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EFFECT OF SOWING DATES AND ORGANIC NUTRIENTS ON GROWTH AND YIELD OF CABBAGE (*BRASSICA OLERACEA* VAR. CAPITATA) IN TEMPERATE KASHMIR INDIA

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ABSTRACT

Cabbage (*Brassica oleracea* var. capitata) is an important cole crop cultivated widely in India where optimizing sowing time and organic nutrient inputs is essential for maximizing productivity under temperate conditions. A field experiment was conducted during the *Rabi* 2021–22 at the Research Farm of Vegetable Science, SKUAST-Kashmir, using a split-plot design with three replications. Treatments included three sowing dates (30th, 32nd, and 34th Standard Meteorological Weeks) and four organic nutrient treatments (100% FYM, 75% FYM + biofertilizer, 100% vermicompost, and 75% vermicompost + biofertilizer). Growth and yield parameters were evaluated and analyzed using LSD at 5% significance. Early sowing (30th SMW) significantly enhanced vegetative growth, head development, and yield attributes compared to later sowing. Among organic treatments, 75% vermicompost + biofertilizer resulted in maximum plant height (17.7 cm), plant spread (39.6 cm), head diameter (18.2 cm), and yield (297.7 q/ha). The interaction of early sowing with 75% vermicompost + biofertilizer produced the highest head yield (383.2 q/ha). These results indicate that early sowing coupled with Vermicompost and Biofertilizer application is the most effective strategy for improving cabbage growth and productivity in temperate climates.

***Keywords*:** biofertilizer; cabbage; organic inputs; sowing date; vermicompost; yield.

Introduction

Cabbage (*Brassica oleracea* var. *capitata*) is an economically significant leafy vegetable in the Brassicaceae family and widely cultivated across diverse agro-climatic zones of India. Among the cole crops, it holds a first position in production and second in cultivated area (Singh *et al.,* 2023). As reported by National Horticulture Board (NHB; 2021), cabbage is cultivated on approximately 4.04 lakh ha with an annual production of 95.86 lakh tonnes, underscoring its importance in the Indian vegetable sector. Cabbage exhibits considerable morphological diversity, and varietal differences such as leaf texture and head compactness are widely used for classification and varietal improvement (Parkash *et al.,* 2008). The crop is not only valued for its high yield potential but also for its nutritional significance, being a rich source of essential amino acids, β-carotene, ascorbic acid, and minerals that contribute to its dietary and health-promoting properties (Singh *et al.,* 2010). Its anti-carcinogenic compounds and antioxidant potential further elevate its consumer preferance and market demand. Despite its importance, sustaining high productivity while preserving soil health remains a key

challenge. In this context, adopting sustainable nutrient management strategies, particularly the use of organic inputs and biofertilizers, provides an eco-friendly alternative to chemical fertilizers and plays a pivotal role in improving growth, yield, and long-term sustainability (Rana *et al.,* 2023).

Materials and Methods

The experiment was conducted out during the *Rabi* 2021–22 at the Research Farm of Vegetable Science, Faculty of Horticulture, SKUAST-Kashmir, Srinagar. The site, situated at 38.1°N latitude, 74.89°E longitude, and 1,587 m above mean sea level, characterized by moderately hot summers and cold winters. A split-plot design with three replications was adopted, involving three sowing dates i.e., 30th (D_1), 32nd (D_2), and 34th (D_3) standard meteorological week (SMW) and four organic nutrient inputs viz., 100% FYM @ 30 t/ha (S_1), 75% FYM + biofertilizer @ 5 l/ha (S_2), 100% vermicompost @ 15 t/ha (S_3), and 75% vermicompost + biofertilizer@ 5 l/ha (S_4). The cabbage cultivar 'Golden Acre' was transplanted at spacing of 60 × 45 cm. Initial soil analysis indicated a pH of 6.95, electrical conductivity (EC) of 0.21 dS/m, organic carbon content of 0.78%, and available nutrient levels of 298.73 kg/ha nitrogen, 23.62 kg/ha phosphorus, and 199.37 kg/ha potassium. Data on plant growth and yield attributes were analyzed using the least significant difference (LSD) test at the 5% probability level (Gomez KA & Gomez AA 1984).

