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Assessment of growth dynamics, yield performance and morphological attributes in six exotic cabbage varieties

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ABSTRACT

An experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University in Dhaka, spanning from December 2021 to April 2022. The objective was to assess growth, yield performance and morphological characteristics of six exotic cabbage varieties in accordance with the UPOV standards. Significantly diverse outcomes were observed among the studied varieties. Variety V_1 exhibited the maximum number of leaves (18.7), statistically similar to V_2 and V_6. The highest outer leaf length (29.2 cm) was recorded in V_5, while V_1 displayed the greatest outer stem length (7.6 cm), akin to V_3. V_2 demonstrated the maximum outer stem diameter (23.3 mm), comparable to V_1 and V_6. V_3 presented the broadest plant width, including leaves (42.1 cm), along with the highest interior stem length (8.9 cm), head length (14.2 cm) and head diameter (23.3 cm). Additionally, V_3 yielded the highest head weight (1.8 kg) and achieved the best yield per hectare (91.4 t/ha). In summary, considering the overall performance across growth parameters and yield metrics, V_3 emerged as the superior variety among the six exotic cabbage varieties investigated in this study.

Key Words: *UPOV Standard, Exotic varieties, Brassica oleracea, Growth and Yield performance.*

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I. Introduction

Cabbage (*Brassica oleracea*) locally known as 'Bhadha Kopi'. It's an important Cole crop, a member of the Cruciferae family (Daly et al., 1995). Cabbage is one of the most important leafy vegetables in Bangladesh and one of the five leading vegetables in the world (Rashid et al., 1999). Cabbage is most popular vegetable across the globe in respect to area, production and availability almost around the year (Swiader et al., 1992). As a vegetable, cabbage has high nutritive value and high consumer's demand. It has been reported that 100g of green edible portion of cabbage contains 92% water, 24 K Cal of food energy, 1.5g of protein, 4.8g of carbohydrate, 40mg of calcium, 0.6mg of iron, 600 IU of

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carotene, 0.05mg of riboflavin, 0.3mg of niacin and 60 mg of vitamin C (Rashid, 1993). Besides its nutritive value, it is a profitable cash crop for the farmers in Bangladesh. However, the productivity of cabbage per unit area is relatively low in our country as compared to the developed countries of the world (Anon. 2006). Production of crops depends on many factors such as quality of seed, improved varieties, proper management practices including time of sowing of seeds, plant population, proper fertilizer management and intercultural operation etc. However, the total production of cabbage can be raised by increasing the area under cultivation and adopting improved production technology. Variety is an essential factor for successful crop yield. An improved variety represents a higher yield than the wild one. Cabbage varieties have been bred to produce good yielding mature heads very early in the season (Cervenski et al., 2011). There is a wide scope of increasing cabbage production with the introduction of new suitable cultivars from abroad. There are many cabbage varieties available in the market, which different agriculture organizations have imported. Based on our demand and weather, we have left variety trial till now. Considering the above-mentioned facts, the study was undertaken to learn about the morphological characteristics of cabbage and identify a suitable variety that could be suggestive for growth and yield of cabbage for the farmers of Bangladesh.

II. Materials and Methods

The experiment was conducted at the Horticultural farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, from December 2021 to March 2022 to study the morphological characteristics and yield of different Cabbage verities. Six exotic varieties (name:- V_1: SK3-005; V_2: Quicker; V_3: No. 20; V_4: Super set; V_5: Atlas-70 and V_6: Atlas-2020) of cabbage were used in this study. Seeds were collected from A R Malik Seeds Pvt. Ltd. The single factor experiment was laid out following a Randomized Complete Block Design (RCBD) with three replications. Manure and fertilizers were applied as BARI recommendations. Various intercultural operations were accomplished for better growth and development of the plants when it was required. Data on different morphological characteristics were recorded following Union of Protection of Plant Varieties (UPOV) guidelines based on visual observation and represented into appropriate categories. Data have also been collected based on vegetative growth and yield attributing parameters. Three plants were randomly selected from each unit of plot for the collection of data. The following data were recorded from the cabbage plants during the study period and final harvest was completed within 85-90 days. The data recorded for different vegetative and yield contributing parameters were statistically analyzed using Statistix-10 computer package program to determine the significance of variation among the treatments. Differences between varieties were evaluated by the Least Significance Difference test (LSD) at a 5% level of significance.

