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Effect of different organic sources of nitrogen with biofertilizers on yield attributes, quality parameters and economics of bottle gourd (*Lagenaria siceraria* Mol. Standl.) CV. Pusa Naveen

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Abstract
A field experiment was conducted in randomized block design at Horticulture Instructional Farm, C. P. College Agriculture, Sardarkrushinagar Dantiwada Agricultural University, and Sardarkrushinagar to find out the suitable dose of nitrogen from different organic sources and biofertilizer in bottle gourd cv. Pusa Naveen. It is conducted that 100% Nitrogen through Poultry manure + *Azotobacter* + PSB + *Trichoderma viride* application gave significantly maximum number of fruits per vine, weight of fruit, yield per vine, yield per plot, yield per hectare, maximum gross return, net return, benefit cost ratio and maximum diameter of fruit. While, length of fruit with respect to different organic sources of fertilizer and biofertilizers was found non-significant.

Keywords: Pusa Naveen, bottle gourd, nitrogen, biofertilizers, yield, quality, economics

Introduction
Bottle gourd (*Lagenaria siceraria* Mol. Standl.) belongs to the family cucurbitaceae and having chromosome number 2n=22. It is grown extensively throughout tropical and subtropical regions of the world. Its native is thought to be tropical Africa and Asia (Thompson and Kelly, 1967) [17]. It is commonly known as *Lauki* and *Ghiya* in Hindi. In Gujarat, it is known as *Dudhi.*

The leading states in India, growing bottle gourd on extensive scale are Rajasthan, Punjab, Uttar Pradesh, Bihar, West Bengal, Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh and Tamil Nadu. In Gujarat, It is grown in almost every districts of the state. The major growing area of Gujarat is confined to Ahmadabad, Baroda, Gandhinagar, Kheda, Surat, Junagadh, Mehsana and Banaskantha districts. Bottle gourd is considered as protective food and supplies of adequate quantities of vitamins, proteins, carbohydrates and minerals. It is very popular vegetable in market as well as in kitchen garden and grown widely in *Kharif* and summer seasons throughout the country. Fruits of bottle gourd are long, round or oval to oblong in shape. Its wild forms are bitter in taste due to a nonglucosidal bitter constituent. The fruits in the green stage are used for vegetable and also for preparation of some sweets. It is also used as utensils, making musical instruments, floats for fishing nets and many other purposes. In view of the requirements of the increasing population of our country and for maintaining the income of our farming community, it is quite essential to increase the crop production. The best possible way to achieve the desired results is the use of improved farming technology and resources.

The combined use of biofertilizers and fertilizers is one of the essential requirements for increasing the yield of vegetable crops. Adequate and judicious application of fertilizers is the surest way of increasing the yield and improving the quality of crop. In the present context of higher prices of fertilizers, it is necessary to provide its substitutes to supply optimum and economical dose of nutrient requirement for the bottle gourd crop. Biofertilizer is defined as a substance which contains living organisms which, when applied to seed, plant surface or soil, colonize the rhizosphere or interior of the plant and promote growth by increasing the supply or availability of primary nutrients to the host plant.

Biofertilizers are well recognized as an important component of integrated plant nutrient management for sustainable agriculture and hold a great promise to improve crop yield. In recent years, free living bacteria (*Azotobacter*), associate (*Azospirillum*) and symbiotic (*Rhizobium*) and phosphate solubilizing (*Bacillus megaterium, B. polymyxa* and *P. striata*) are gaining much popularity. Application of biofertilizer encouraged plant growth and productivity of many crops, (Adam *et al.* 2002) [1]. Utilization of bio-fertilizers in the form of microbein is very successful in minimizing chemical fertilizers. It's well known that a considerable number of bacterial species, mostly those associated with the plant rhizosphere are able to exert a beneficial effect on plant growth. Phosphorus solubilization ability of microorganism is considered to be one of the most important traits associated with plant nutrition. Now a days, *Bacilli, Rhizobia and Pseudomonas* are the best studied P-solubilizer bacteria species (Rodriguez and Fraga, 1999) [14]. Several studies have shown that *bacillus spp*. inoculation to seed and soil can solubilize fixed soil P and applied P, resulting in better growth and higher yield in different crops (Cakmakc *et al.* 2006) [3]. Microorganisms enhance the P_2O_5 availability to plants by mineralizing organic P in soil and by solubilizing precipitated phosphates (Pradhan and Sukla, 2005) [13].

