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Effect of Different Sources of Nutrients and Mulching on Growth and Yield Contributing Characters of Cabbage

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Abstract: The experiment was conducted to know the effect of different source of nutrients and mulching on the growth and yield of cabbage. The experiment consisted of four levels of nutrients and three mulching. Sources of nutrients had significant effect on most of the parameters studied. The plants which received organic + inorganic fertilizers produced the highest (79.01 t ha^{-1}) marketable yield, whereas plants having no fertilizer gave yield of 30.65 t ha^{-1}. Mulching had no marked effect on harvest index, but had significant effect on rest of the parameters studied. The use of black polythene sheet mulch produced the highest marketable yield (70.24 t ha^{-1}) and the lowest (45.13 t ha^{-1}) in this respect was observed without mulch. The treatment combination of organic + inorganic fertilizers with black polythene sheet mulch gave the highest marketable yield (97.83 t ha^{-1}) of cabbage.

Key words: Nutrients, growth, yield, cabbage

Introduction

Cabbage (*Brassica oleracea* var. capitata) is a biennial and herbaceous vegetable of the family cruciferae. It has originated from the seacoast of England, Denmark and northwestern part of France (Thompson and Kelly, 1957). This unique vegetable has been widely grown in both tropical and temperate regions of the world. Major cabbage growing countries of the world are South Korea, Germany, Japan, India, South Africa and China (FAO, 1996).

It is one of the five leading vegetables in Bangladesh. Among the vegetables grown in Bangladesh cabbage ranks second in respect of production and area. The leading cabbage growing districts in Bangladesh are Kustia, Meherpur, Jessore, Bogra and Tangail. There were 12060 hectares of land under cabbage cultivation with a production of 113 thousand metric tons in the country during the year 1997-98 (BBS, 1999) with an average yield of 9.29 t ha^{-1} which is quite low in comparison with other countries of the world like South-Korea (61.17 t ha^{-1}), Germany (54.81 t ha^{-1}), Japan (40.32 t ha^{-1}) and India (19.12 t ha^{-1}) (FAO, 1998). Lack of appropriate production technologies adopted by the farmers is one of the main reasons for such low yield of cabbage in Bangladesh (Islam *et al*., 1989).

Cultivation of any crop depends on several factors sources of nutrients is one of them. Growth yield and quality of cabbage are related to judicious application of manures and fertilizers. Nutrients may be applied through two sources, viz. organic and inorganic. Increased use of inorganic fertilizer causes health hazards and creates environmental pollution. Organic sources of nutrients are less expensive and friendly to the environment. To minimize the economic return avoiding health hazards and for a sustainable agriculture, the use of organic sources of nutrients should be encouraged. On the other hand, a judicious combination of organic and inorganic nutrients might be helpful to obtain a good economic return leaving the congenial soil condition.

The annual average rainfall in Bangladesh is about 203 cm, which is very high. But its distribution is uneven. The maximum precipitation (311 cm) takes place during the month of July and August (Iqbal *et al.*, 1992). Moisture content of soil during the early part of the growing season remains high and which declines later. That is they application of irrigation becomes inevitable for obtaining a reasonable yield. But irrigation is not easily available all over the country and is expensive too. To overcome such problems mulching can play a vital role by conserving soil moisture. Mulching is of two types, natural and artificial mulching. Natural mulching means the breaking of the upper crust of soil to disconnect the capillary tube for checking evaporation. Artificial mulching is the covering of soil with crop residues or polythene sheet or another materials. Mulching increases the efficiency of the applied fertilizer and irrigation (Roy *et al.*, 1990). Nitrogen use efficiency can be increased up to 53% with special arrangement of mulch (Sweeney *et al.*, 1987). It is evident

that moisture management and fertilizers application is the most important variables for cabbage production. Considering these two important factors, the present experiment was designed with the following objectives:

I) To find out an appropriate sources of nutrients for the growth and yield of cabbage
II) To recognize mulching as an alternative to irrigation.

