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EFFECT OF PLANT SPACINGS ON THE PERFORMANCE OF HYBRID CABBAGE *(Brassica oleracea var. capitata)* VARIETIES

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Abstract

A field experiment on cabbage *(Brassica oleracea var. capitata)* comprising two plant spacings viz. 60 × 40 cm and 60 × 45 cm and ten hybrid cabbage varieties viz. Green Rich, Green-621, Green Coronet, Summer Warrior, Rare Ball, Atlas-70, Southern treasure, Laurels, K-K Cross and K-S Cross was conducted during 15 October to 12 February of 2005-07 at the Agricultural Research Station, Raikhali, Rangamati Hill District to find out the optimum plant spacing and suitable cabbage variety(s). The wider spacing of 60 × 45 cm resulted in significantly maximum number of folded leaves and head weight (without unfolded leaves) in comparison to closer spacing of 60 × 30 cm. The variety Green Coronet showed the highest plant height, number of unfolded leaves, length of the biggest loose leaf, widest leaf, head height, and head weight (with unfolded leaves).This variety took the highest duration (119 days), while Green-621 took the lowest duration for harvest (105 days). Although Green Coronet grew vigorously, it did not produce the highest head yield. All the varieties had good head compactness except Laurels and Green Coronet which had medium and less compactness, respectively. The combination of 60 × 30 cm spacing with variety Southern Treasure and K-S cross produced the highest head diameter, but wider spacing of 60 × 45 cm accompanied by Southern Treasure produced the highest head weight without unfolded leaves followed by K- K Cross in both the years. The pooled analysis showed the highest marketable head yield (73.32 t/ha) in the combination of 60 x 40 cm spacing with K- K Cross, which was closely followed by Southern Treasure (71.71 t/ha) and Laurels (71.56 t/ha). The variety Green-621 was found suitable for early harvest with reasonable yield (67.82 t/ha).

Keywords: Cabbage, *Brassica oleracea var. capitata*, hybrid variety, spacing, head yield, Rangamati.

Introduction

Cabbage *(Brassica oleracea var. capitata)* is an important vegetable of almost all parts of the world. It is one of the five best vegetables in the world (Rashid, 1999). It is an important winter leafy vegetables grown in Bangladesh. The taste in cabbage is due to the "Sinigrin glucoside" and it is rich in minerals and vitamin A, B_1, B_2, and C (Singh *et al.,* 2004). The average yield of cabbage in Bangladesh is very low (8.9 t/ha) (BBS, 2005) compared to other countries

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(Japan 40.03 t/ha, South Korea 59.07 t/ha, and India 17.88 t/ha) of the world (FAO, 1994). This low yield may be attributed to a great extent on the method of low production management practices adopted by the farmers. Of the many factors of improved cultivation practices, use of proper spacing for transplantation and suitable cultivars are indeed to influence on the yield contributing characters and consequently on the yield. The use of proper spacing is an important factor for securing higher yield of desirable heads of cabbage. There are reports that successful production of cabbage depends on maintenance of optimum plant density in the field (Farooque and Islam, 1989 ; Rahman and Haque, 1982 ; Nahar *et al,* 1996, and Wien and Wurr, 1997). They opined that the yield of cabbage depends upon the number of plants per unit area and the size of the harvested portion of each plant. Generally spacing of 60 × 45 cm is recommended for growing most of the cabbage cultivars for higher yield (Anon., 1995; Thamburaj and Sigh 2004; Singh *et al.*, 2004). But Islam *et al.* (1989) and Farooque and Islam (1989) reported that the spacings of 60 × 30cm and 60 × 45 cm produced similar results. Dense planting of cabbage seedling can produce higher head yield owing to the presence of more number of plants per unit area although they produce smaller head irrespective of varieties.

Besides spacing, the cultivar itself plays a great role for higher yield of the crop. There is a wide scope of increasing cabbage production with the introduction of new suitable hybrid cultivars from abroad. There are many hybrid cabbage varieties available in the market, which have been imported by different seed companies. Prior to recommendation for farmers, varietal performances need to be determined. Otherwise farmers will be deprived of getting benefit from cabbage cultivation. The present study, therefore, was undertaken to evaluate the yield potentiality of hybrid cabbage cultivars at two plant spacings for the higher head yield.

