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Effect of integrated nutrient management, yield and quality of cabbage (*Brassica oleracea* L. var. *capitata*) in Bilkishganj M.P. region

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Abstract
In the diversified farming system, integrated nutrient management under different crop geometry along with growth regulators is the most appropriate approach to solve various issues related to productivity, quality as well as sustainability in efficient and economical way. Cabbage is well known for its nutritive and health benefits. A field experiments were conducted to study the effect of vermicompost, inorganic fertilizers and growth retardant (cycocel) with different spacing on cabbage carried out in factorial randomized block design at Agriculture Farm and Department of Horticulture, Mansarovar Global University Sehore (Madhya Pradesh) India during the two year 2023-24 and 2024-25. Results indicated that yield and yield contributing components of cabbage the highest poold plant height(100% RDF Inorganic Fertilizer with 45 X 45 CM spacing48.38 cm), highest poold plant spread was observed in 50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45 X 30 CM spacing75.17cm, highest poold number of open leaves% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45 X 45 CM spacing20.37, highest poold leafarea50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45 X 45 CM spacing1659.35, maximum poold thickness of main stem25% RDF Inorganic Fertilizer + 75% Organic (Vermicompost) with 45 X 45 CM spacing 45.44, highest poold days taken to head initiation with F_2S_1 72.57, The highest poold days taken to head maturity 16.59, highest poold head diameter 38.24, highest poold head size 15.59, highest poold gross head weight (kg/head) 3.58, highest poold net head weight (kg/head) 3.34, highest poold yield (kg/plant) 3.06.

Keywords: Cabbage, Vermicompost, Fertilizer, Cycocel, Spacing, Yield

Introduction

Cabbage (*Brassica oleracea*e L. var. *capitata*) 2n =2x=18 is one of the most economically and nutritionally important crop of Brassicaceous family. It is cultivated in 90 countries. It is also a vital part of fast food in Indian -cuisine due to wider adaptability, economical and all year availability. It has important values because of its nutrient values like vitamins and protein. Vegetables are source of essential vitamins such as vitamin C, vitamin A, vitamin B1, vitamin B6, vitamin B9, vitamin E, and minerals, dietary fiber and phytochemicals to humans. Due to the intensive cultivation practices and injudicious use of macronutrients, soils are becoming deficient in secondary micronutrients. In addition to macronutrients, micronutrients have been found to be beneficial for cabbage production.

Vegetables are foods that provide protection. In addition to minerals like potassium, fiber, and folate, consuming foods high in folate, such as spinach, tomatoes, and bell peppers, is crucial for women of reproductive age in order to avoid neural tube abnormalities in their unborn children. Additionally, vegetables help to maintain the body's alkalinity balance. The three most essential base elements required to neutralize the acid created by the body are calcium, magnesium, and potassium with addition to aiding with apatite satisfaction, the spongy moss produced by the majority of the fibrous structure of vegetable leaves, stems, bulbs, tubers, and roots also helps push food down the digestive canal, so avoiding constipation. Mineral salts, moderate acid juices and chemicals further aid the digestive function with their laxative effects. Vegetables are therefore crucial to human nutrition as preventive foods. It is also crucial for maintaining the expanded population's nutritional security. Compared to grains, vegetable crops yield four to ten times as much. Because they are the least expensive natural food source and may effectively complement the nation's staple cereals, veggies are therefore essential to the food chain.

Dietitians advised us to consume 300 g of vegetables per day. According to the Indian Council of Medical Research, for optimal growth and development, one should take 125 g of leafy vegetables, 75 g of root vegetables, and 100 g of other vegetables daily. As a result, we must produce more vegetables than we present.

India has a diverse variety of agroclimatic conditions that make it possible to cultivate a number of vegetable crops. With an area of 10099.82 thousand ha under vegetable cultivation, production of 185883.22 thousand MT and productivity of 18.40 t/ha, India is now the world's second-largest producer of vegetables, after China, and accounts for 11% of global production (National Horticulture Database 2018-19). In Madhya Pradesh, on the other hand, there are 1256.27 thousand ha, production of 27703.82 thousand MT and productivity of 22.05 t/ha.

India's natural environment offers us a wide variety of vegetable crops that may be grown throughout the year. Vegetables come in a variety of forms that can be eaten as leaves, stems, flowers, fruits, or seeds. Given the seasonality and soil requirements, farmers can grow vegetables all year round to generate a consistent flow of income to cover daily costs. Vegetable crops of the short duration kind can be cultivated as intercrops or as the main crop in horticulture or agronomy. As a result, a farmer can choose from a wide variety of crops to modify his cropping pattern under the circumstances.

