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Effect of different planting dates on growth, yield and quality of Cabbage (*Brassica oleracea var. capitata*) hybrids

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Abstract
Cabbage (*Brassica oleracea var. capitata* L.) is one of the most important cool season leafy vegetables in India, as well as in the world, belonging to the family Cruciferae. The investigation entitled Effect of different planting dates on growth, yield and quality of Cabbage (*Brassica oleracea var. capitata*) hybrids was carried out in *rabi* season at Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences Prayagraj. Study included four planting dates (15th September, 01st, 15th and 30th October) and three varieties (TMCH20-009, TMCH20-011 and POLO6640) each replicated thrice in Factorial Randomized Block Design (FRBD). Planting dates and different hybrids had significantly influenced the growth, yield and quality parameters at all the growth stages. Among all the treatment combinations, treatment T_8 (15 October + TMCH20-011) recorded significantly better plant height, number leaves per plant recorded. Among yield and yield attributing characters significantly better days to taken head initiation, net head weight polar diameter were recorded.

Keywords: Cabbage, planting dates, growth, yield, quality

1. Introduction
Cabbage was originally used to refer to multiple forms of *B. oleracea*, including those with loose or non-existent heads. A related species, *Brassica rapa*, is commonly named Chinese, napa or celery cabbage, and has many of the same uses. It is also a part of common names for several unrelated species. It is one of the most important members of genus Brassica. The word “Cabbage” is derived from the French word “coboche” means head. It is a popular vegetable around the world in respect of area, production and availability, almost round the year. In India it is generally grown during the rabi season. Cabbage was originally used for medicinal purposes earlier to cultivation and use as food. It occupies the pride place among cole crops due to its pleasant taste, delicious flavor, nutritive value and very low fat and calories content. It is grown for heads which are used as vegetable, eaten raw and frequently preserved as sauerkraut or pickle. It is also used as salad, cooked and mixed with potatoes for vegetable purpose, more in raw than in processed form.

The original family name of brassicas was Cruciferae, which derived from the flower petal pattern thought by medieval Europeans to resemble a crucifix. The word brassica derives from bresic, a Celtic word for cabbage. Many European and Asiatic names for cabbage are derived from the Celto-Slavic root cap or kap, meaning "head". The late Middle English word cabbage derives from the word caboche ("head"), from the Picard dialect of Old French. This in turn is a variant of the Old French caboce. Through the centuries, "cabbage" and its derivatives have been used as slang for numerous items, occupations and activities. Cash and tobacco have both been described by the slang "cabbage", while "cabbage- head" means a fool or stupid person and "cabbaged" means to be exhausted or, vulgarly, in a vegetative state.

Cabbage was most likely domesticated somewhere in Europe before 1000 BC, although savoys were not developed until the 16th century AD. By the Middle Ages, cabbage had become a prominent part of European cuisine. Cabbage heads are generally picked during the first year of the plant's life cycle, but plants intended for seed are allowed to grow a second year and must be

kept separate from other cole crops to prevent cross-pollination. Cabbage is prone to several nutrient deficiencies, as well as to multiple pests, and bacterial and fungal diseases.

Among all these factors, planting time is the most important factors which affect the production of this crop. It is a cool season, long-day plant for good vegetative growth. Long days coupled with temperatures above 25 ºC cause the plant to bolt and flower, which is detrimental to cabbage production. For adapting the crop to cope with the temperature

extremes, alteration in the time of sowing is among the few strategies available. Following the timely sowing provides favourable climatic conditions resulting in enhanced growth during establishment and early vegetative growth. Precise knowledge of optimum sowing time and selection of important varieties plays an important role in increasing crop yields as it provides suitable environmental conditions at all the growth stages of the crop. Planting in the late spring resulting in exposure to higher temperatures during the early stages of its development causing lower yields and if such a crop is also long day (LD) requiring for its development, such as spinach (*Spinacia oleracea* L.) the yield will drop even more with later sowings. Genetic potentiality of a variety is fully expressed when it is synchronized with the optimum environmental conditions such as temperature, light, humidity, rainfall etc. The different genotypes, growth responses vary to different environment and eventually decides the selection of a genotypes for a particular or different date of sowing for stabilizing higher yields

2. Materials and Methods

The present investigation was done to understand the performance of cabbage with planting dates. The investigation was carried out at Horticultural Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during *Rabi*-2023-24. The experiment was laid out in Factorial Randomized Block design with 12 treatment combinations replicated thrice. Treatments comprised of T_1 (TMCH20-009+15th September); T_2 (TMCH20-011+ September); T_3 (POLO 6640+15th September); T_4 (TMCH20-009+1st October); T_5 (TMCH20-011+ October); T_6 (POLO 6640+1st October); T7 (TMCH20-009+15th October); T8 (TMCH20-011+15th October); T_9 (POLO 6640-009+15th October); T_{10} (TMCH20-009+30th October); T_{11} (TMCH20-011+30th October) and T_{12} (POLO 6640+30th October). Observations were recorded at different stages of growth for parameters like plant height, number of leaves, days to head initiation, polar diameter and net head weight. The data were statistically analysed by the method suggested by Gomez and Gomez (1984) [4].

