Vol 4 No 3 September 2023 Pages 21-26 e-ISSN 2708-5694

Journal of Agriculture, Food and Environment (JAFE)

Journal Homepage: https://journal.safebd.org/index.php/jafe

https://doi.org/10.47440/JAFE.2023.4304

Research Article

Effects of application of nitrogen and vermicompost on growth performance and yield of Bari Chinashak-1 (*Brassica chinensis* L.)

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Article History

Received: 23 June 2023

Revised: 14 September 2023

Accepted: 24 September 2023

Published online: 30 September 2023

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Keywords

Vermicompost, nitrogen, China Shak

How to cite: Hossain MS, Islam MA, Akter A, Afrin M and Haque T (2023). Effects of Application of Nitrogen and Vermicompost on Growth Performance and Yield of Bari Chinashak-1 (*Brassica chinensis* L.). J. Agric. Food Environ. 4(3): 21-26.

A B S T R A C T

A field experiment was carried out at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh from March to May 2018 to investigate the effects of various doses of nitrogen and vermicompost on growth and yield performance of BARI Chinashak-1. The research work comprised of two factors, factor A: four doses of nitrogen viz., (i) N_0- 0 kg N/ha, (ii) N_1- 90 kg N/ha, (iii) N_2- 120 kg N/ha and (iv) N_3- 150 kg N/ha and factor B: Three doses of vermicompost viz., (i) V_0- 0 ton/ha, (ii) V_1- 3 ton/ha and (iii) V_2-5 ton/ha. The tallest plant (38.71 cm), maximum leaf number /plant (13.99), highest length (34.99 cm) and breath (22.70 cm) of leaves and maximum yield (26.27 t/ha) were recorded when 150 kg N/ha was applied. The shortest plant (31.03 cm), minimum leaf number/plant (11.82), shortest length (28.31 cm) and breath (18.50 cm) of leaves and minimum yield (18.34 t/ha) was found in the plots that did not get any nitrogen (0 kg N/ha). In case of vermicompost, the maximum plant height (36.79 cm), number of leaves/plant (13.97), the highest leaf length (33.84 cm) and breath (22.09 cm) and maximum total yield (24.70 t/ha) was observed at 5 ton/ha, whereas the shortest plant (33.32 cm), minimum number of leaves/plant (12.22), the lowest leaf length (29.68 cm) and breath (19.57 cm), and minimum total yield (20.98 t/ha) was observed with 0 ton/ha. For combined effect, the tallest plant (40.56 cm), maximum leaf number (15.33), length (36.50 cm) and breath (24.11 cm) of leaves, plant spread (77.10 cm) were observed from N_3V_2 combination.

Introduction

BARI Chinashak-1 (*Brassica chinensis* L.) is a new vegetable crop in Bangladesh that belongs to the family Cruciferae. It was introduced by the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, and through selection recommended as a short-duration leafy vegetable which was later released through the National Seed Board (NSB) in 1984 (Azad *et al.* 2017). Nowadays, it is very commonly grown in China, Japan, and South-East Asian countries (Choudhoury, 2009).

Excessive application of chemical/inorganic fertilizers is sometimes responsible for various unpredicted effects on the environment. These chemical fertilizers may generate sensitivity to diseases and pests and predominantly decrease fertility as well as the quality of the soil. In contrast, uses of inorganic fertilizers along with organic manures are more fruitful and sustainable for soil productiveness. Research revealed that combined application of inorganic fertilizers and organic nutrients improved the production of tomatoes and cabbage (Islam *et al.* 2017a, b). The application of organic manures in agriculture also plays a role in inhibiting environmental threats, damage to soil, and loss of nutrients because of the excessive application of lethal inorganic fertilizers and insecticides (Tindall, 2000).

Nitrogen is most effective in increasing the yield of BARI Chinashak-1 compared to other nutrients (Salunkhe *e. al.*, 1987). Early and rapid vegetative growth which is required for successful production of BARI Chinashak-1 is noticeably influenced by the nitrogenous fertilizers added to the soil. However, the optimum quantity of this fertilizer would also vary depending on the agro-climatic situation.