Application of heavy doses of chemical fertilizers without organic manures or bio-fertilizers causes deterioration of soil health in terms of physical and chemical properties of soil, declining of soil microbial activities, reduction in soil humus and increased soil, water and air pollution. FYM is principle source of organic matter in our country. Use of FYM alone or in combination with biofertilizers helps in proper supply of nutrition and maintaining soil health. It supplies the essential plant nutrients, which improve the physico-chemical properties, increases water holding capacity and encourages the soil microbial activities. FYM is also advantageous for its residual value, it contains about 0.64% N, 0.20% P_2O_5 and 0.50% K_2O (Gaur, 1991) [7]. Vermicompost is adopted as organic manure produced by use of earthworm. It modifies soil physical and chemical properties. It contains about 3.0 per cent nitrogen, 1.0 per cent phosphorus and 1.5 per cent potassium (Parmar, 2008) [12]. Poultry manure contains uric acid having 3.30 per cent nitrogen which change rapidly to ammonical form and hence efficiently utilized for better plant growth. It contains about 3.30 per cent nitrogen, 0.63 per cent phosphorus and 1.40 per cent potassium (Gaur, 1984) [6]. Castor cake is one of the important sources of organic manure. It contains about 4.4 per cent nitrogen, 2.0 per cent phosphorus and 1.5 per cent potassium along with a large quantity organic matter. Oil cakes are quick acting organic manure. Though they are insoluble in water, their nutrient become quickly available to the crop within a week or ten days after application because the decomposition rate of cake is faster than the other bulky organic manures due to low C: N ratio and nitrifies quickly (Gaur, 1987) [5]. Keeping in view the above facts, a field experiment was conducted to find out the effect of different organic sources of nitrogen with biofertilizers on yield and quality of bottle gourd cv. Pusa Naveen.

Materials and Methods

A filed experiment was carried out during summer 2016 at Horticulture Instructional Farm, C. P. College Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to find out the suitable dose of nitrogen from different organic sources and bio-fertilizer in bottle gourd cv. Pusa Naveen. The soil of the experimental field was loamy sand having pH 7.66, EC 0.16 dsm^{-1}, Organic carbon 0.21%, available nitrogen 215 kg/ha, available P_2O_5 37.11 kg/ha and available K_2O 185 kg/ha. The treatment consists of four different organic manures *viz,* FYM, castor cake, vermicompost and poultry manure T_1. Seeds were weighed separately for all the experimental plots and treated with *Azotobacter* and PSB strain *Bacillus subtilis* @ 20 g per kg of seed before sowing. First of all about half kg jaggery was mixed in 2 liter a water and boiled. After cooling it, bio-fertilizer and culture mixed in the solution and stirred well for proper mixing. The seeds were put into bowl and culture solution was mixed for proper coating. After drying shade, seeds were used for sowing. Thus seventeen treatments were replicated four times in a randomized block design with three replications.

Table 1: Details of different treatments

Treat. No.	Treatments
T_1	100% RDF + 20 t/ha FYM (control)
T_2	100% Nitrogen through FYM
T_3	100% Nitrogen through Castor cake
T_4	100% Nitrogen through Vermicompost
T_5	100% Nitrogen through Poultry manure
T_6	100% Nitrogen through FYM + *Azotobacter* + *Trichoderma viride*
T_7	100% Nitrogen through Castor cake + *Azotobacter* + *Trichoderma viride*
T_8	100% Nitrogen through Vermicompost + *Azotobacter* + *Trichoderma viride*
T_9	100% Nitrogen through Poultry manure + *Azotobacter* + *Trichoderma viride*
T_{10}	100% Nitrogen through FYM + PSB + *Trichoderma viride*
T_{11}	100% Nitrogen through Castor cake + PSB + *Trichoderma viride*
T_{12}	100% Nitrogen through Vermicompost + PSB + *Trichoderma viride*
T_{13}	100% Nitrogen through Poultry manure + PSB + *Trichoderma viride*
T_{14}	100% Nitrogen through FYM + *Azotobacter* + PSB + *Trichoderma viride*
T_{15}	100% Nitrogen through Castor cake+ *Azotobacter* + PSB + *Trichoderma viride*
T_{16}	100% Nitrogen through Vermicompost + *Azotobacter* + PSB + *Trichoderma viride*
T_{17}	100% Nitrogen through Poultry manure+ *Azotobacter* + PSB + *Trichoderma viride*