3. Results and Discussion

a. Growth Parameters

- **Plant height**

  The data pertaining to plant height of cabbage in different treatments were recorded and significant differences were observed at different stages of crop growth, i.e. 20 and 40 days after transplanting analysed.

- **Plant height 20 days after transplanting**

  Plant height 20 days after transplanting as shown in Table 1 varied significantly between different hybrids, planting dates and their interaction. Higher plant height (14.9 cm) was found in hybrid H2 (TMCH20-011) and lesser plant height (13.7 cm) was recorded in hybrid H3 (POLO 6640). It was observed that plant height was significantly influenced by date of planting, significantly higher plant height (15.3 cm) was recorded in D3 (15th October) followed by D4 (30th October) while lesser plant height (14.1 cm) was recorded in D1 (15th September). Interaction data revealed that treatment T8 (TMCH20-011 + 15th October) recorded significantly higher plant height (16.5 cm) followed by T_7 (TMCH20-009 + 15th October, 15.6 cm) while lesser plant height (13.2 cm) was recorded in T3 (POLO 6640 + 15th September).

- **Plant height 40 days after transplanting**

  Plant height 40 days after transplanting as shown in Table 1 varied significantly between different hybrids, planting dates and their interaction. Higher plant height (26.3 cm) was found in hybrid H2 (TMCH20-011) and lesser plant height (19.2 cm) was recorded in hybrid H3 (POLO 6640). It was observed that plant height was significantly influenced by date of planting, significantly higher plant height (24.1 cm) was recorded in D4 (30th October) followed by D3 (15th October) while lesser plant height (21.7 cm) was recorded in D1 (15th September). Interaction data revealed that treatment T8 (TMCH20-011 + 15th October) recorded significantly higher plant height (27.5 cm) followed by T_{11} (TMCH20-011 + 30th October, 26.1 cm) while lesser plant height (17.1 cm) was recorded in T3 (POLO 6640 + 15th September). Taller plants in hybrid TMCH20-11 with 15th October sowing may be due to its genetic makeup and the appropriate planting time might have provided the conducive period for plant growth and establishment. Similar results under different climatic conditions as influenced by time of planting were reported by Kanase *et al*. (2018)

- **Number of leaves**

  The data pertaining to number of leaves of cabbage in different treatments were recorded and significant differences were observed at different stages of crop growth, i.e. 20 and 40 days after transplanting analysed.

- **Number of leaves 20 days after transplanting**

  Number of leaves 20 days after transplanting as shown in Table 2 varied significantly between different hybrids, planting dates and their interaction. Higher number of leaves (7.8) was found in hybrid H2 (TMCH20-011) and lesser number of leaves (6.9) was recorded in hybrid H3 (POLO 6640). It was observed that number of leaves was significantly influenced by date of planting, significantly higher number of leaves (7.9) was recorded in D3 (15th October) followed by D2 (1st October) while lesser number of leaves (7.0) was recorded in D1 (15th September). Interaction data revealed that treatment T8 (TMCH20-011 + 15th October) recorded significantly higher number of leaves (9.2) followed by T_{11} (TMCH20-009 + 30th October, 7.8) while lesser number of leaves (6.7) was recorded in T_1 (TMCH20-009 + 15th September).

Number of leaves 40 days after transplanting

Number of leaves 40 days after transplanting as shown in Table 2 varied significantly between different hybrids, planting dates and their interaction.

More number of leaves (15.5) was found in hybrid H2 (TMCH20-011) and lesser number of leaves (12.4) was recorded in hybrid H3 (POLO 6640). It was observed that number of leaves was significantly influenced by date of planting, significantly more number of leaves (14.5) was recorded in D3 (15th October) at par D4 (30th October) while lesser number of leaves (13.5) was recorded in D1 (15th September).