Banik and Sharma (2009) stated that the application of vermicompost improved health parameters and overall soil quality. By using 100% recommended doses of fertilizers along with vermicompost, the productivity of baby corn can be increased and also better soil health can be attained. Several research works reported vermicompost as an outstanding soil conditioner that can increase the production

of different vegetables and fruits for example strawberries (Arancon *et al*., 2004), peppers (Arancon *et al*., 2005), garlic (Argüello *et al*., 2006), tomatoes (Miceli *et al*., 2007), and Chinese cabbage (Wang *et al*., 2010). A research work conducted by Wang *et al*., (2010) reported that the use of vermicompost considerably improved vitamin C, flavonoids, and phenols contents in Chinese cabbage. Another research work on tomatoes also reported that the vitamin C content was reduced while higher NO_3^- was applied, but then it was improved in tomato plants cultivated with poultry manure and grass-clover treatment (Toor *et al*., 2010).

Very little work has been done in respect of vermicompost and Nitrogenous fertilizers under the agro-climatic condition of Bangladesh. Therefore, the objective of the present investigation was to find out the suitable rate of vermicompost and to evaluate the response of inorganic nitrogen for production of BARI Chinashak-1.

2. Materials and Methods

2.1. Climate and Soil

The research work was conducted at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh. The sub-tropical climate and high land are the main features of the experimental area. The soil of the research area was silty loam which belonged to the Old Brahmaputra Flood plain of Agro-Ecological Zone -9 (AEZ-9).

2.2. Planting material

In this research work, seeds of BARI Chinashak-1 were collected from BARI, Joydebpur, Gazipur. This seed was used as the planting material at the rate of 100 g/ha.

Plate 1: BARI Chinashak-1

2.3. Treatment and Design of the experiment

The research work was conducted with two factors. The factors with their levels were; Factor A: Four doses of nitrogen; viz; N_0= No Nitrogen, N_1= 90kg Nitrogen/hectare, N_2=120kg Nitrogen/hectare and N_3= 150kg Nitrogen/hectare. Factor B: Three levels of vermicompost; viz; V_0= 0 ton vermicompost/hectare, V_1=3 ton vermicompost/hectare and V_2=5 ton vermicompost/hectare. Randomized Complete Block Design (RCBD) was used for this two-factor experiment with three replications. There were three blocks each of which consisted of 12 plots, where 12 treatments were allotted randomly. Hence, the total number of plots was 36. The size of the unit plot was 1 m × 1 m = 1 m^2. Both plant to plant and row-to-row distances were 20 cm.

2.4. Preparation of land

The selected land for the experiment was first cultivated in March using a power tiller. After first ploughing the land was kept exposed for 5 days before cultivation. Then laddering was done followed by the elimination of weeds and other debris. At the same time, the colds were broken, and the soil was broken up for good tilth. Manure and fertilizers were applied in line with the treatments and considering the suggested dose for BARI Chinashak-1 (Azad *et al*., 2017).

2.5. Data collection

Plant Height, leaf length, leaf breadth was measured in centimeter (cm) by a meter scale at 15, 25, and 35 days after seed sowing (DAS). All the leaves of every single plant were calculated individually. Only the smallest new leaves at the tip were omitted from calculating. The yield of BARI Chinashak-1 per plot was calculated from harvest of leaves per plot at 35 days after sowing (DAS). The yield of BARI Chinashak-1 per plot was expressed in kg.

2.6. Statistical analysis

The collected data for various parameters studied were statistically analyzed to observe the significance of the nitrogen and vermicompost on yield and yield related attributes of BARI Chinashak-1. MSTAT Program was used to conduct the analyses of variance (ANOVA). The significance of the difference between the pairs of treatment combination means was estimated by the Least Significant Differences (LSD) at 5% and 1% level of probability (Gomez and Gomez, 1984).

