Effect of Planting Time and Spacing on Growth and Yield of Cabbage

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Article History

Manuscript No. 366
Received in 6th September, 2012
Received in revised form 6th May, 2013
Accepted in final form 5th June, 2013

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Keywords

Cabbage, planting time, spacing, yield.

Abstract

An experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from October, 2010 to March, 2011 to study the effect of planting time and spacing on the growth and yield of cabbage. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and includes three different planting times; T_1 (7th November), T_2 (21st November) and T_3 (5th December) in 2010, and three different spacing; S_1 (60 cm×40 cm), S_2 (60 cm×45 cm) and S_3 (60 cm×50 cm). The results of the study revealed significant differences in terms of plant height, number of leaves plant^{-1}, number of non-wrapper leaves plant^{-1}, weight of plant, fresh weight of head plant^{-1}, diameter of head, thickness of head, dry matter of head plant^{-1} and moisture content percentage. The highest fresh weight of head plant^{-1} (1.36 kg) was recorded from T_1S_1 and the lowest fresh weight of head plant^{-1} (0.4 kg) from T_3S_3. The spacing (60 cm×50 cm) and 21st November planting time were found suitable for growth and yield of cabbage.

1. Introduction

Cabbage (*Brassica oleracea var. capitata* L.) belongs to the family Cruciferae. It is the most important Cole crop and is one of the five leading vegetables of the world (Rashid, 1993). It is biennial and herbaceous in nature and is extensively grown during winter season in Bangladesh. Head, the edible portion of cabbage is a large bud which is formed by several fleshy leaves overlapping one another. It has been reported that 100g of green edible portion of cabbage contains 92% water, 24 calories of food energy, 1.5g of protein, 4.8g of carbohydrate, 40 mg of calcium, 0.6 mg of iron, 600 IU of carotene, 0.05 mg of riboflavin, 0.3 mg of niacin and 60 mg of vitamin C (Rashid, 1993).

Among the vegetables grown in Bangladesh, cabbage ranks second in respect of production and area. *Bogra, Jessore, Kustia, Meherpur* and *Tangail* are the cabbage growing areas in Bangladesh. At present in Bangladesh, it is being cultivated in area of 41182 hectares which is increasing day by day with a production of 219958 metric tons (BBS, 2010). Production of crops depends on so many factors, optimum planting time and population are two of the very important factors which influence the productivity.

Optimum planting time depends on the existing cropping pattern and prevailing environment. Cabbage needs cool temperature for its optimum growth and head formation. In Bangladesh, it is planted in early September to late November. However, the temperature remains fairly high up to mid-October (max. 30-32°C; and min. 24-27°C) on average which gradually comes down to about 20° C in mid-December and this cool period extends up to mid-February. Planting time is very critical and sowing of seed should be done carefully so that the crop can take the best advantage of the entire cool period. It is, therefore important to observe the effect of planting time for achieving optimum growth and yield of cabbage.

It is well established that plant spacing has significant influence on growth and yield of cabbage. Yield is a function of inter plant and intra plant competition. Competition associated with different spacing alters plant morphology in various ways. Optimum plant spacing should be maintained to exploit maximum natural resources, such as nutrients, sunlight, soil moisture etc. and to ensure satisfactory yield and proper use of land. The optimum plant spacing depends on several factors including the growing environment, dose of fertilizer, source of nutrients, cultivars used, moisture availability and fertility status of the land. Early planting and wide spacing significantly enhanced the growth of cabbage (Shaker, 1999). The wider spacing (60 cm×60 cm) resulted in the highest mean total soluble solid (8.77%), chlorophyll (0.24 mg g^{-1}) contents, head diameter (13.9 cm) and weight (1184.33 g) (Mahesh-Kumar et al. 2002). Considering the above mentioned facts, the present study was undertaken to find out the suitable planting time along

with suitable plant spacing for the better growth and yield of cabbage.