Interaction data revealed that treatment T8 (TMCH20-011 + 15th October) recorded significantly more number of leaves (17.4) followed by T_{11} (TMCH20-009 + 15th October, 15.4) while lesser number of leaves (12.1) was recorded in T3 (POLO 6640 + 15th September). Higher number of leaves in hybrid TMCH20-11 with 15th October sowing may be due to its genetic character and the appropriate planting time might have provided the optimum period for plant growth and establishment. Similar results under different climatic conditions as influenced by time of planting were reported by Saikia *et al*. (2010) in broccoli.

b. Yield Attribute

Days taken to head initiation

The data pertaining to days taken to head initiation of cabbage in different treatments were recorded and significant differences were observed, analysed. Days taken to head initiation as shown in Table 3 varied significantly between different hybrids, planting dates and their interaction. Lesser days taken to head initiation (19.5) was found in hybrid H2 (TMCH20-011) and higher days taken to head initiation (23.9) was recorded in hybrid H3 (POLO 6640). It was observed that days taken to head initiation was significantly influenced by date of planting, significantly lesser days taken to head initiation (20.1) was recorded in D2 (1st October) followed by D3 (15th October) while lesser days taken to head initiation (22.5) was recorded in D1 (15th September).

Interaction data revealed that treatment T8 (TMCH20-011 + 15th October) recorded significantly lesser days taken to head initiation (18.9) at par T_5 (TMCH20-011 + 1st October, 19.2) while higher days taken to head initiation (26.0) was recorded in T3 (POLO 6640 + 15th September).

Earliness in head initiation in TMCH20-011 with 15th October planting might be due to its genotypic character and more carbohydrate assimilation as a result of better photosynthesis in plants as they had optimum growing conditions for plant growth and development. Similar results under different climatic conditions as influenced by time of planting were reported by (Vipul *et al*., 2017 and Kanase *et al*., 2018)

Polar diameter

The data pertaining to polar diameter of cabbage in different treatments were recorded and significant differences were observed, analysed and illustrated in figure. Polar diameter as shown in Table 3 varied significantly between different hybrids, planting dates and their interaction. Higher polar diameter (14.6 cm) was found in hybrid H2 (TMCH20-011) and lesser polar diameter (13.1 cm) was recorded in hybrid H3 (POLO 6640). It was observed that polar diameter was significantly influenced by date of planting, significantly higher polar diameter (14.1 cm) was recorded in D3 (15th October) at par D2 (1st October) while lesser polar diameter (13.7 cm) was recorded in D1 (15th September).

Interaction data revealed that treatment T8 (TMCH20-011 + 15th October) recorded significantly higher polar diameter (15.2 cm) followed by T_{11} (TMCH20-009 + 30th October, 14.4 cm) while lesser polar diameter (13.1 cm) was recorded in T_3 (POLO 6640 + 15th September). Higher polar diameter in TMCH20-011 with 15th October planting might be due to its genotypic character and more metabolite assimilation as a result of better photosynthesis in plants as they had optimum growing conditions for plant growth and development. Similar results under different climatic conditions as influenced by time of planting were reported by Vipul *et al*. (2017).

Net head weight

The data pertaining to net head weight of cabbage in different treatments were recorded and significant differences were observed, analysed.

Net head weight as shown in Table 4 varied significantly between different hybrids, planting dates and their interaction.

Higher net head weight (1135.6 g) was found in hybrid H2 (TMCH20-011) and lesser net head weight (865.3 g) was recorded in hybrid H3 (POLO 6640). It was observed that net head weight was significantly influenced by date of planting, significantly higher net head weight (1060.2 g) was recorded in D4 (30th October) at par D3 (15th October) while lesser net head weight (965.5 g) was recorded in D1 (15th September).

Interaction data revealed that treatment T8 (TMCH20-011 + 15th October) recorded significantly higher net head weight (1215.2 g) followed by T_{11} (TMCH20-011 + 30th October, 1127.6 g) while lesser net head weight (778.4 g) was recorded in T3 (POLO 6640 + 15th September).

Higher net head weight in TMCH20-11 due to different genotypic character of the parents resulting in different hybrid genetic character and the prevailing climatic conditions might be 15th October planting may due to more metabolite assimilation as a result of better photosynthesis in plants as they had optimum growing conditions for plant growth and development. Similar results under different climatic conditions as influenced by time of planting were reported by Khan *et al*. (2015) in broccoli.

