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Studies on organic nutrient management of bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) under different shadenet condition

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Abstract
The present investigation comprising two different growing condition *viz.* 50 % green shadenet and 50% white shadenet with nine levels of sources of organic nutrients were tested in the Factorial Randomized Block Design with three replications during summer-2016. The results revealed that maximum vine length at 60 DAS (392.50 cm) was recorded with treatment 50% FYM + 50% poultry manure + biofertilizers (*Azospirillium*+PSB+KSM) (T_4). Maximum number of branches per plant (3.18), yield per plant (3.71 kg) and per meter square (5.19 kg) was found with application of 50% castor cake + 50% poultry manure + biofertilizers + *Trichoderma viride* + neem oil (T_9). The interaction effect of growing condition and different sources of organic nutrient was not significant for all growth, flowering, yield and quality parameters. The 50% white shadenet and application of 50% castor cake + 50% poultry manure + biofertilizers + *Trichoderma viride* + neem oil found economically superior over rest treatments. Thus, for obtaining better growth and yield with higher benefit cost ratio, bottle gourd should sown in 50% white shadenet and apply 50% castor cake + 50% poultry manure + biofertilizers (*Azospirillium*+PSB+KSM) + *Trichoderma viride* + neem oil.

Keywords: biofertilizer, bottle gourd, growth, KSM, PSB, yield

Introduction
Bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) belongs to the family cucurbitacece. It is an important protective food and supply adequate quantities of vitamins, proteins, carbohydrates and minerals. Organic nutrient management in bottle gourd by application of nitrogen through FYM, poultry manure, neem and castor cake as potential source of organic matter, application of biofertilizers as *Azospirillium*, phosphorus solubilizing bacteria (PSB) and potassium solubilizing microorganisms (KSM) ensure the sustainable production, bioagents as *Trichoderma viride* and neem oil protect the main produce organically from various diseases and pests and crop produced under different shadenet condition make it to grow better under off-season adverse agro climatic conditions for enhancing growth, yield and marketable quality to secure higher net returns.

Material and Methods
The present investigation entitled, studies on organic nutrient management on growth, yield and quality of bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) under different shadenet condition was conducted during summer-2016 at Horticulture Instructional Farm, Department of Horticulture, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar (Gujarat). Experiment was laid out in factorial randomized block design keeping two factor v*iz.*, growing condition *viz.* 50 per cent green shadenet (g_1) and 50 per cent white shadenet (g_2) and sources of organic nutrient, the first factor with two type growing condition and second factor *i.e.* sources of organic nutrient with nine levels *viz.* T_1 = 50% FYM + 50% Poultry Manure (f_1), T_2 = 50% Neem cake + 50% Poultry Manure (f_2), T_3 = 50% Castor cake + 50% Poultry Manure (f_3), T_4 = T_1+Biofertilizers (*Azospirillium* +PSB +KSM) (f_4), T_5 = T_2 +Biofertilizers (*Azospirillium* +PSB +KSM) (f_5), T_6=T_3+ Biofertilizers (*Azospirillium* +PSB +KSM) (f_6), T_7 = T_4 + *Trichoderma viride* + Neem oil (f_7), T_8 = T_5 + *Trichoderma viride* + Neem oil (f_8), T_9 = T_6 + *Trichoderma viride* + Neem oil (f_9) thus, making eighteen treatment combinations and analyzed as described by Panse and Sukhatme (1985) [8] with three replications.

Observations were recorded periodically in relation to growth, yield and quality parameters using standard techniques.

Results and Discussion

A. Growth parameters

The mean data presented in Table 1 showed non significant influence of growing conditions, sources of organic nutrients and their interaction in respect to vine length at 30 days after sowing (DAS).

Table 1: Effect of growing condition and sources of organic nutrient on growth and flowering parameters