2. Materials and Methods

A field experiment was conducted at Horticulture Farm in Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The trial was carried out during *rabi* season (October 2010 to March 2011). The land was medium high with adequate irrigation facilities. The soil was having a texture of sandy loam with pH 5.6. Seeds of *Autumn Queen* variety of cabbage were used in the experiment. Seed bed was made on 12th October for raising cabbage seedlings. The size of the seed bed was 1.2 m×2 m. Seeds were treated by Vitavax 200 WP@ 2.5 g kg^{-1} of seed to protect some seed borne diseases such as damping off and leaf spot. Then the seeds were sown on seed bed at three times on 12th October, 27th October and 11th November 2010 to maintain the same age at the time of transplanting and sowing was done thinly spaced at 5 cm distance and the seeds were sown at a depth of 2 cm and covered with a fine layer of soil followed by light watering with a water can. No chemical fertilizer was applied for rising of seedlings. Healthy seedlings were transplanted. The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications. Three different plant spacing viz. S_1 (60 cm×40 cm), S_2 (60 cm×45 cm) and S_3 (60 cm×50 cm) and three different transplanting times viz. T_1: 07/11/2010, T_2: 21/11/2010 and T_3: 05/12/2010 were maintained in this study. The land was properly leveled followed by laddering to bring a good tilth. Fertilizers were applied @ 161, 113, 180 and 30 kg ha^{-1} N, P_2O_5, K_2O and S respectively. Cowdung was used @ 5 tha^{-1} during land preparation. The seedling having 5-6 true leaves were transplanted at the spacing 60 cm×40 cm, 60 cm×45 cm and 60 cm×50 cm in a plot on 7th November, 2010, 21st November, 2010 and 5th December, 2010 in the afternoon. Intercultural operations were done as and when needed. The head cabbage was harvested during the period from 27th January to 25th February 2011. Data on plant height, number of leaves per plant, number of non-wrapper leaves per plant and yield contributing characters were recorded from ten selected plants. The recorded data on different parameters were statistically analyzed with the help of MSTAT Program. The treatments mean were separated by Duncan's Multiple Range Test (Gomez and Gomez, 1984) at 5% level of significance for interpretation of the result.

3. Results and Discussion

3.1. Plant height

Significant variation was found in plant height at different days after transplanting (Table 1). The tallest plant at 20 DAT (17.4cm), 35 DAT (24.9 cm), 50 DAT (30.7 cm), 65 DAT (31.7 cm) and 80 DAT (35.9 cm) were found in T_2. Whereas, the shortest plant height at 20 DAT (15.8 cm), 35 DAT (17.9 cm), 50 DAT (20.6 cm), 65 DAT (22.5 cm) and 80 DAT (24.0 cm) were found in T_3. The results showed that the plant height at different DAT was increased in treatment (T_2) and then got shorter after the treatment (T_2). This might be due to the fact that 21st November (T_2) planted crops possibly got favorable condition for better growth than those of other planting dates.

Plant height varied significantly due to the different spacing (Table 1). The tallest plant at 20 DAT (17.5 cm), 35 DAT (22.3 cm), 50 DAT (26.2 cm), 65 DAT (28.5 cm) and 80 DAT (31.5 cm) were found in S_3. Whereas, the shortest plant height at 20 DAT (16.2 cm), 35 DAT (20.1 cm), 50 DAT (23.8 cm), 65 DAT (26.1 cm) and 80 DAT (29.1 cm) were found in S_1. The results showed that the plant height at different spacings was increased with the increasing of spacing. This might be due to receiving sufficient amount of light and nutrients. The trend of the present results was agreed to that of Singh et al., (2007).

The variation was recorded significantly due to combined effect of planting time and plant spacing (Table 2). The tallest plant at 20 DAT (18.4 cm), 35 DAT (27.4 cm), 50 DAT (33.2 cm), 65 DAT (33.9 cm) and 80 DAT (37.2 cm) was recorded from T_2S_3. The shortest plant height at 20 DAT (15.1 cm), 35 DAT (16.4 cm), 50 DAT (18.4 cm), 65 DAT (20.5 cm) and 80 DAT (22.3 cm) were recorded from T_3S_3.

3.2. Number of leaves plant^{-1}

Number of leaves $plant^{-1}$ was significantly influenced by planting time (Table 1). The highest number of leaves (28.5) $plant^{-1}$ was found in T_2 at 80 DAT and lowest number of leaves (8.7) $plant^{-1}$ was found in T_1 at 20 DAT. At 20 and 35 DAT number of leaves $plant^{-1}$ of cabbage showed statistically insignificant variation but at 50, 65 and 80 DAT it varied significantly.

The maximum number of leaves $plant^{-1}$ (25.3) was found from S_3 treatment at 80 DAT. On the other hand the minimum number of leaves $plant^{-1}$ was recorded at 20 DAT (9.4). The number of leaves $plant^{-1}$ at different DAT was increased with the wider spacing. This was due to receiving of sufficient amount of nutrients in the wider spacing. The trend of the present results was agreed to that of Meena (2003).

Number of leaves $plant^{-1}$ at 35, 50, 65 and 80 DAT varied significantly due to combined effect of planting time and spacing (Table 2). The maximum number of leaves (30.8) $plant^{-1}$ was recorded from T_2S_3 and the minimum (8.7) was recorded from T_1S_1.