Materials and Method

The experiment was conducted at the Agricultural Research Station, Raikhali in the district of Rangamati during the *rabi* seasons of 2005-06 and 2006-07. The experimental field comprised with the Piedmont plain soil having medium loamy to moderately fine texture (sandy clay loam) and belongs to AEZ 29. The soil was poor in organic matter and moderately acidic. Nitrogen, phosphorus, sulphur and potassium were low in soil. N and P were below critical limit, S was close to the critical limit and K and Zn were just above the critical level (Table 1). The experiment was laid out in factorial randomized complete block design with three replications, having two spacings viz. S_1 = 60 × 40 cm and S_2 = 60 × 44cm and ten cabbage varieties viz. V_1= Green Rich, V_2 = Green-621, V_3= Green Coronet, V_4 = Summer Warrior, V_5 = Rare Ball, V_6 = Alas-70, V_7 = Southern Treasure, V_8

= Laurels, V_9 = K- K Cross, and V_{10}, = K- S Cross. All the varieties were hybrid collected from Dhaka. The unit plot size was 3.0 × 3.6 cm which accommodated 40 and 45 plants from 60 × 45 cm and 60 × 40 cm spacings, respectively.

Table 1. Soil characteristics of the experimental plot prior to experimentation.

Parameter	Soil test value		Critical level
	2005-06	2006-07	
Texture	Sandy clay loam	Sandy clay loam	-
pH	5.5	5.6	-
Organic matter (%)	0.82	0.83	-
Total nitrogen (%)	0.079	0.081	0.12
Available phosphorous (μg/g soil)	8.3	8.5	10
Available potassium (meq/100 g soil)	0.16	0.17	0.12
Available sulphur (μg/g soil)	13.0	14.0	14.0
Available zinc (μ/g soil)	2.12	2.14	2.0

Manures and fertilizers were applied to the soil @ 180 kg N, 40 kg P, 100 kg K, 30 kg S, 5 kg Zn, and 5 tons well rotten cowdung per hectare (Nasreen and Islam, 1992). The source of N, P, K, S, and Zn were urea, TSP, MoP, gypsum and ZnO. The total amount of cowdung, TSP, gypsum, ZnO, and one-third quantity of urea and MoP were incorporated into the soil before transplanting and the remaining two-thirds of urea and MP were applied in two equal installments as topdressing at the 3^{rd} and 5^{th} weeks after transplanting. Thirty days old seedlings were transplanted on 10 November 2005 and 12 November 2006, respectively. The crop was irrigated immediately after topdressing and then at 15 days interval. The crop was harvested when the head was compact. The head harvest started 22 January and continued up to 15 Febmary of both years. The data on plant height at harvest, number of unfolded leaves, number of folded leaves, length and width of the biggest loose leaves, head height, head diameter, head weight with unfolded leaves and marketable weight were recorded from randomly selected 10 plants from the inner rows of the plots. The plot yield from the harvest area of 10.8 m^2 was calculated and then it was converted to per hectare yield. The treatment means were separated by DMRT at 5% level of probability.

Results and Discussion

Effects of spacing

Spacings maintained in cabbage planting significantly affected number of folded leaves only in 2006-07, head diameter, head weight without unfolded leaves and head yield per hectare in both the years (Table 2). The wider spacing of 60 × 45

cm produced significantly higher number of folded leaves (2006-07), but other parameters were statistically identical. The plants grown under wider spacing received more nutrients, light and moisture around compared to plants of closer spacing, which was probably the cause of better performance in yield attributes and yield of individual cabbage head. Similar findings in cabbage production were also reported by Farooqe and Mondal (1987), Rahman and Haque (1982); Hossain *et al.* (1983) and Nahar *et al*. (1996). The total marketable head yield of cabbage per hectare grown in closer spacing resulted in significantly higher yield (65.34 and 67.82 t/ha) in both the years than those of wider spacing. The maximum marketable yield in the closer spacing of 60 x 40 cm was due to more number of plants per hectare (4630 plants), but other parameters were higher in wider spacing. This is in agreement with the findings of Hossain *et al.* (1983) and Nahar *et al.* (1986) who also obtained the highest yield of cabbage per hectare from the closer spacing.

