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Response of Chlorophyll and Nutrients Concentration in Leaves of Cape Gooseberry (*Physalis peruviana* L.) to Integrated Nutrient Management

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A field study was conducted at Horticulture Research Farm, Banaras Hindu University, Varanasi, during 2013-14 and 2014-15 to find out the nutrient status of cape gooseberry (*Physalis peruviana* L.) plant influenced by adoption of integrated nutrient management. The experiment was laid out in randomized block design with fifteen treatments replicated thrice. The results clearly indicated that the integrated use of nutrients had significantly effect on the chlorophyll and nutrients status of the leaf. The maximum chlorophyll concentration was recorded to be maximum (21.57 SPAD reading) in 50% NPK + FYM + PSB application. The highest (4.89%) nitrogen content was found with100% NPK + FYM + AZB + PSB while it was lowest (1.68%) in50% NPK. Phosphorus content was found to be maximum (1.33%) in 100% NPK + FYM + AZB + PSB. The minimum (0.51%) phosphorus content was discerned in 50% NPK. Potassium content was highest (3.62%) in 100% NPK + FYM + AZB + PSB while lowest (1.43%) potassium content was found in 50% NPK.

Introduction

The Cape gooseberry (*Physalis peruviana* L.) belongs to the family Solanaceae commonly known as rasbhari in India. It is tetraploid and hexaploid (2n=4×=48 and 2n=6×=72) in nature. The genus *Physalis* includes about 100 species characterized by fruits that bear an inflated calyx (Legge, 1974). Integrated nutrient management includes the use of inorganic, organic and microbial sources of nutrients which ensure balanced nutrient proportion by enhancing nutrient response efficiency and maximizing crop productivity of desired quality. It also helps in minimizing the existing gap between the nutrient removal through continuous use of chemical fertilizers and supply through slow release of fertilizers. It is well reported that the extensive use of chemical fertilizers adversely affect the soil health and results in decreased crop productivity and quality (Macit *et al.*, 2007). Thus, in this experiment an attempt has been made to assess the response of chlorophyll and nutrients concentration in cape gooseberry leaves (*Physalis peruviana* L.) to integrated nutrient management.

Materials and Methods

The present investigation was carried out during winter season of 2013-14 and 2014-15 at the Vegetable Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The treatment comprised with different doses of NPK@ 100, 80 and 60 kg ha^{-1}, farm yard manure @15 tonne ha^{-1}along with bio-fertilizers (Azotobacter and phosphorus solubilising bacteria) @ 50mL in 20 litres of water according to the treatment combination. The design of the experiment was randomized block design with three replications and fifteen treatments viz., T1- 50% NPK, T_2 - 50% NPK + FYM, T_3 - 50% NPK + FYM + AZB, T_4 - 50% NPK + FYM + PSB, T_5 -50% NPK + FYM + AZB + PSB, T_6 -75% NPK, T_7 -75% NPK + FYM, T_8 -75% NPK + FYM + AZB, T_9 -75% NPK + FYM + PSB, T_{10} - 75% NPK + FYM + AZB + PSB, T_{11} -100% NPK, T_{12} -100% NPK + FYM, T_{13} -100% NPK + FYM + AZB, T_{14} -100% NPK + FYM + PSB and T_{15} -100% NPK + FYM + AZB + PSB.

The required quantity of organic manures as per treatment combination was applied at the time of land preparation. Urea was applied in two split doses before planting and flowering stages while the full doze of phosphorus and potash was given before planting. Azotobactor and phosphorus solubilising bacteria solutions were made by dissolving 50mL in 20 litres of water. The roots of cape gooseberry seedlings having 4-5 full open leaves were thoroughly dipped in the solution for about 30 min. and then planted on beds at 50 cm × 50 cm distance with the help of khurpi on 10th September of 2013 and 2014, respectively. Other cultural practices like weeding, hoeing, irrigation, insect pest and disease management were done as and when required. Observation on total chlorophyll concentration was measured by chlorophyll meter and value was read as (SPAD reading) just before flower bud formation. For a meaningful plant analysis, care should be taken during sampling. In cape gooseberry plant, fully expanded matured leaves without petiole were selected for sampling (Bhargava and Raghupati, 1993).

Total nitrogen was estimated by the micro-Kjeldhl method as per procedure suggested by AOAC (1990). The estimation of N through the micro-Kjeldahl method consisted of three processes, *viz.,* digestion, distillation and titration.

The phosphorus content was estimated from digestion of acid with a spectrophotometer using the procedure of Bhargava and Raghupati (1984).

The potassium content was estimated from digestion of acid with flame photometer using procedure as described by Bhargava and Raghupati (1984).

Results and Discussion

Accumulation of nutrient in plant tissue indicates the accessibility of the concerned nutrients from the soil to the plant. In plant, nutrient exists in good relationship between the concentration of nutrients in the plant and the total biomass of the plant.

A correct nutrient in the plant tissues is closely associated with maximum yield, except in the case of luxury consumption of nutrients like potassium. Significant error may arise in the plant analysis due to wrong sampling therefore selecting the right plant part, stages of growth and time of sampling are very crucial in plant analysis.

The plant nutrient content was influenced significantly by the various treatment combinations. Maximum nitrogen content was reported in 100% NPK + FYM + AZB + PSB treated plants followed by 100% NPK + FYM + AZB and 75% NPK + FYM + AZB + PSB treatment, whereas the minimum nitrogen content was noted in 50% NPK treated plants (Table 1).

