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Responses of nutrient combinations on yield and yield attributing characters of garlic (*Allium sativum* L.) and soil properties in Chitwan, Nepal

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Abstract

A field experiment was conducted on Garlic (*Allium sativum* L.) to study the responses of different nutrients sources on growth parameters, yield, soil properties and economic return. The experiment was laid out in Randomized Completely Block Design (RCBD) in Agriculture and Forestry University farm during the year 2018-2019. There were 5 treatments viz. T_1 (140:140:70 kg NPK + 20t FYM ha^{-1}), T_2 (140:140:70 kg NPK + 5.5t Vermicompost ha^{-1}), T_3 (140:140:70 kg NPK + 20 lit Azotobacter + PSB + KMB ha^{-1}), T_4 (20t FYM + 20 lit Azotobacter + PSB + KMB ha^{-1}) and T_5 (140:140:70 kg NPK + 20t FYM +20 lit Azotobacter + PSB+KMB + 5.5t Vermicompost ha^{-1}) each with four replications. Among the treatments, plants supplied with T_1 recorded maximum plant height (54.37cm) which was statistically similar to T_5 (54.28cm) and T_4 (49.04cm). However, the maximum number of leaves was recorded with T_5 (6.83) followed by T_1 (5.97) and T_4 (5.91). Likewise, the highest bulb yield was found in T_5 (118.7q/ha) which was statistically similar to T_3 (110q/ha) and the lowest yield was obtained with T_4 (87.4q/ha). However, the highest net return and Benefit-Cost Ratio was recorded on T_2($14311.58 ha^{-1}, 2.91) followed by T_1 (13316.51 ha^{-1}, 2.89) and T_3 (13854.241 ha-1, 1.99), while the lowest net return and Benefit-Cost Ratio was recorded on T_4 ($8883.19, 1.16).The maximum uptake of Nitrogen (149.305kg/ha), Phosphorus (40.73 kg/ha) and Potassium (152.3 kg/ha) was found to be on T_5 while the least uptake was recorded in T_3(139.6 kg/ha), T_4(29.19 kg/ha) and T_4 (132.5kg/ha). Thus, vermicompost in combination with chemical fertilizers is good source of nutrient for the highest profitability among different combinations of nutrient.

Keywords: Allium sativum, Azotobacter, Profitability, Vermicompost, Yield

Introduction

Garlic (Allium sativum), originated in central Asia classified under Amaryllidaceae family is the second most important bulb crop after onion (Purseglove, J. W, 1975) [1]. It is widely used in flavoring food, preparation of chutneys pickles, curry powder, tomato ketch up etc statistic show the global importance of garlic, with about 19 million hectares planted and an overall annual production of nearly 327 million tons (samavatean *et al.*, 2011) [2]. About 19.65 ton/ha of garlic is produced annually in Nepal.

None of the garlic genotypes has been recommended, registered or released from NARC for cultivation in Nepal. The demand of the spices is at the peak in October due to the festive season and there is short supply of the garlic. More over being a non-perishable it can be easily stored under ordinary conditions incurring minimal postharvest losses. Among the different management practices, nutrient management plays an important role for the good growth, yield and quality of garlic. Application of all needed nutrient through all chemical fertilizer are known to have deleterious effect on the soil fertility leading to unsustainable yield, while integration of the chemical fertilizer with organic manures and bio fertilizers are able to maintain the soil health productivity and fertility (Jen-Hshuan Chen, 2008) [3]. Organic manure improves soil structure and water holding capacity resulting in more extensive root development and enhances Soil micro flora and fauna activity, which results availability of micronutrient available to plants (Zeidan M S, 2007) [4]. High nitrogen fertilizer applications have also caused soil salinization and acidification (Qian *et al*., 2014; Yu *et al*. 2015) [5, 6]. Potentially inhibiting garlic growth and resulting in low yield with poor quality and lower economic benefits.

Keeping these challenges in view present investigation was carried out to examine the effect of different nutrient management practices on the production economic benefits and optimum nutrient uptake by plants. Our result will provide the direct evidence needed by farmer to apply appropriate nutrient management practices for garlic production in an economical and environmentally rational manner.