3.3. Number of non-wrapper leaves plant^{-1}

Number of non-wrapper leaves $plant^{-1}$ showed statistically significant variation due to the different planting time (Table

Table 1: Main effect of planting time and spacing on plant height and number of leaves plant^{-1} of cabbage at different days after transplanting (DAT)

Treatment	Plant height (cm) at (DAT)					Number of leaves plant^{-1} at (DAT)				
	20	35	50	65	80	20	35	50	65	80
Planting time										
T_1	17.15^{a}	21.03^{b}	24.89^{b}	28.70^{b}	31.25^{b}	8.79^{b}	13.42^{b}	17.32^{b}	20.97^{b}	23.66^{b}
T_2	17.38^{a}	24.92^{a}	30.74^{a}	31.74^{a}	35.95^{a}	9.68^{ab}	17.67^{a}	23.08^{a}	24.32^{a}	28.45^{a}
T_3	15.79^{b}	17.99^{c}	20.64^{c}	22.56^{c}	24.03^{c}	10.00^{a}	13.58^{b}	16.56^{b}	19.89^{c}	21.81^{c}
LSD (p=0.05)	0.63	0.49	1.72	0.77	1.14	1.16	0.83	0.83	0.77	1.09
F-test	**	**	**	**	**	*	**	**	**	**
Spacing										
S_1	16.22^{b}	20.18^{c}	23.88^{b}	26.15^{b}	29.15^{c}	9.46	14.57	18.20^{b}	20.77^{b}	23.67^{b}
S_2	16.56^{b}	21.39^{b}	26.13^{a}	28.31^{a}	30.53^{b}	9.37	15.17	19.28^{a}	22.35^{a}	24.99^{a}
S_3	17.54^{a}	22.36^{a}	26.27^{a}	28.53^{a}	31.54^{a}	9.58	14.93	19.49^{a}	22.07^{a}	25.25^{a}
LSD (p=0.05)	0.66	0.71	0.83	0.44	0.44	-	-	0.51	0.64	0.65
F-test	**	**	**	**	**	NS	NS	**	**	**

NS=Non-significant; **=Significant at 1% probability; *=Significant at 5% probability; T_1: 7th November, 2010; T_2: 21st November, 2010; T_3: 5th December, 2010; S_1:60 cm×40 cm; S_2:60 cm×45 cm and S_3:60 cm×50 cm

Table 2: Combined effect of planting time and spacing on plant height and number of leaves plant^{-1} of cabbage at different days after transplanting (DAT)

Treatment	Plant height (cm) at (DAT)					Number of leaves plant^{-1} at (DAT)				
combination	20	35	50	65	80	20	35	50	65	80
T_1S_1	16.08	21.92^{c}	27.09^{c}	30.09^{c}	33.04^{c}	8.92	14.30^{c}	18.75^{c}	21.46^{c}	24.71^{c}
T_1S_2	18.08	21.00^{cd}	24.00^{d}	28.13^{d}	30.58^{d}	8.75	12.83^{d}	16.42^{de}	20.58^{cd}	23.13^{d}
T_1S_3	16.96	20.17^{d}	23.59^{de}	27.88^{d}	30.13^{d}	8.71	13.13^{d}	16.79^{d}	20.88^{c}	23.13^{d}
T_2S_1	17.42	23.38^{b}	29.42^{b}	31.21^{b}	35.63^{b}	9.21	16.96^{b}	21.92^{b}	24.00^{b}	27.00^{b}
T_2S_2	16.63	23.96^{b}	29.63^{b}	30.08^{c}	35.04^{b}	9.83	17.67^{ab}	22.09^{b}	23.04^{b}	27.54^{b}
T_2S_3	18.42	27.42^{a}	33.17^{a}	33.92^{a}	37.17^{a}	9.83	18.38^{a}	25.25^{a}	25.92^{a}	30.79^{a}
T_3S_1	16.17	18.88^{e}	22.29^{ef}	24.29^{e}	25.96^{e}	10.00	14.25^{c}	17.17^{d}	21.58^{c}	23.25^{d}
T_3S_2	16.13	18.67^{e}	21.21^{f}	22.88^{f}	23.83^{f}	10.17	13.58^{cd}	16.79^{d}	19.71^{d}	21.84^{e}
T_3S_3	15.08	16.42^{f}	18.42^{g}	20.50^{g}	22.29^{g}	9.83	12.92^{d}	15.71^{e}	18.38^{e}	20.33^{f}
LSD (p=0.05)	-	1.23	1.44	0.76	0.76	-	0.82	0.88	1.11	1.14
F-test	NS	**	**	**	**	NS	**	**	**	**

NS=Non-significant; **=Significant at 1% probability; T_1: 7th November, 2010; T_2: 21st November, 2010; T_3: 5th December, 2010; S_1:60 cm×40 cm; S_2:60 cm×45 cm and S_3:60 cm×50 cm

3). The maximum number of non-wrapper leaves plant^{-1} (29.3) was recorded from T_1 treatment. Again, the minimum (21.8) was observed from T_3 treatment.