Materials and Methods

The experiment was carried out at the Horticulture Farm, BAU, Mymensingh from October 1999 to March 2000 to study the effect of sources of nutrients and mulching on the growth and yield of cabbage. Soil sample was collected from the experiential plot and analyzed in the laboratory. The variety was Atlas-70. The two-factor experiment was laid out in a randomized complete block design (RCBD) and 24 treatment combination. The unit plot size was 4 x 3 m^2. Seedlings were raised in the seedbed and transplanted in the plot at the age of 25 days. There were two factor in the experiment: I) sources of nutrients, a) no fertilizer, b) organic manure, c) organic + inorganic fertilizers, d) Inorganic fertilizers and ii) mulching, a) no mulch, b) water hyacinth mulch, c) black polythene sheet mulch.

The land was ploughed several times to provide a good tilth and favorable condition for growing cabbage. Weeds and stubbles were removed and laddered to level the plot. The experimental plot except the control received a constant dose of 132 kg N, 44 kg $P_2 0_5$ and 120 kg K_2O ha^{-1} (BARC, 1997). The details of manure and fertilizers used for the crop are shown in Appendix Table 1. Intercultural operations like gap filling, weeding, earthling up, etc. were done properly. Data on plant height, spread of plant, number of loose leaves per plants, diameter of head, thickness of head, fresh weight of head, gross yield, marketable yield were recorded from 10 randomly selected plants from each unit plot avoiding border effect.

Collected data were statistically analyzed according to the principle of experimental design. Analysis of variance was made on yield and yield attributes of cabbage. The means were separated and compared by LSD method.

Results and Discussion

Plant height: There was a significant difference among different sources of nutrients on plant height. Increasing trend of plant heights were found up to organic + inorganic fertilizers at 30 and 60 DAT and inorganic fertilizer treatment at 90 DAT during the growth period. Plant height at 30, 60 and 90 DAT was also significantly influenced by the application of mulching. The tallest plant (39.7 cm) at 90 DAT was obtained from the plots mulched with black polythene sheet and the shortest (33.79 cm) plant from no mulch treatment (Table 1). Such effect was probably due to adequate amount of moisture in the topsoil. Rahman *et al.* (1989) expressed similar views on the growth of cabbage.

The combined effect of sources of nutrients and mulching was found significant in respect of plant height at 60 DAT and non-significant at 30 and 90 DAT. The maximum plant height (35.32 cm) was found in the treatment combination of organic + inorganic fertilizers with black polythene mulch at 60 DAT and the lowest (18.88 cm) from no fertilizer and no mulch treatment combinations (Table 3).

Spread of plant: Effect of sources of nutrients on the spread of plant at different DAT was found significant. Maximum spread of plant (71.14 cm) was obtained from the plots receiving organic + inorganic fertilizer at 90 DAT and the lowest (52.76 cm) from control treatment. This might be due to different source of nutrients, which provides more nutrients available to the plant resulted in maximum vegetative growth and increased spread of plants. Mulching had no significant influence on spread of plant at different DAT (Table 1).

Spread of plant was significantly influenced by the combined effect of source of nutrients and mulching. Maximum spread of plant (75.24 cm) was found from the treatment combination of organic + inorganic fertilizers with black polythene mulch and the minimum (52.32 cm) from the control treatment with no mulch (Table 3).

Number of loose leaves per plant: It is apparent from Table 1 that number of loose leaves per plant increased with time irrespective of fertilizer treatments. At 90 DAT, the control treatment gave maximum number (18.06) of loose leaves whereas; the minimum number (16.74) was obtained from organic fertilizer treatment. Number of loose leaves per plant varied significantly due to the effect of mulching. Plants, which were not mulched, produced maximum number of loose leaves. But the plants with black polythene sheet mulch gave minimum number of loose leaves $plant^{-1}$ (Table 1).

The combined effect of sources of nutrients and mulching on the number of loose leaves/plant were significantly influenced at 60 and 90 DAT. At 90 DAT, the maximum number of loose leaves/plant (19.79) was found in the control treatment combination and the minimum (15.66) was obtained from the treatment combination of organic fertilizer with black polythene mulch (Table 3).