Materials and Method

Experiment Site and Design: The experiment was laid out in RCBD with five treatment combinations in four replication, within the Agriculture and Forestry University (AFU) farm premises. The experiment field was at the geographical location of $27^0$37'N latitude, 84o25'E longitude at an altitude of 256masl and has a sub-tropical climate.

The plot was kept at 1.2m X1.2m maintaining 15cm X15cm row-row and plant-plant distance planted with local variety. Of about 50cm wide border was left around the experiment field and as the distance between the blocks was maintained. The healthy and large sized cloves were selected and treated with systemic fungicide Bavistin (2g/lit) and was soaked for 30 min before sowing. The cloves were sown 28th December 2018 with crop growing period of four months**.**

Agronomic Practices

The land was ploughed and leveled by tractor with disc plough and field sanitation was maintained. Full dose of FYM (20t/ha^{-1}), Vermicompost (5.5t/ha^{-1}) and 1/4thdose of bio-fertilizer Azotobacter + PSB + KMB (20 lit. ha^{-1}) was applied one week before sowing and thoroughly mixed with soil. 1/3rd dose of Nitrogen (140kg ha$^{-1)}$ in the form of urea, full dose of phosphorous (140kg ha^{-1}) and potash (70kg ha^{-1}) in the form of DAP and MOP were applied as a basal dose respectively. Remaining 2/3rd dose of Nitrogen weretop dressed at an interval of 30 and 40 days after sowing. Remaining 3/4th dose of bio-fertilizer (Azotobacter, phosphorous and potash solubilizing bacteria) were applied at 15 days after sowing.

For the prevention of weed infestation and moisture retention in the field, straw mulching was practiced removed after 10 days of planting when emergence of seedlings was completed. Different intercultural practices like gap filling, thinning, weeding, irrigation practices were done in the field in the required time according to need of crop. Fungicide (Bavistin @2gm/lit), cow urine (100ml/lit), cow milk (10ml/lit) were sprayed at 15 days of interval for the prevention of thrips infestation, viral disease prevention and supplement of essential sulphur.

Experiment, Treatment and Details

Table 1: The following table represents treatments applied in the experiment field

Treatments	Treatments details
T_1	140:140:70 kg NPK + 20t FYM ha^{-1}
T_2	140:140:70 kg NPK + 5.5t Vermicompost ha^{-1}
T_3	140:140:70 kg NPK + 20 lit. Azotobacter + PSB + KMB ha^{-1}
T_4	20t FYM ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1}
T_5	140:140:70 kg NPK +20t FYM ha^{-1} + 5.5t Vermicompost ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1}

Soil analysis

Soil sample was collected randomly from the entire experimental field following zigzag fashion from 0-15 cm depth before planting using a screw auger to determine soil chemical properties. The total nitrogen available P, K organic matter, soil pHand soil texture was determined in Soil and Fertilizer testing laboratory, Hetauda. The sample of the FYM and vermicompost were also subjected to determine their chemical, physical properties and nutrient content.

Data collection

Out of the total 64 plant planted in each plot, 10 plants were selected randomly as sample plant and tagged for data collection. Data were collected at 15, 30, 45, 60, 75 and 90 days after planting. The vegetative parameters like plant height, leaf length, number of leaves and yield attributing parameters like Polar diameter of bulb, equatorial diameter of the bulb, neck thickness, average weight of the bulb, number of cloves per bulb, nutrient uptake kg/ha and total yield were measured. The data were analyzed statistically and the results were interpreted by Duncan's multiple range test (DMRT) using Gen stat and Microsoft excel. One way analysis of variance (ANOVA) test was used to determine the treatment effect on the measured valuables. A paired F- test, and the least significance difference (LSD) multiple comparison test were used to identify statistical difference among the treatment for all analysis, a probability level of <0.05 was considered as statistically significant.

Economic analysis

For economic analysis total cost of the individual treatment were recorded in order to find out the profitability of the treatment combination.