Effects of variety

Significant variations were observed among the varieties for all the parameters studied (Table 2). The tallest plants were in Green Coronet (V_3) (24.88 cm in Y_1 and 25.63 cm in Y_2), which was found significantly different from other varieties. The medium plant height at harvest was recorded in Atlas-70 (V_6) and Laurels (V_8) in 2005-06 and in Green-621 (V) in 2006-07. The lowest plant height was found in Green Rich (V_1) followed by Rare Ball (V_5), Southern Treasure (V_7), K-S Cross (V_{10}), and K-K Cross (V_9) in 2005-06 but in 2006-07, the lowest plant height in Green Rich (V_1), Summer Warrior (V_4), Southern Treasure (V_7) and K-S Cross (V_{10}). The maximum number of unfolded leaves was recorded in Green Coronet (V_3) in 2005-06. Similar trend was followed in 2006-07. This is in agreement with the report of Anon. (1994). The other varieties produced less number of unfolded leaves during both the years. The variety K-S Cross (V_{10}) produced maximum number of folded leaves closely followed by that in 2005-06, while K-S Cross (V_{10}) produced maximum number of folded leaves, which was statistically at par with Green-621(V_2) and Green Rich (V_1). The variety Green Coronet produced the lowest number of unfolded leaves in both the years. Significantly the maximum length of the biggest loose leaf was recorded in Green Coronet (V_3) while the variety K-K Cross (V_9) produced the lowest length of the biggest loose leaf in both the years. The width of the biggest loose leaf was found maximum in Green Coronet (V_3), in both the years closely followed by K-S Cross (V_{10}) only in 2006-07. The variety K-K Cross performed poor during two years in respect of width of the biggest loose leaf. The maximum days to head harvest after transplanting (30 days old seedling) was required for Green Coronet (89 and 89 days in 2005-06 and 2006-07, respectively). The second maximum days to head harvest after transplanting was taken by K- K Cross (88 in 2005-06 and 87.50 in 2006-07). The lowest days to head after transplanting

was observed in Green-621(74 days in 2005-06 and 76 days in 2006-07). The varieties Atlas-70 and Laurels took 80 days to 82 days to reach the harvest stage. The rest of the varieties were harvested between 83 days to 85 days. Therefore, it may be concluded that Green-621 was an early variety taking 104-106 days from seed sowing to maturity. Green Coronet and K-K cross were late maturing varieties taking 117-120 days to harvest, while the rest of the varieties were mid varieties taking 109-115 days for harvest.

The maximum head height was recorded in Green Coronet (V_3) in 2005-06 that was at par with K-K Cross (V_9), Rare Ball (V_5), and K-S Cross (V_{10}) but V_3, V_9, V_5, and V_{10} were statistically identical in 2006-07 in this respect. The lowest head height was recorded in Laurels (V_8) in both the years. The highest head diameter was obtained from K-K Cross (V_9), which was closely followed by K - S Cross (V_{10}) in first year, while Southern Treasure (V_7) was at par with K-K Cross (V_9) and K-S Cross (V_{10}). The lowest head diameter was found in Green Coronet (V_3) and Rare Ball (V_5) in both the years. The variety Green Coronet (V_3) produced the highest head weight with unfolded leaves which was significantly different from other varieties. These are in agreement with the findings of BARI (1993) and BARI (1994). The lowest head weight with unfolded leaves was recorded in Green Rich, Green-621, and Summer Warrior. The maximum head weight without unfolded leaves was obtained from Southern Treasure (1.99 kg in 2005-06 and 2.04 kg in 2006-07). This is in agreement with the report of BARI (1993) where it was reported that Southern Treasure gave the maximum head weight (2.75 kg) followed by K-K Cross (2.6 kg). The second highest head weight without unfolded leaves was found in Green 621 and K- K Cross, which were at par with K- S Cross in both the years. The variety Green Coronet was the poorest in terms of head weight without unfolded leaves in both the years.

The K- K cross produced the highest marketable head yield (66.09 t/ha in 2005-06 and 68.66 t/ha in 2006-07), which was similar to Southern Treasure, K-S Cross and Green-621. Nahar *et al*. (1996) and BARI (1997) obtained 64.65 t/ha and 61.69 t/ha marketable yield, respectively, by using the variety K-K Cross. The second highest marketable head yield was obtained from Laurels, which was at par with Rare Ball and Green Rich. The variety Green Coronet gave the lowest marketable head yield. The Green Coronet exhibited vigorous growth but did not give satisfactory yield probably because of lacking of optimum climatic requirements for that variety. The variety Green-621 gave better yield and took minimum days for harvest. The pooled analysis showed that K-K Cross gave the highest marketable head yield (67.38 t/ha), which was similar to Southern Treasure (67.03 t/ha), Green-621 (66.46 t/ha), and K- S Cross (65.62 t/ha). Green Coronet performed the poorest in respect of marketable yield. In case of head compactness, all the varieties produced compact heads except Green Coronet and

Laurels. Green Coronet gave less compact head whereas Laurels produced medium compact head (Table 2).