III. Results and Discussion

Number of leaves

Leaves number of exotic varieties showed significant variations. Table 01 showed that V_1 produced the highest number of leaves (18.7) while the lowest (14.0) was found from V_5 compared to other varieties.

Table 01. Performance of different cabbage varieties on growth attributes

Treatment	Number of leaves	Outer leaf length (cm)	Outer stem length (cm)	Outer stem diameter (mm)	Width of plant including leaf (cm)	Interior stem length (cm)
V_1	18.7 a	23.4 d	7.6 a	22.5 a	38.5 b	7.3 f
V_2	18.0 a	23.0 d	5.8 c	23.3 a	39.6 b	8.9 d
V_3	17.0 ab	27.4 bc	7.5 a	21.5 ab	42.1 a	8.1 e
V_4	15.7 bc	28.2 b	5.9 c	21.2 ab	38.6 b	8.4 a
V_5	14.0 c	29.2 a	6.3 b	19.6 b	34.4 c	5.8 b
V_6	18.0 a	27.0 c	5.2 d	22.4 a	39.3 b	6.0 c
LSD	2.24	0.86	0.23	2.16	1.55	0.22
CV %	7.31	1.8	1.96	5.46	2.2	1.24

*V_1: SK3-005; V_2: Quicker; V_3: No. 20; V_4: Super set; V_5: Atlas-70 and V_6: Atlas-2020

Yield/hectare

Significant variation of yield/hectare was found with different cabbage varieties. Highest yield per hectare (91.4t) was found from V_3 and lowest (64.5t) from V_5 variety (Table 02).

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Table 02. Performance of different cabbage varieties on yield and yield attributes

Treatment	Head length (cm)		Head diameter (cm)		Head weight (kg)		Yield/ hectare (t/ha)	
V_1	12.2	c	22.5	a	1.45	d	72.5	d
V_2	13.7	ab	23.3	a	1.76	b	88.0	b
V_3	14.2	a	21.5	ab	1.83	a	91.4	a
V_4	13.6	b	21.2	ab	1.71	c	85.5	c
V_5	12.0	c	19.6	b	1.29	e	64.5	f
V_6	10.1	d	22.4	a	1.32	e	66.0	e
LSD	0.53		2.16		0.04		0.42	
CV %	2.3		5.46		1.26		0.3	

*V_1: SK3-005; V_2: Quicker; V_3: No. 20; V_4: Super set; V_5: Atlas-70 and V_6: Atlas-2020

Classification of Cabbage according to the Head length following the UPOV standard: None of the six cabbage varieties under the study can be categorized on a small scale (5-10 cm). All the six cabbage varieties under the study showed medium scale (10-15 cm) (table 03) where V_1, V_2, V_3, V_4, V_5, V_6 belong to this category. None among the six cabbage varieties under the study can categorized on large scale (15-20 cm).

Table 03. Classification of cabbage according to head length

Category	Length range (cm)	Varieties*
Short	5-10	-
Medium	10-15	V_1, V_2, V_3, V_4, V_5, V_6
Large	15-20	-

*V_1: SK3-005; V_2: Quicker; V_3: No. 20; V_4: Super set; V_5: Atlas-70 and V_6: Atlas-2020

Classification of Cabbage according to the Leaf number per plant following the UPOV standard: None among the six cabbage varieties under the study can categorized on a small scale (5-10 cm). One among the six cabbage varieties under the study showed medium scale (10-15 cm) (table 04) where V_5 belong to this category. Five of the six cabbage varieties under the study showed large scale (15-20 cm) where V_1, V_2, V_3, V_4 and V_6 belong to this category.

