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Effect of varieties and nutrient levels on yield and quality of cabbage (*Brassica oleracea* var. *capitata* L.)

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Abstract
The present disquisition was convened at Horticultural Research Farm, College of Agriculture, Tikamgarh (Madhya Pradesh) was convened during the *rabi* season of 2020-21 with a view to studying Effect of Varieties and Nutrient Levels on Yield and Quality of Cabbage (*Brassica oleracea* var. *capitata* L.). Twelve treatment combinations of two varieties (V_1 selection-21, V_2 Golden Acer) and six nutrient levels *viz.* (NPK-75:60:60, 75:80:60, 100:60:60, 100:80:60, 125:60:60, 125:80:60 kg h^{-1}). The experimental design used in a factorial randomized block design with three replication. V_2 Golden Acer seems to be growing taller compared to other varieties plant height (21.72, 29.84, 35.36 cm), girth of stem (1.49, 2.51, 3.77 cm), Number of non-wrapping leaf $plant^{-1}$ (10.6, 12.85) Yield parameters *i.e.* Head weight (g) / fresh weight of head (g) plant $^{-1}$ at harvest (1508.17), Diameter of head cm (13.64), Head yield kg $plot^{-1}$(19.15), Head yield quintal ha^{-1}. (199.48). The growth, yield, and quality parameters were significantly superior for nutrient levels N_6 (125:80:60 kg NPK ha^{-1}) compared to other nutrient levels. Similarly the interaction V_2N_6 showed better performance in all these aspects for cabbage. Consequently, variety V_2 (Golden Acer), Nutrient level N_6, and interaction V_2N_6 demonstrated superior results in terms of growth, yield, and economics for cabbage.

Keywords: Cabbage varieties, nutrient levels (N P K), yield and yield attributes

Introduction
Cabbage (*Brassica oleracea* var. *capitata* L.) is the most important vegetable crop of the family Cruciferae and is biennial and herbaceous in nature. It is rich in important minerals and vitamins such as A, B1, B2, and C. Cabbage leaves are also known for their medicinal cooling effects. It is a good source of Ca, K and also an important source of anti oxidants whereas it rich in some substances with high antioxidants capacity like Vit.-C, carotenoids, and polyphenols (Leja *et al.*, 2007) [1].

Cabbage is cultivated on 2.47 million ha. area all over the world with 71.26 million metric tonnes production with average of 28.81metric tonnes ha^{-1} China occupies the first rank in area and production followed by India. The total production of 6.870 MT is achieved by cultivating it on 0.310 M ha. Resulting in an average productivity of 22.1 mt/ha. The place of Madhya Pradesh in the Cabbage production is 7th. Mandla district in MP. is a largest vegetables producing district. In Mandla district in MP 44,656.33 tonnes vegetables produced in the year of 2016-17.

Cabbage is Highly nutritious vegetable compared to cauliflower and knoll-khol, boasting significant amounts of vitamin-A (2000 IU), thiamine (0.06mg), riboflavin (0.03 mg) and vitamin-C (124mg) per 100 g of its edible part. It is also rich in essential minerals minerals such as K_2O (114 mg), phosphorus (44 mg), calcium (39 mg), sodium (14.1 mg), and iron (0.8 mg) per 100 g of its edible part. (Fageria *et al*., 2003) [2]. Cabbage is not commonly used as salad fresh but also used as boiled, cooked, curing, pickling, and dehydration purposes. It neutralizes acidity, improves digestion, and appetite (Katyal and Chadha, 1985) [3]. Cabbage is believed to have potential anti-cancer properties and may offer protection against bowel cancer due to the presence of indole-3-carbinal, although further research is required to fully understand its effects and confirm its role in cancer prevention. The leaves are used to recover from ulcers and wounds.

Sauerkraut is a traditional fermented food made by fermenting shredded cabbage leaves under pressure. The fermentation process creates a tangy flavor and preserves the cabbage. Its a popular condiment and ingredient used in various dishes in their juice have a curative effect on scurvy disease. It is also used to prepare stuffed ‘parathas’

Phosphorus is crucial for living organisms as it forms an integral part of phospholipids, nucleic acid, nucleoproteins, and coenzymes, playing a significant role in their composition and functioning potassium is the nutrient and quality improvement involves carbohydrate metabolism, enzyme activation, nitrogen uptake, protein synthesis, and translocation of accumulated substance (Singh *et al.*, 2004) [5]. Potassium increase disease resistance to the plant. Minimize wilt in cabbage plants to optimize water usage, leading to increased protein and chlorophyll formation, thereby enhancing the overall quality of cabbage head about to with concerning taste and keeping quality (Rutkauskiene and Poderys, 1999) [4].

Materials and Methods

The field experiment investigation carried out during the Rabi season 2020-21 at the research form of the, Department of Horticulture (vegetable science) JNKVV, college of agriculture, Tikamgarh (M.P.) Tikamgarh is situated in the bundlekhand zone (agro-climatic zone –VIII) in the north-eastern part of Madhya Pradesh, at 24' 430 North latitude and 78' 490 East longitude, with an altitude of 358 meters above mean sea level. The experimental field's topography is plain, and the soil is medium black soil with a loamy texture and uniform topography.