3. Result and Discussion

3.1. Effect of nitrogen and vermicompost at various doses on plant height of BARI Chinashak-1

Plant height showed significant difference due to various levels of nitrogen and vermicompost at 15, 25, and 35 days after sowing (DAS). Due to use of nitrogen, the highest plant height was recorded at 35 DAS, (38.71 cm) from N_3 treatment (150 kg N/ha). At the same DAS the shortest (31.03 cm) plant height was found from N_0. In case of vermicompost, the longest height (36.79 cm) of plant was found from V_3, and the shortest height (33.32 cm) of plant was recorded from V_0 at 35 DAS (Figure 1). Combined effect shows that at 35 DAS, the longest (40.56 cm) plant height was observed from N_3V_2 (150kg N/ha + 5 ton/ha), while N_0V_0 (0 kg N/ha + 0 ton/ha) treatment combination produced the lowest (28.61 cm) plant height (Table 1).

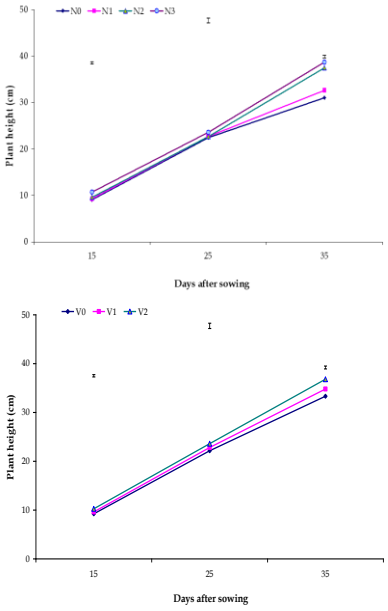

Figure 1. Effect of various doses of nitrogen and vermicompost on plant height of BARI Chinashak-1 at different days after sowing. Vertical bars indicate LSD at 1% level of probability. N_0 = 0 kg N/ha, N_1 = 90 kg N/ha, N_2 = 120 kg N/ha, N_3 = 150 kg N/ha. V_0 = 0 t/ha, V_1 = 3 t/ha, V_2 = 5 t/ha.

3.2. Influence of various levels of nitrogen and vermicompost on leaf number per plant

Statistically significant variation was observed due to the application of different doses of nitrogen and vermicompost on number of leaves of BARI Chinashak-1 at 15, 25, and 35 DAS. At 35 DAS, the maximum (13.99) leaf number was found when 150 kg N/ha (N_3 treatment) was used. In contrast, from each plant the minimum (11.82) leaf number was found from N_0 (Figure 2). At 35 DAS, the maximum (13.97) leaf number was observed in V_3, due to apply of vermicompost. The maximum (15.33) leaf number was found from the combined treatment of N_3V_2 (150kg N/ha+ 5 ton VC/ha), at 35 DAS (Table 1).

3.3. Influence of various doses of nitrogen and vermicompost on leaf length of BARI Chinashak-1

Because of the application of nitrogen, at 35 DAS, the longest (34.94 cm) leaf length was recorded from N_3, and the shortest (28.31 cm) leaf length was found from N_0. On the other hand, in the case of vermicompost at 35 DAS, the longest (33.84 cm) leaf length was observed from V_3, and the shortest (29.68 cm) leaf length was found from V_0 (Figure 3).

The combined effect shows longest (36.50 cm) leaf length was recorded from N_3V_2 (150kg N/ha + 5 ton/ha) which is statically (35.96 cm) similar to N_2V_2 (120kg N/ha + 5 ton/ha), while N_0V_0 (0 kg N/ha + 0 ton/ha) gave the shortest (26.20 cm) leaf length at 35 DAS (Table 1).

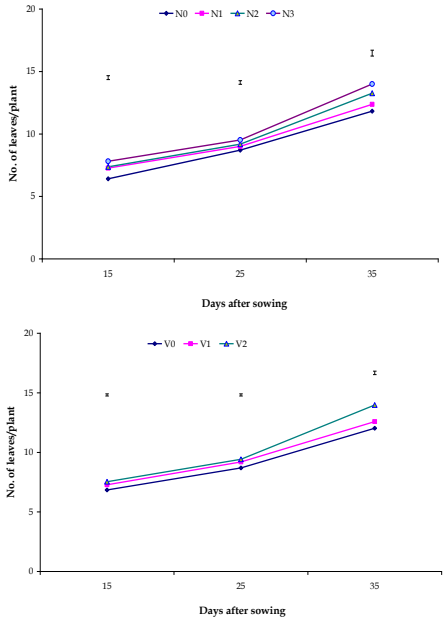

Figure 2. Effect of nitrogen and vermicompost on leaf number/plant of BARI Chinashak-1 at different days after sowing. Vertical bars indicate LSD at 1% level of probability. N_0 = 0 kg N/ha, N_1 = 90 kg N/ha, N_2 = 120 kg N/ha, N_3 = 150 kg N/ha. V_0 = 0 t/ha, V_1 = 3 t/ha, V_2 = 5 t/ha

