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Study of gherkin (*Cucumis anguria* L.) production by using optimum quantity of chemical and bio-fertilizers

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Abstract
An experiment on gherkin (*Cucumis anguria* L.) was carried out at farmer's field, in Ranebennur Taluk of Haveri District Karnataka during 2015 to study the Gherkin (*Cucumis anguria* L.) production by using optimum quantity of Chemical and Bio-Fertilizers. The results of the experiment data revealed that the application of 100% NPK + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*, treatments recorded Significantly highest vine length (145.55cm), more number of leaves per plant (45.23), more number of branches per plant (4.37), lowest days to flowering (30.00) and highest fruit yield (12.70 t/ha).

Keywords: *Azotobacter*, *Cucumis anguria*, gherkin, *Glomus fasciculatum* and trichoderma

Introduction
The Gherkin (*Cucumis anguria* L.) is an important horticultural vegetable crop belonging to the family cucurbitaceae, mainly cultivated and consumed in Africa, Brazil, Cuba, India, United States and Zimbabwe. It is a monoecious, annual trailing or climbing vine. The fruits of gherkin are consumed as boiled, fried, and fresh in salads. The unripe fruits are used for processing as pickles, eaten as a cooked vegetable and are used in curries (Purseglove 1969) [11]. It was introduced in India during late eighties for export oriented production (Anon 1975) [3]. The gherkin is also known for traditional importance in medicinal to treat stomach ache, jaundice, hemorrhoids and preventing stone formation in kidney (Baird and Thierest 1988) [4]. Gherkin responds well to fertilizers and organic manures. The use of expensive commercial fertilizers as per the requirement of the crop is not much affordable to the average farmers. The application of high input technologies such as chemical fertilizers, pesticides, herbicides improved the production but there is growing concern over the adverse effects of the use of chemicals on soil productivity and environmental quality. The situation thus demands evaluation of proper technology for improving the growth, yield and nutrient uptake in gherkin without much adverse effect on natural resources.
Modern nutrient management strategy has shifted its focus towards the concept of sustainability. Hence, the present investigation was carried out to study the impact of bio fertilizers along with combination of different level of N, P and K on nutrient uptake in gherkin (*Cucumis anguria* L.) production in Haveri District of Karnataka.

Material and methods
The experiment was conducted in the farmer's field, at Ranebennur taluk of Haveri district Karnataka during 2015 and laid out in Randomized Completely Block Design with fourteen treatments and replicated thrice. The treatment details are as below.

T_1 - Control
T_2 - 100% RDNPK
T_3 - 75% NP and 100% K
T_4 - 50% NP and 50% K
T_5 - *Azospirillum brasilense*
T_6 - *Azotobacter chroococcum*
T_7 - *Trichoderma viridae (PSF)*
T_8 - *Glomus fasciculatum (VAM)*
T_9 - 50% NP and 50% K + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum*
T_{10} - 50% NP and 50% K + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*

T_{11} - 75% NP and 100% K + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum*
T_{12} - 75% NP and 100% K + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*
T_{13} - 100% NPK + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum*
T_{14} - 100% NPK + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*

The seeds of gherkin var. Ajaxa were sown at a spacing of 100cm x 30cm. The soil of the experimental plot was red sandy loam having 6.5 to 7.0 pH. Before leveling of the individual plots for sowing gherkin, Farm yard manure (FYM) was applied @ 25 tonnes per hectare as a basal dose and subsequently mixed well in the soil. At the time of sowing seed, 1/3 of nitrogen and full dose of phosphorus and full dose of potassium (260: 175: 260 NPK kg/ha) were applied as per the treatments. The remaining 2/3of nitrogen was applied 20th and 40th day after sowing. The recommended dose of chemical and bio fertilizers were applied. Regular weeding, irrigation and plant protection were followed. Observations on growth and yield parameters viz., vine length (cm), number of leaves, number of branches, days to first flowering and yield (kg/plot) were recorded and analyzed.