Note: Biofertilizers (Seed treatment): @20 ml per kg seed

To raise the crop recommended package of practices were followed. The treatments were evaluated on the basis of yield attributes, quality parameter and economics performance from ten randomly selected tagged plants at different stages. The mean data were subjected to statistical analysis following analysis of variance technique (Gomez and Gomez, 1984) [8].

Results and Discussion

Yield Parameters

The data pertaining to number of fruits per vine are presented in Table 2. It was observed from the data that numbers of fruits per vine was significantly influenced by different treatments. Among the treatments, maximum number of fruits per vine (8.48) and average weight of fruit (594.13 g) were recorded with application of 100% Nitrogen through Poultry manure + *Azotobacter* + PSB + *Trichoderma viride* (T_{17}). This might be due to gradual and steady release of nutrient during the growth period as well as enhanced biological activity in soil which enhance fruit setting. The present findings are in line with findings of Kumar *et al*., (2012) [9], Das et al., (2015) [4], Baghel *et al*., (2017) [2] and Nagar *et al*., (2017) [10] for bottle gourd. The Application of organic sources of nitrogen improve the physical condition of soil, increase the activities of soil microorganism and enhance the porosity of soil, which were directly responsible for higher production of bottle gourd fruits. The present findings are in unison to Parmar *et al*., (2011) [11] in cucumber, Sarhan *et al*., (2011) [15] summer squash, Singh (2012) [16] and Kumar *et al*., (2012) [9] in bottle gourd.

Yield per vine was significantly influenced by the application of different treatments. Significantly maximum yield per vine (4.75 kg), yield per plot (36.44 kg) and yield per hectare (30.37 t) were recorded with application of 100% Nitrogen through Poultry manure+ *Azotobacter* + PSB + *Trichoderma viride* (T_{17}). Increase in yield plant, per plot and per hectare might be due to the organic manure along with biofertilizers is increase the content of organic matter, maintain the nutrient balance for crop, increase availability of available nutrient and improve the physical and chemical properties of the soil. Application of poultry manure which content high carbohydrate may be attributed to balance C:N ratio and increase activity of plant metabolism. The results are in accordance with the findings of Parmar *et al*., (2011) [11] in cucumber, Sarhan *et al*., (2011) [15] in summer squash, Singh (2012) [16] and Kumar *et al*., (2012) [9] in bottle gourd.

Table 2: Effect of different organic sources of nitrogen with biofertilizers on yield attributes and quality parameters