Combined effect of plant spacing and variety

Significantly maximum plant height was recorded in $S_2 \times V_3$, which was similar to $S_2 \times V_5$ and $S_3 \times V_3$ during both the years (Table 3) The $S_2 \times V_6$ combination produced the maximum number of unfolded leaves that was statistically similar to $S_1 \times V_3$ and $S_2 \times V_3$ in both the years. The lowest number of unfolded leaves was recorded from $S_1 \times V_{10}$, $S_1 \times V_7$, $S_2 \times V_7$, and $S_1 \times V_4$ in 2005-06 and from $S_1 \times V_{10}$, $S_2 \times V_{10}$, $S_1 \times V_4$, $S_1 \times V_7$ and $S_2 \times V_7$ in 2006-07. The maximum number of folded leaves was observed in $S_1 \times V_{10}$ (29.68 and 31.23 in 2005-06 and 2006-07, respectively), which was at par with $S_1 \times V_1$, $S_1 \times V_2$, $S_2 \times V_4$, $S_2 \times V_7$, and $S_2 \times V_{10}$ in both the years. The length and width of the biggest leaf was obtained from $S_2 \times V_3$ in both years. The $S_2 \times V_{10}$ combination also gave the width of the biggest leaf that was statistically identical to $S_2 \times V_3$, and $S_1 \times V_3$ in both the years. The maximum days to head harvest after transplanting was recorded in $S_1 \times V_3$, which was at par with $S_2 \times V_3$. The combinations of $S_2 \times V_6$, $S_2 \times V_8$, $S_1 \times V_6$, and $S_1 \times V_8$ took medium time for head harvest. The variety Green-621 took the minimal days to reach the harvest stage irrespective of plant spacings. Significantly the highest head height was obtained from $S_2 \times V_3$, which was at par with $S_1 \times V_5$, $S_1 \times V_{10}$ and $S_2 \times V_9$ in both the years and the lowest head height from $S_1 \times V_6$ that was statistically identical to $S_1 \times V_1$, $S_1 \times V_4$, $S_1 \times V_7$, $S_2 \times V_1$, and $S_2 \times V_6$ from both the years. The maximum head diameter was recorded in $S_2 \times V_{10}$, which was statistically similar to $S_2 \times V_7$. In 2005-06, the second highest head diameter was obtained from $S_2 \times V_8$ closely followed by $S_1 \times V_4$, $S_1 \times V_6$, and $S_1 \times V_2$, while in 2006-07, from $S_2 \times V_6$, which was at par with $S_1 \times V_6$, $S_2 \times V_2$, $S_2 \times V_4$, $S_2 \times V_6$, and $S_2 \times V_8$. The lowest head diameter was recorded in $S_1 \times V_1$ in 2005-06 whereas during 2006-07 in $S_1 \times V_3$ that was at par with $S_2 \times V_3$. The maximum head weight with unfolded leaves was obtained from $S_2 \times V_3$ followed by $S_2 \times V_7$, $S_1 \times V_3$, $S_1 \times V_8$, and $S_2 \times V_9$ in both the years. The combination of $S_2 \times V_3$ gave the highest head weight without unfolded leaves (2.17 and 2.23 kg in 2004-05 and 2006-07, respectively) followed by $S_2 \times V_9$ and $S_2 \times V_{10}$. The lowest head weight without unfolded leaves was observed in $S_1 \times V_6$, which was similar to $S_1 \times V_5$, $S_1 \times V_8$, $S_2 \times V_4$ and $S_2 \times V_5$ in 2005-06 but in 2006-07, in $S_1 \times V_3$, which was at par with $S_2 \times V_3$. The highest marketable head weight was obtained from $S_1 \times V_9$ which was at par with $S_1 \times V_7$, $S_1 \times V_8$ in both the years. The treatment $S_1 \times V_9$ showed maximum head yield due to higher yield attributing characters. Almost all the varieties showed more compact except V_3 (less compact) and V_8 (medium compact). The pooled analysis revealed that considering $S_1 \times V_9$ followed by $S_1 \times V_7$ and $S_1 \times V_8$ showed maximum head yield but variety K-Cross (V_9) took more time to harvest in both the spacings.

Table 2. Growth attributes and days to harvest after transplanting as influenced by spacing and cabbage varieties during 2005-07.

