

EFFECT OF FERTILIZER MANAGEMENT AND MULCHING ON THE GROWTH AND YIELD OF LETTUCE

M A Ali¹, A M Farooque², M H Akand³ & A H M Solaiman⁴

ABSTRACT

The experiment consisted of four levels of fertilizers and manure treatments viz. control, Cowdung 23.14 t/ha, chemical fertilizer (Urea 352 kg/ha, TSP 180 kg/ha and MP 158 kg/ha) and organic + inorganic fertilizer (cowdung 11.5 t/ha, Urea 177 kg/ha, TSP 62 kg/ha and MP 63 kg/ha) and four different mulching treatments viz., no mulch, rice straw, water hyacinth and black polythene mulch. Organic + inorganic fertilizer treatment gave maximum plant height (27.40 cm) and maximum number of leaves (24.6) per plant at 50 DAT during period of final harvesting. At the final harvest, the maximum fresh weight of leaves per plant (454.6 g), leaf area (411.5 cm²), gross yield (46.01 t/ha), marketable yield (45.46 t/ha), percentage of dry matter content (11.24), percentage of fibre content (2.65) were recorded from organic + inorganic fertilizer treatment which was significantly superior to all other fertilizer treatments. Mulching treatments also showed a significant difference on plant height, number of leaf (at all dates of observation), leaf area, leaf yield per plant, percentage of fibre content, percentage of dry matter content, gross yield marketable yield per hectare at final harvest. The maximum values were in plants height (25.61 cm), numbers of leaves (22.77), fresh leave weight (424.96 g) per plant, leaf area (393.2 cm²), gross yield (26.01 t/ha) marketable yield (45.26 t/ha), percentage of dry matter (11.29) and percentage of fibre content (2.66) at final harvest. Different levels of organic + inorganic fertilizer as well as mulching had also significant combined effects on different parameter studied. Maximum plant height (29.13 cm), number of leaves per plant (26.00), fresh weight of leaves per plant (496.20 g), gross yield of leaves (50.27 t/ha) marketable yield (49.62 t/ha), percentage of dry matter of leaves (12.25) and percentage of fibre content (3.1) at final harvest (at 50 DAT) were observed in the treatment combination of organic + inorganic fertilizer with black polythene mulch. The best performance was obtained from treatment combination of organic + inorganic fertilizer with black polythene mulch that was considered to be the best combination of fertilizer management and mulching for maximising yield of lettuce

Key words: Organic, Inorganic fertilizer, mulch, Lettuce

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is the most popular crop in the world. It belongs to the family Compositae. It is leafy herb with milky juice crop. It produces a short stem early in the season, a cluster of leaves varying considerably in shape, character and colour in different varieties. Later in the season a seed stock is produced (Ryder, 1979). It is mainly a cold loving crop. The best day temperature range for lettuce cultivation is 18°C to 25°C and the night temperature is 10°C to 15°C (Ryder, 1998).

Lettuce is popular for its delicate, crispy, texture and slightly bitter taste as fresh condition. The nutritive value of lettuce is very high but rests largely upon a good content of minerals and a moderate storage of vitamins to the human diet plus substantial amount of fibre and that of water (Work, 1997). It also contains protein, carbohydrate and vitamin C. It is usually used as salad with tomato, carrot, cucumber or other salad vegetable. Moreover, it is anodyne, sedative, diuretic and expectorant (Kallo, 1986).

¹ & ⁴Lecturer, ²Vice-Chancellor, SAU, Dhaka, ³Assoc. Prof., Department of Horticulture and Postharvest Technology, SAU, Dhaka -1207.