Due to different spacing, the number of non-wrapper leaves plant^{-1} of cabbage varied insignificantly (Table 3). The maximum number of non-wrapper leaves plant^{-1} (24.9) was recorded from S_3 and the minimum (24.3) was recorded from S_1. The number of non-wrapper leaves plant^{-1} increased with the increasing of spacing.

Combined effect of planting time and spacing showed statistically insignificant differences (Table 4). The maximum number of non-wrapper leaves plant^{-1} (29.8) was found from T_1S_1 and minimum (21.0) from T_3S_1.

3.4. Weight of plant

Weight of plant showed statistically significant differences due to the different planting time (Table 3). The highest weight of plant (2.18 kg) was recorded from T_1 and the lowest weight of plant (1.0 kg) was recorded from T_3. Optimum planting time ensured proper growth of plant and consequently the highest plant weight. Weight of plant varied significantly due to different plant spacing (Table 3). The highest weight of plant (1.86 kg) was recorded from S_3 and the lowest (1.52 kg) was recorded from S_1. Weight of plant was increased with the increase in spacing. This might be due to availability of

Table 3: Main effect of planting time and spacing on number of non-wrapper, weight of plant, weight of head, diameter of head and thickness of head of cabbage at different days after transplanting (DAT)

Treatment	Number of non-wrapper leaves	Weight of plant (kg)	Weight of head plant^{-1} (kg)	Diameter of head (cm)	Thickness of head (cm)
Planting time					
T_1	29.30^{a}	2.18^{a}	1.28^{a}	19.68^{ab}	12.06
T_2	22.85^{b}	1.80^{b}	0.98^{b}	20.43^{a}	12.39
T_3	21.81^{b}	1.04^{c}	0.53^{c}	19.35^{b}	12.31
LSD (p=0.05)	1.10	0.14	0.004	0.91	-
F-test	**	**	**	*	NS
Spacing					
S_1	24.93	1.52^{c}	0.86^{b}	17.61^{b}	10.06^{b}
S_2	24.78	1.65^{b}	0.9211^{ab}	18.28^{b}	11.43^{a}
S_3	24.26	1.86^{a}	1.004^{a}	19.36^{a}	12.13^{a}
LSD (p=0.05)	-	0.10	0.09	0.78	1.15
F-test	NS	**	*	**	*

NS=Non-significant, **=Significant at 1% probability, *=Significant at 5% probability; T_1: 7th November, 2010; T_2: 21st November, 2010; T_3: 5th December, 2010; S_1:60 cm×40 cm; S_2:60 cm×45 cm and S_3:60 cm×50 cm

sufficient amount of light and nutrients. Due to the combined effect of planting time and plant spacing significant variation was recorded (Table 4). The highest weight of plant (2.3 kg) was observed from T_1S_1 and the lowest (1.1 kg) from T_3S_3.

3.5. Fresh weight of head plant^{-1}

Fresh weight of head plant^{-1} showed statistically significant differences due to the different planting time in cabbage (Table 3). The highest fresh weight of head plant^{-1} (1.28 kg) was recorded from T_1 and the lowest fresh weight of head plant^{-1} (0.53 kg) was recorded from T_3. Optimum planting time ensured proper growth of plant and consequently the highest fresh weight of head. The highest fresh weight of head plant^{-1} (1.0 kg) was recorded from widest spacing (S_3) and the lowest (0.86 kg) was observed from closest spacing (S_1). Fresh weight of plant was increased with the increase in spacing. This might be due to the availability of sufficient amount of light and nutrients. The trends of these present results agreed with that of Mahesh-Kumar et al., 2002 (Table 3). Significant variation was recorded due to the combined effect of planting time and spacing (Table 4). The highest fresh weight of head (1.36 kg) was observed from T_1S_1 and the lowest (0.4 kg) was found in T_3S_3.