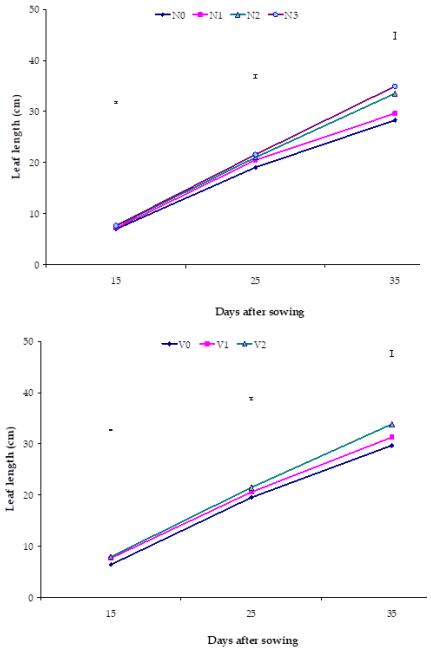

Figure 3. Effect of various doses of nitrogen and vermicompost on leaf length of BARI Chinashak-1 at different DAS. Vertical bars indicate LSD at 1% level of probability. N_0 = 0 kg N/ha, N_1 = 90 kg N/ha, N_2 = 120 kg N/ha, N_3 = 150 kg N/ha. V_0 = 0 t/ha, V_1 = 3 t/ha, V_2 = 5 t/ha.

Table 1. Combined effects of various doses of nitrogen and vermicompost on different parameters of BARI Chinashak-1.

Treatment	Plant height (cm) at (DAS)			No. of leaves/plant at DAS			Leaf length (cm) at (DAS)			Leaf breadth (cm) at (DAS)		
	15	25	35	15	25	35	15	25	35	15	25	35
N_0V_0	8.74	22.17	28.61	6.00	8.11	10.67	5.48	18.00	26.20	2.61	11.33	17.40
N_0V_1	9.12	22.24	31.56	6.56	8.89	11.67	7.39	19.27	27.72	3.57	12.29	17.89
N_0V_2	9.38	22.94	32.91	6.67	9.11	13.11	8.04	19.92	31.02	3.89	12.63	20.20
N_1V_0	8.76	22.32	31.77	7.00	8.67	11.33	5.87	19.77	27.33	2.84	11.36	18.33
N_1V_1	9.24	22.56	31.78	7.22	9.00	12.33	7.49	20.72	29.60	3.80	12.86	19.13
N_1V_2	9.86	23.19	34.32	7.56	9.33	13.44	8.13	20.97	31.89	4.09	13.00	21.47
N_2V_0	8.96	21.38	36.33	7.01	8.78	12.89	6.81	19.80	31.77	3.59	13.22	21.12
N_2V_1	9.51	22.90	36.78	7.33	9.33	12.89	7.70	21.12	32.93	3.83	13.44	22.20
N_2V_2	10.43	23.69	39.36	7.78	9.44	14.00	8.17	22.09	35.96	4.33	13.64	22.59
N_3V_0	10.43	22.71	36.56	7.33	9.22	13.19	7.44	20.51	33.43	3.77	13.46	21.42
N_3V_1	10.51	23.52	39.02	8.00	9.56	13.44	8.04	21.20	34.88	4.06	13.60	22.58
N_3V_2	11.31	24.56	40.56	8.11	9.78	15.33	7.39	22.94	36.50	4.42	14.82	24.11
LSD0.05	0.29	0.64	0.34	0.17	0.16	0.27	0.17	0.41	0.80	0.17	0.56	0.83
LSD0.01	0.39	0.87	0.47	0.23	0.22	0.36	0.23	0.56	1.08	0.23	0.76	1.13
Level of significance	**	**	**	**	**	**	**	**	*	**	**	*