Among various factors responsible for higher yield, supply of nutrient and availability of moisture play vital role in the production and quality of lettuce. Deficiency of soil nutrient is now considered as one of the major constraints to successful upland crop production in Bangladesh (Islam and Noor, 1982). Being a succulent vegetable, it needs plenty of water for its normal growth and development. Therefore, irrigation is essential for its successful production. Mulching may be practiced in crop cultivation which can substitute irrigation to minimize cost of production. Mulch is again highly effective in checking evaporation and is hence recommended for most crops of home garden like potato, sweet potato, carrot and ginger (Kim et al. 1988; Chowdhury et al. 1993; Jaiswal et al. 1996). Mulching also suppress weed infestation effectively. Furthermore, it stimulates microbial activity in soil through increasing soil temperature which improves agro-physical properties of soil. The present experiment was undertaken- (1) to identify the proper dose of manure and fertilizer (2) to know the effect of mulching on growth and yield of lettuce production and (3) to know the combined effect of fertilizer and manure with mulching.

MATERIALS AND METHODS

The experiment was conducted at the Horticulture Farm and Laboratories of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during the period from October 2004 to February 2005 to study the effects of fertilizer management and mulching on the growth and yield of lettuce. Seed of lettuce cultivar, 'Green Wave' was used in the experiment and sown on 10th October 2004. It is leafy and spreading type as well as heat tolerant in nature. The experiment consisted of two factors as Factor A: fertilizer management- Control (F_0), Organic manure (F_1 , Cowdung 23.14 t/ha), Inorganic fertilizers (F_2 , Urea 352 kg/ha, TSP 180 kg/ha and MP 158 kg/ha), Organic manure + inorganic fertilizers (F_3 , cowdung 11.5 t/ha, Urea 177 kg/ha, TSP 62 kg/ha and MP 63 kg/ha) and Factor B: Mulches (four levels)-Control (M_0), Rice straw (M_1), Dry Water hyacinth (M_2), Black polythene (M_3) were used. The two factors experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. Lettuce seed were soaked in water for 48 hours and then seeds were mixed with soil and sown in seed bed. Thirty days old seedlings were transplanted on 10th November 2004 in the afternoon. Harvest and data collection were done at 30 DAT, 40 DAT and finally at 50 DAT. The analysis of variance for most of the characters was accomplished by 'F' variance test. The significance of difference between pair of means was tested by the least significant difference (LSD) test at 5% and 1% level of probability (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Plant height

The plant height was recorded at different stages of growth i.e. 30, 40 and 50 days after transplanting. During the period of plant growth the maximum plant height (27.40 cm) was observed in F_3 treatment where organic + inorganic fertilizers were applied together at 50 days after transplanting (Fig.1). In general, plants height increased gradually in the early stages and decreased at the later stages of the plant growth. During the period of plant growth the highest plant height was observed in black polythene mulch treatment (M_3) followed by water

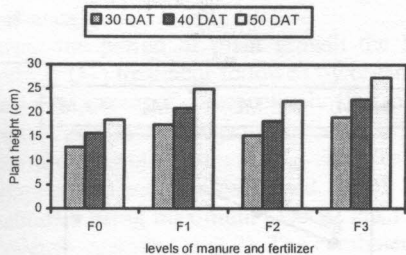


Fig. 1. Effect of fertilizer management on plant height of lettuce

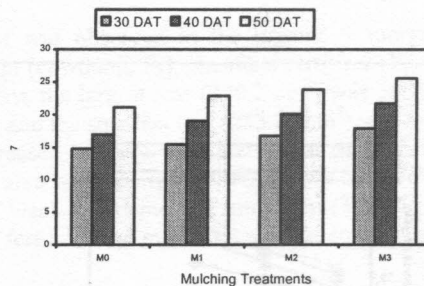


Fig. 2. Effect of mulching on plant height of lettuce

hyacinth (M_2), straw mulch (M_1) and control (M_0) treatment respectively (Fig.2). At 50 days, the plant height was the highest in respective of mulch treatment being maximum 25.61 cm in case of black polythene (M_3) mulch and minimum (21.11 cm) in the control treatment.