Treatment	Plant height at harvest (cm)		No. of unfolded leaves		No. of folded leaves		Length of the biggest loose leaf (cm)		Width of the biggest leaf (cm)	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Spacing (cm)										
S_1	19.69	20.58	8.91	9.17	25.80	27.55b	33.86	34.84	31.68	32.18
S_2	20.17	20.84	9.71	9.73	26.28	28.74a	34.30	35.28	32.46	32.98
Variety										
V_1	17.62e	18.14g	9.80c	l0.09c	26.72b	30.48a	32.75c	33.77c	31.23de	31.77cd
V_2	22.70b	23.72c	10.05bc	l0.l0c	26.62b	30.75a	34.12b	34.97b	32.08cd	32.60c
V_3	24.88a	25.63a	11.13a	11.52a	22.13e	23.07f	41.02a	41.73a	34.80a	35.22a
V_4	l7.20d	18.23g	8.77d	8.l3e	28.18a	28.20c	32.75c	33.73c	31.70cde	32.20cd
V_5	17.62c	24.77b	9.72c	9.85d	26.50b	27.30d	34.02b	34.95b	32.22c	32.72cd
V_6	19.15c	20.81d	10.58b	l0.68b	25.43c	26.03e	33.57bc	34.50bc	29.67f	30.28e
V_7	17.62e	18.76fg	7.37e	7.60e	27.15b	29.22b	33.l8bc	34.32bc	30.90e	31.40d
V_8	19.15c	19.73e	8.70e	8.83b	26.67b	29.52b	34.23b	35.18b	33.33b	33.83b
V_9	17.62e	19.00f	9.83c	9.97d	24.37d	25.93e	3l.47d	32.65d	30.97e	31.47d
V_{10}	17.77e	18.30g	7.18e	7.72e	28.97a	30.95a	33.68bc	34.82b	33.82b	34.35ab
CV (%)	4.18	2.59	4.90	4.59	2.68	2.37	2.38	2.21	2.28	2.35

Means in a column having dissimilar letter (s) are significantly different at 5% level of probability as per DMRT.

S_1= 60 × 40 cm, S_2 = 60 × 45 cm

V_1= Green Rich, V_2 = Green 621, V_3 = Green Coronet, V_4 = Summer Warrior, V_5= Rare Ball, V_6 = Atlas-70, V_7 = Southern Treasure, V_8 = Laurels, V_9= K-K Cross, V_{10} = K- S Cross.

Y_1 = 2005-06, Y_2 = 2006-07; Head compactness scale: more compact =1, Medium compact =2 and Less compact =3 (V_3=3, V_8=2, other varieties =1).

Table 2 Cont'd. Yield attributes and head yield of cabbage as influenced by spacing and cabbage varieties during 2005-07.

Treatment	Head weight (cm)		Head diameter (cm)		Head weight with unfolded leaf (kg)		Head weight without unfolded leaf (kg)		Head yield (t/ha)			Days to harvest	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Pooled	Y_1	Y_2
Spacing (cm)													
S_1	14.60	15.03	17.53b	18.001	2.20	2.28	1.71b	1.74b	65.34a	67.82a	66.58a	83	83
S_2	14.74	15.09	18.18a	18.83a	2.46	2.53	1.88b	1.90a	57.66b	60.49b	59.07b	84	83
Variety													
V_1	14.l0c	14.44c	17.93d	18.29c	2.26c	2.28d	175c	1.79c	56.65d	60.20d	58.42d	85c	84c
V_2	l4.92b	15.36b	16.03h	18.70b	2.07d	2.13c	1.87b	l.93b	64.32abc	68.59a	66.46ab	76h	74h
V_3	15.68a	16.15a	17.57ef	16.42e	2.77a	2.85a	1.44e	1.46e	50.38e	51.30e	50.84e	89a	89a
V_4	14.28c	14.71a	18.32c	18.60b	2.08d	2.14e	1.7lcd	1.83c	57.02d	59.30d	58.16d	83e	83e
V_5	15.48a	15.95a	17.27fg	17.60d	2.35bc	2.40bcd	1.67d	1.80c	62.53c	65.0lc	63.77c	84cd	83cd
V_6	13.88c	14.32c	l8.62bc	19.35a	2.24c	2.3lbcd	1.65d	1.70d	57.65d	59.97d	58.81d	8lg	80g
V_7	14.35c	14.78c	18.87ab	19.41a	2.37bc	2.44bc	1.99a	2.04a	65.54ab	68.52a	67.03ab	84d	83d
V_8	13.17d	13.53d	17.88bc	18.26c	2.40bc	2.46b	l.75c	l.80c	63.75bc	66.36bc	65.06bc	82f	81f
V_9	15.65a	16.05a	l9.12a	19.20a	2.46b	2.54b	1.88b	1.93b	66.09a	68.66a	67.38a	88b	87b
V_{10}	15.18ab	15.79ab	18.97a	19.35a	2.24c	2.47b	1.86b	l.92b	64.28abc	66.96ab	65.62abc	84b	83d
CV (%)	2.85	2.97	2.59	3.01	5.45	4.71	3.21	3.09	2.40	2.19	2.41	2.34	2.67