Table 4: Combined effect of planting time and spacing on number of non-wrapper, weight of plant, weight of head, diameter of head and thickness of head of cabbage

Treatment combination	Number of non-wrapper leaves	Weight of plant (kg)	Weight of head (kg)	Diameter of head (cm)	Thickness of head (cm)
T_1S_1	29.22^{a}	2.31^{a}	1.36^{a}	17.81^{b}	11.44^{b}
T_1S_2	28.89^{a}	2.12^{b}	1.26^{a}	19.23^{ab}	12.36^{ab}
T_1S_3	29.78^{a}	2.11^{b}	1.22^{a}	19.65^{ab}	12.00^{ab}
T_2S_1	22.56^{b}	2.10^{b}	1.06^{b}	19.24^{ab}	11.64^{b}
T_2S_2	23.00^{b}	1.71^{c}	0.92^{b}	18.33^{b}	12.44^{ab}
T_2S_3	23.00^{b}	1.60^{c}	0.96^{b}	20.1^{a}	12.66^{ab}
T_3S_1	21.00^{c}	1.17^{d}	0.60^{c}	19.52^{ab}	13.36^{a}
T_3S_2	22.44^{bc}	1.11^{d}	0.58^{c}	19.78^{ab}	12.50^{ab}
T_3S_3	22.00^{bc}	0.85^{e}	0.40^{d}	18.90^{ab}	12.52^{ab}
LSD (p=0.05)	-	0.17	-	1.69	1.44
F-test	NS	*	NS	**	**

NS=Non-significant, **=Significant at 1% probability, *=Significant at 5% probability; T_1: 7th November, 2010; T_2: 21st November, 2010; T_3: 5th December, 2010; S_1:60 cm×40 cm; S_2:60 cm×45 cm and S_3:60 cm×50 cm

3.6. Diameter of head

Diameter of head showed statistically significant differences due to different planting time in cabbage (Table 3). The highest diameter of head (20.4 cm) was recorded from T_2 and the lowest (19.4 cm) was found in T_3. Optimum planting time ensured proper growth of plant and consequently the highest diameter of head. The highest diameter of head (19.4 cm) was recorded from S_3 and the lowest (17.6 cm) was recorded from S_1. Diameter of plant was increased with the increasing of spacing. This might be due to availability of sufficient amount of light and nutrients (Table 3). Significant variation was recorded due to combined effect of planting time and plant spacing (Table 4). The highest diameter of head (20.1 cm) was observed from T_2S_3 and the lowest (17.8 cm) in T_1S_1.

3.7. Thickness of head

Thickness of head showed statistically significant differences due to the different planting time in cabbage (Table 3). The highest thickness of head (12.4 cm) was recorded from T_2 and the lowest (12.1 cm) from T_1. Optimum planting time ensured proper growth of plant and consequently the highest thickness of head. Thickness of plant varied significantly due to different plant spacing (Table 3). The highest thickness of head (12.1 cm) was recorded from S_3 and the lowest (10.1 cm) from S_1. Thickness of plant was increased with the increase in spacing.

Significant variation was recorded due to combined effect of planting time and plant spacing in terms of thickness of head in cabbage (Table 4). The highest thickness of head (12.7 cm) was observed from T_2S_3 and the lowest (11.5 cm) in T_1S_1.

4. Conclusion

Experimental result revealed that, combination of planting time 21st November and wider spacing 60 cm×50 cm exhibited significant variation for all the parameters studied. Findings of the experiment indicated that the yield of cabbage head was greatly involved by this planting time and spacing.

5. References

BBS., 2010. Monthly statistical Bulletin. Bangladesh, December, 2007. Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning. Government of the People's Republic of Bangladesh, Dhaka, 67.

Gomez, K.A., Gomez, A.A., 1984. Statistical Procedures for Agricultural Research. (2nd Edn.). John Willey and Sons, Singapore, 28-92.

Mahesh-kumar, P.J., Pereira F.I., Ladeira, I.R., 2002. Effect of spacing and mulching on the qualitative characteristics of cabbage. Horticultura Brasileira. 23(1), 100-104.

Meena. 2003. Effect of different spacings on growth and yield of cabbage (*Brassica oleracea* var. *capitata* L.). Annals of Agricultural Research 24(1), 166-168.

Rashid, M.M., 1993. *Sabjibiggan* (in Bengali). 1st Edition. published by Bangla Academy, Dhaka, 179-187.

Shaker, S.F., 1999. Effect of planting date and spacing on seed yield of cabbage. Annals of Agriculture Science Moshtohor 37(1), 423-431.

Singh, J.P., Munib, K., Rakshanda, M., 2007. Effect of nitrogen levels and spacing on the growth and yield of cabbage. Environment and Ecology 25(1), 153-155.