The Romans and Greeks utilized cabbage (*Brassica oleracea*e L. var *capitata*), one of the earliest Cole crops, as a vegetable. One of the most widely grown cole crops in India, it produces 9095 thousand MT of cabbage overall from an area of 399 thousand hectares (National Horticulture Database 2018-19). In Madhya Pradesh, however, a total of 302.97 thousand MT of cabbage is produced from an area of 9.06 thousand hectares, with a productivity of 33.44 t/ha (National Horticulture Database, 2017-18). As a cole crop, cabbage is descended from wild cliff cabbage, or colewort's, from whence the word "cole" comes. With chromosomal number 2n=2x=18, it is a member of the Brassicaceae or Crucifereae family. It is said to have come from the Mediterranean area and Western Europe (De Candolle, 1882). The original form does not have a header. Much later, in the 16^{th} century or more, the head cabbage was mentioned.

Farmers in Madhya Pradesh have adopted cabbage as a significant crop because they prefer to grow known crops using traditional ways. The current study was conducted in Madhya Pradesh to investigate the many aspects of cabbage growth, yield, and quality. It aimed to hypothesis the impact of fertilizers, Vermicompost, and growth regulator concentrations at varying spacings on cabbage as Farmers in the Bhopal region do not, however, have complete access to specific information on the appropriate dosage of Vermicompost, cycocel, and spacing.

Therefore, the investigation was conducted with the following objectives.

- Evaluation of Integrated Nutrient Management
- Interaction of Integrated Nutrient Management and crop geometry
- Evaluation of quality parameter with different treatments
- Evaluation of yield parameter with different treatments

Materials and Methods

The present investigation entitled Effect of Integrated Nutrient Management, Yield and Quality of Cabbage (*Brassica oleracea* L. var. *capitata*) in Bilkishganj M.P. region. was carried out at Agriculture Farm and Department of Horticulture, Mansarovar Global University Sehore (Madhya Pradesh) India during the two year (2023-24 to 2024-25). The literature available with respect to present study has been reviewed as under:

Site of Experiment

The present investigation was carried out in the Agriculture Farm and Department of Horticulture, Mansarovar Global University Sehore (Madhya Pradesh) India during the year 2023-24 and 2024-25. Geographically, the research farm of the university is located at 25.45ºN latitude and 78.61ºE longitude at an altitude of 285 m from mean sea level having a sub-tropical climate. Different parameter related to vegetative growth and yield parameters were measured at the research farm.

Soil Condition

The soils of experimental field of the university are comes under the order of Entisols. The soil of experimental plot red parwa soil proper drainage and optimum water holding capacity.

Design and layout experiment

The experiment was conducted in open field condition at Agriculture Farm and Department of Horticulture, Mansarovar Global University Sehore (Madhya Pradesh). The experiment was laid out in a factorial randomized block design with 36 treatment combinations with three replications. The experimental details are given below:

Experimental details

Variety to be selected	:	Pusa Drum Head
Design of Experiment	:	Factorial RBD
Treatment combinations	:	12
Replications	:	3
Total number of plots	:	36
Gross plot size	:	3.20 x 2.80 m^2
Net plot size	:	2.70 × 1.8 m^2
Plant distance	:	30x30 cm, 30x45c m and 45×45 cm

Treatment details

Integrated Nutrients Management

F_1 - 100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha)

F_2 -75% RDF Inorganic Fertilizer + 25% Organic (Vermicompost)

F_3 - 50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost)

F_4 – 25% RDF Inorganic Fertilizer + 75% Organic (Vermicompost)

Spacing

S_1- 30x30 cm

S_2- 45x30 cm
S_3- 45x45 cm

Results and Discussion

The present investigation on Effect of Integrated Nutrient Management, Yield and Quality of Cabbage (*Brassica oleracea* L. var. *capitata*) in Bilkishganj M.P. region. was carried out with a view to find out each character have been presented, discussed and possible interpretations have been drawn in this chapter and various experiments during 2023-24 and 2024-25 result obtained from this investigation are presented as follows.

The integrated nutrient management, crop geometry and cycocel at 60 DAT (days after transplanting) the maximum pooled plant height was recorded in treatment F_1S_3 (48.38 cm) with were most effective significantly superior followed by second significantly F_2S_3 (47.73 cm) the minimum pooled plant height was recorded in treatment F_3S_1 (41.10 cm). These results are in consequence with the findings of Meena and Paliwal (2003) [13], Patil *et al.*, (2003) [14], Sharma *et al*. (2009) [18] and Kumar and Dhar, (2010) [11].

