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Response of vermicompost and nitrogen on growth, yield and quality of bottle gourd [*Lagenaria siceraria (*Mol.) Standl.]

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Abstract

In the present investigation, the response of bottle gourd to different levels of vermicompost (control, 3, 6 and 9 tones ha^{-1}) and nitrogen (control, 50, 75 and 100 kg ha^{-1}) was studied at SKRAU, Bikaner during summer season of 2016. The vermicompost applied at the rate of 6 tones ha^{-1} has shown least number of days for appearance of first female flower, while number of primary branches per vine, length of leaf (cm), per cent fruit set, fruit length, weight and total yield per vine etc. were found maximum in plants applied with 9 tones ha^{-1}. The application of increasing levels of nitrogen 100 kg ha^{-1}has significantly increased the length of leaf, per cent fruit set, number of fruits per vine, fruit length, weight and total yield per vine etc., chlorophyll content in plant (mg/100), P uptake by plant and available N content in soil after harvesting compared to the control. The treatment combination of vermicompost (9 t ha^{-1}) + nitrogen (100 kg ha^{-1}) has showed maximum number of primary branches per vine, leaf length (cm), per cent fruit set, number of fruits per vine etc. compared to the control plants. The maximum yield (q ha^{-1}) was found under the treatment combination of vermicompost (9 t ha^{-1}) + nitrogen (100 kg ha^{-1}) while remaining treatment combinations was at par with each other. The higher nitrogen content as well as B: C ratio (1.70) in plant was observed in the treatment combination of vermicompost (6 t ha^{-1}) + nitrogen (100 kg ha^{-1}).

Key words: Bottle gourd, Vermicompost, Nitrogen, Growth, Yield, Quality

Introduction

Bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) is one of the most important vegetable crop belonging to family cucurbitaceae. It is cultivated in spring, summer and rainy season throughout India. The major growing states in India are Uttar Pradesh, Punjab, Gujarat, Assam, Tamil Nadu and Rajasthan. The mature fruit contains minerals (30.7mg), protein (0.29g), carbohydrate (2.5g), vitamins (0.51mg) and about 96.1 per cent moisture per 100 g fresh edible portion (Gopalan et al., 1982). Besides culinary purpose, it is also used for preparations of different type of sweets, rayta and halwa. Dried fruit shells are used for making musical instruments, utensils and floats for fishing nets (Chadha, 2001). It has wide medicinal value as laxative, digestive and to prevent constipation. Poultice prepared from fruits is used in wounds, fruit ash mixed with honey used to cure headache, sugar mixed leaves can be given to jaundice patients (Singh and Joshi, 2002).

Vermicompost is an organic fertilizer enriched with all beneficial soil microbes and also contains all the essential plant nutrients. It contains about 2.5 per cent N, 1.5 per cent P_2O_5 and 1.5 per cent K_2O and also rich in micronutrients such as Mg (0.46%), Fe (7563 ppm), Zn (278 ppm), Mn (475 ppm), Bo (34 ppm), Cu (27 ppm) (Gupta, 2003). It is non-toxic; utilize low energy input for composting and recycled bio-organic product. It is eco-friendly and has beneficial effect on the biochemical activities of the soil (Ali and Jahan, 2001). It also enhances soil aeration, texture, tilth and quality, fertility and mineral content of the soil. It improves water holding capacity of soil because of its high organic matter content and promotes better root growth and nutrient absorption (Nourbakhsh, 2007).

Nitrogen is one of the most important nutrients for crop growth, second only to water. Nitrogen exists in many different chemical forms and passes around natural and agricultural ecosystems in a cycle. It is one of the main chemical elements required for plant growth and reproduction. It is a component of chlorophyll and therefore essential for photosynthesis. It is also the basic element of plant proteins, including the genetic material DNA, RNA, amino acid and vitamins is important in periods of rapid

vegetable growth. It also play an important role in plant metabolism by virtue of being an essential constituent of diverse type of metabolically active compounds like amino acids, proteins, nucleic acids, prophytins, flavins, purine, pyrimidine, nucleotide, flavin nucleotides, enzymes, co-enzymes and alkaloid.