The study involved two varieties, V_1 (selection-21) and V_2 (Golden Acer), along with six different nutrient levels. The treatment (N_1-N_6), were applied at different nutrient levels, measured in kg NPK per hectare, as follow (N_1-75:60:60, N_2-75:80:60, N_3-100:60:60, N_4-100:80:60 N_5-125:60:60, N_6-125:80:60). The experiment was organized in a factorial randomized block design consisting of twelve treatment combination, and each combination was replicated three times. Before transplanting and during field preparation, the entire amount of phosphorus (P) and potassium (K) along with half dose of nitrogen (N) as per each treatment was applied. The nutrient were supplied in the from of DAP (Di-Ammonium phosphate) for phosphorus, MOP (Muriate of potash) for potassium, and urea for nitrogen. Entire quantity of P and K and half dose of N as per treatment was applied in the form of DAP, MOP and Urea, respectively before transplanting at the time of field preparation. After transplanting the seedlings in the field with a spacing of 60 x 45 cm (row-to-row x plant-to-plant) in the last week of October 2020, the remaining dose of nitrogen was given to the cabbage plants at 20 days after transplanting. The seedling that were selected for transplantation were 28 days old and had a uniform height. Following the transplanting process the plant were promptly given irrigation to enhance their establishment, subsequently, irrigation was provided based on the plants specific requirement. Randomly, five plants were selected from each plot and tagged for further monitoring. The observations were recorded for various parameters, including plant height (cm), stem girth (cm), number of non-wrapping leaves, fresh head weight of (g), head diameter (cm), head yield (kg plot^{-1}), and head yield (q ha^{-1}). The economics analysis was conducted using the prevailing market prices of different inputs and outputs.

Yield Parameters and Yield

Varieties

Maximum values of head weight 1508.17g, Diameter of head 13.64cm and Head yield plot^{-1} 19.15kg head yield 199.48 qha^{-1}were measured significantly under variety Golden Acer over variety Selection-21 head weight 1501.94g, Diameter of head 13.29cm and Head yield plot^{-1} 18.94kg head yield 199.48 qha^{-1}respectively The observed difference in head length of cultivars is likely attributed to the variations in their genotypes. The finding is consistent with previous reports by researcher in the field. Singh *et al*. (2015) [6] in cauliflower.

Nutrient levels

Higher values of head weight 1532.50 g, Diameter of head 14.47 cm and Head yield plot^{-1} 20.48 kg head yield 213.28 qha^{-1} were recorded with nutrient level N_6 (NPK-125:80:60 kg ha^{-1}) followed by N_5, N_4, N_3 and N_2, while minimum values (head weight 1481.17 g, Diameter of head 12.60 cm and Head yield plot^{-1}18.23 kg head yield 189.84 qha^{-1} The respective observation were made under nutrient levels N_1 (NPK-70:60:60 kg ha^{-1}) The enhanced nitrogen supply likely accelerated chlorophyll and amino acid synthesis leading to effective carbohydrate utilization and enlargement of the head. These findings are in agreement with Yanglem and Tumbare (2014) [8] in cauliflower. Verma and Nawange (2015) [7] in cabbage, The presence of the three major element in a suitable combination has indeed been proven to enhance vegetative growth in plants, with similar results reported in various studies reported by Mankar *et al*. (2015) [9] in cabbage, Singh *et al*. (2015) [6] in broccoli. Its possible that the improved availability of metabolic and auxin activities in the plants led to increased fresh weight of leaves and head, as well as total head yield per plant and hectare. These factores can significantly influence plant growth and productivity. Mankar *et al*. (2015) [9] in cabbage, These findings are in close conformity to Kumari *et al*. (2015) [9, 10] Verma and Nawange (2015) [7].

Table 1: Effect of varieties, nutrients levels and their interaction on yield of cabbage

Treatment	Head weight (g)	Diameter of Head (cm)	Head yield (kg) per plot	Head yield quintal per hac.
Varieties				
V_1(Selection-21	1501.94	13.29	18.94	197.31
V_2(Golden acer	1508.17	13.64	19.15	199.48
S.Em±	1.89	0.08	0.04	0.45
CD at 5%	5.55	0.23	0.13	1.31
Nutrient Levels				
N_1	1481.17	12.60	18.23	189.84
N_2	1490.83	13.02	18.38	191.41
N_3	1499.17	13.27	18.70	194.79
N_4	1519.17	14.00	19.50	203.13
N_5	1507.50	13.43	19.00	197.92
N_6	1532.50	14.47	20.48	213.28
S.Em±	3.28	0.14	0.07	0.77
CD at 5%	9.61	0.40	0.22	2.27

Interaction (V X N)				
V_1N_1	1478.33	12.57	18.05	188.02
V_1N_2	1488.33	12.63	18.45	192.19
V_1N_3	1496.67	13.03	18.60	193.75
V_1N_4	1513.33	13.93	19.40	202.08
V_1N_5	1506.67	13.13	18.90	196.88
V_1N_6	1528.33	14.43	20.25	210.94
V_2N_1	1484.00	12.63	18.40	191.67
V_2N_2	1493.33	13.40	18.30	190.63
V_2N_3	1501.67	13.50	18.80	195.83
V_2N_4	1525.00	14.07	19.60	204.17
V_2N_5	1508.33	13.73	19.10	198.96
V_2N_6	1536.67	14.50	20.70	215.63
S.Em±	4.63	0.19	0.11	1.10
CD at 5%	NS	NS	NS	NS

Conclusion

Considering the condition in Tikamgarh (M.P.) it is observed that the Golden Acer cultivar of cabbage shows superior performance in terms of plant growth, yield, quality, and profitability compared to selection-21 cv. Therefore, cultivating Golden Acer with the recommended supplementation of 125 kg/ha nitrogen, 80kg/ha phosphorus, and 60kg/ha potassium would be a more favorable option.

Suggestions for further work

1. It is essential to replicate the investigation to confirm the results.
2. It is worth considering the integration of organic manure and bio fertilizers in addition to chemical fertilizer during testing.
3. For future studies, it would be beneficial to examine nutrient levels and test a broader range of varieties.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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