T1= NPK +FYM=$1.12
T2=NPK+ Vermicompost =$1.30
T3=Bio-fertilizer+ NPK =$2.47
T4=FYM+ Bio-fertilizer=$2.87
T5=FYM+ NPK+ Bio-fertilizer+ Vermicompost=$3.55

Labor =$4.49
Planting material=$1.80
Field preparation=$1.35

Market price of garlic was $1.89/kg and net profit was calculated separately by subtracting the cost of treatment from additional income of respective treatment

The benefit: cost (BC ratio) was calculated separately for each treatment according to following formula

B: C= (gross return/ha)/ (total cost of production/ha)

Results and Interpretation

To study the responses of different integrated nutrient management practices, evaluation was carried out under the basis of nutrient uptake, yield and economic efficiency.

Table 2: Effect of different nutrient combinations on plant height of garlic at 15 days of interval in Chitwan, Nepal, 2018/19

Treatments	15 days	30 days	45days	60days	75days	90days
T_1(140:140:70 kg NPK + 20t FYM $ha^{-1)}$	7.24	14.48	23.02^{ab}	35.90^{a}	49.4^{a}	54.37^{a}
T_2(140:140:70 kg NPK + 5.5t Vermicompost ha^{-1})	6.61	13.72	22.74^{ab}	31.84^{ab}	40^{ab}	46.74^{b}
T_3 (140:140:70 kg NPK + 20 lit. Azotobacter + PSB + KMB ha^{-1})	6.67	13.36	21.05^{b}	28.95^{b}	37.6^{b}	45.41^{b}
T_4 (20t FYM ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1})	6.79	16.19	23.97^{ab}	33.64^{ab}	44.9^{ab}	49.04^{ab}
T_5 (140:140:70 kg NPK +20t FYM ha^{-1} + 5.5t Vermicompost ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1}0	8.55	15.97	25.98^{a}	36.91^{a}	46.5^{ab}	54.28^{a}
S.E.D			1.4	2.463	4.29	2.85
CV			3.7	4.3	7.4	9
LSD(0.05)			3.05	5.366	9.35	6.209
F-value	0.227	0.169	0.047	0.046	0.097	0.022
Grand mean	7.18	14.75	23.35	33.45	43.7	49.97

The results reveal that the plant height was significantly influenced by integrated source of nutrient at 45, 60, 75 and 90 days after sowing while it was non-significant at 15 and 30 days after sowing. The maximum plant height was found in plant provided with RDF NPK + FYM (54.37 cm at 90 days after sowing).The plant height recorded in T5 and T1 were found to be statistically similar as well as T2 and T3 were found to be statistically similar at 5% level of significance. Increase in plant height in the treatment T1 might be due to major nutrients supplied fertilizers will be utilized quickly by the crop and all other micro and macro nutrients available in organic manure will be released slowly. Hence, combination of those manures helped to increase availability of major nutrients which being the constituent of protein and protoplasm, vigorously increasing the vegetative development of the plant.(sankar *et al.*, 2005)The least plant height (45.41 cm) was recorded in the plants received with T_4 (NPK+Bio-fertilizer).

Table 3: Effect of different nutrient combinations on number of leaves of garlic at 15 days of interval in Chitwan, Nepal, 2018/19:

Treatments	15 days	30 days	45days	60days	75days	90days
T_1(140:140:70 kg NPK + 20t FYM $ha^{-1)}$	2.27	3.7^{ab}	4.24^{ab}	4.30^{ab}	5.01^{ab}	5.97^{ab}
T_2(140:140:70 kg NPK + 5.5t Vermicompost ha^{-1})	2.42	3.56^{ab}	4.13^{ab}	4.12^{ab}	4.68^{b}	5.89^{ab}
T_3 (140:140:70 kg NPK + 20 lit. Azotobacter + PSB + KMB ha^{-1})	2.75	3.47^{b}	3.54^{b}	3.49^{b}	4.34^{b}	5.37^{b}
T_4 (20t FYM ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1})	2.98	3.83^{ab}	4.25^{ab}	4.06^{ab}	5.05^{ab}	5.91^{ab}
T_5 (140:140:70 kg NPK +20t FYM ha^{-1} + 5.5t Vermicompost ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1}0	2.70	4.12^{a}	4.62^{a}	4.36^{a}	5.54^{a}	6.83^{a}
S.E.D		0.245	0.429	0.366	0,361	0.442
CV		5.5	2.2	5.5	2.7	1
LSD(0.05)		0.533	0.935	0.797	0.786	0.968
F-value	0.634	0.133	0.224	0.196	0.059	0.075
Grand mean	2.62	3.735	4.16	4.06	4.92	5.99