The maximum vegetative growth was recorded at 50 DAT. The highest plant height of 29.13 cm was found from the organic and inorganic fertilizer treatment with black polythene mulch (M_3F_3) at 50 DAT and the lowest (16.46 cm) from the control treatment at 50 DAT (Table 1).

Table 1. Combined effect of fertilizer management and mulching on plant height of lettuce

Treatment combinations	Plant height (cm) at different days after transplanting		
	30 DAT	40 DAT	50 DAT
M_0F_0	10.93	13.66	16.46
M_0F_1	16.36	18.93	23.30
M_0F_2	14.76	15.93	20.33
M_0F_3	16.93	19.30	24.37
M_1F_0	12.13	15.26	18.63
M_1F_1	17.16	20.10	23.90
M_1F_2	14.16	17.36	21.50
M_1F_3	18.30	23.46	27.53
M_2F_0	14.16	16.30	18.87
M_2F_1	17.13	21.43	25.27
M_2F_2	15.40	18.86	22.27
M_2F_3	20.40	23.80	28.57
M_3F_0	14.06	17.86	20.47
M_3F_1	19.80	23.46	27.50
M_3F_2	17.30	21.06	23.33
M_3F_3	20.73	24.50	29.13
LSD 0.01	1.5	2.471	1.063

Number of leaves per plant

The maximum (24.67) number of leaves per plant was produced by the organic + inorganic fertilizer (F_3) treatment and the minimum (17.12) was produced by the control (F_0) treatment (Fig.3). Significant variation was found in case of production of leaves per plant due to the effect of mulching (Fig.4). At 50 DAT, black polythene (M_3) mulching produced maximum (22.77) number of leaves, which was identical with that of water hyacinth (22.25) and rice straw (21.12).

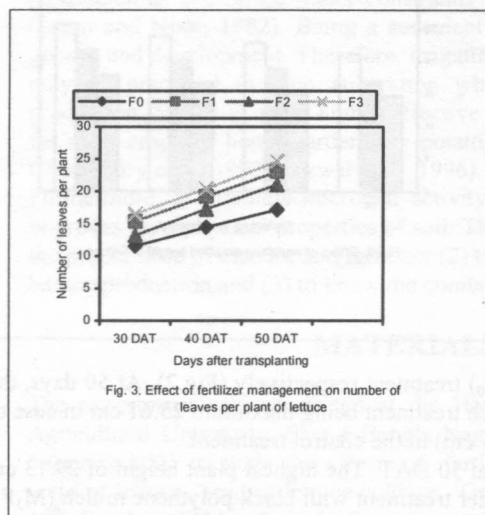


Fig. 3. Effect of fertilizer management on number of leaves per plant of lettuce

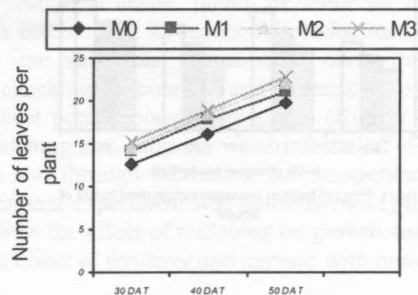


Fig. 4. Effect of mulching on number of leaves per plant of lettuce

Such response was possibly due to the physiochemical and biological improvement occurred in the soil including favorable temperature and moisture regimes, nutrient availability and microbial activity that mulching might have provided. At 50 DAT number of leaves per plant was recorded to be the highest (26) from the treatment combination of organic + inorganic fertilizer with black polythene mulch (F₃M₃) treatment. The lowest number of leaves (16.2) was observed from the control treatment, where no fertilizers and mulch were used (Table 2).