Diameter of cabbage head: The study revealed that there was significant influence of sources of nutrients on the diameter of cabbage head. The maximum diameter (24.83

Table 1: Effect of sources of nutrients and mulching on plant height, spread of plant and number of loose leaves per plant of cabbage

Treatments		Plant height (cm) at			Spread of plant (cm) at			No. of loose leaves/ plant at		
		30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
Source of nutrients										
F_O		19.59	22.24	31.65	49.30	51.81	52.76	6.14	14.35	18.06
F_1		24.06	31.11	36.86	52.97	58.01	64.55	5.78	12.92	16.74
F_2		25.81	33.11	39.34	59.55	63.73	71.14	5.73	13.20	16.93
F_3		24.96	28.69	40.24	57.96	62.43	64.68	4.82	12.57	17.85
LSD	(0.05)	1.13	1.29	1.12	2.83	1.44	1.58	0.22	0.87	0
	(0.01)	1.51	1.73	1.66	3.78	1.91	2.11	0.29	1.16	
Mulch										
M_O		21.94	24.86	33.79	52.07	53.26	57.12	6.09	13.70	17.80
M_1		24.46	30.14	37.57	55.73	61.24	65.93	5.66	13.10	17.79
M_2		24.42	31.37	39.71	57.03	62.48	66.68	5.10	12.98	16.59
LSD	(0.05)	0.99	1.12	1.08	2.52	1.24	1.37	0.31	0.66	0.17
	(0.01)	1.32	1.52	1.44	3.27	1.65	1.82	0.42	0.88	0.22

Table 2: Effect of sources of nutrients and mulch on some yield contributing characters of cabbage

Treatment		Diameter of head (cm)	Thickness of head (cm)	Fresh weight of head (kg)	Gross yield (t ha^{-1})	Marketable yield (t ha^{-1})	Harvest Index
Source of nutrients							
F_O		16.14	8.34	1.004	50.04	30.65	61.64
F_1		22.50	13.79	1.99	91.75	60.38	68.97
F_2		24.83	14.55	2.56	103.78	79.01	76.54
F_3		23.12	13.52	2.17	97.19	65.54	70.63
LSD	(0.05)	1.39	1.08	0.02	9.71	0.99	4.26
	(0.01)	1.85	1.44	0.03	12.9	1.32	5.68
Mulch							
M_O		19.63	11.11	1.47	64.18	45.13	70.38
M_1		22.06	13.56	2.03	92.17	62.07	69.02
M_2		23.25	14.74	2.30	100.72	70.24	68.94
LSD	(0.05)	1.20	0.94	0.08	8.40	0.95	NS
	(0.01)	1.60	1.25	0.02	11.21	1.39	NS

Table 3: Combined effect of different sources of nutrients and mulching on plant height, spread of plant and number of loose leaves per plant of cabbage

Treatments Combination		Plant height (cm) at			Spread of plant (cm) at			No. of loose leaves/ plant at		
		30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
$F_O M_O$		18.88	20.23	30.57	48.80	51.14	52.32	6.96	14.97	19.79
$F_O M_1$		19.60	21.93	29.42	49.44	51.42	52.66	6.07	14.44	18.70
$F_O M_2$		20.31	24.56	34.96	49.66	52.87	53.83	5.39	13.65	15.68
$F_1 M_O$		22.87	27.24	34.64	50.13	54.01	58.93	6.00	14.20	17.79
$F_1 M_1$		24.95	32.72	38.72	53.01	59.60	67.15	5.97	12.22	16.75
$F_1 M_2$		24.37	33.38	37.24	55.75	60.41	67.57	5.36	12.33	15.66
$F_2 M_O$		23.53	29.23	33.70	58.93	53.52	63.60	6.23	12.56	16.38
$F_2 M_1$		26.37	34.78	42.50	59.35	68.54	74.57	5.81	13.31	16.31
$F_2 M_2$		27.53	35.32	41.81	60.37	69.13	75.24	5.16	13.72	18.11
$F_3 M_O$		22.48	22.71	36.24	50.43	54.38	55.30	5.17	13.07	17.26
$F_3 M_1$		26.90	31.14	39.65	61.10	65.41	69.68	4.80	12.41	19.38
$F_3 M_2$		25.49	32.21	44.83	62.33	67.50	70.07	4.50	12.23	16.92
LSD	(0.05)	1.97	2.15	2.16	4.91	2.49	2.74	0.54	1.33	0.296
	(0.01)	2.63	2.87	2.88	6.55	3.32	3.65	0.72	1.77	0.395

Table 4: Combined effect of different sources of nutrients and mulching on some yield contributing characters of cabbage