Materials and Methods

The present study was conducted experiment farm, SKRAU, Bikaner situated at an elevation of 234.7 meters above mean sea level on latitude of $28^0$01' N and longitude of $73^0$22'Eduring summer season 2016. The experiment was laid out in factorial randomized block design (RBD) with three replications comprising of sixteen treatment combination of four levels of vermicompost (control, 3, 6 and 9 tonnes ha^{-1}) and four levels of nitrogen (control, 50, 75 and 100 kg ha^{-1}).The seeds were soaked in cold water overnight before sowing for better germination and sown in the rows keeping 2.0 m inter-row spacing and plant to plant distance of 0.50 m at a depth of 1.5 to 2.0 cm.Fertilization, other cultural practices and need based plant protection measures were followed as recommended for commercial production.The whole quantity of vermicompost was uniformly spread at the time of bed preparation in the soil. The required quantity of urea as per nitrogen treatments was supplied in three splits *i.e.* one-third at the time of sowing and remaining quantity in two splits. The first dose of urea was top dressed 30 days after sowing and remaining dose at 60 days after sowing.

The data were recorded on five randomly selected plants from each replication for days to appearance of first female flower, node at which first female flower appeared, Number of primary branches per vine, per cent fruit set, number of fruit per vine, weight of fruit, total yield per vine, total yield (q/ha). Length and width of leaf (cm) at 60 days after sowing, length of fruits and length of main vine (m) at harvest was measured with the help of measuring tape. Girth of fruits was measured with the help of vernier calliper. The Crude fiber content in fruit (per cent) was estimated the method of (AOAC, 1960). Chlorophyll content in plant (mg/100g) was estimated by method of Hiscox and Israelstom (1979). The NPK content in plant estimation were done by colorimetric method (Snell and Snell, 1939), vanadomolybdo phosphate yellow colour method, flame photometric method respectively. NPK uptake by plant was calculated from nitrogen, phosphorus and potassium content in fruit and yield of fruit. Available of NPK in soil after harvesting was determined by alkaline Permanganare method (Subbiah and Asija 1956) and available P_2O_5 in the soil was estimated by Olsen's method (Olsen *et al.* 1954). The available potassium was determined by flame photometer method.The recorded data were averaged and statistically analysed (Steel and Torrie, 1981) using the statistical programme developed by O.P. Sheoran.

Results and Discussion

The effect of four levels of vermicompost and nitrogen was studied to understand the growth, yield and quality of bottle gourd. The results obtained are presented in Table 1, 2 & 3 for individual effect and interaction, respectively.

Effect of vermicompost

Among four levels of vermicompost studied, varied differences in all the growth traits were found to be statistically significant (Table 1 & 2). Periodical growth rate revealed that the levels of vermicompost 6 t ha^{-1} vermicompost in less days taken to appearance of first female flower (58.91) than the control (60.65). Node number at which first female flower appeared earlier in 9 t ha^{-1} vermicompost (11.52), was at par with 6 t ha^{-1}. Maximum number of primary branch/vine at harvest was recorded in 9 t ha^{-1} vermicompost (10.99) and leaf length at 60 days after sowing (27.43 cm) than the control (7.82 and 19.52 cm), respectively. Maximum length of main vine was recorded in 9 t ha^{-1} vermicompost (3.99 m) which at par with 6 t ha^{-1} (3.94 m) as compared to control (2.84m). Maximum leaf width (26.19 cm) was observed in 9 t ha^{-1} vermicompost but not any significantly difference with 6 t ha^{-1} (25.87 cm) than the control (18.64). Improvement in plant growth attributes with the application of vermicompost might be due to better not only provided plant nutrients but also improve the physical condition of the soil in respect of granulation, friability, porosity which intern provided a balance nutritional environment favorable both soil rhizosphere and plant system. Similar results have been reported by Kaur *et al.*, 2015.

Out of the four application of vermicompost (Table 1 & 3) maximum per cent fruit set (52.16), number of fruit per vine (9.46), fruit length (37.74 cm), fruit girth (22.83 cm),fruit weight (874.43g) and total yield per vine (8.91 kg) were observed in 9 t ha^{-1} vermicompost as compared to control and highest total yield (249.75 t/ha) in 9 t ha^{-1} vermicompost which was statistically at par with 6 tha^{-1} (245.57) as compared to control. The significant improvement in yield account of vermicompost along with nutrients from soil particularly at later stage of crop growth might have encases the rate of photosynthesis with further increased vegetative growth and provided more site for translocation of photosynthesizes with ultimately increased the yield. Similar results have been obtained by Coulibaly *et al*., (2016).