Results and Discussion

The results of the mean data of the experiment as influenced by bio fertilizers with different level of NPK on growth parameters viz., vine length (cm), number of leaves per plant, and number of branches per plant are presented in Table no.1.
Application of (T_{14})100% NPK + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum* recorded significantly highest vine length (145.55cm) and was on par with treatment (T_{12}) 75% NP and 100% K + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*, (T_{13}) 100% NPK + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum* and (T_{11}) 75% NP and 100% K + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum* respectively. The lowest vine length (110.57 cm) recorded in control. Bio-fertilizers produced the growth promoting substances viz., auxin, gibbrellins and cytokinin which contributes towards vigorous growth of the plant in cucumber reported by Nirmala and Vadivel (1999) [9], and Wange and Kale (2004) [15] reported in brinjal.

Table 1: Effect of bio-fertilizers on vine length (cm), number of leaves per vine, number of branches per vine, days to first flowering and yield in gherkin

Treatments	Vine length (cm)	Number of leaves per vine	Number of branches per vine	Days to first flowering	Yield t\ha
T_1 – Control	110.57	27.15	1.43	36.79	05.27
T_2 – 100% RDNPK	124.30	37.56	2.50	33.15	09.53
T_3 – 75% NP and 100% K	123.50	38.50	1.86	34.58	09.16
T_4 – 50% NP and 50% K	120.33	36.55	1.54	35.89	07.40
T_5 – *Azospirillum brasilense*	118.90	34.56	1.35	37.57	06.20
T_6 – *Azotobacter chroococcum*	119.00	32.00	1.56	36.67	06.67
T_7 – *Trichoderma viridae (PSF)*	121.23	33.50	1.91	36.67	06.94
T_8 – *Glomus fasciculatum (VAM)*	120.50	35.55	1.78	36.45	06.57
T_9 –50% NP and 50% K + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum*	125.00	36.89	1.78	35.56	07.87
T_{10} - 50% NP and 50% K + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*	123.33	37.25	2.00	34.56	08.81
T_{11} -75% NP and 100% K + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum*	141.55	43.55	2.12	32.45	12.55
T_{12} -75% NP and 100% K + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*	144.25	45.17	4.05	31.25	12.68
T_{13}-100% NPK + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum*	142.50	44.20	3.98	31.54	12.59
T_{14}-100% NPK + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*	145.55	45.23	4.37	30.00	12.91
F Test	*	*	*	NS	*
S.Em±	4.55	1.25	0.56	2.46	1.14
C.D. @ 5%	12.79	3.73	1.67	7.36	3.32
C.V.%	10.43	9.45	11.43	9.15	14.35

Notations: DAS =Days after sowing, NS: Non significant, PSF = Phosphate Solubilizing Fungi (*Trichoderma viridae*)
VAM = Vesicular Arbuscular Mycorrhizae (*Glomus fasciculatum*), N.P.K. = Nitrogen, Phosphorus, Potassium.

The increased vine length might be due to continued vegetative growth enhanced by spilt application of nitrogen. The highest vine length in the best treatment might be due to ready availability of nutrients, their improved absorption and translocation by plants more quickly, which resulted in higher photosynthetic activity than other treatments. Similar results were reported by Singh and Chhonkar (1986) [14] in muskmelon.
The influence of bio fertilizers with different levels of NPK also had significance influence with respect to number of leaves per plant. The treatment (T_{14}) 100% NPK + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum* recorded highest number of leaves (45.23) and which was on par with treatment (T_{12}) 75% NP and 100% K + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*, (T_{13}) 100% NPK + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum* and (T_{11}) 75% NP and 100% K + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum* respectively. The increased number of leaves due to the application of bio fertilizers would have enhanced nitrogen activity of the plant, which may lead to the increased vegetative growth. These results are in accordance with the findings of Kumaraswamy and Madalageri (1990) [7] in tomato, Randhawa *et al.* (1981) [12] and Muruganandam (2000) **[8]** in watermelon. The minimum numbers of leaves per plant (27.15) are recorded in control.