Table 4: Effect of different nutrient combinations on average length of leaves of garlic at 15 days of interval in Chitwan, Nepal, 2018/19

Treatments	15 days	30 days	45days	60days	75days	90days
T_1(140:140:70 kg NPK + 20t FYM $ha^{-1)}$	5.90	7.81^{ab}	12.94^{a}	21.02^{a}	29.75^{a}	28.27^{a}
T_2(140:140:70 kg NPK + 5.5t Vermicompost ha^{-1})	4.15	6.70^{b}	11.24^{c}	17.04^{a}	22.60^{b}	24.7^{a}
T_3 (140:140:70 kg NPK + 20 lit. Azotobacter + PSB + KMB ha^{-1})	4.52	7.54^{ab}	11.35^{c}	18.86^{a}	22.19^{b}	27.03^{a}
T_4 (20t FYM ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1})	4.56	8.61^{a}	13.69^{a}	21.17^{a}	26.24^{ab}	26.92^{a}
T_5 (140:140:70 kg NPK +20t FYM ha^{-1} + 5.5t Vermicompost ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1}	4.01	7.71^{ab}	12.37^{bc}	22.05^{a}	27.32^{ab}	27.62^{a}
S.E.D.		0.671	0.518	2.267	2.444	2.805
CV		7.6	5.1	5.9	7.4	12.3
LSD(0.05)		1.463	1.128	4.931	5.326	6.11
F-value	0.321	0.147	0.002	0.232	0.042	0.7634.
Grand mean	4.63	7.67	12.32	20.03	25.62	26.91

The no. of leaves and average length of leaves per plant of garlic was found to be non-significant among the different nutrient combinations at all the stages of crop growth. These results are in accordance with the findings of (EL-Hifny, 2010).

Table 5: Yield, yield attributing parameters and nutrient uptake of garlic as influence by integrated nutrient management.

Treatments	Equatorial diameter SS(cm)	Polar diameter (cm)	Bulb neck thickness (cm)	Number of coves /bulb	Average bulb weight (gm.)	Total yield (q/ha)
T_1(140:140:70 kg NPK + 20t FYM $ha^{-1)}$	3.26^{ab}	2.95^{b}	0.57^{a}	17.30^{b}	21.33^{bc}	94.8^{cd}
T_2(140:140:70 kg NPK + 5.5t Vermicompost ha^{-1})	3.42^{ab}	2.87^{bc}	0.51^{abc}	20.80^{ab}	22.83^{abc}	111.7^{bc}
T_3 (140:140:70 kg NPK + 20 lit. Azotobacter + PSB + KMB ha^{-1})	3.33^{ab}	2.642^{cd}	0.48^{bc}	22.57^{a}	24.57a^{b}	110^{ab}
T_4 (20t FYM ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1})	3.12^{b}	2.48^{d}	0.45^{c}	16.35^{b}	19.67^{c}	87.4^{d}
T_5 (140:140:70 kg NPK +20t FYM ha^{-1} + 5.5t Vermicompost ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1}	3.57^{a}	3.25^{a}	0.54^{ab}	23.77a	22.01^{a}	118.7^{a}

S.E.D	0.1557	0.124	0.0285	2.078	1.973	4.44
CV	1.1	3.81	4.5	4.7	3.4	1.6
LSD(0.05)	0.339	0.271	0.062	4.528	4.299	9.58
F-value	0.112	<0.001	0.009	0.015	0.024	<0.001
Grand mean	3.34	2.838	0.51	20.16	23.08	102.5