** = Significant at 1% level of probability, * = Significant at 5% level of probability.
DAS= Different Days After Sowing

3.4 Influence of various doses of nitrogen and vermicompost on leaf breadth of BARI Chinashak-1

Application of Nitrogen also increases leaf breadth. At 35 DAS, the maximum (22.70 cm) leaf breadth was observed from N_3, and the minimum (18.50 cm) leaf breadth was found from N_0. Due to applying of vermicompost, the maximum (22.09 cm) leaf breadth was observed when 5t/ha vermicompost was applied, and the minimum (19.57 cm) leaf breadth was calculated from V_0 at 35 DAS (Figure 4). Combined effect shows the maximum (24.11 cm) leaf breadth was recorded from N_3V_2 (150kg N/ha + 5 ton/ha), while N_0V_0 (0 kg N/ha + 0 ton/ha) gave the minimum (17.40 cm) leaf breadth at 35 DAS (Table 1) (Table 1).

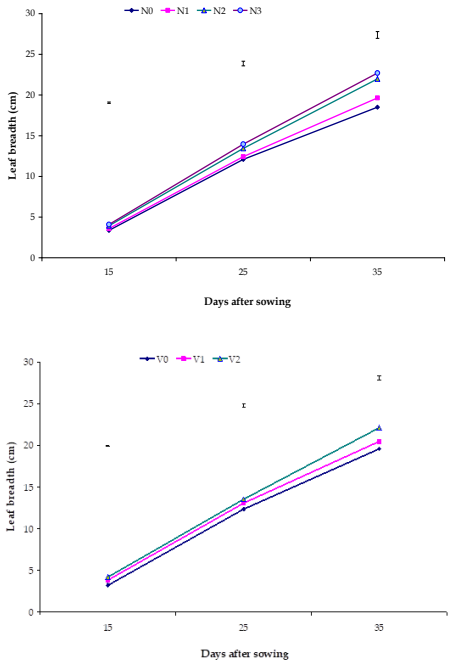

Figure 4. Effect of various doses of nitrogen and vermicompost on leaf breadth of BARI Chinashak-1 at different DAS. Vertical bars indicate LSD at 1% level of probability. N_0 = 0 kg N/ha, N_1 = 90 kg N/ha, N_2 = 120 kg N/ha, N_3 = 150 kg N/ha. V_0 = 0 t/ha, V_1 = 3 t/ha, V_2 = 5 t/ha

3.5 Influence of nitrogen and vermicompost on fresh weight of BARI Chinashak-1

There was statistically significant variation in the fresh weight of BARI Chinashak-1 because of the use of various doses of nitrogen and vermicompost. The highest (374.37 g) fresh weight was recorded from N_3 (150 kg N/ha), whereas the lowest (180.51 g) fresh weight was recorded from N_0 (0 kg N/ha) (Table 2). With the application of vermicompost, maximum fresh weight (395.02 g) was found from V_2 treatment (5 tons/ha). However, the minimum fresh weight (175.69 g) was recorded from V_0 (0 ton/ha) (Table 3). Considering the combined effect, maximum (488.44 g) and minimum (50.77 g) fresh weight were recorded from N_3V_2 (150kg N/ha + 5 ton/ha) and N_0V_0 (0 kg N/ha + 0 ton/ha) treatment combinations respectively (Table 4).

Table 2. Influence of various levels of nitrogen on yield and yield-related attributes of BARI Chinashak-1.