Table 2. Combined effect of fertilizer management and mulching on number of leaves/plant of lettuce

Treatment combinations	Number of leaves/plant at different days after transplanting		
	30 DAT	40 DAT	50 DAT
M ₀ F ₀	10.53	13.40	16.20
M ₀ F ₁	13.10	16.90	20.50
M ₀ F ₂	12.50	16.20	19.80
M ₀ F ₃	14.63	18.10	22.40
M ₁ F ₀	11.53	14.50	16.60
M ₁ F ₁	14.53	19.30	22.90
M ₁ F ₂	12.56	16.70	20.30
M ₁ F ₃	16.56	20.40	24.70
M ₂ F ₀	11.90	14.90	17.00
M ₂ F ₁	15.90	20.00	24.20
M ₂ F ₂	13.40	17.40	21.40
M ₂ F ₃	17.50	21.40	25.60
M ₃ F ₀	12.30	15.10	17.90
M ₃ F ₁	16.96	20.70	24.60
M ₃ F ₂	14.46	18.63	22.60
M ₃ F ₃	17.30	21.60	26.00
LSD 0.01	1.573	1.745	2.03

Leaf area

During the period of plant growth the largest leaf was observed in the organic + inorganic fertilizer (F_3) treatment followed by organic treatment (cowdung, F_2), chemical fertilizer (F_1) and control treatment (F_0) respectively (Fig. 5). At 50 days the largest leaf (320.2 cm^2) was obtained from the organic + inorganic fertilizer (F_3) treatment and the smallest leaf (253.32 cm^2) was found from the control treatment (F_0). The leaf area increased linearly with increasing time up to a certain period and then decreased. At 50 DAT, leaf area was the highest irrespective of mulching treatments being maximum (393.22 cm^2) in case of black polythene and minimum (350.37 cm^2) in control treatment (Fig.7). The combined effect of fertilizer and mulching at different days after transplanting was also

significant. The maximum leaf area (446.4 cm^2) was found from organic + inorganic fertilizer

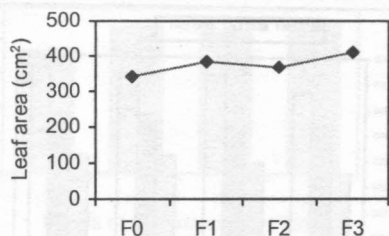


Fig. 5. Effect of fertilizer management on leaf area of lettuce at 50 DAT

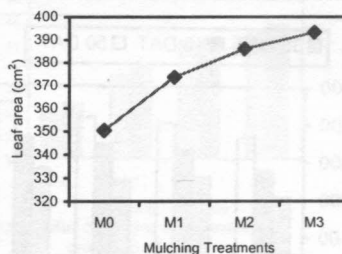


Fig. 6. Effect of mulching on leaf area of lettuce at 50 DAT

with black polythene mulch (M_3F_3) at 50 DAT and the lowest (335.90 cm^2) from the control treatment (Table 3.)

Table 3. Combined effect of fertilizer management and mulching on leaf area of lettuce

Treatment combinations	Leaf area (cm ²) at different days after transplanting		
	30 DAT	40 DAT	50 DAT
M ₀ F ₀	248.20	298.90	335.90
M ₀ F ₁	260.80	311.26	351.20
M ₀ F ₂	256.30	307.40	345.20
M ₀ F ₃	278.20	328.30	369.20
M ₁ F ₀	251.30	303.50	341.80
M ₁ F ₁	293.50	343.20	384.00
M ₁ F ₂	274.60	324.80	364.00
M ₁ F ₃	313.20	363.80	404.70
M ₂ F ₀	285.00	304.50	345.80
M ₂ F ₁	304.20	354.50	395.80
M ₂ F ₂	284.60	336.90	376.90
M ₂ F ₃	334.10	385.20	425.70
M ₃ F ₀	258.80	308.00	346.60
M ₃ F ₁	309.20	359.60	399.90
M ₃ F ₂	291.20	341.60	380.00
M ₃ F ₃	355.30	406.10	446.40
LSD 1%	43.94	51.51	33.78

