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Vijay kumar Gupta
Ph.D. Scholar, ITM University Gwalior, M.P, India

Girish Pandey
Dean (School of Agriculture), ITM University Gwalior, M.P, India

Mahesh Singh
Assistant Professor (Plant Pathology), ITM University Gwalior, M.P, India

Correspondence
Vijay kumar Gupta
Ph.D. Scholar, ITM University Gwalior, M.P, India

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Effect of integrated nutrient management on growth yield and quality of cabbage

Vijay kumar Gupta, Girish Pandey and Mahesh Singh

Abstract
The present investigation was aimed at determining the effect of INM treatments on growth and yield of cabbage plants. Total 16 number of different INM combinations was tested during the experiment. Observations indicate that application of 100% RDF showed significantly high performance in whole plant height (cm), number of leaves per plant, diameter of head (cm), and yield (t/ha) compared to application of75% RDF+ Neem cake (2.5t/ha), 75%RDF+vermicompost (5t/ha) and 75% RDF + FYM (25t/ha). The overall results suggest that application of 75% RDF + 2.5t/ha neem cake improves plant mineral concentration through nitrogen fixation and thereby alters yield and yield attributes in cabbage.

Keywords: INM, Cabbage, Neem Cake, Vermicompost

Introduction
FAO, (1988) [2] has identified cabbage as one of the top twenty vegetables and an important source of food globally. It has been domesticated and used for human consumption since the earliest antiquity (Smith, 1995) [11]. Cabbage (*Brassica oleracea* L.), a member of cruciferae and a useful vegetable, belongs to the genus Brassica (Jim and Tony, 2006) [4]. It is generally believed to have originated from the wild, leafy, nonheading types which are found growing in Europe (Grubben and Denton, 2004) [3].
Soil contains natural reserve of plant nutrients, but these reserves are largely in forms unavailable to plants, and only a minor portion is released each year through biological activities and chemical processes. Optimum plant growth, nutrient must be available in sufficient and balanced quantities. Therefore, fertilizers are designed to supplement the nutrients to fulfill the crop requirement. A headed cabbage with a yield of 25t/ha approximately absorbs 100kg N, 12kg P and 75kg K (Grubben and Denton, 2004) [3]. Singh and Naik (1990) [8] reported maximum marketable heads at fertilizer level of 60 to 120kg N and 30-90 kg P2O5 per hectare. Similar recommendations were recommended by Morris (1950) [5]. Optimally cabbage requires 60-85 kg N/ha; 60-80 kg P2O5/ha; and 30-90kg K2O/ha (Shika and Doug, 2001) [7]. Also Bhardwaj *et al*, (2000) [1]. Keeping the views in mind present investigation is taken up to identify the best possible INM combination for sustainable productivity with improve the quality of soil.

Material and Method
The experiment was conducted during 2016-17 and 2017-18 at school of agriculture ITM University Gwalior (MP). The soil of experiment field was sandy loam and neutral in nature with low nitrogen, medium phosphorus and medium potash availability. Experiment was laid out in randomized block design with 16 INM treatments. Cultural practices such as adequate application of fertilizers have to be adhered to in order to obtain good yields in cabbage production. Despite many investigations in area of nutrition and knowledge about how organic, mineral and organomineral fertilizers influence growth yield and quality of crops, there is need to investigate further on the effect of fertilization on the production of vegetables. Therefore the objective of this study is to determine the best fertilizer type for the maximum growth and yield of cabbage varieties in gird region of Madhya Pradesh.

Results and discussion
The results of present investigation based on the periodical observations taken at different time interval during crop growth were presented here for quick grasp of the experiment.

Plant height (cm)
Plant height was recorded at harvest of crop for both the experimental years were analyzed and mean were presented in table -1. The results revealed that the maximum plant height were recorded with the application of 100% RDF (35.30cm), while the minimum plant height was recorded in control (no fertilizer). The 75% RDF + 2.5 t/ha Neem cake was produced significantly *at par* plant height of crop.