Factor A- Date of sowing

- D_1-30th Standard meteorological week (23rd July to 29th July)
- D_2-32nd Standard meteorological week (6th August to 12th August)
- D_3-34th Standard meteorological week (20th August to 26th August)

Factor B- Organic sources

- *S_1- 100% FYM (30t/ha)*
- *S_2- 75% FYM (22.5t/ha) + Biofertilizer@5l/ha*
- *S_3- 100% Vermicompost (15t/ha)*
- *S_4- 75% Vermicompost (11.25t/ha) + Biofertilizer @5l/ha*

Soil application of biofertilizers *viz*., *Azotobacter*, *Phosphate Solubilizing Bacteria* and *Potassium Solubilizing Bacteria* was given @5l/ha.

Results and Discussion

Sowing date had a pronounced and significant impact on vegetative growth and yield formation in cabbage (Table 1). The 30th SMW (D_1) consistently outperformed later sowings for plant height (20.1 cm), plant spread (46.4 cm) and non-wrapper leaves (12.7), translating into superior head development (19.7 cm) and yield in terms of head weight (1.05 kg plant^{-1}), head yield (352.4 q ha^{-1}) and biological yield (384.6 q ha^{-1}). In contrast, 34th SMW (D_3) showed the weakest vegetative vigour and the lowest yield as head weight (0.55 kg plant^{-1}), head yield (183.3 q ha^{-1}) and biological yield (207.9 q ha^{-1}). These results clearly demonstrate that earlier transplanting aligns key growth stages with more favorable temperature and radiation conditions, promoting greater leaf expansion, photosynthetic activity and assimilate availability for head formation. Similar advantages of early have been reported for cabbage and Chinese cabbage in diverse environments (Singh *et al.,* 2010; Abed *et al*., 2015; Jat *et al.,* 2023).

Nutrient source also significantly influenced cabbage growth and yield (Table 1). The combination of 75% vermicompost + biofertilizer (S_4) resulted in the greatest plant spread, (39.0 cm), highest number of non-wrapper leaves (11.7/ plant^{-1}) and maximum head weight (0.89 kg plant^{-1}), head yield (297.7 q ha^{-1}) and biological yield (331.9 q ha^{-1}) followed by 75% FYM + biofertilizer (S_2), while 100% FYM (S_1) was generally inferior. The superiority of S4 likely reflects (i) the higher nutrient density and favourable mineralization pattern of vermicompost (Edwards *et al.,* 2010), (ii) improved root growth and rhizosphere activity (Arancon *et al.,* 2004), and (iii) enhanced nutrient uptake facilitated by biofertilizer inoculants (Vessey J K, 2003). Similar positive effects of integrating vermicompost with biofertilizers on growth and marketable yield have been documented in cabbage (Adhikari *et al.,* 2023; Bhattarai *et al.,* 2023) and other vegetables crops (Rana *et al.,* 2023).

The D × S interaction was significant for key morphological and yield traits (Table 2). The combination D_1 × S_4 (early sowing with 75% vermicompost + biofertilizer) produced the maximum plant height (20.6 cm), spread (50.6 cm), head diameter (20.3 cm), and yield in terms of head weight (1.15 kg plant^{-1}), head yield (383.2 q ha^{-1}) and biological yield (421.2 q ha^{-1}). This treatment also exhibited a favorable shoot/root balance (S/R 1.7), supporting efficient resource capture and partitioning to heads. Conversely, D_3 × S_1 (late sowing with 100% FYM) recorded the lowest growth and yields with a head weight of 149.9 q ha^{-1} and biological yield of 169.4 q ha^{-1}. The interaction pattern underscores that the benefits of early sowing are amplified when coupled with biologically active organic inputs that ensure steady nutrient availability and robust root

function. These results concur with earlier studies that (a) emphasize the importance of aligning planting windows with cooler, more favourable periods for head initiation and development (Singh *et al.,* 2010; Abed *et al.,* 2010; Zagade *et al*., 2010), and (b) demonstrate the beneficial effects of organic manures-particularly Vermicompost and biofertilizers in improving soil physic-chemical properties, nutrient availability, and yield stability in cabbage (Rana *et al.,*2023; Adhikari *et al.,* 2023; Bhattarai *et al.,* 2023). These findings highlight the need to integrate optimal sowing schedules and organic nutrient management with ongoing genetic improvement programs in cabbage (Parmar *et al.,* 2023)

Conclusion

The study demonstrates that early sowing (30th SMW) in combination with 75% vermicompost combined with biofertilizer significantly enhance cabbage growth, head formation, and yield. Favorable thermal conditions during early transplanting and improved nutrient availability from organic inputs were key drivers of superior performance. These results highlight the importance of synchronizing planting schedules with organic nutrient management to achieve sustainable productivity.