The results of mean comparing of number of branches per vine between all treatments significant difference exists. The maximum number of branches per vine was recorded in treatment (T_{14}) 100% NPK + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum* (4.37) and was followed with treatment (T_{12}) 75% NP and 100% K + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*, (T_{13}) 100% NPK + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum* and (T_{11}) 75% NP and 100% K + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum* respectively. The increased rate of photosynthetic products entering in to the system might have caused cell elongation and rapid cell division in the growing portion resulting in more number of branches per vine resulting in higher yield in gherkin **(**Curry and Byrne, 1992) [6]. Similar results were reported by Bindiya *et al*. (2012) [5] in gherkin and Singh and Chhonkar (1986) [14] in musk melon. The lowest branches (1.43) are recorded in control.

The results of the mean data of the experiment as influenced by bio fertilizers with different level of NPK on yield parameters viz., days to first flowering and yield (t\ha) are presented in Table 1.

Early flowering is an important character in gherkin. Though earliness is considered as a genetically controlled trait, other factor like environmental, cultural practices and nutrition of the plants can also influence it to an appreciable extent. In the present study the plants treated with 100% NPK + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum* (T_{14}) showed earliness in flowering of 30 days compare to other treatments. This might be due to better nutritional status of the plants which was favoured by the treatments. Similar findings have been reported in cucumber by Nirmala *et al.* (1999) [9] and Patil *et al*. (1998) [10].

Increased production of leaves might help to elaborate more photosynthates and induce flowering stimulus, thus affecting early initiation of flower bud. Early vigorous growth seen in treatments with organic manures would have helped to synthesize more cytokinin by these plants which might have helped to the translocation of these synthesized cytokinin as well as more quantity of available phosphorus through xylem vessels and accumulation of cytokinin and phosphorus in these axillary buds would have favoured the plants to enter into reproductive phase Amrithalingam and Balakrishnan, (1988) [1].

The highest fruit yield (12.91 t/ha) was recorded with 100% NPK + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum* (T_{14}) which was on par with treatment (T_{12}) 75% NP and 100% K + *Azotobacter chroococcum* + *Trichoderma viridae* + *Glomus fasciculatum*, (T_{13}) 100% NPK + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum* and (T_{11}) 75% NP and 100% K + *Azospirillum brasilense* + *Trichoderma viridae* + *Glomus fasciculatum* respectively. This may be due the application of Azotobacter and Azospirillum bio fertilizers were effective in nitrogen fixation, synthesis of plant growth promoting hormones and enzyme activation reported by Anburani *et al*. (2003) [2] in brinjal. Significantly lowest fruit yield (5.27t/ha) was recorded in control.

More yield of gherkin in present study could be due to the influence of bio-fertilizers in combination with different level of NPK enhanced the synthesis of photosynthates by increasing the synthesis of growth regulators like IAA, GA, amino acids, and vitamins. The vigorous vegetative growth might have accelerated the photosynthetic rate and there by increased the supply of carbohydrates. Better assimilation of these carbohydrates might have created favourable conditions for auxin synthesis inducing flowering resulting in more number of fruit set which in turn might have increased the yield. Present findings are in conformity with the reports of Shivashankarmurthy *et al*. (2007) [13] in cucumber.

Conclusion

According to this study using bio-fertilizers has increased growth and yield of gherkin significantly. In other words, the presences of bacteria have increased gherkin growth factors. Result from the present study indicated that growth and yield of gherkin, have been affected by the inoculation with *Azotobacter chroococcum*, because these bio-fertilizers can fix the atmospheric nitrogen in soil. Seeds inoculated with *Azotobacter chroococcum* had beneficiary response on growth and yield of gherkin by 5 - 30%. As a result, biological fertilizers can be recommended for the sake of achieving the higher quality production. The traits fruit weight and fruit size could be used for the selection of better yielding lines under Haveri region. The results compare means indicated that combination of bio fertilizer and chemical fertilizer treatments maximize fruit yield.

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