Leaf Length (cm)
Leaf length was recorded at harvest. The data obtained from both years were presented in table-1. Length of Leaf was also influenced by different sources of nutrition. Maximum leaf length were recorded with the application of RDF100% which was statistically *at par* and followed by 75% RDF+ Neem cake (2.5t/ha), 75%RDF+vermicompost (5t/ha) and 75% RDF + FYM (25t/ha). However, the minimum leaf length was recorded under control.

Yield and Yield Attributes
Diameter of head (cm)
Diameter of head is a very important yield decidingcharacter in cabbage crop. The diameter of head was also affected with the sources of nutrition in the field. The maximum diameter of head (19.48 cm) was recorded with the application of 100% RDF while, it was followed by 75% RDF+ Neem cake (2.5t/ha), 75%RDF+vermicompost (5t/ha) and 75% RDF + FYM (25t/ha). However, the minimum diameter of head (13.57 cm) recorded under control (no nutrient). This may be due to nutrients especially nitrogen was easily available for plant in sufficient quantity which increases the production of photosynthates in plant. This view confirmed by Padem and Plan (1992) [6].

Weight of head (g)
Weight of head is also an important yield decidingcharacter in cabbage crop. The weight of trimmed and untrimmed head was also affected with the sources of nutrition. The maximum weight of untrimmed and trimmed head was recorded with the application of 100% RDF while, it was followed by 75% RDF+ Neem cake (2.5t/ha), 75%RDF+vermicompost (5t/ha) and 75% RDF + FYM (25t/ha). However, the minimum weight of head recorded under control (no nutrient).
This may be due to increase in growth and yield attributingcharacters like plant height, number of unwrapped and wrapped leaves, stalkweight etc. because plants were absorbed maximum amount of nutrientsover all the treatments. This view confirmed by Singh *et al.* (2001) [9], and Singh (1996) [10].

Yield (t/ha)
As similarly to other yield attributes the maximum head yield (57.62 t/ha) was recorded with the application of 100% RDF while, the minimum was recorded in control (30.87 t/ha). However, application of75% RDF+ Neem cake (2.5t/ha), 75%RDF+vermicompost (5t/ha) and 75% RDF + FYM (25t/ha) produced statistically *at par* yield to 100% RDF. This may be due to maximum amount of nitrogen given through urea which can easily available to crop than bulky organic manure thereby plant growth and developments were increased, thus net weight per head was also increased thereby net yield was increased Singh *et al.*(2001) [9].

Quality Characters
Quality characters of cabbage were also significantly affected by the different source of nutrition. Major quality character i.e. TSS%, Moisture % at harvest of cabbage head and 50% days to head initiation were recorded and analyzed both the years of experimentation and means were presented in table - 2.

TSS % at Harvest in cabbage head
The maximum TSS% (35.30) was recorded under the treatment combination75 % RDF + Vermicompost (5 t/ha.). while the minimum was recorded in control (26.43%). However, 75 % RDF + Neem cake (2.5t/ha) 34.40%, 50 % RDF + FYM (25 t/ha) 32.69%, Vermicompost (5 t/ha.) 31.30% and FYM (25 t/ha) 30.95% were at par to the treatment combination75 % RDF + Vermicompost (5 t/ha.).

Moisture % at Harvest in cabbage head
The maximum Moisture% (35.25) was recorded under the treatment combination75 % RDF + Vermicompost (5 t/ha.) while, the minimum was recorded in control (24.09%). However, 75 % RDF + Neem cake (2.5t/ha) 34.70%, and 50 % RDF + FYM (25 t/ha) 32.49were at par to the treatment combination75 % RDF + Vermicompost (5 t/ha.).

Days to 50% head initiation
Days to 50% head initiation were counts from the date of sowing to the 50% head were emerged in the field. The results own that the proper nutrition was taking appropriate time to head initiation which was maximum for maximizing the yield. However, the application of 100% RDF took maximum days to 50% head initiation, 75%RDF and rest through organic method was also took significantly at par number of days to 50% head initiation. It means that there is scope of minimize the crop duration through integration of organic matter it also increase the taste and other cooking quality of the vegetable. The results of present study was close conformity with Singh *et al.*, (2001) [9].