Vermicompost had non-significant effect (Table 3) on the crude fiber content in fruit however; maximum crude fiber was recorded in 9 tha^{-1} (1.39%).Maximum chlorophyll content (49.54mg/100g) was observed in 9 t/ha and minimum in control. More N content in plant (0.0432), N and P uptake by plant was observed in 9 t/ha vermicompost than the other treatments. Available of NPK

in soil after harvesting (99.28, 36.35 and 357.34) was significantly increase with increases the levels of vermicompost 9 t ha^{-1} was superior over control. The increasing photosynthetic efficiency resulting in more dry matter production and nutrient concentration in plant seems to be major factor responsible for higher NPK uptake to plant root zoon under higher application of vermicompost 9 t ha^{-1}. Similar findings have been reported by Thirunavukkarasu and Balaji (2015).

Effect of nitrogen

The results of application of 100 kg nitrogen was helpful in increasing vegetative growth (Table 1 & 2). The beneficial effect of higher level of nitrogen in increasing the growth in terms of node number at which first female flower appeared earlier in 100 kg ha^{-1} (11.49), was at par with 75 kg ha^{-1} (11.72) than the control. Maximum length of main vine (4.11m) was observed in 100 kg N ha^{-1} which at par with 75kg N ha^{-1} (4.06 m). Number of primary branch per vine at harvest and (11.32)and leaf length (28.25 cm) significant higher were recorded in 100 kg ha^{-1} than the control. Maximum width of leaf (26.93 cm) was recorded under 100 kg ha^{-1}, followed by 75 kg ha^{-1} (26.68 cm) than the control. Nitrogen might be due to better nutritional availability in the root zone as well as in the plant system. It also plays an important role in proper growth and development of plants by virtue of being an essential constituent of diverse type of metabolically active. The results reported by Arshad *et* al, (2014) is in line with present findings.

The might have (Table 1 & 2) increased the yield attributes significantly higher by increasing the sink size in terms of per cent fruit set (53.73 per cent), number of fruit per vine (9.71), length of fruit (38.88 cm), weight of fruit (913.23 g), total yield per vine (9.30 kg) were recorded under 100 kg ha^{-1} than the control. Maximum yield (260.83 q ha^{-1}) was recorded under nitrogen level 100 kg ha^{-1} which was statistically at par with 75 kg ha^{-1} (257.89 q ha^{-1}) as compared to control. Supply of nitrogen in the plant which was increases the mobilization and accumulation of photosynthesis.

Higher Crude fiber content (1.39 per cent) is significantly increases (Table 3) at higher dose of nitrogen 100 kg ha^{-1} which was at par with 75 kg ha^{-1} (1.37 per cent). Maximum chlorophyll content (50.45mg/100g) was observed in 100 kg ha^{-1} than the control. Data presented in table-3 revealed that maximum nitrogen content (0.0440 per cent) in plant was recorded with 100 kg ha^{-1} as compared to control. Maximum nitrogen and phosphorus uptake (11.55 and 11.75 kg) by plant were recorded under 100 kg ha^{-1} than the control. Available N content in soil after harvesting (94.66 kg ha^{-1}) was observed in 100 kg ha^{-1} than the control. Nitrogen content of leaves and fruit appeared to be due to improved nutritional environment in the dense root zone of the plant. Higher nutrient contents in plant also seem to be attributes higher functional activity of roots for longer duration under this treatment. Similar observations were also reported by Oloyede *et* al., (2012).

Interactive effect

The interaction effect of vermicompost and nitrogen (Table-2 & 3) were found significant increase for number of primary branches per vine(11.32), length of leaf (31.30cm) at 60 days after sowing, Fruit set (59.60%), number of fruit per vine(10.40), Length of fruit (43.10cm), Weight of fruit(1071.50g), Total yield per vine(10.90 kg) and total yield (306.0 q ha^{-1}) were recorded under the treatment combination with 9 t ha^{-1}vermicompost level with 100 kg ha^{-1} nitrogen than the control. The significant higher nitrogen content in plant (0.0458 per cent), nitrogen and phosphorus uptake by plant (13.9 & 14.2 kg ha^{-1}) were recorded with treatment combination at 9 t ha^{-1} vermicompost level with 100 kg ha^{-1} nitrogen than other combination. This is because of more photosynthetic formation and their translocation to sink. Secondly, it may be due to efficient use of both nutrients in physiological processes of plant. The uptake of these nutrients also increased due to development of dense rooting system of crop. Similar results have also been reported by Kumar *et* al., (2012).