Table 1 : Effect of sowing dates and organic inputs on growth and yield attributes of cabbage

Treatment	PH (cm)	PS (cm)	NWL (No.)	CL (cm)	HD (cm)	S/R Ratio	HW (kg/plant)	HY (q/ha)	BY (q/ha)
30th SMW (D_1)	20.1	46.4	12.7	7.4	19.7	1.7	1.05	352.4	384.6
32nd SMW (D_2)	19.3	38.9	11.3	6.8	17.5	1.5	0.80	268.2	294.3
34th SMW (D_3)	12.1	27.1	7.4	5.8	15.1	1.4	0.55	183.3	207.9
CD (P≤0.05)	0.11	0.15	0.06	0.25	0.35	0.09	0.17	12.20	7.03
100% FYM (S_1)	16.6	35.8	9.4	6.4	17.0	1.52	0.71	238.8	262.3
75% FYM + BF (S_2)	17.4	37.7	10.8	6.8	17.9	1.5	0.83	276.6	306.5
100% VC (S_3)	16.8	36.7	9.8	6.5	17.2	1.5	0.77	258.8	281.5
75% VC + BF (S_4)	17.7	39.0	11.7	6.8	18.2	1.6	0.89	297.7	331.9
CD (P≤0.05)	0.07	0.08	0.09	0.09	0.29	0.01	0.04	7.04	11.08

SMW = Standard Meteorological Week; FYM = Farm Yard Manure; BF = Biofertilizer; VC = Vermicompost; PH = Plant height; PS = Plant spread; NWL = Non-wrapper leaves; CL = Core length; HD = Head diameter; S/R = Shoot/root ratio; HW = Head weight; HY = Head yield; BY = Biological yield.

Table 2 : Interaction effects of sowing dates and organic inputs on growth and yield of cabbage

Treatment (D × S)	PH (cm)	PS (cm)	NWL (No.)	CL (cm)	HD (cm)	S/R Ratio	HW (kg/plant)	HY (q/ha)	BY (q/ha)
$D_1 \times S_1$	19.6	43.5	12.05	7.2	18.7	1.6	0.98	326.5	356.5
$D_1 \times S_2$	20.2	46.4	13.3	7.6	20.0	1.7	1.08	359.9	390.9
$D_1 \times S_3$	19.8	45.0	12.0	7.2	19.8	1.7	1.02	339.9	369.9
$D_1 \times S_4$	20.6	50.6	13.4	7.6	20.3	1.7	1.15	383.2	421.2
$D_2 \times S_1$	18.8	38.4	10.1	6.5	16.8	1.5	0.72	239.9	260.1
$D_2 \times S_2$	19.7	39.0	11.5	6.7	18.1	1.5	0.82	273.2	303.2
$D_2 \times S_3$	19.0	38.5	10.8	6.6	16.9	1.5	0.79	263.2	281.3
$D_2 \times S_4$	19.8	39.5	12.9	7.0	18.3	1.6	0.89	296.5	331.5
$D_3 \times S_1$	11.6	25.4	6.1	5.6	14.3	1.4	0.45	149.9	169.4
$D_3 \times S_2$	12.2	27.8	7.8	5.9	15.5	1.4	0.59	196.6	225.5
$D_3 \times S_3$	11.6	26.5	6.8	5.7	14.7	1.4	0.52	173.3	193.3
$D_3 \times S_4$	12.8	28.8	8.8	5.9	15.8	1.5	0.64	213.2	243.2
CD (P≤0.05)	0.18	0.23	0.15	0.34	0.64	0.10	0.21	19.21	18.21

SMW = Standard Meteorological Week; FYM = Farm Yard Manure; BF = Biofertilizer; VC = Vermicompost; PH = Plant height; PS = Plant spread; NWL = Non-wrapper leaves; CL = Core length; HD = Head diameter; S/R = Shoot/root ratio; HW = Head weight; HY = Head yield; BY = Biological yield.

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