Leaf yield / plant

The maximum fresh weight of leaves per plant was 454.6 g after 50 days of transplanting recorded from the organic + inorganic fertilizer (F_3) treatment. While the minimum (365.0 g) was from the control (F_0) at final harvest of the crop (Fig. 7). The fresh weight of leaves per plant was also found to differ significantly by mulching treatment (Fig. 8). The plants grown over black polythene mulch gave maximum fresh weight of leaves (427.6 g), which was followed by water hyacinth (416.2g) and rice straw (415.18 g) mulches being found statistically identical with each other. The control treatment showed the minimum fresh weight of leaves (379.9 g). The increased fresh weight of leaves under mulching treatment may be attributed to the availability of more soil moisture that possibly increased the rate of cell division and elongation producing more leaves and their development leading to increased fresh weight of leaf. The result is consistent with that of Hochmuth and Howell (1983) in sweet potato and Sutater (1987) in potato crop.

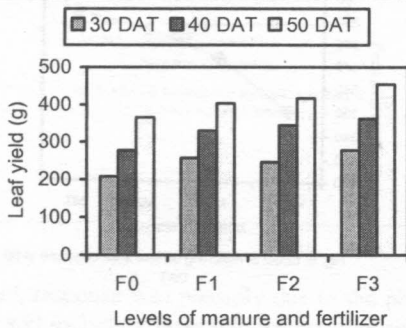


Fig. 7. Effect of fertilizer management on leaf yield per plant of lettuce

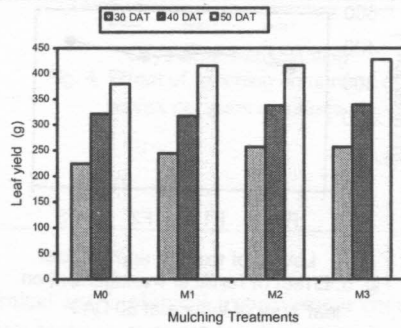


Fig. 8. Effect of mulching on leaf yield per plant of lettuce

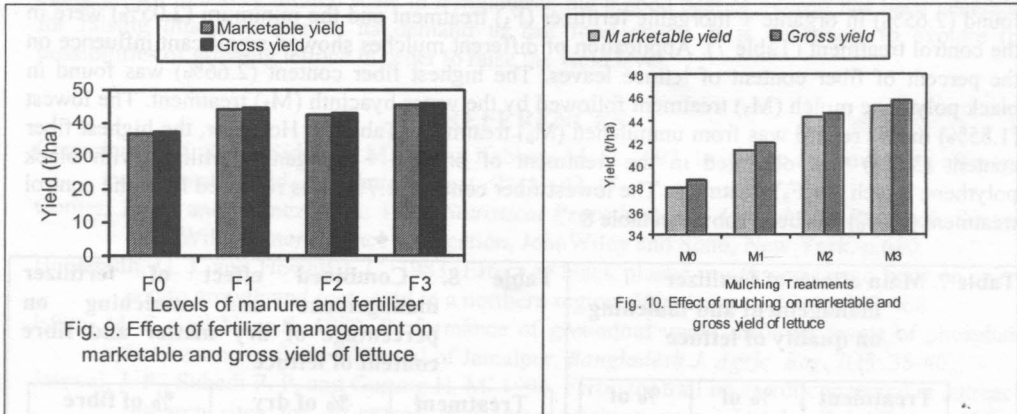
The maximum fresh weight of leaves (496.2 g) was recorded from the treatment combination of organic + inorganic fertilizer with black polythene mulch (M_3F_3) and the lowest (340.00 g) was observed from the control treatment (M_0F_0) has been shown in the table 4.