Means in a column having dissimilar letter (s) are significantly different at 5% level of probability as per DMRT
S_1 = 60 × 40 cm, S_2 = 60 x 45 cm, V_1 = Green Rich, V_2 = Green 621, V_3 = Green Coronet, V_4= Summer Warrior, V_5 = Rare Ball, V_6 = Atlas-70, V_7 = Southern Treasure, V_8 = Laurels, V_9 = K-K Cross, V_{10} = K- S Cross.
Y_1 = 2005-06, Y_2= 2006-07; Head compactness scale: more compact = 1, Medium compact = 2 and Less compact =3 (V_3=3, V_8=2, other varieties = 1)
* After transplanting

Table 3. Combined effect of spacing and variety on growth characters of cabbage during 2005-2007.

Interaction (S×V)		Plant height at harvest (cm)		Unfolded leaf (No.)		Folded leaf (No.)		Length the biggest leaf (cm)		Width of the biggest leaf (cm)	
Spacing (cm)	Variety	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
	V_1	17.57h-k	18.09hi	9.86bc	10.13bc	20.07ab	30.13abc	32.00f	32.98i	30.00ghi	30.57fgh
	V_2	23.63bc	24.33b	9.96bc	10.00bc	29.68a	30.60ab	32.30f	33.28hi	30.47ghi	30.97fgh
	V_3	24.60ab	25.34a	l1.23a	11.43a	20.43k	21.07g	39.83b	40.06b	34.23abc	34.57abc
	V_4	17.27ijk	17.78i	7.33de	7.60fg	27.43de	28.l0d	32.97ef	33.93f-i	31.07fgh	31.57e-h
S_1	V_5	23.l3cd	23.83bc	9.50bc	9.83bc	25.30gb	26.30e	36.00c	36.67c	33.07cd	33.57cd
	V_6	19.67fg	20.26e	9.70bc	9.90bc	24.87gb	25.53ef	34.07de	34.87d-g	29.80hi	30.37gh
	V_7	16.30k	18.0lhi	6.70e	7.23g	27.26de	28.40d	34.03de	35.I7def	31.27fg	31.77efg
	V_8	19.50fg	20.09ef	5.10d	8.33ef	28.23bcd	29.l3cd	34.37de	35.43cde	33.47cd	33.97cd
	V_9	16.97jk	19.l9fg	9.40bc	9.57bc	25.40gh	25.57ef	30.57g	31.63j	30.67ghi	31.l7fgh
	V_{10}	18.30g-j	18.85gh	7.20e	7.63fg	29.67a	30.67ab	32.47f	33.87f-i	32.77d	33.33cd
	V_1	17.67h-k	18.20hi	9.73bc	10.04bc	24.37hi	30.83ab	33.50def	34.57d-h	32.47de	32.97de
	V_2	21.77de	23.llc	I0.I3bc	10.20b	26.97ef	30.90ab	35.93c	36.67c	33.70bcd	34.23bcd
	V_3	25.17a	25.92a	11.30a	11.60a	24.l9hi	25.07f	42.20a	42.87a	35.37a	35.87a
	V_4	18.13g-j	18.68ghi	10.20b	8.67de	28.39abc	28.30d	32.53f	33.S3ghi	32.33def	32.83de
S_2	V_5	24.97ab	25.71a	9.86bc	9.87bc	27.70cde	28.30d	32.03f	33.23hi	31.37efg	31.87ef
	V_6	20.73ef	21.36d	11.47a	I 1.47a	26.00fg	26.53e	33.07ef	34.13e-i	29.53i	30.20h
	V_7	18.93gh	19.52efg	8.03d	7.97efg	28.83abc	30.03abc	32.33f	33.47ghi	30.53ghi	31.03fgh
	V_8	18.8oghi	19.36efg	9.30c	9.33cd	25.10gh	29.90bc	34.l0de	34.93d-g	33.20cd	33.70cd
	V_9	18.27g-j	18.81gh	10.27b	10.37b	23.33ij	26.30e	32.37f	33.67ghi	31.27efg	31.l7efg
	V_{10}	17.23ijk	17.75i	7.03e	7.80	29.68a	31.23a	34.90cd	35.77cd	34.87ab	35.37ab
CV *(%)*		4.18	2.59	4.90	4.59	2.68	2.37	2.38	2.21	2.28	2.35

Means in a column having dissimilar letter (s) are significantly different at 5% level of probability as per DMRT

S_1= 60 × 40 cm, S_2 = 60 × 45 cm, V_1 = Green Rich, V_2 = Green 621, V_3 = Green Coronet, V_4 = Summer Warrior, V_5 = Rare Ball

V_6 = Atlas-70, V_7 = Southern Treasure, V_8 = Laurels, V_9 = K-K Cross, V_{10} = K- S Cross, Y_1 = 2005-06, Y_2 = 2006-07.