The yield contributing character like bulb equatorial diameter and polar diameter representing average weight of the bulb were significant. The highest equatorial (3.570 cm) and the polar bulb diameter (3.25 cm) was recorded in the plant provided with T_5 (140:140:70 kg NPK +20t FYM ha^{-1} + 5.5t Vermicompost ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1}) followed by T_3 (140:140:70 kg NPK + 20 lit. Azotobacter + PSB + KMB ha^{-1}) viz. equatorial diameter (3.420 cm) and polar diameter (2.95 cm) which was statistically similar with T_2 ((140:140:70 kg NPK + 5.5t Vermicompost ha^{-1}) with equatorial diameter (3.33 cm) and polar diameter (2.870 cm) respectively. Similarly, the equatorial (3.12) and polar diameter (2.48) was found significantly lowest in T_4which was on par with T_1 (equatorial: 3.26 cm and polar (2.642 cm). (Jawadagi *et al.*, 2012) [10] Reported improvement available bulb weight, bulb diameter, and bulb neck thickness in treatment having FYM 12.50 t/ha + vermicompost 2 t/ha + bio fertilizer in kharif onion (Bhagwan Singh Choudhary, 2013) [14] recorded maximum garlic bulb yield with 100% RDF + 5 t/ha vermicompost treatment combination.

The maximum number of cloves per bulb (23.77) was observed in T_5 (140:140:70 kg NPK +20t FYM ha^{-1} + 5.5t Vermicompost ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1}) which was on par with T3 (22.57) and T_2 (20.80) and the minimum number of the cloves per bulb (16.35) was recorded in T_4 which was on par with T_1 (17.30)

The average bulb weight was significantly highest in T_5 (27. 57 gm) followed by T_3 (24.57 gm) which was on par with T_2 (21.33 gm). The lowest average bulb weight was found in T_4 (16.35 gm) which was statistically similar with T_1 and T_2.

Bulb yield per hector was significantly influenced by the different nutrient combination of treatments at all the stages of the crop growth. The highest yield per hector was quintals was obtained in T_5 (118.7 q/ha) which was on par with T_3 (110q/ha) and the lowest yield was obtained in T_4 (87.4 q/ha) which was on par with T_1 (94.8 q/ha). It clearly reflects that the importance of chemical fertilizer in two or more combination with organic fertilizer might provide higher availability of potash and micro nutrient in soil as a result of increase decomposition of FYM and Vermicompost affected the continuous slow release of nutrients and bio fertilizers viz. Azotobacter, PSB, and KMB have contributed by supplying growth promoters. (okon *et al*., 1985) [9]

Biometric observation was significantly influenced by the combined use of inorganic fertilizer with organic source of nutrients. This might me due to gradual and steady release of nutrients during the growth period as well as enhanced biological activity and proper nutrition to the crop (Vijay kumar singh, 2015) [16] and (patil *et al.*, 2007) [15]

Table 6: Effect of different nutrient combinations on nutrient uptake and soil properties of garlic in Chitwan conditions 2018/19

Treatments	Soil pH	Residual Organic Matter (%)	Soil textural classification	N (kg/ha)	P (kg/ha)	K (kg/ha)
T_1(140:140:70 kg NPK + 20t FYM ha^{-1})	6.3	3.86 (M)	SL	143.09	32.27	138.4
T_2(140:140:70 kg NPK + 5.5t Vermicompost ha^{-1})	6.1	3.74 (M)	SL	140.37	30.62	143.22
T_3 (140:140:70 kg NPK + 20 lit. Azotobacter + PSB + KMB ha^{-1})	6.0	3.10 (M)	LS	139.6	39.96	146.23
T_4 (20t FYM ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1})	6.3	3.91 (M)	LS	141.86	25.19	132.5
T_5 (140:140:70 kg NPK +20t FYM ha^{-1} + 5.5t Vermicompost ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1}	6.2	3.69 (M)	SL	149.305	40.73	152.3