Table 04. Classification of cabbage according to leaf number per plant

Category	Length range (cm)	Varieties*
Less	5-10	-
Medium	10-15	V_5
More	15-20	V_1, V_2, V_3, V_4, V_6

*V_1: SK3-005; V_2: Quicker; V_3: No. 20; V_4: Super set ; V_5: Atlas-70 and V_6: Atlas-2020

Classification of Cabbage according to the Plant height following the UPOV standard: None among the six cabbage varieties under the study can categorized on small scale (Less than 15 cm). Two of the six cabbage varieties under the study showed medium scale (15-20 cm) (table 05), where V_2 and V_5 belong to this category. Four of the six cabbage varieties under the study showed large scale (20-25 cm) where V_1, V_3, V_4, V_6 belong to this category.

Table 05. Classification of cabbage according to plant height

Category	Length range (cm)	Varieties*
Short	10-15	-
Medium	15-20	V_2, V_5
Tall	20-25	V_1, V_3, V_4, V_6

*V_1: SK3-005; V_2: Quicker; V_3: No. 20; V_4: Super set ; V_5: Atlas-70 and V_6: Atlas-2020

Classification of Cabbage according to the Head diameter following the UPOV standard: One among the six cabbage varieties under the study showed small scale (10-15 cm) where V5 belong to this category. Five of the six cabbage varieties under the study showed medium scale (15-20 cm), where V_1, V_2, V_3, V_4, V_6 belong to this category (table 06). None of the six cabbage varieties under the study can categorized on large scale (20-25 cm).

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Table 06. Classification of cabbage according to head diameter

Category	Length range (cm)	Varieties*
Small	10-15	V_5
Medium	15-20	V_1, V_2, V_3, V_4, V_6
Large	20-25	-

*V_1: SK3-005; V_2: Quicker; V_3: No. 20; V_4: Super set ; V_5: Atlas-70 and V_6: Atlas-2020

Classification of Cabbage according to the outer leaf length following the UPOV standard: none among the six cabbage varieties under the study can categorize small scale (15-20 cm). Two of the six cabbage varieties under the study showed medium scale (20-25 cm), where V_1, V_2 belong to this category. Four of the six cabbage varieties under the study showed large scale (25-30 cm) where V_3, V_4, V_5, V_6 belong to this category (table 07).

Table 07. Classification of cabbage according to outer leaf length

Category	Length range (cm)	Varieties*
Short	15-20	-
Medium	20-25	V_1, V_2
Large	25-30	V_3, V_4, V_5, V_6

*V_1: SK3-005; V_2: Quicker; V_3: No. 20; V_4: Super set; V_5: Atlas-70 and V_6: Atlas-2020

Classification of Cabbage according to the outer stem diameter following the UPOV standard: One of the six cabbage varieties under the study can be categoris as small scale (15-20 cm) where V5 belong to this category (table 08).

Table 08. Classification of cabbage according to outer stem diameter

Category	Length range (cm)	Varieties*
Short	15-20	V_5
Medium	20-25	V_1, V_2, V_3, V_4, V_6
Large	25-30	-

*V_1: SK3-005; V_2: Quicker; V_3: No. 20; V_4: Super set; V_5: Atlas-70 and V_6: Atlas-2020

Five among the six cabbage varieties under the study showed medium scale (20-25 cm), where V_1, V_2, V_3, V_4, V_6 belong to this category. None among the six cabbage varieties under the study can categorized in large scale (25-30 cm).

Classification of Cabbage according to the Plant maximum diameter including outer leaves following the UPOV standard: One among the six cabbage varieties under the study can categorized in small scale (30-35 cm) where V5 belong to this category. Four of the six cabbage varieties under the study can categorized in medium scale (35-40 cm) where V_1, V_2, V_4, V_6 belong to this category. One among the six cabbage varieties under the study can categorized in large scale (40-45 cm) where V_3 belongs to this category (table 09).