The integrated nutrient management, crop geometry and cycocel at 60 DAT (days after transplanting) the maximum pooled plant spread (cm^2) was recorded in treatmentF_3S_2 (75.17) with were most effective significantly superior followed by second significantly F_4S_2 (74.74) the minimum pooled plant spread (cm^2) was recorded in treatment F_1S_1 (67.85). Similar results are also recorded by, Sharma and Chandra (2002) [19], in cabbage.

The interactive effect of fertilizer and cycocel shows on 60 days that the spacing on number of open leaves were found the mean maximum and minimum interaction during 2023 - 24 and 2024 - 25 and Perusal of the pooled data it was the maximum and minimum numbers of open leaves found in treatment (20.37 and 18.20 cm) during 2023 - 24 and 2024 - 25 respectively. These results are in similar line with the results of Reid and Carr (1967) [17], Hangarge (1997) [8], Meena and Paliwal (2003) [13].

The interactive effect of fertilizer and cycocel shows on 60 days that the numbers of interaction of effect INM and spacing the mean maximum and minimum interaction during 2023 - 24 and 2024 - 25 and Perusal of the pooled data it was the maximum and minimum open leaf area found in treatment (1659.35 cm and 1301.82 cm) during 2023 - 24 and 2024 - 25 respectively. These results are in accordance with the findings of Emden and Cockshull (1967) [5], Sharma and Arya (2001) [20], Chitrakar (2004) [15] on cabbage.

The interactive effect of fertilizer and cycocel shows on 60 days that the numbers of interaction of effect INM and spacing on thickness of main stem (mm) were found the mean maximum and minimum interaction during 2023 - 24 and 2024 - 25 and Perusal of the pooled data it was the maximum and minimum thickness of main stem (mm) found in treatment (45.44mm and 40.08 mm) during2023 - 24 and 2024 - 25 respectively. These results were in the line of findings reported by Chinaswamy and Marikulandi (1996), Subham (1998), Mehandran and Kumar (1998) and Lendve *et al*. (2011) in cabbage.

The interactive effect of fertilizer and spacing the pooled data it was the maximum and minimum days taken to head initiation found in treatment (72.57days and 67.81 days) during 2023 - 24 and 2024 - 25 respectively. The results are in accordance with the findings of Kumar *et al.* (2008) [10].

The interactive effect of fertilizer and spacing showed that the days taken to head maturity were found thepooled data itwas the maximum and minimum days taken to head maturity found in treatment (16.59 days and 11.62 cm) during 2023 - 24 and 2024 - 25 respective years. The results are in conformity with the findings of Hiwal *et al.* (2010), Shelke *et al.* (1999) [21] in brinjal, Shizou *et al.* (1999) [22] in capsicum.

The interactive effect of fertilizer and spacing appeared that the head diameter were found the pooled data it was the maximum and minimum head diameter found in treatment (38.24 cm and 33.75 cm) during 2023 - 24 and 2024 - 25 respectively. The results are in conformity with the findings of Krishna *et al.* (2018) [9] in chrysanthemum.

The interactive effect of fertilizer and spacing showed that the head size were found the pooled data it was the maximum and minimum head size found in treatment (15.59 cm and 13.45 cm) during 2023 - 24 and 2024 - 25respectively.These results were in the line of findings reported by Gholampour *et al.* (2012) [7] in cabbage.

The interactive effect of fertilizer and spacing appeared that the pooled data it was the maximum and minimum net head weight found in treatment (3.34kg and 1.17kg) during 2023 - 24 and 2024 - 25 respectively. The similar findings were also reported by Emden and Cockshull (1967) [5] in cabbage.

The interactive effect of fertilizer and spacing exhibited that the gross head weight were found the pooled data it was the maximum and minimum gross head weight found in treatment (3.58 kg and 1.58 cm) during 2023 - 24 and 2024 - 25 respectively. The similar findings were also reported by Emden and Cockshull (1967) [5] in cabbage.

The interactive effect of fertilizer and spacing the pooled data it was the maximum and minimum Yield per hectare found in treatment (3.06 q/ha and 1.04) during 2023 - 24 and 2024 - 25 respectively. These results were supported with the findings of Gaur and Mukhargee (1976) [6], Hangarge (1997) [8], Dalal *et al.* (2010) [3] and Chaudhary *et al.* (2018) [2].

Application of 300 ppm CCC along with INM involving50% RDF through Inorganic Fertilizer and 50% Organic (Vermicompost) using 45x45 cm spacing maybe recommended for producing higher cabbage yield (head weight, head diameter, headsize), better quality (ascorbic acid, phosphorus, calcium, magnesium, total chlorophyll) and maximum returns in Mansarovar region.