Note: LS = Loamy sand; SL= Sandy loam; M= Medium

The highest uptake of nitrogen was observed in T_5 (149.305 kg/ha) followed by treatment T_2 (140.37 kg/ha) and T_4 (141.86kg/ha) while the least uptake was found in T_3 (139.6 kg/ha). Similarly, maximum Phosphorus (P) uptake was recorded in T_5 (40.73 kg/ha) followed by treatment T_2 (30.63 kg/ha) and T_1 (32.27 kg/ha) while the least uptake was found in T_4 (29.19kg/ha). The maximum uptake of potassium was found in T_5 (152.3 kg/ha) while least uptake was recorded in T_4 (132.5 kg/ha). The texture of soil was found to be sandy loam in T to loamy sand with pH at a range of 5.6-6.3 slightly acidic in nature and residual organic matter content was found to be at range of 3.01-3.86 % after the harvesting of garlic. These properties of soil might have affected the on yield and yield attributing parameters of different treatments. From the table maximum residual organic matter was found in T_4 which leads to lower uptake of organic matter by crop and lower yield of garlic.

Table 7: Economic efficiency of different nutrient combinations of garlic under Chitwan conditions:

Treatments	Cost of Productions ($/ha)	Yield (qt/ha)	Gross Return ($/ha)	Net profit ($/ha)	B:C ratio
T_1(140:140:70 kg NPK + 20t FYM ha^{-1})	4600.69	94.8	17917.2	13316.51	1:2.89
T_2(140:140:70 kg NPK + 5.5t Vermicompost ha^{-1})	4909.72	101.47	19221.3	14311.58	1:2.91
T_3(140:140:70 kg NPK + 20 lit. Azotobacter + PSB + KMB ha^{-1})	6935.76	109.97	20790	13854.24	1:1.99
T_4 (20t FYM ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1})	7635.41	87.41	16518.6	8883.19	1:1.16
T_5 (140:140:70 kg NPK +20t FYM ha^{-1} + 5.5t Vermicompost ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1})	8815.97	118.88	22434.3	13618.33	1:1.55

The cost of garlic cultivation among the treatment includes human labor, land preparation, seed, manure; fertilizer, irrigation, insecticide, etc. were calculated on hectare basis.

Among all the nutrient combination treatments, the net profit of obtained with application of T_2 ($14311.58/ha) was followed by T_3 ($13854.24/ha) and$T_5$ ($13618.33) per ha. The lowest net profit of $8883.19 ha^{-1} was obtained in T_4 which was followed by T_1 $13316.51 ha^{-1}. Similarly the highest Benefit: Cost ratio (2.91) was obtained from T_2 and followed by T_1 (2.89), T_3 (1.99). The lowest B: C ratio was obtained with T_4 (1.16) which was followed by T_5 (1.55). This shows that T_2 was the most economically profitable and efficient than other nutrient combination in terms of vegetative and yield character for garlic under Chitwan condition.

Note: FYM= Farm Yard Manure; PSB= Phosphorous Solubilizing Bacteria; KMB= Potassium Mobilizing Bacteria; B: C= Benefit: Cost; DAS= Days after Sowing; CV= Coefficient of Variation; LSD= Least Significance Difference; S.E.D= Standard Error of Difference; Values with the same letter in a column are not significantly different at 5% DMRT.

Conclusion

Garlic (*Allium sativum*) is the 2nd most important bulb crop in Nepal. The nutrient combination of treatment T_5 (140:140:70 kg NPK + 20t FYM +20 lit Azotobacter + PSB+KMB + 5.5t Vermicompost ha^{-1}) and T_2 (140:140:70 kg NPK + 5.5t Vermicompost ha^{-1}) was found to be more effective against T_4 (20t FYM ha^{-1} + 20 lit. Azotobacter + PSB + KMB ha^{-1}). T_2 treated plot produced higher yield and maximum Benefit: Cost ratio than other nutrient combinations treatments. Vermicompost being cheap, locally available, environment-friendly, and superior to traditional compost for its ability to improve soil structure, water holding capacity leaving the soil with enriched organic matter content. Bio-fertilizer and Chemical being costly, timely not available in most rural areas and bio-fertilizer losses effectiveness in tropical region like Chitwan if soil is too hot or dry. Thus, application of vermicompost with recommended dose of Chemical fertilizer can be the best option of nutrient combinations for farmers in achieving optimum yield, higher market value, maximum B: C ratio and should be emphasized for its commercial in every nook and corner of Nepal.

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