Sr. No.	Treatment	Number of Fruits / vine	Average weight of fruit (g)	Yield /vine (kg)	Yield per plot (kg)	Yield/ hectare (t)	Length of fruit (cm)	Diameter of fruit (cm)
T1	100% RDF + 20 t/ha FYM (control)	6.61	488.17	2.97	30.20	25.17	25.76	16.32
T2	100% Nitrogen through FYM	6.80	514.13	3.14	31.31	26.10	27.59	17.60
T3	100% Nitrogen through Castor cake	6.69	504.53	3.13	30.95	25.79	27.53	18.76
T4	100% Nitrogen through Vermicompost	6.71	492.07	3.00	30.15	25.13	27.74	18.17
T5	100% Nitrogen through Poultry manure	6.75	495.23	3.04	30.47	25.39	28.30	17.95
T6	100% Nitrogen through FYM + *Azotobacter* + *Trichoderma viride*	7.00	545.23	3.52	31.51	26.26	25.80	19.04
T7	100% Nitrogen through Castor cake + *Azotobacter* + *Trichoderma viride*	6.88	545.53	3.67	31.78	26.48	27.71	17.57
T8	100% Nitrogen through Vermicompost + *Azotobacter* + *Trichoderma viride*	7.15	535.60	3.38	31.72	26.43	29.35	19.73
T9	100% Nitrogen through Poultry manure + *Azotobacter* + *Trichoderma viride*	7.02	511.20	3.29	30.92	25.77	28.62	17.30
T10	100% Nitrogen through FYM +PSB + *Trichoderma viride*	7.38	548.23	3.75	31.79	26.49	26.89	20.35
T11	100% Nitrogen through Castor cake + PSB + *Trichoderma viride*	7.31	553.57	3.74	32.21	26.84	28.78	19.67
T12	100% Nitrogen through Vermicompost + PSB + *Trichoderma viride*	7.43	560.90	3.87	32.38	26.98	29.07	20.14
T13	100% Nitrogen through Poultry manure + PSB + *Trichoderma viride*	7.81	568.23	4.14	32.45	27.05	30.58	20.67
T14	100% Nitrogen through FYM + *Azotobacter* + PSB + *Trichoderma viride*	8.11	575.33	4.38	34.19	28.49	29.52	20.59
T15	100% Nitrogen through Castor cake + *Azotobacter* + PSB + *Trichoderma viride*	7.90	570.93	4.22	35.58	29.66	31.03	20.84
T16	100% Nitrogen through Vermicompost + *Azotobacter* + PSB + *Trichoderma viride*	8.11	573.73	4.35	35.67	29.73	30.67	21.22
T17	100% Nitrogen through Poultry manure + *Azotobacter* + PSB + *Trichoderma viride*	8.48	594.13	4.75	36.44	30.37	32.20	21.28
	S.Em. (±)	0.25	18.36	0.21	1.38	1.15	1.34	0.93
	C.D. (P=0.05)	0.72	52.76	0.60	3.97	3.30	NS	2.67
	C.V. (%)	6.02	5.89	10.01	7.40	7.40	8.12	8.31

Quality parameters

The effect of different sources of nitrogen with biofertilizers on length of fruit was found non-significant.

Parsual of data presented in Table 2 shows significant different among the treatments on fruit diameter. Maximum diameter of fruit (21.28 cm) was reported with application of 100% Nitrogen through Poultry manure + *Azotobacter* + PSB + *Trichoderma viride* (T_{17}). This might be due to gradual and steady release of nutrient during the growth period as well as enhanced biological activity and proper nutrition to crop. This findings are similar with the findings of Parmar *et al*., (2011) [11] in cucumber and Kumar *et al*., (2012) [9] in bottle gourd.

Table 3: Effect of different organic sources of nitrogen with biofertilizers on economics and benefit cost ratio

Treatment	Yield/ha (t)	Gross returns (₹/ha)	Cost of cultivation (₹/ha)	Net returns (₹/ha)	Benefit: Cost Ratio
T_1	25.17	251700	55246	196454	4.55
T_2	26.10	261000	45725	215275	5.70
T_3	25.79	257900	47148	210752	5.47
T_4	25.13	251300	46765	204555	5.37
T_5	25.39	253900	45250	208650	5.61
T_6	26.26	262600	45915	216685	5.71
T_7	26.48	264800	47338	217462	5.59
T_8	26.43	264300	46955	217345	5.62
T_9	25.77	257700	45440	212260	5.67
T_{10}	26.49	264900	45915	218985	5.76
T_{11}	26.84	268400	47338	221062	5.66
T_{12}	26.98	269800	46955	222845	5.74
T_{13}	27.05	270500	45440	225060	5.95

T_{14}	28.49	284900	46095	238805	6.18
T_{15}	29.66	296600	47518	249082	6.24
T_{16}	29.73	297300	47135	250161	6.30
T_{17}	30.37	303700	45620	258080	6.65

Selling price of bottle gourd is 10₹ per kg

Economics

The economics indicating cost of cultivation, gross return, net return and benefit cost ratio under various treatments are presented in Table 3. Total cost of cultivation per hectare was worked out for individual treatments. Among the treatments, application of 100% Nitrogen through Poultry manure + *Azotobacter* + PSB + *Trichoderma viride* (T_{17}) recorded maximum gross return Rs. 3,03,700 per hectare, net return Rs. 258080 per hectare and benefit cost ratio 6.65.

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