Treatment		Diameter of head (cm)	Thickness of head (cm)	Fresh weight of head (kg)	Gross yield (t ha^{-1})	Marketable yield (t ha^{-1})	Harvest Index
$F_O M_O$		16.65	8.44	0.75	31.64	22.40	65.39
$F_O M_1$		15.78	8.66	1.07	53.03	32.92	62.90
$F_O M_2$		16.99	9.70	1.19	65.42	36.63	56.62
$F_1 M_O$		20.72	11.62	1.72	79.69	52.77	70.15
$F_1 M_1$		22.68	14.47	1.99	88.29	59.63	71.23
$F_1 M_2$		24.09	15.28	2.26	107.25	68.75	65.54
$F_2 M_O$		22.38	13.98	1.71	73.84	52.21	72.43
$F_2 M_1$		25.56	16.51	2.79	113.41	86.98	76.49
$F_2 M_2$		26.56	18.41	3.19	124.69	97.83	80.71
$F_3 M_O$		19.79	10.38	1.69	71.55	53.15	73.54
$F_3 M_1$		24.23	14.60	2.26	113.94	68.74	65.46
$F_3 M_2$		25.35	15.57	2.57	106.19	77.75	72.90
LSD	(0.05)	2.39	1.87	0.037	16.80	1.72	7.37
	(0.01)	3.20	2.50	0.049	22.425	2.29	9.84

Source of nutrients: F_O = No fertilizer, F_1 = Organic fertilizer, F_2 = Organic + inorganic fertilizer and F_3 = Inorganic fertilizer
Mulch: M_O = No mulch, M_1 = Water hyacinth mulch and M_2 = Block polythene mulch

Appendix Table 1: Combination of manure and fertilizers used for the crop

Manures and Fertilizers	Dose ha^{-1}	Available nutrients (kg ha^{-1}) N (132)	P_2O_5 (44)	K_2O (120)
a) Organic (F_1):				
Cowdung	21 ton	91.38	42.00	21.00
MOC	800 kg	39.44	3.20	5.20
Ash	4 ton	1.08	0.16	94.00
Total		131.90	45.30	120.20
b) Organic + Inorganic (F_2):				
Cowdung	10.5 ton	45.69	21.00	10.50
MOC	400 kg	19.72	1.60	2.60
Ash	2 ton	0.52	0.80	47.00
Urea	143 kg	65.78	-	-
TSP	46 kg	-	22.08	-
MP	100 kg	-	-	60.00
Total		131.90	45.30	120.00
c) Inorganic (F_3):				
Urea	286 kg	132.00	-	-
TSP	92 kg	-	44.00	-
MP	200 kg	-	-	120.00
Total		132.00	44.00	120.00

Appendix Table 2. Nutrient content of different manures and fertilizers

Sources of nutrients	Nutrient content (%) N	P_2O_5	K_2O
Cowdung	4.35	0.2	0.1
MOC	4.93	0.4	0.65
Ash	0.027	0.02	2.35
Urea	46	-	-
TSP	-	48	-
MP	0	-	60

Source: Fertilizer Recommendation Guide 1997 (BARC, 1997)

cm) of head was found with the plants having both organic + inorganic fertilizer and the lowest (16.14 cm) from the control treatment. Subhan (1989) expressed similar views that application of organic manure increase head diameter. Different mulching treatments had significant influence on diameter of head. The application of black polythene mulch produced the highest diameter (23.25 cm) of cabbage head. It might be due to the presence of sufficient soil moisture which sub sequentially has contributed in the formation of larger and comparatively broader head of cabbage. The lowest diameter (19.63 cm) of head was found form no mulch treatments (Table 2).

Combined effect of sources of nutrients and mulching had no significant influence on diameter of cabbage head (Table 4).

Thickness of cabbage head: Different sources of nutrients and mulching had significant effect on thickness of cabbage head. Maximum thickness of head (14.55 cm) was obtained from organic + inorganic fertilizer treatment and was statistically identical with inorganic fertilizer (13.52 cm) and organic manure applied (13.79 cm). The lowest thickness of head was obtained from control treatment. Incase of mulching the black polythene mulch and water hyacinth mulch gave thick (14.74 and 13.56 cm) cabbage head and the minimum thickness (11.11cm) was obtained from no mulch treatment (Table 2)

Combined effect of source of nutrients and mulching head significant influenced on thickness of head. The maximum thickness of head (18.41 cm) was obtained from the treatment combination of F_2M_2 and the minimum (8.44 cm) from control (F_0M_0) treatment (Table 4).