Level of nitrogen	Fresh weight (g/plant)	% Dry matter content	% Moisture content	Yield/plot (kg)
N_0	180.51	8.10	91.90	1.83
N_1	286.88	5.10	94.90	2.19
N_2	266.62	6.23	93.77	2.53
N_3	374.37	5.32	94.68	2.63
$LSD_{0.01}$	55.55	1.56	1.56	0.11
Level of significance	**	**	**	**

** = Significant at 1% level of probability
N_0 = 0 kg N/ha, N_1 = 90 kg N/ha, N_2 = 120 kg N/ha, N_3 = 150 kg N/ha

3.6. Influence of nitrogen and vermicompost with various doses on dry matter content (%) of BARI Chinashak-1

Various levels of nitrogen and vermicompost had significant influence on the dry matter content (%) of BARI Chinashak-1. The maximum dry matter content (8.10 %) was recorded from N_0 (0 kg N/ha), whereas the minimum (5.10%) was observed with N_1 (90 kg N/ha) treatment (Table 2). Dry matter content (%) of BARI Chinashak-1 showed significant differences because of the effect of different levels of vermicompost. Maximum (7.98%) dry matter was found from V_0 (0 ton/ha), and minimum (4.72%) was observed from V_2 (5 ton/ha) (Table 3). The highest (15.63%) dry matter content was observed from N_0V_0 (0 kg N/ha + 0 ton/ha), while N_0V_2 (0 kg N/ha + 120 ton/ha) gave the lowest (3.14%) (Table 4).

Table 3. Influence of various levels of vermicompost on yield and yield-related parameters of BARI Chinashak-1.

Vermicompost	Fresh weight (g/plant)	% Dry matter content	% Moisture content	Yield/ plot (kg)
V_0	175.69	7.98	92.02	2.10
V_1	260.58	5.87	94.13	2.32
V_2	395.02	4.72	95.28	2.47
$LSD_{0.01}$	48.11	1.35	1.35	0.10
Level of significance	**	**	**	**

** = Significant at 1% level of probability. V_0 = 0 t/ha, V_1 = 3 t/ha, V_2 = 5 t/ha

3.7 Effect of nitrogen and vermicompost at different levels on moisture content (%) of BARI Chinashak-1

Moisture content (%) of BARI Chinashak-1 showed significant variation due to the effect of various doses of nitrogen and vermicompost. The highest (94.90%) moisture content was recorded from N_1 (90 kg N/ha), whereas the lowest (91.90%) was observed from N_0 (0 kg N/ha) (Table 2). With the use of various levels of vermicompost, the maximum (95.28%) moisture content was recorded from V_2 (5 ton/ha), and the minimum (92.02%) was found from V_0 (0 ton/ha) (Table 3). The highest (96.85%) moisture content was recorded from N_0V_2 (0 kg N/ha + 3 ton/ha), while N_0V_0 (0 kg N/ha + 0 ton/ha) gave the lowest (84.37%) (Table 4).

Table 4. Combined effects of nitrogen and vermicompost at various levels on yield and yield-related attributes of BARI Chinashak-1.

Treatment combination	Fresh weight (g/plant)	% Dry matter content	% Moisture content	Yield/ plot (kg)
N_0V_0	50.77	15.63	84.37	1.46
N_0V_1	159.89	5.52	94.48	1.90
N_0V_2	330.89	3.14	96.85	2.14
N_1V_0	210.66	4.88	95.11	2.06
N_1V_1	220.00	6.37	93.63	2.24
N_1V_2	430.00	4.03	95.97	2.26
N_2V_0	220.00	5.37	94.62	2.41
N_2V_1	249.11	6.71	93.28	2.53
N_2V_2	330.77	6.60	93.40	2.65
N_3V_0	221.33	6.01	93.99	2.46
N_3V_1	413.33	4.85	95.15	2.59
N_3V_2	488.44	5.10	94.90	2.83
$LSD_{0.01}$	96.22	2.70	2.70	0.19
Level of significance	**	**	**	**

** = Significant at 1% level of probability
N_0 = 0 kg N/ha, N_1 = 90 kg N/ha, N_2 = 120 kg N/ha, N_3 = 150 kg N/haV_0 = 0 t/ha, V_1 = 3 t/ha, V_2 = 5 t/ha