Table 3 Cont'd. Combined effect of spacing and variety on yield and yield attributes and head yield of cabbage during 2005-2007.

Interaction (S×V)		Head height (cm)		Head diameter (cm)		Head wt. with unfolded leaf (kg)		Head wt. without unfolded leaf (kg)		Head yield (t/ha)			Days to harvest*	
Spacing (cm)	Variety	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	poled	Y_1	Y_2
	V_1	14.I3fg	14.41f-i	15.67j	17.75fg	2.l2fg	2.l9fgh	1.69f-i	1.73ghi	65.04cd	67.65cd	66.34cd	85cd	84d
	V_2	15.27bcd	15.l2bcd	17.40fg	18.03ef	1.97g	2.03h	1.80bc	1.85f	66.49c	69.15c	67.82c	76k	75k
	V_3	14.97cd	15.4Icd	16.97gh	16.17i	2.57bcd	2.64bc	1.74e-h	1.43j	50.40i	51.13i	50.76k	89a	89a
	V_4	13.77g	14.l8hi	18.8abc	I9.17c	2.04g	2.10gh	1.72e-i	1.77fgh	60.04e	62.44e	61.24g	82i	82hi
	V_5	15.67abc	16.l4abc	17.17gh	17.49fg	2.33def	2.40def	1.68g-j	1.73ghi	69.1Th	71.94b	70.56b	83fg	83fg
S_1	V_6	13.70g	14.15i	18.90b	19.28bc	2.06g	2.12gh	1.59j	1.64i	60.46e	62.88e	61.67fg	82hij	8lhij
	V_7	13.97fg	14.93ghi	18.30cde	1&98cd	2.07g	2.13gh	1.80de	1.85ef	70.50ab	73.32ab	71.7lab	84efg	83efg
	V_8	13.40gh	13.80ij	16.38hi	17.20gh	2.33def	2.39def	1.63ij	1.68hi	70.I6ab	72.96ab	71.56ab	82ij	8lij
	V_9	15.33bcd	15.79bcd	17.13gh	17.43fg	2.35c-f	2.42de	1.77efg	l.82efg	71.96a	74.69a	73.32a	88b	87ab
	V_{10}	15.50ab	16.29ab	18.l7de	18.544e	2.17fg	2.3ldef	1.74e-h	1.86ef	69.20b	71.96b	70.57b	85cde	83fg
	V_1	14.70efg	14.48e-i	16.40i	18.83cd	2.40cde	2.3ldef	1.8Ide	1.86ef	59.4lef	66.13d	63.72ef	85cde	83fg
	V_2	14.57def	15.00d-h	18.47bcd	19.37bc	2.I7efg	2.24efg	1.95b	2.0lbc	63.59d	68.02cd	64.85de	76k	76k
	V_3	16.40a	16.89a	18.Ilde	16.67hi	2.99a	3.07a	l.78efg	1.50j	50.37i	51.47i	50.91k	89a	90a
	V_4	14.50de	15.24def	17.83ef	19.23bc	2.l2fg	2.l9fgh	1.69g-j	1.89de	54.00h	56.16h	54.54j	84def	84def
	V_5	15.30bcd	15.l6bcd	17.37fg	17.llfg	2.37cde	2.39def	1.65hij	1.86ef	55.58gh	58.08gh	56.96hi	86c	85c
S_2	V_6	14.07efg	14.49e-i	18.33cde	19.42bc	2.42cd	2.49cd	1.71e-i	1.76fgh	54.85gh	57.05h	55.94ij	81j	80h
	V_7	14.73def	15.17d-g	19.43a	19.84ab	2.67b	2.75b	2.17a	2,23a	64.16d	66.15d	65.l5de	84def	84def
	V_8	12.93h	13.26j	18.93b	19.3lbc	2.47bcd	2.54bcd	1.87cd	1.92cde	57,34fg	59.l0fg	58.56h	83gh	82ij
	V_9	15.97ab	13.31j	17.10gh	17.78fg	2.58bc	2.66bc	1.97b	2.03b	60.22e	62.63e	61.34g	88a	88ab
	V_{10}	14.57def	15.28de	19.77a	20.16a	2.3lcde	2.57bcd	1.94b	1.92cde	59.36ef	61.97ef	60.66g	84efg	84def
CV (%)		2.85	2.97	2.59	3.01	5.45	4.71	3.21	3.09	2.40	2.19	2.01	2.34	2.67