Table 1: Pooled effects of various inorganic-organic fertilizer combinations and planting spacings on plant height, spread, leaf number, leaf area, stem thickness, and days to head initiation

Treatment	Treatment combinations	Plant Hight	Plant spread (cm^2)	Number of open leaves	Leaf area (cm^2) of open leaves	Thickness of main stem (mm)	Days taken to head initiation
		Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
F1S1	100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 30 X30 CM spacing	43.59	67.85	18.31	1301.82	42.65	70.21
F1S2	100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 45 X 30 CM spacing	47.36	68.51	18.97	1339.45	40.08	70.39
$F1S_3$	100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 45 X 45 CM spacing	48.38	72.18	19.71	1336.48	40.10	70.64
F2S1	75% RDF Inorganic Fertilizer + 25% Organic (Vermicompost) with 30 X30 CM spacing	43.88	72.74	18.20	1414.70	43.47	72.57
F2S2	75% RDF Inorganic Fertilizer + 25% Organic (Vermicompost) with 45 X 30 CM spacing	45.92	74.39	19.22	1453.56	43.89	70.50
F2S3	75% RDF Inorganic Fertilizer + 25% Organic (Vermicompost) with 45 X 45 CM spacing	47.73	72.65	19.74	1522.68	44.70	70.37
F3S1	50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 30 X30 CM spacing	41.10	72.75	19.32	1514.10	43.87	68.30
F3S2	50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45 X 30 CM spacing	44.21	75.17	19.85	1573.26	44.69	68.49
F3S3	50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45 X 45 CM spacing	47.20	73.71	20.37	1659.35	45.43	67.81
F4S1	25% RDF Inorganic Fertilizer + 75% Organic (Vermicompost) with 30 X30 CM spacing	42.91	71.47	18.94	1463.18	43.58	68.24
F4S2	25% RDF Inorganic Fertilizer + 75% Organic (Vermicompost) with 45 X 30 CM spacing	42.90	74.74	19.18	1514.28	43.43	68.87
F4S3	25% RDF Inorganic Fertilizer + 75% Organic (Vermicompost) with 45 X 45 CM spacing	43.00	74.47	19.50	1535.45	45.44	68.11
S Em±		0.45	2.17	0.34	19.91	1.73	0.43
CD at 5%		0.18	1.61	0.78	56.51	1.60	0.20

Table 2: Table presenting pooled effects of fertilizer-organic combinations and planting spacings on head diameter, head size, net and gross head weight, yield, and days to head maturity

Treatment	Treatment combinations	Head diameter (cm)	Head size (cm)	Net head weight (kg)	Gross head weight (g)	Yield (q/ha)	Days taken to head maturity
		Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
F1S1	100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 30 X30 CM spacing	33.75	14.23	1.46	1.86	1.09	14.67
F1S2	100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 45 X 30 CM spacing	35.77	14.61	2.00	2.39	1.84	12.36
F1s3	100% RDF Inorganic Fertilizer (120:80:60 NPK kg/ha) with 45 X 45 CM spacing	36.02	14.71	2.15	2.56	2.13	11.97
F2S1	75% RDF Inorganic Fertilizer + 25% Organic (Vermicompost) with 30 X30 CM spacing	36.25	13.45	1.70	2.10	1.04	16.59
F2S2	75% RDF Inorganic Fertilizer + 25% Organic (Vermicompost) with 45 X 30 CM spacing	33.95	13.83	1.47	1.87	1.28	15.75
F2S3	75% RDF Inorganic Fertilizer + 25% Organic (Vermicompost) with 45 X 45 CM spacing	34.17	13.89	1.48	1.89	2.13	15.54
F3S1	50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 30 X30 CM spacing	36.50	15.03	1.17	1.58	1.19	12.43
F3S2	50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45 X 30 CM spacing	37.58	15.36	2.33	2.74	1.76	11.62
F3S3	50% RDF Inorganic Fertilizer + 50% Organic (Vermicompost) with 45 X 45 CM spacing	37.66	15.59	3.34	3.58	3.06	12.04
F4S1	25% RDF Inorganic Fertilizer + 75% Organic (Vermicompost) with 30 X30 CM spacing	36.45	15.04	1.69	2.10	1.32	12.99
F4S2	25% RDF Inorganic Fertilizer + 75% Organic (Vermicompost) with 45 X 30 CM spacing	37.55	15.34	2.04	2.45	1.97	11.76
F4S3	25% RDF Inorganic Fertilizer + 75% Organic (Vermicompost) with 45 X 45 CM spacing	38.24	15.39	2.51	2.92	2.75	12.39
S Em±		0.25	0.04	0.11	0.11	0.07	0.26
CD at 5%		0.72	0.22	0.28	0.28	0.20	0.76

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