Table 4. Combined effect of fertilizer management and mulching on leaf yield per plant of lettuce

Treatment combinations	Leaf yield g / plant at different days after transplanting		
	30 DAT	40 DAT	50 DAT
M ₀ F ₀	195.50	270.00	340.00
M ₀ F ₁	231.80	302.90	389.50
M ₀ F ₂	222.60	300.60	380.00
M ₀ F ₃	244.30	317.20	410.00
M ₁ F ₀	205.80	275.20	370.60
M ₁ F ₁	255.40	326.30	426.80
M ₁ F ₂	241.40	313.90	413.50
M ₁ F ₃	273.40	349.80	449.80
M ₂ F ₀	210.7	281.40	375.20
M ₂ F ₁	266.00	339.90	440.90
M ₂ F ₂	288.00	330.60	431.70
M ₂ F ₃	289.50	295.80	462.50
M ₃ F ₀	219.20	284.70	374.40
M ₃ F ₁	274.10	349.80	453.00
M ₃ F ₂	263.40	338.50	441.20
M ₃ F ₃	303.80	384.50	496.20
LSD 5%	15.34	20.55	17.85
LSD 1%	20.65	27.67	24.04

Gross yield and marketable yield of lettuce leaves (t/ha)

The maximum gross yield (46.01 t/ha) was recorded from organic + inorganic fertilizer (F_3) treatment and the lowest (37.38 t/ha) was from the control treatment (Fig. 9). The gross yield of lettuce leaves per hectare was found to be statistically significant due to mulching. The highest (44.8 t/ha) yield was obtained from black polythene mulch treatment (M_3) and the lowest (38.71 t/ha) in this respect was from the control treatment (Fig.10). The highest gross yield of lettuce (50.27 t/ha) was found from organic + inorganic fertilizer with black polythene mulch (M_3F_3) treatment and the lowest (35.44 t/ha) was in the control treatment (M_0F_0) have been presented in table 5.



Marketable yields of lettuce varied significantly due to different fertilizer levels. The maximum marketable yield (45.46 t/ha) was found from organic + inorganic fertilizer (F_3) treatment at 50 DAT. The minimum yield (36.83 t/ha) in this respect was found from control treatment (Fig.9). The highest yield (45.26 t/ha) was obtained from black polythene mulch (M_3) and the lowest (38.15 t/ha) in this regard was obtained from the control (M_0) treatment (Fig.10). The highest marketable yield of lettuce (49.62 t/ha) was obtained from organic + inorganic fertilizer with black polythene mulch (M_3F_3) treatment and the lowest (34.90 t/ha) was in the control treatment (M_0F_0) has been presented in Table 5.

Table 5. Combined effect of fertilizer management and mulching on gross yield and marketable yield of lettuce

Treatment combinations	Gross yield (t/ha) at different days after transplanting			Marketable yield (t/ha) at different days after transplanting		
	30 DAT	40 DAT	50 DAT	30 DAT	40 DAT	50 DAT
M_0F_0	20.07	27.62	35.44	19.55	27.08	34.90
M_0F_1	23.66	30.73	39.47	23.18	30.29	38.70
M_0F_2	22.64	29.77	38.48	22.26	29.36	38.00
M_0F_3	24.96	32.24	41.47	24.43	31.72	41.00
M_1F_0	21.07	31.69	37.57	20.58	27.52	37.06
M_1F_1	26.13	32.11	43.17	25.54	32.63	42.08
M_1F_2	24.64	31.90	41.9	24.14	31.39	41.35
M_1F_3	27.9	35.28	45.55	27.34	34.88	44.98
M_2F_0	21.61	28.64	38.05	21.07	28.14	37.52
M_2F_1	27.11	34.48	44.63	26.60	33.99	44.09
M_2F_2	26.33	33.64	43.69	25.80	33.06	43.17
M_2F_3	29.07	36.51	46.67	28.45	35.98	46.25
M_3F_0	21.90	28.55	38.46	21.42	28.47	37.87
M_3F_1	27.86	35.48	45.81	27.42	34.89	45.30
M_3F_2	26.82	34.36	44.67	26.34	33.848	44.12
M_3F_3	31.16	39.05	50.27	30.84	38.45	49.62
LSD 5%	0.426	3.200	3.200	1.271	1.433	1.251
LSD 1%	0.3164	2.403	2.376	1.71	1.929	1.685