Table.1 Effect of integrated nutrient management on nitrogen, phosphorus, potassium and chlorophyll content in cape gooseberry leaves (mean of 2 year)

Name of treatments	Nitrogen content (%).			Phosphorus content (%).			Potassium content (%).			Chlorophyll (SPAD reading).		
	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled	2013-14	2014-15	Pooled
T_1 (50% NPK)	1.67	1.70	1.68	0.503	0.520	0.512	1.42	1.44	1.43	17.07	17.05	17.06
T_2 (50% NPK + FYM)	1.93	1.93	1.93	0.573	0.577	0.575	1.75	1.76	1.76	17.80	17.82	17.81
T_3 (50% NPK + FYM + AZB)	2.73	2.74	2.74	0.590	0.603	0.597	1.82	1.82	1.82	17.43	17.45	17.44
T_4 (50% NPK + FYM + PSB)	2.33	2.36	2.34	0.743	0.740	0.742	2.33	2.35	2.34	21.57	21.58	21.57
T_5 (50% NPK + FYM + AZB + PSB)	3.44	3.46	3.45	0.853	0.870	0.862	2.83	2.83	2.83	16.27	16.27	16.27
T_6 (75% NPK)	2.03	2.00	2.02	0.650	0.657	0.653	1.97	1.98	1.98	17.07	17.07	17.07
T_7 (75% NPK + FYM)	3.03	3.01	3.02	0.807	0.813	0.810	2.50	2.53	2.52	18.73	18.73	18.73
T_8 (75% NPK + FYM + AZB)	4.15	4.17	4.16	0.897	0.893	0.895	2.93	2.96	2.95	17.83	17.35	17.59
T_9 (75% NPK + FYM + PSB)	3.79	3.83	3.81	1.030	1.060	1.045	3.15	3.17	3.16	18.60	18.65	18.62
T_{10} (75% NPK + FYM + AZB + PSB)	4.33	4.43	4.38	1.113	1.147	1.130	3.32	3.34	3.33	17.03	17.05	17.04
T_{11} (100% NPK)	2.67	2.67	2.67	0.747	0.747	0.747	2.16	2.15	2.16	18.30	18.32	18.31
T_{12} (100% NPK + FYM)	3.30	3.33	3.32	0.833	0.837	0.835	2.63	2.63	2.63	14.23	14.24	14.24
T_{13} (100% NPK + FYM + AZB)	4.74	4.80	4.77	0.950	0.953	0.952	3.03	3.15	3.09	16.00	16.05	16.03
T_{14} (100% NPK + FYM + PSB)	3.97	3.98	3.98	1.233	1.240	1.237	3.52	3.57	3.54	19.13	19.18	19.16
T_{15} (100% NPK + FYM + AZB + PSB)	4.86	4.92	4.89	1.323	1.337	1.330	3.60	3.64	3.62	19.03	19.25	19.14
CD (P=0.05)	0.18	0.17	0.17	0.125	0.100	0.113	0.16	0.13	0.15	1.55	0.18	0.87

Similar results were also obtained by Ranjit and Bandyopadhyay (2014) in tomato, Singh and Singh (2009) in strawberry.

Increased plant nutrient content might be due to the biological nitrogen fixation and production of enzyme complex, which solubilize the unavailable form of nutrient elements and render them available (Marwaha, 1995).

Higher phosphorus content of leaves was reported in 100% NPK + FYM + AZB + PSB treated plants. This increase may be explained owing to organic acids production by plants and bacteria in the rhizosphere, which in turn stimulates the availability of P, Fe and Zn. These findings corroborate the results of Smith and Read, 199, Shen *et al.,* 2004.

Phosphorus is an essential nutrient for plant growth and development and is one of the most important elements in crop production. Despite its wide distribution in nature, it is a deficient nutrient in most of soils, especially in soils which have a high phosphorus fixation capacity. Phosphate solubilizing microorganisms render these insoluble phosphates into soluble form through the process of acidification, chelatiation and exchange reactions (Banik and Dey, 1981; Bhattacharya *et al.*, 1986).

Increase in phosphorus uptake with the increase in application of nitrogen has been reported by Yadav (2010) in peach. Higher potassium content in cape gooseberry leaf was reported in 100% NPK + FYM + AZB + PSB treated plants followed by 100% NPK + FYM + PSB treatment, whereas it was the minimum in 50% NPK treated plant. These results are in agreement with findings of Baba*et al.*, (2010) in strawberry, Shashi *et al.*, (2011) in aonla.

Maximum chlorophyll concentration was recorded in 50% NPK + FYM + PSB treated plants followed by 100% NPK + FYM + PSB treated plants. Similar results were also reported by Wang and Lin (2002) and Singh and Singh (2009) in strawberry.

Increased chlorophyll may be attributed because of increased biological nitrogen fixation, better organic nitrogen utilization, better development of root system and enhanced synthesis of plant growth regulators like IAA, GA_3 and cytokinin (Martinez *et al.*, 2001).

From the results it may be concluded that the integrated use of nutrients was better than their alone application. Treatment 100% NPK + FYM + AZB + PSB performed better in respect of nitrogen, phosphorus and potassium whereas where as 50% NPK + FYM + PSB better in respect of Chlorophyll content.

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