Treatments	Vine length (cm) 30 DAS	Vine length (cm) 60 DAS	Number of branches per plant at 45 DAS	Leaf area (cm^2) at 45 DAS	Days taken for initiation of flowering	Number of male flower per plant	Number of female flower per plant
Sources of organic nutrient (F)							
T_1 = 50% FYM + 50% Poultry Manure (f_1)	51.00	334.17	3.03	3586.06	45.50	49.07	15.03
T_2 = 50% Neem cake + 50% Poultry Manure (f_2)	52.83	367.17	2.88	3630.71	45.17	46.57	16.50
T_3 = 50% Castor cake + 50% Poultry Manure (f_3)	56.33	375.17	3.02	3615.18	45.00	47.03	17.70
T_4 = T_1+Biofertilizers (*Azospirillium*+PSB+KSM) (f_4)	53.17	392.50	3.13	3641.13	45.00	51.33	17.23
T_5 = T_2+Biofertilizers (*Azospirillium*+PSB+KSM) (f_5)	51.83	388.33	3.10	3658.75	45.83	48.83	17.17
T_6=T_3+ Biofertilizers (*Azospirillium*+PSB+KSM) (f_6)	53.33	358.33	3.15	3619.62	44.00	48.43	16.90
T_7 = T_4 + *Trichoderma viride* + Neem oil (f_7)	53.67	379.67	3.15	3638.98	45.33	48.17	16.90
T_8 = T_5 + *Trichoderma viride* + Neem oil (f_8)	54.00	390.50	2.80	3630.60	46.17	47.00	17.57
T_9 = T_6 + *Trichoderma viride* + Neem oil (f_9)	53.33	377.33	3.18	3613.19	47.83	49.83	17.70
S.Em.±	1.50	11.65	0.09	49.33	1.09	1.64	0.62
C.D. at 5%	NS	33.47	0.25	NS	NS	NS	NS
Growing condition (G)							
50 per cent green net (g_1)	53.78	353.85	2.96	615.89	44.85	45.02	14.90
50 per cent white net (g_2)	52.78	393.52	3.14	636.17	46.22	51.93	19.03
S.Em.±	0.71	5.49	0.04	23.25	0.51	0.77	0.29
C.D. at 5%	NS	15.78	0.12	NS	NS	2.22	0.84
Interaction (G x F)							
S.Em.±	2.12	16.47	0.12	69.76	1.54	2.32	0.88
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS
C. V.%	6.89	7.64	6.99	3.33	5.86	8.28	8.95

The different growing condition exerted significant influence on vine length (cm) at 60 DAS (Table 1). Significantly maximum vine length (392.52cm) was recorded with 50% white shadenet and minimum vine length (353.85 cm) was observed with 50% green shadenet. This might be due to the 50 per cent white shadenet favor plant growth since plants are less stressful, humidity is higher and evapotranspiration is low. This finding is in the accordance with the result of Abu-Zahra and Mazen (2015) [1] in cucumber.

Inspection of data showed significant difference for vine length (cm) at 60 DAS among different levels of sources of organic nutrient. Maximum vine length (392.50 cm) was recorded with application of 50 % FYM + 50 % poultry manure + biofertilizers (*Azospirillium*+PSB+KSM) (T_4) and it was statistically at par with T_8. While, minimum vine length (353.85 cm) was found in treatment 50% FYM + 50% poultry manure (T_1). This might be due to the application of organic manure along with biofertilizer is necessary to increase the content of organic matter, improve the physical and chemical properties of the soil and maintain the nutrients balance for crops. This study was supported by Aldal and Hussein (2016) [2] in squash.

Significantly superior individual effect of growing condition and sources of organic nutrient and not significant interaction of both on number of branches per plant at 45 DAS was presented in Table 1. Significantly maximum (3.14) and minimum number of branches per plant (2.96) was recorded with 50% white shadenet and 50% green shadenet respectively. These might be due to the white shadenet favor more sun light as compare to green shadenet which resulted in more plant growth. These results are in conformity with the findings of Abu-Zahra and Mazen (2015) [1] in cucumber.

Number of branches per plant at 45 DAS was significantly affected by organic nutrient. Maximum number of branches per plant (3.18) was observed with application of 50% castor cake + 50% poultry manure + biofertilizers (*Azospirillium* + PSB+KSM) + *Trichoderma viride* + neem oil (T_9) and it was statistically at par with treatment T_7. While, minimum number of branches per plant (2.80) was observed in treatment 50% neem cack + 50% poultry manure + biofertilizers (*Azospirillium*+PSB+KSM) + *Trichoderma viride* + neem oil (T_8). These might be due to organic manure and biofertilizer improves water holding capacity, availability of nutrient and micro nutrients. This finding is in the accordance with results of Negi *et al.* (2017) [6] in broccoli and Singh *et al.* (2015) [9] in cabbage.

Effect of growing condition, sources of organic nutrient and its interaction on leaf area at 45 DAS was found not significant.

B. Flowering Parameters

Data pertaining to Table 1, number of male and female flower per plant was significantly influenced by different growing condition, whereas, effect of sources of organic nutrient and its interaction was found not significant.

Significantly minimum and maximum number of male flower per plant (45.02 and 51.93) was reported in 50% green shadenet and 50% white shadenet respectively.

Maximum number of female flower per plant (19.03) was reported in 50% white shadenet. However, minimum number of female flower per plant (14.90) was recorded in 50% green shadenet. This may be attributed to permit required light color and light intensity for inducing flowering by white shadenet. These results are in conformity with the finding of Mousa *et al.* (2017) [5] in summer squash.