Data showed in table 3 that maximum net return (Rs. 151438.5) and B: C ratio (1.70) were recorded with treatment of combination at 6 t ha^{-1} vermicompost level with 100 kg ha^{-1} nitrogen, which statistically at par with treatment of combination at vermicompost level 6 t ha^{-1} and 75 kg ha^{-1} nitrogen, than the other treatment combination.

Table 1. Response of vermicompost and nitrogen levels on growth, yield and quality of bottle gourd.

Treatments	Days to appearance of first female flower	Node No. at which first female flower appeared	Length of main vine (m) at harvest	Width of leaf (cm) at 60 DAS	Girth of fruit (cm)	Crude fiber content in fruit (%)	Chlorophyll content in plant (mg/ 100g)	K uptake (kg ha^{-1})	Available N in soil after harvest (kg ha^{-1})	Available P in soil after harvest (kg ha^{-1})	Available K in soil after harvest (kg ha^{-1})
Vermicompost level											
V_0 (Control)	60.65	12.40	2.84	18.64	16.24	1.32	43.12	23.63	78.36	28.59	281.40
V_1 (3 t ha^{-1})	59.83	12.30	3.63	23.81	20.75	1.33	45.36	33.41	85.84	31.39	309.42
V_2 (6 t ha^{-1})	58.91	11.72	3.94	25.87	22.54	1.35	49.12	46.51	94.42	34.58	340.81
V_3 (9 t ha^{-1})	59.41	11.52	3.99	26.19	22.83	1.39	49.54	47.23	99.28	36.35	357.34

SEm±	0.18	0.14	0.15	0.39	0.06	0.02	0.14	1.97	0.27	0.26	1.63
CD (P=0.05)	0.51	0.42	0.43	1.12	0.18	NS	0.40	5.70	0.77	0.75	4.70
Nitrogen levels											
N_0 (control)	58.00	12.71	2.65	17.37	15.14	1.30	41.95	23.06	84.44	32.54	320.90
N_1 (50 kg ha^{-1})	58.40	12.17	3.58	23.48	20.46	1.33	44.95	35.32	86.30	32.59	321.28
N_2 (75 kg ha^{-1})	61.00	11.57	4.06	26.68	23.25	1.37	49.80	45.51	92.51	32.63	321.67
N_3 (100 kg ha^{-1})	61.40	11.49	4.11	26.98	26.98	1.39	50.45	46.54	94.66	33.13	325.57
SEm±	0.18	0.14	0.15	0.39	0.06	0.02	0.14	1.97	0.27	0.26	1.63
CD (P=0.05)	0.51	0.42	0.43	1.12	0.18	0.07	0.40	5.70	0.77	NS	NS

Table 2. Effect of vermicompost and nitrogen levels on growth and yield of bottle gourd.

Treatment	No. of primary branches/vine at harvest	Length of leaf (cm) at 60 DAS	Percent fruit set	Number of fruit per vine	Length of fruit (cm)	Weight of fruit (g)	Total yield/vine (kg)	Yield (q ha^{-1})
Vermicompost levels								
V_0 (Control)	7.82	19.52	37.12	7.34	26.86	537.38	5.48	153.48
V_1 (3 t ha^{-1})	10.00	24.94	47.42	8.60	34.31	709.34	7.23	202.60
V_2 (6 t ha^{-1})	10.86	27.09	51.52	9.38	37.28	859.81	8.76	245.57
V_3 (9 t ha^{-1})	10.99	27.43	52.16	9.46	37.74	874.43	8.91	249.75
S.Em±	0.03	0.07	0.03	0.03	0.02	2.27	0.02	2.23
C.D.(P=0.05)	0.09	0.21	0.08	0.08	0.06	6.55	0.07	7.78
Nitrogen levels								
N_0 (Control)	7.29	18.19	34.59	7.10	25.03	460.50	4.70	131.53
N_1 (50 kg ha^{-1})	9.86	24.59	46.76	8.33	33.84	704.30	7.18	201.16
N_2 (75 kg ha^{-1})	11.20	27.94	53.13	9.46	38.44	902.94	9.20	257.89
N_3 (100 kg ha^{-1})	11.32	28.25	53.73	9.71	38.88	913.23	9.30	260.83
SEm±	0.03	0.07	0.03	0.03	0.02	2.27	0.02	2.23
CD (P=0.05)	0.09	0.21	0.08	0.08	0.06	6.55	0.07	7.87
Interaction								
$V_0 + N_0$	5.80	14.40	27.30	5.10	19.70	332.10	3.40	94.80
$V_0 + N_1$	7.80	19.40	36.90	7.0	26.70	507.90	5.20	145.10
$V_0 + N_2$	8.80	22.0	41.90	8.60	30.30	651.10	6.60	186.0
$V_0 + N_3$	8.90	22.30	42.40	8.60	30.70	658.50	6.70	188.10
$V_1 + N_0$	7.40	18.30	34.90	7.30	25.20	438.30	4.50	125.20
$V_1 + N_1$	9.90	24.80	47.10	8.10	34.10	670.40	6.80	191.50
$V_1 + N_2$	11.30	28.20	53.50	9.50	38.70	859.40	8.80	245.50
$V_1 + N_3$	11.40	28.50	54.20	9.60	39.20	869.20	8.90	248.30
$V_2 + N_0$	8.00	19.90	37.90	8.0	27.40	531.20	5.40	151.70
$V_2 + N_1$	10.80	26.90	51.20	9.10	37.0	812.60	8.30	232.10
$V_2 + N_2$	12.30	30.60	58.20	10.20	42.10	1041.80	10.60	297.50
$V_2 + N_3$	12.20	30.90	58.80	10.30	42.60	1053.60	10.70	300.90
$V_3 + N_0$	8.10	20.20	38.30	8.0	27.70	540.30	5.50	154.30
$V_3 + N_1$	10.90	27.30	51.80	9.20	37.50	826.40	8.40	236.0
$V_3 + N_2$	12.40	31.0	58.90	10.30	42.60	1059.50	10.80	302.60
$V_3 + N_3$	12.50	31.30	59.60	10.40	43.10	1071.50	10.90	306.0
SEm±	0.05	0.14	0.05	0.05	0.04	4.53	0.04	5.45
CD (P=0.05)	0.17	0.42	0.15	0.16	0.11	13.09	0.13	15.74