3.8. Influence of various doses of nitrogen and vermicompost on yield of BARI Chinashak-1 per hectare

The maximum yield (26.27 tons/ha) per hectare of BARI Chinashak-1 was recorded from N_3 (150 kg N/ha), whereas the minimum yield (18.34 tons) was found from N_0 (0 kg N/ha). Rahman *et al.* (1985) studied Indian spinach and reported that the highest yield (62.89 ha) was obtained when the highest dose of nitrogenous fertilizer was applied. The maximum (24.70 ton) yield of BARI Chinashak-1 per hectare was recorded from V_2 (5 ton/ha), whereas the minimum (20.98 ton) yield was found from V_0 (0 ton/ha) (Figure 5). Adiloğlu *et al.* (2018) found that fresh weight and yield of lettuce were increased with the increasing dose of vermicompost. The highest (28.30 ton/ha) yield of BARI Chinashak-1 was recorded from N_3V_2 (150kg N/ha + 5 ton/ha), while N_0V_0 (0 kg N/ha + 0 ton/ha) gave the lowest (1.46 ton/ha) yield per hectare of BARI Chinashak-1 (Figure 6).

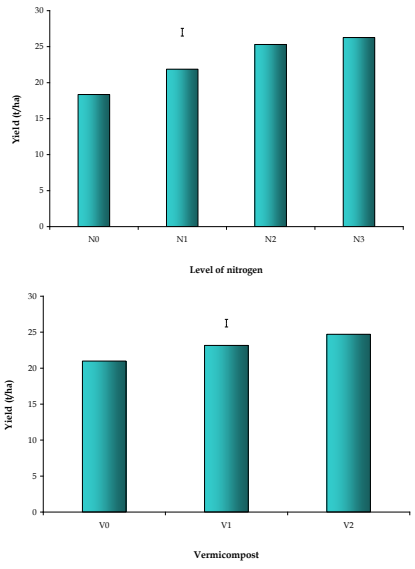

Figure 5. Effect of various doses of nitrogen and vermicompost on yield of BARI Chinashak-1. The vertical bar indicates LSD at 1% level of probability. N_0 = 0 kg N/ha, N_1 = 90 kg N/ha, N_2 = 120 kg N/ha, N_3 = 150 kg N/ha. V_0 = 0 t/ha, V_1 = 3 t/ha, V_2 = 5 t/ha.

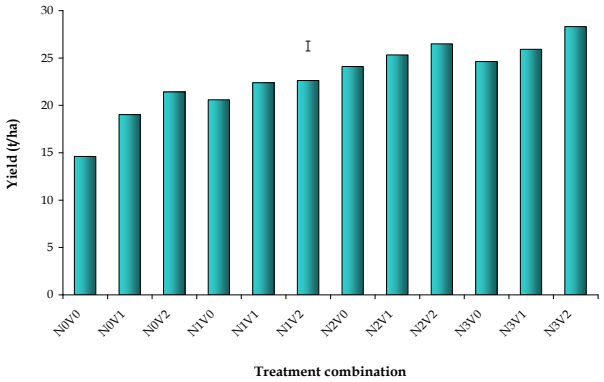

Figure 6. Combined effect of various doses of nitrogen and vermicompost on yield of BARI Chinashak-1. The vertical bar indicates LSD at 1% level of probability.
N_0 = 0 kg N/ha, N_1 = 90 kg N/ha, N_2 = 120 kg N/ha, N_3 = 150 kg N/ha
V_0 = 0 t/ha, V_1 = 3 t/ha, V_2 = 5 t/ha.

Conclusion

For better production of crops, the application of nitrogen fertilizer at optimum dose is one of the most vital factors. vermicompost is another important source of nutrients for increasing the production and yield of different crops. In Bangladesh information about vermicompost to be used for cultivation of BARI Chinashak-1 is scanty. Growth and yield of BARI Chinashak-1 mostly depend on the rate of nitrogen fertilizers along with vermicompost application. These two factors either individually or combinedly encourage the growth, development, quality, and production of BARI Chinashak-1. In the case of nitrogen, the maximum yield was found at 150kg N/ha and the minimum from 0kg N/ha. In the case of vermicompost, the maximum yield was obtained from 5 tons/ha and the minimum was from 0 ton/ha. 150 kg N/ha together with 5 ton /ha vermicompost produced the maximum yield of BARI Chinashak-1 whereas per hectare the minimum yield was recorded at the combination from 0 kg N/ha along with 0 ton /ha vermicompost.

Conflict of Interest

The authors announce that there is no conflicting interest in the publication of this paper.

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