C. Yield Parameters

Data in Table 2 showed that effect of growing condition was observed significant with respect to days taken for fruit set to edible harvesting but sources of organic nutrient and interaction was found non- significant. Minimum days taken for fruit set to edible harvesting (5.90) was reported in 50% white shadenet. While, maximum days taken for fruit set to edible harvesting (6.19) was recorded in treatment 50% green shadenet. This may be due to favorable condition of fruit development under white shadenet.

Table 2: Effect of growing condition and sources of organic nutrient on yield and quality parameters

Treatments	Days taken for fruit set to edible harvesting	Sex ratio	Per cent fruit set	Number of fruits per plant	Average weight of fruit (g)	Yield per plant (kg)	Yield per meter square (kg)	Fruit length (cm)	Fruit diameter (cm)
Sources of organic nutrient (F)									
T_1 = 50% FYM + 50% Poultry Manure (f_1)	5.92	4.03	58.03	4.60	470.50	2.83	4.13	22.27	5.20
T_2 = 50% Neem cake + 50% Poultry Manure (f_2)	5.98	3.99	57.43	4.56	540.67	2.20	4.45	22.34	5.64
T_3 = 50% Castor cake + 50% Poultry Manure (f_3)	6.00	4.07	55.66	4.61	554.50	3.22	4.42	23.33	5.94
T_4 = T_1+Biofertilizers (*Azospirillium*+PSB+KSM) (f_4)	6.10	4.01	58.23	4.30	564.67	3.24	4.44	22.59	5.51
T_5 = T_2+Biofertilizers (*Azospirillium*+PSB+KSM) (f_5)	6.07	4.01	55.73	4.60	576.33	3.20	4.66	24.04	5.63
T_6=T_3+ Biofertilizers (*Azospirillium*+PSB+KSM) (f_6)	5.88	4.26	58.97	4.46	582.67	3.20	4.61	23.46	5.81
T_7 = T_4 + *Trichoderma viride* + Neem oil (f_7)	6.12	4.05	56.90	4.73	542.83	3.02	5.00	23.38	6.13
T_8 = T_5 + *Trichoderma viride* + Neem oil (f_8)	6.13	3.81	59.50	4.86	590.00	3.51	5.17	21.87	6.39
T_9 = T_6 + *Trichoderma viride* + Neem oil (f_9)	6.20	4.04	60.83	4.95	575.84	3.71	5.19	22.42	6.11
S.Em.±	0.14	0.13	1.45	0.19	41.56	0.13	0.17	0.68	0.24
C.D. at 5%	NS	NS	NS	NS	NS	0.37	0.53	NS	0.69
Growing condition (G)									
50 per cent green net (g_1)	6.19	4.08	52.40	3.39	563.48	2.23	3.48	22.72	5.70
50 per cent white net (g_2)	5.90	3.97	63.44	5.88	548.07	4.24	5.83	22.99	5.93
S.Em.±	0.07	0.06	0.68	0.09	19.59	0.06	0.09	0.32	0.11
C.D. at 5%	0.19	NS	1.97	0.25	NS	0.18	0.25	NS	NS
Interaction (G x F)									
S.Em.±	0.20	0.18	2.05	0.26	58.77	0.18	0.26	0.96	0.34
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
C. V.%	5.67	7.78	6.14	9.86	18.32	9.87	9.70	7.26	10.16

Data in Table 2 revealed that effect of growing condition, sources of organic nutrient and their interaction was found not significant with respect to sex ratio.

Effect of growing condition was reported significant however sources of organic nutrient and its interaction with growing condition was found not significant with respect to per cent fruit set and number of fruits per plant. Maximum per cent fruit set (63.44) and number of fruit per plant (5.88) was observed by 50% white shadenet while, minimum per cent fruit set (52.40) and number of fruit per plant (3.39) was reported by 50% green shadenet. This might be due to that white shadenet providing required light intensity and favorable condition for more plant growth, flowering, fruit setting fruit retention and development. These results are in conformity with the findings of Mousa *et al.* (2017) [5] in summer squash.

Data showed that effect of growing condition, sources of organic nutrient and their interaction was found not significant with respect to average weight of fruit (g), Table 2.