Table 1: Effect of different INM combination on growth and yield attributes in cabbage CV

Treatment	TSS% at Harvest	Moisture % at Harvest	Days to 50% head initiation
Control	26.43	24.09	40.01
Biofertilizer (PSB) 3 Kg/ha.	27.80	24.39	42.69
FYM (25 t/ha)	30.95	29.92	42.81
Vermicompost (5 t/ha.)	31.30	31.23	49.43
Neem cake (2.5t/ha)	32.16	31.25	47.45
50 % RDF Kg./ha	28.61	26.50	49.93
50 % RDF + Biofertilizer (PSB) 3 Kg/ha.	28.99	26.91	53.01
50 % RDF + FYM (25 t/ha)	32.69	32.49	55.66
50 % RDF + Vermicompost (5 t/ha.)	32.93	34.01	56.84
50 % RDF + Neem cake (2.5t/ha)	33.38	34.12	55.80
75 % RDF Kg./ha	29.23	28.56	57.53
75 % RDF + Biofertilizer (PSB) 3 Kg/ha.	29.96	29.46	57.70

75 % RDF + FYM (25 t/ha)	30.26	29.74	58.47
75 % RDF + Vermicompost (5 t/ha.)	35.30	35.25	58.95
75 % RDF + Neem cake (2.5t/ha)	34.40	34.70	58.55
100% RDF (100: 60:80) Kg. /ha.	29.42	29.34	61.83
SEm±	1.647	1.588	1.416
CD@5%	4.659	4.493	4.004

Golden Acre (pooled Data of 2016-17 & 2017-18)

Table 2: Effect of different INM combination TSS%, Moisture % and Days to 50% head initiation in cabbagecv Golden Acre (pooled Data of 2016-17 & 2017-18)

Treatment	Plant Height at Harvest (cm)	Length of Leaf at Harvest (cm)	Diameter of head (cm)	Weight of untrimmed head (g)	Weight of trimmed head (g)	Yield (t/ha)
Control	26.43	24.09	13.57	513.37	386.87	30.87
Biofertilizer (PSB) 3 Kg/ha.	27.80	24.39	17.10	550.70	415.65	37.35
FYM (25 t/ha)	28.61	26.50	17.27	561.29	424.73	39.02
Vermicompost (5 t/ha.)	29.23	28.56	17.59	618.29	446.42	41.36
Neem cake (2.5t/ha)	28.99	26.91	17.42	577.87	434.78	39.70
50 % RDF Kg./ha	29.42	29.34	17.88	630.80	466.23	43.60
50 % RDF + Biofertilizer (PSB) 3 Kg/ha.	29.96	29.46	18.06	636.25	475.83	44.12
50 % RDF + FYM (25 t/ha)	30.26	29.74	18.13	649.45	486.38	44.96
50 % RDF + Vermicompost (5 t/ha.)	31.30	31.23	18.27	667.63	561.46	50.42
50 % RDF + Neem cake (2.5t/ha)	30.95	29.92	18.21	663.26	558.12	49.41
75 % RDF Kg./ha	32.16	31.25	18.42	676.46	564.62	50.85
75 % RDF + Biofertilizer (PSB) 3 Kg/ha.	32.69	32.49	18.46	684.68	572.14	51.55
75 % RDF + FYM (25 t/ha)	32.93	34.01	18.71	695.20	578.74	51.83
75 % RDF + Vermicompost (5 t/ha.)	34.40	34.70	19.20	717.30	592.66	56.79
75 % RDF + Neem cake (2.5t/ha)	33.38	34.12	18.93	709.25	579.13	55.66
100% RDF (100: 60:80) Kg. /ha.	35.30	35.25	19.48	720.84	620.80	57.62
SEm±	1.647	1.588	0.559	26.263	21.481	3.612
CD@5%	4.659	4.493	1.580	74.295	60.768	10.216

Conclusion

The results of present investigation were concluded as the application of 75% RDF and 2.5t/ha can prove a better option for cabbage to get maximum monetary return with improving the soil health and environmental health.

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