Table 3. Effect of vermicompost and nitrogen levels on quality and economics of bottle gourd.

Treatment	N content in plant (%)	N uptake (kg ha^{-1})	P uptake (kg ha^{-1})	Net return (Rs./ ha)	B : C ratio
Vermicompost levels					
V_0 (Control)	0.0400	6.20	6.49	64905.0	1.12
V_1 (3 t ha^{-1})	0.0410	8.39	8.79	88397.0	1.20
V_2 (6 t ha^{-1})	0.0432	10.75	11.18	107777.50	1.21
V_3 (9 t ha^{-1})	0.0432	10.90	11.45	96117.30	0.92
SEm±	0.0001	0.13	0.10	-	-
CD (P=0.05)	0.0003	0.37	0.28	-	-
Nitrogen levels					
N_0 (Control)	0.0393	5.19	5.82	25123.30	0.32
N_1 (50 kg ha^{-1})	0.0411	8.30	8.91	79976.80	1.00
N_2 (75 kg ha^{-1})	0.0431	11.19	11.44	125036.80	1.55
N_3 (100 kg ha^{-1})	0.0440	11.55	11.75	127059.80	1.57
SEm±	0.0001	0.13	0.10	-	-
CD (P=0.05)	0.0003	0.37	0.28	-	-
Interaction					
$V_0 + N_0$	0.0377	3.60	4.0	18874.90	0.33
$V_0 + N_1$	0.0395	5.70	6.10	58191.60	1.01
$V_0 + N_2$	0.0411	7.60	7.80	90592.80	1.56
$V_0 + N_3$	0.0418	7.90	8.00	91960.80	1.57
$V_1 + N_0$	0.0385	4.80	5.40	27351.80	0.38
$V_1 + N_1$	0.0404	7.70	8.30	79525.20	1.08
$V_1 + N_2$	0.0421	10.30	10.60	122399.0	1.65
$V_1 + N_3$	0.0429	10.70	10.90	1245308.90	1.67
$V_2 + N_0$	0.0402	6.10	6.90	33599.80	0.38
$V_2 + N_1$	0.0423	9.80	10.50	97017.10	1.09
$V_2 + N_2$	0.0445	13.30	13.50	149054.40	1.68
$V_2 + N_3$	0.0458	13.80	13.90	151438.50	1.70
$V_3 + N_0$	0.0407	6.30	7.0	20663.60	0.20
$V_3 + N_1$	0.0421	9.90	10.80	85173.50	0.82
$V_3 + N_2$	0.0446	213.50	13.80	138101.0	1.33
$V_3 + N_3$	0.0454	13.90	14.20	140531.10	1.35
SEm±	0.00019	0.25	0.19	-	-
CD (P=0.05)	0.00055	0.73	0.55	-	-

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