Table 1: Effect of different planting dates on plant height of different cabbage hybrids after 20 and 40 days of transplanting

	Plant height 20 DAT					Plant height 40 DAT				
Dates / Hybrid	15th September (D1)	1st October (D2)	15th October (D3)	30th October (D4)	Mean	15th September (D1)	1st October (D2)	15th October (D3)	30th October (D4)	Mean
TMCH20-009 (H1)	14.3	14.1	15.6	13.6	14.3	22.3	23.8	24.6	24.7	23.8
TMCH20-011 (H2)	14.3	14.2	16.5	14.7	14.3	25.8	25.7	27.5	26.1	26.3
POLO 6640 (H3)	13.2	13.7	13.8	13.9	13.2	17.0	18.9	19.8	21.3	19.2
Mean	14.0	14.1	15.3	14.1	14.0	21.7	22.8	23.9	24.0	
Factors	F Test	SE(d) ±	C.D. 0.05			F Test	SE(d) ±	C.D. 0.05		
Factor (D)	S	0.119	0.249			S	0.147	0.308		
Factor (H)	S	0.103	0.215			S	0.128	0.266		
Factor (D X H)	S	0.206	0.431			S	0.255	0.533		

Table 2: Effect of different planting dates on number of leaves of different cabbage hybrids after 20 and 40 days of transplanting

Number of leaves 20 DAT						Number of leaves 40 DAT				
Date / Hybrids	15th September (D1)	1st October (D2)	15th October (D3)	30th October (D4)	Mean	15th September (D1)	1st October (D2)	15th October (D3)	30th October (D4)	Man
TMCH20-009 (H1)	6.7	7.6	7.6	7.1	7.2	14.1	13.9	13.6	14.1	13.9
TMCH20-011 (H2)	7.2	7.2	9.2	7.8	7.8	14.4	14.7	17.4	15.4	15.5
POLO 6640 (H3)	7.1	6.8	7.1	7.1	6.9	12.1	12.2	12.5	13.1	12.4
Mean	7.1	7.2	7.9	7.3		13.5	13.6	14.5	14.2	
Factors	F Test	SE(d) ±		C.D. 0.05		F Test	SE(d) ±		F Test	
Factor (D)	S	0.153		0.319		S	0.549		S	
Factor (H)	S	0.132		0.276		S	0.476		S	
Factor (D X H)	S	0.265		0.553		S	0.952		S	

Table 3: Effect of different planting dates on days taken to initiation and polar diameter of different cabbage hybrids

Days taken to head initiation						Polar diameter				
Date / Hybrids	15th September (D1)	1st October (D2)	15th October (D3)	30th October (D4)	Mean	15th September (D1)	1st October (D2)	15th October (D3)	30th October (D4)	Mean
TMCH20-009 (H1)	21.4	21.1	20.1	21.8	21.1	13.8	13.9	14.1	13.8	13.9
TMCH20-011 (H2)	20.2	19.2	18.9	19.6	19.5	14.1	14.8	15.2	14.4	14.6
POLO 6640 (H3)	26.1	19.8	24.8	24.8	23.9	13.1	13.2	13.2	13.1	13.1
Mean	22.5	20.1	21.3	22.1		13.7	14.1	14.1	13.8	
Factors	F Test	SE(d) ±		C.D. 0.05		F Test	SE(d) ±		C.D. 0.05	
Factor (D)	S	0.283		0.592		S	0.088		0.184	
Factor (H)	S	0.245		0.512		S	0.076		0.160	
Factor (D X H)	S	0.491		1.025		S	0.153		0.319	

Table 4: Effect of different planting dates on net head weight of different cabbage hybrids

Net head weight					
Date / Hybrids	15th September (D1)	1st October (D2)	15th October (D3)	30th October (D4)	Mean
TMCH20-009 (H1)	1058.60	1080.40	1077.00	1077.93	1073.48
TMCH20-011 (H2)	1059.73	1140.20	1215.20	1127.60	1135.68
POLO 6640 (H3)	778.40	836.60	871.33	975.07	865.35
Mean	965.58	1019.07	1054.51	1060.20	
Factors	F Test	SE(d) ±		C.D. 0.05	
Factor (D)	S	22.662		47.301	
Factor (H)	S	19.626		40.964	
Factor (D X H)	S	39.252		81.928	

4. Conclusion

Based on the results of the present investigation, it is concluded that among the different treatment combinations of hybrids and planting date, treatment T8 (TMCH 20-011 + 15th October) recorded significantly better results in plant height, number of leaves, plant spread, days taken to head initiation, polar diameter, equatorial diameter, gross head weight, net head weight, yield, TSS and ascorbic acid content as well as significantly higher net return and B: C ratio (2.34).

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