Data revealed that the yield per plant and yield per meter square was significantly influenced by different growing condition and sources of organic nutrient but their interaction was found not significant. Maximum yield per plant (4.24 kg) and per meter square (5.83 kg) was recorded with 50% white shadenet whereas, minimum yield per plant (2.23 kg) and yield per meter square (3.48 kg) was observed with 50% green shadenet. The influence of favorable environmental variable like temperature, relative humidity and light intensity promote photosynthesis activity and accumulation of carbohydrates which helps in more plant growth, more flowering, lower sex ratio and more fruit setting ultimately resulted in higher yield under white shadenet. These results

are in line of the finding reported by Dhaulakhandia *et al*. (1995) [4] in leafy vegetables, Vethamoni and Natrajan (2008) [10] in sweet pepper and Pal *et al*. (2015) [7] in tomato.

Maximum yield per plant (3.71 kg) and per meter square (5.19 kg) was observed with treatment 50% castor cake + 50% poultry manure + biofertilizer (*Azospirillium*+ PSB+ KSM) + *Trichoderma viride* + neem oil (T_9) and it was statistically at par with treatment T_8. Whereas, minimum yield per plant (2.83 kg) and per meter square (4.13 kg) was found in treatment 50% FYM + 50% poultry manure (T_1). These might be due to the sources of organic nutrient favor increase in yield per plant because of favorable soil condition which increase uptake of NPK nutrients due to the influence of biofertilizers which provide favorable conditions around the root rhizosphere resulted in better absorption of nutrients.

D. Quality Parameters

Data showed that effect of growing condition and sources of organic nutrient and their interaction was found not significant with respect to fruit length.

Data showed that fruit diameter was significantly influenced by sources of organic nutrients, whereas it was remained unaffected by growing condition and interaction effect of their both.

Maximum fruit diameter (6.39 cm) was recorded in treatment 50% neem cake + 50% poultry manure + biofertilizers (*Azospirillium* + PSB + KSM) + *Trichoderma viride* + neem oil (T_8) and it was statistically at par with T_9. While minimum fruit diameter (5.20 cm) was observed with treatment 50% FYM + 50% poultry manure (T_1). This might be due to the sources of organic nutrient favor increase in photosynthesis activity and accumulation of carbohydrates which helps in better fruit growth. These findings are corroborated with the findings of Das *et.al* (2015) [3] in bottle gourd.

E. Economics

Data perusing in Table 3 showed that with growing condition of 50% white shadenet recorded more gross return (₹ 58.30), net return (₹ 39.63) and benefit cost ratio (3.12) than 50% green shadenet for bottle gourd. Whereas, in case of sources of organic nutrient, treatment 50% castor cake + 50% poultry manure + biofertilizers (*Azospirillium* + PSB+KSM) + *Trichoderma viride* + neem oil (T_9) and 50% neem cake + 50% poultry manure + biofertilizers (*Azospirillium* + PSB + KSM) + *Trichoderma viride* + neem oil (T_8)gave more gross return (₹ 51.90) and (₹ 51.70), net return (₹ 32.99) and (₹ 32.98) and benefit cost ratio (2.76)and (2.76), respectively, than other treatment.

Table 3: Effect of growing condition and organic nutrients on economics

Treatment	Yield per (m^2)	Gross returns (₹/m^2)	Cost of cultivation (₹/m^2)	Net returns (₹/m^2)	Benefit: Cost Ratio
1. Growing condition					
g_1	3.48	34.80	18.67	16.13	1:1.86
g_2	5.83	58.30	18.67	39.63	1: 3.12
2. Sources of organic nutrient					
f_1	4.13	41.30	18.41	22.89	1: 2.24
f_2	4.45	44.50	18.63	25.87	1: 2.39
f_3	4.42	44.20	18.53	25.67	1: 2.39
f_4	4.44	44.40	18.53	25.87	1: 2.40
f_5	4.66	46.60	18.66	27.94	1: 2.50
f_6	4.61	46.10	18.85	27.25	1: 2.45
f_7	5.00	50.00	18.77	31.23	1: 2.66
f_8	5.17	51.70	18.72	32.98	1: 2.76
f_9	5.19	51.90	18.81	32.99	1: 2.76

The sale price of bottle gourd was ₹10/kg.
FYM@ ₹ 1.00 / kg
Neem cake @ ₹ 12.00 /kg
Castor cake @ ₹ 9.00 /kg
Poultry manure@ ₹ 3.00 /kg
Biofertilizers cost @ ₹ 100.00 / liter
Trichoderma viride @ ₹ 60.00 / kg
Neem oil @ ₹ 280.00 / liter

Conclusion

To achieve better growth, maximum yield and higher benefit cost ration bottle gourd should be grown under 50 per cent shadenet and apply 50% N from castor cake + 50% N from poultry manure + biofertilizers (*Azospirillium* + PSB + KSM) + *Trichoderma viride* + neem oil.

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