Table 09. Classification of cabbage according to plant maximum diameter, including outer leaves

Category	Length range (cm)	Varieties*
Short	30-35	V_5
Medium	35-40	V_1, V_2, V_4, V_6
Large	40-45	V_3

*V_1: SK3-005; $\mathbf{V_2}$: Quicker; V_3: No. 20; V_4: Super set; V_5: Atlas-70 and V_6: Atlas-2020

These study categories and classified cabbage varieties according to the UPOV standards (table 10). As per leaf attitude, all varieties i.e V_1, V_2, V_3, V_4, V_5, V_6 expressed erect type. Leaf length of cabbage varieties is classified into three categories viz; short, medium and long. However, in the present study, all varieties had convex on the upper side of the leaf. Considerable variation was also observed for the shape of the blade, with variety like V_5 elliptic leaf shape while V_6 showed broad ovate and V_1, V_3 showed ovate blade shape, V_4 showed transverse broad elliptic type leaf shape. Based on undulation of the outer leaf margin, the varieties were classified into four groups viz; V_4, V_5 were very weak and V_3

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showed weak and V_2, V_6 showed outer leaf margin. None other varieties showed strong outer leaf margin. Most of the varieties expressed transverse elliptic head shape in longitudinal sections except V_2. In case of base shape in longitudinal section- V4 showed a rounded shape and most of the varieties (V_1, V_2, V_3, V_5, V_6) showed flat shape. Most of the varieties showed a waxy owed gray green leaf color except V_4, where V_4 showed waxy green color leaf. In the case of leaf color intensity (outer leaf) – V_3, V_4 showed medium color intensity, while the rest of the varieties expressed light color intensity. In table 12- most of the variety expressed fully covered head. As per, Color intensity of covered leaf - light color was expressed by V_1, V_2, V_5, V_6 and medium color expressed by V_3, V_4. On the basis of head density- V_5 and V_6 showed medium head density, V_3 and V_4 showed high head density while V_1 and V_2 showed very high head density. Table 10- V_1 shows V_4 expressed fine internal head structure, V_2, V_3 expressed medium internal head structure and V_5, V_6 expressed coarse internal head structure.

Table 10. Morphological characterization of cabbage head following UPOV standard

Morphological characteristics	Categories	Varieties*
Attitude of outer leaves	Erect	V_1, V_2, V_3, V_4, V_5, V_6
Shape of Blade	Elliptic	V_5
	Broad ovate	V_6
	Transverse broad elliptic	V_4
	Obovate	V_1, V_3
Profile of upper side of blade	Convex	V_1, V_2, V_3, V_4, V_5, V_6
Outer leaf color (with wax)	Green	V_4
	Gray green	V_1, V_2, V_3, V_5, V_6
Color intensity of outer leaf	Light	V_1, V_2, V_4, V_5,
	Medium	V_3
	Dark	V_6
Waxiness of outer leaf	Weak	V_3, V_4
	Medium	V_1, V_2, V_5
	Strong	V_6
Undulation of outer leaf margin	Very weak	V_4, V_5
	Weak	V_3
	Medium	V_2, V_6
Head shape in Longitudinal section	Transverse elliptic	V_1, V_3, V_4, V_5, V_6
	Circular	V_2
Shape of base in Longitudinal section	Rounded	V_4
	Flat	V_1, V_2, V_3, V_5, V_6
Covering of head	Covered	V_1, V_2, V_3, V_4, V_5, V_6
Color of head cover leaf	Yellow green	V_1, V_2, V_3, V_4, V_5, V_6
Color intensity of covered leaf	Light	V_1, V_2, V_5, V_6
	Medium	V_3, V_4
Density of Head	Medium	V_5, V_6
	Dense	V_3, V_4
	Very dense	V_1, V_2
Internal structure of Head	Fine	V_1, V_4
	Medium	V_2, V_3
	Coarse	V_5, V_6

*V_1: SK3-005; **V_2**: Quicker; V_3: No. 20; V_4: Super set; V_5: Atlas-70 and V_6: Atlas-2020

IV. Conclusion

The highest growth and yield rate performed by SK3-005(V_1), Quicker (V_2) and No. 20 (V_3) cabbage varieties comprised with other varieties and lowest was found from Atlas-70(V_5). On the other hand, among other varieties, Quicker (V_2) and No. 20 (V_3) showed their superiority in producing higher cabbage yields. Farmers in Bangladesh can benefit from adopting these varieties, enhancing both the quality and quantity of cabbage production. Further research and widespread adoption of improved varieties, aligned with appropriate field practices, can contribute significantly to elevating cabbage productivity in the country.

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