Means showing different letter (s) are significantly different at 5% level of significance by DMRT

S_1= 60 × 40 cm, S_2 = 60 × 45 cm, V_1 = Green Rich, V_2 = Green 621, V_3 = Green Coronet, V_4 = Summer Warrior, V_5 = Rare Ball V_6 = Atlas-70, V_7 = Southern Treasure, V_8 = Laurels, V_9 = K-K Cross, V_{10} = K- S Cross, Y_1 = 2005-06, Y_2 = 2006-07

*After transplanting.

Based on the above results, it can be concluded that the cabbage varieties K-K Cross with closer spacing (60 × 40 cm) showed maximum head yield followed by Southern Treasure and Laurels having same spacing in AEZ-29. The variety Green-621 was found suitable for cultivation as an early variety with spacing 60 × 40 cm for reasonable good yield.

References

Anonymous. 2005. Annual Report for 2004-2005. Hill Research Station, Khagrachhari, BARI (Bangladesh Agril. Res. Inst), Khagrachhari. p. 15.

BARI (Bangladesh Agricultural Research Institute) 1993. Annual Report for 1992-1993. Bangladesh Agril. Res. Inst., Joydebpur, Gazipur. p. 434-435.

BARI (Bangladesh Agricultural Research Institute) BARI (Bangladesh Agricultural Research Institute). 1997. Annual Report for 1996-1997. Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. p. 128.

BARI (Bangladesh Agricultural Research Institute). 1994. Annual Report for 1993-1994. Bangladesh Agril. Res. Inst., Joydebpur, Gazipur. p. 424.

BBS (Bangladesh Bureau of Statistics). 2005. Yearbook of Agricultural Statistics of Bangladesh. Bangladesh Bur. of Stat., Minis. of Plan., Govt. of the People's Repub. Bangladesh, Dhaka. p.1 09.

FAO.1994. Statistical Year Book. Food and Agriculture Organization of The United Nations, Rome, Italy. 48. pp. 126-17.

Farooque, A. M. and A. F. M. S. Islam. 1989. Effect of spacing and different management practices on the growth and yield of cabbage. *Bangladesh Hort*. **17** (1): 45-47.

Farooque, A. M. and M. F. Mondal. 1987. Effect of spacing and levels of nitrogen on growth and yield of cabbage. *Bangladesh Hort*. **15** (2): 1-6.

Hossain, M. F., M. A. Siddique and M. M. Hossain.1983. Influence of time of planting and plant density on the yield of three varieties of cabbage. *Bangladeh J. Agric. Res.* **8** (2): 110-115.

Islam, A. F., M. S. Islam, A. M. Farooque and M. N. Islam. 1989. Effect of age of seedling and spacing on the performance of cabbage. *Bangladesh Hort.* **15** (2): 1-6.

Nahar, J., M. H. Rahman, S. H. Choudhury and R. Begum. 1996. Effect of spacing and methods of cultivation on the growth and yield of cabbage. *Bangladesh Hort.* **24** (1&2): 87-90.

Nasreen, S. and M. S. Islam. 1992. Response of cabbage to N, P. K, S., Zn and Mo fertilization. *Bangladesh J. Agril. Sc.* **19** (2): 28 1-285.

Rahman, A. and M. A. Haque. 1982. Effect of plant density on the growth and yield of cabbage. *Bangladesh J. Agric*. **7** (3-4); 9-14.

Rashid, M. M. 1999. "Shabjibiggayan (In Bengali)". Rashid Publishing House, 94, Old DOHS, Dhaka-1206. p. 233.

Singh, N. P., A. K. Bhardway, A. Kumar and K. M. Singh. 2004. Modern Technology on Vegetable Production. Int. Book Distri. Co. Chaman Studio Building, 2nd Floor, Charbagh Lucknow 226004, U. P., India. p. 135.

Thamburaj, S and N. Singh. 2004. Vegetables, Tuber Crops and Spices. Kuldeep Sharma, In-charge, Directorate of Information and Publication of Agriculture, Indian Council of Agriculture Research, Krishi Anusandhan Bhaban, Pusa, New delhi, 110012. p.115.

Wien, H. C. and D. C. E. Wurr.1997. Cauliflower, brocoli, cabbage and brussels sprout. pp. 511-552. In: H. C. Wien (ed.), The Physiology of Vegetable Crops. Cab International, Wallingford, Oxon, Ox10 8De, U. K.