Percentage of dry matter fiber content

The dry matter of lettuce leaves was recorded to be the highest (11.24%) where both organic + inorganic fertilizers (F_3) were applied. The lowest dry matter (9.9%) of leaf was obtained from the control treatment (Table 7). The maximum dry matter of leaves (11.29%) was found from black polythene (M_3) treatment followed the water hyacinth (M_2) treatment. The minimum (9.28%) in this respect was from the control treatment (Table 7). However, the maximum dry matter of lettuce leaves (12.25%) was observed in the treatment combination of organic + inorganic fertilizer management with black polythene mulch (M_3F_3) treatment and the minimum dry matter (8.5%) was recorded from the control treatment (Table 8). The maximum fiber production was found (2.65%) in organic + inorganic fertilizer (F_3) treatment and the minimum (2.05%) were in the control treatment (Table 7). Application of different mulches showed significant influence on the percent of fiber content of lettuce leaves. The highest fiber content (2.66%) was found in black polythene mulch (M_3) treatment followed by the water hyacinth (M_2) treatment. The lowest (1.85%) in this regard was from unmulched (M_0) treatment (Table 7). However, the highest fiber content (3.1%) was observed in the treatment of organic + inorganic fertilizer with black polythene mulch (M_3F_3) treatment. The lowest fiber content (1.7%) was recorded from the control treatment (M_0F_0) has been shown in table 8.

Table 7. Main effects of fertilizer management and mulching on quality of lettuce

Treatment fertilizer and manure	% of dry matter content	% of Fiber content
F_0	9.90	2.05
F_1	10.73	2.50
F_2	10.35	2.30
F_3	11.24	3.65
LSD 0.01	0.5194	0.1328
M_0	9.28	1.85
M_1	8.63	2.41
M_2	11.02	2.57
M_3	11.29	2.66
LSD 0.01	0.5194	0.1328

Table 8. Combined effect of fertilizer management and mulching on percentage of dry matter and fibre content of lettuce

Treatment combination	% of dry matter at 50 DAT	% of fibre content at 50 DAT
M_0F_0	8.50	1.70
M_0F_1	9.50	1.90
M_0F_2	9.00	1.80
M_0F_3	10.12	2.00
M_1F_0	10.10	2.10
M_1F_1	10.80	2.50
M_1F_2	10.50	2.35
M_1F_3	11.10	2.70
M_2F_0	10.50	2.25
M_2F_1	11.20	2.70
M_2F_2	10.90	2.55
M_2F_3	11.80	2.80
M_3F_0	10.50	2.15
M_3F_1	11.40	2.90
M_3F_2	11.0	2.50
M_3F_3	12.25	3.10
LSD 0.05	0.771	0.197
LSD 0.01	1.039	0.265

it may be concluded from the investigation that Maximum plant height (29.13 cm), number of leaves per plant (26.00), fresh weight of leaves per plant (496.20 g), gross yield of leaves (50.27 t/ha) marketable yield (49.62 t/ha), percentage of dry matter of leaves (12.25) and percentage of fibre content (3.1) at final harvest (at 50 DAT) were observed in the treatment combination of organic + inorganic fertilizer with black polythene mulch. The best performance was obtained from

treatment combination of organic + inorganic fertilizer with black polythene mulch that was considered to be the best combination of fertilizer management and mulching for maximising yield of lettuce. Fertilizer management and mulching affects growth, development and yield of lettuce. So, this experiment has undertaken to find out appropriate or optimum doses of fertilizer and effective mulch for exploiting the yield potential of this crop.

In order to confirm the result of this study, further experiment is suggested since this experiment was conducted in one year and in a certain place only. Irrigation is a costly practices and mulching may be an alternative proposition for successful lettuce crop production. Lettuce is being grown in a very limited scale in Bangladesh, but a good deal of interest has been generated for raising this crop due to its demand in fast food shops. It is necessary to explore the possibilities of growing lettuce in order to raise the yield level.

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