Fresh weight of cabbage head: Fresh weight of head was significantly influenced by the sources of nutrients and mulching. The height fresh weight (2.56 kg) was obtained from organic + inorganic fertilizer which was statistically identical with inorganic fertilizer (2.17 kg) and the lowest fresh weight (1.004 kg) from control treatment. It might be due to sufficient available plant nutrients in the soil, which helped in the production of large sized head of maximum weight. These results are in agreement with the findings of Mallik and Biswajit (1996). The plants grown over black polythene mulch produced the maximum weight (2.30 kg) of individual head which was statistically similar with that of water hyacinth mulch. The minimum weight of individual head (1.47 kg) was found from no mulch treatment (Table 2). This may be attributed to sufficient supply of soil moisture to the head forming leaves. The result of the experiment is supported by the finding of Rahman *et al.* (1989) and Subhan (1989).

Combined effect of different source of nutrients and mulching had marked influence on the weight of individual cabbage head. There was a significant variation among the treatment combinations. The maximum weight of individual cabbage head (3.19 kg) was obtained from organic + inorganic fertilizer treatment with black polythene mulch and the minimum weight (0.75 kg) from F_0M_0 treatment (Table 4).

Gross yield of cabbage: Gross yield of cabbage was significantly influenced by the sources of nutrients and mulching. The highest gross yield of cabbage (103.78 t ha^{-1}) was obtained from F_2 treatment followed by F_3 (97.19) and F_1 (91.75 t ha^{-1}) treatment. The lowest gross yield (50.04 t ha^{-1}) was found from F_0 treatment. In case of mulching the highest gross yield (100.72 t ha^{-1}) was obtained from the black polythene mulch treatment and the lowest (64.18 t ha^{-1}) from no mulch treatment (Table 2).

Gross yield of cabbage was influenced by the combined effect of source of nutrients and mulching. The highest gross yield of cabbage (124.69 t ha^{-1}) was obtained from the treatment combination F_2M_2 and the lowest gross yield (31.64 t ha^{-1}) from the treatment combination F_0M_0 (Table 4).

Marketable yield of cabbage: Marketable yield of cabbage was significantly influenced by the sources of nutrients and mulching .The highest marketable yield (79.01 t ha^{-1}) was obtained from the plants those received both organic + inorganic fertilizers followed by inorganic fertilizer (65.54 t ha^{-1}) and organic manure (60.38 t ha^{-1}). The lowest marketable yield (30.65 t ha^{-1}) was obtained from control treatment. The maximum marketable yield (70.24 t ha^{-1}) was obtained from the black polythene mulch treatment and the lowest (45.13 t ha^{-1}) from no mulch treatment (Table 2).

Combined effect of different sources of nutrients and mulching was found significant on marketable yield of cabbage. The highest marketable yield (97.83 t ha^{-1}) was obtained from F_2M_2 treatment combination followed by F_2M_1 (86.98 t ha^{-1}) treatment combination and the lowest (22.4 t ha^{-1}) from F_0M_0 treatment combination (Table 4).

Harvest index (HI): Harvest index was significantly influenced by the different sources of nutrients. The highest HI was obtained form organic + inorganic fertilizer treatment followed by inorganic (76.54) and organic (68.97) manures. The lowest HI was found from no fertilizer treatment. Mulching had no significant influence on HI (Table 2).

Harvest index was significantly influenced by the combined effect of sources of nutrients and mulching. The highest HI (80.71) was obtained from F_2M_2 treatment and the lowest (56.62) from F_0M_2 treatment (Table 4).

It is clear from the experiment that among the sources of nutrients organic + inorganic fertilizers gave higher yield of cabbage. Organic manure alone can not produce marked influence on cabbage yield. Organic + inorganic fertilizers application may be encouraged for cabbage production. Among the mulching use of black polythene sheet mulch is comparatively better especially in case of marketable yield. Therefore the treatment combination of organic + inorganic fertilizers with black polythene mulch may be suggested for higher cabbage yield.

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