spread may be the build up of colonies of the applied biofertilizer inoculates and their growth promoting effects, including synthesis of plant growth promoting substances. This increase in vegetative growth may also be attributed to enhanced availability of nutrients at vital periods of growth, greater synthesis of carbohydrates and translocation, improved water status of plants, and, increased nitrate reductase activity. Plant spread improved significantly with inoculation of biofertilizers due to increased cell metabolism resulting from enchanced enzyme activity, chlorophyll content and photosynthetic processes (Kumar *et al*, 2006).

Stem thickness was also found to increase significantly with application of biofertilizers compared to the control (Table 1). Maximum value was recorded in *Azotobacter* inoculation of seedlings + 100% NPK + FYM (T_{14}), followed by *Azotobacter* inoculation of seedlings + 75% NPK + FYM (T_{15}). Increase in stem thickness can be attributed to stimulative activity of the microflora in rhizosphere, leading to increased nutrient availability and, thereby, vigorous plant growth.

Singh and Singh (2004) reported that *Azotobacter* inoculation increased N levels in soil. This increase in N status might be partly attributed to stimulative effect of plant bioregulators which, in turn, increased the rate of nutrient absorption and translocation within the plant system consequently, more N accumulated in the plant parts (Awasthi *et al*, 1998) resulting in overall tree growth. When all three nutrient sources, viz. FYM, inorganic fertilizer and biofertilizer (*Azotobacter*) were applied, it resulted in better plant growth. This can be attributed to improved nutrient and water availability, leading to plant growth from development of better root system with concomitant increase in number of rootlets. This is corroborated by findings of Prahraj *et al* (2002). Increased plant growth might be due to more efficient absorption of nutrient elements because of the better root system developed by biofertilization. Increase in plant-growth can also be ascribed to N addition through biological nitrogen fixation by *Azotobacter* (Bhattacharya *et al*, 2002).

Azotobacter inoculation of seedlings + 75% NPK + FYM (T_{15}) showed minimum number of days to first picking of fruits from date of transplanting seedlings compared to the control (Table 1). This may be due to the ellaboration of small quantities of growth promoting substances like GA, IAA, cytokinins, Vitamin B, etc., by *Azotobacter,* which, along with NPK and FYM might have improved the physiology of plants causing a shift from the vegetative to the reproductive phase (Nair and Najachandra, 1995).

Table 1. Effect of integrated nutrient management strategies on growth and yield of Cape gooseberry

Treatment	Plant height (cm)	Plant spread N-S (cm)	Plant spread E-W (cm)	Stem thickness (cm)	Leaf area (sq. cm)	Shoot number /plant	Days to fruit picking	Fruit yield/ plant
T_1	85.10	40.00	44.70	1.06	44.90	10.00	210.33	363.63
T_2	82.89	39.90	40.86	1.03	41.01	9.33	211.00	313.33
T_3	80.50	37.13	45.20	1.01	43.16	8.00	208.66	303.30
T_4	91.50	41.33	46.09	1.06	46.59	9.66	200.16	359.00
T_5	88.19	41.13	45.20	1.07	44.41	10.00	216.00	331.00
T_6	93.40	42.41	46.80	1.10	47.45	11.66	213.00	347.33
T_7	94.00	42.10	47.40	1.14	48.15	10.66	204.00	386.60
T_8	99.30	44.13	49.00	1.20	50.01	10.66	207.33	450.00
T_9	114.80	46.70	51.09	1.31	52.65	11.66	203.33	407.30
T_{10}	107.40	45.20	50.33	1.25	51.18	11.33	202.66	431.00
T_{11}	103.10	44.80	49.80	1.22	50.34	11.00	206.00	420.10
T_{12}	97.60	43.03	48.03	1.16	49.36	11.00	205.66	398.20
T_{13}	98.00	43.59	48.53	1.18	48.98	11.00	209.00	371.90
T_{14}	136.50	53.90	63.00	1.43	56.59	16.00	198.00	512.00
T_{15}	133.10	50.00	59.06	1.42	58.13	14.66	192.00	501.40
T_{16}	130.50	48.13	60.59	1.40	54.31	13.33	194.66	483.10
T_{17}	123.40	50.76	55.33	1.37	55.40	11.66	197.00	469.00
T_{18}	119.50	48.83	53.00	1.36	54.01	12.66	194.33	450.30
T_{19}	112.30	46.00	50.90	1.28	53.80	11.66	200.00	491.90
T_{20} (Control)	90.80	39.03	40.33	1.08	45.75	10.33	218.00	334.80
CD (P=*0.05*)	15.39	8.77	11.59	0.13	3.74	2.93	7.75	19.75
CV%	8.95	11.95	13.94	6.74	4.55	15.71	2.29	2.94
SEm±	5.37	3.06	4.02	0.04	1.30	1.02	2.70	6.90

Maximum leaf area was observed in the treatment *Azotobacter* inoculation of seedlings + 75% NPK + FYM. It can be inferred that biofertilization, along with NPK and FYM, helps proliferation of roots which, ultimately, results in sturdy and healthy plants showing resistance to biotic and abiotic stresses. Moreover, this also promotes better nutrient uptake and carbohydrate accumulation in leaves, resulting in healthy leaf growth.

Maximum shoot number per plant and fruit yield per plant was obtained in *Azotobacter* inoculation to seedlings + 100% NPK + FYM (T_{14}). The reason for increased number of shoots and fruits per plant is due to solubilization effect of plant nutrients by addition of FYM, as evidenced by increased uptake of N, P, K, Ca and Mg by the crop during the vegetative as well as reproductive phase. These results are in accordance with findings of Patil *et al* (2004). Improvement in these parameters might be due to the secretion of ammonia into the rhizosphere in the presence of root exudates, which helps to modify nutrient uptake by plants, thus maximizing shoot number, fruit size and ultimately, the yield (Harikrishna *et al*, 2002; Sengupta *et al*, 2002). Another reason may be the accelerated mobility of photosynthates from source to sink as influenced by organics and their accumulation in the fruit. This improved translocation was possible perhaps due to better sink capacity resulting in higher number of fruits per plant.

In conciusion, effect of integrated nutrient management on growth and yield of Cape gooseberry shows that the integrated use of biofertilizers, organic manures and chemical fertilizers in combination at an appropriate time, could help in achieving the goal of high fruit yield and safe environment and pave the way for sustainable fruit production. Thus, integrated nutrient management strategy utilizes a judicious combination of biofertilizers, inorganic fertilizers and organic manures to bring about improvement in soil fertility and helps in protecting the environment and producing higher crop yields than when applied singly.

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