

## Effects of organic and inorganic fertilizer management practices and mulch on the growth and yield of potato

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**Abstract:** A field experiment was conducted at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh, during the period from November 2000 to February 2001 to investigate the effects of organic and inorganic fertilizer management practices and mulch on the growth and yield of potato (cv. Diamant). The experiment consisted of 4 types of fertilizer, viz, i) no fertilizer ( $F_0$ ), ii) Organic ( $F_1$ ), iii) Inorganic ( $F_2$ ) and iv) organic + inorganic ( $F_3$ ); 3 mulch viz. i) no mulch (control), ii) water hyacinth mulch and iii) black polythene mulch. The experiment was laid out in RCBD with 12 treatment combinations and 3 replications. Different types of fertilizer showed marked influence on most of the characters. Maximum yield (25.91 t/ha) was produced from organic + inorganic fertilizer and the minimum (14.71 t/ha) was obtained from no fertilizer treatment. Mulching treatments showed significant effect on most of the characters. The highest yield of tuber (25.53 t/ha) was obtained from the plants grown over black polythene mulch and the lowest (13.68 t/ha) from the plants given no mulch treatments. The combination of fertilizers and mulching practices were significant on most of the yield and yield contributing characters. Organic + inorganic fertilizer with black polythene mulch gave maximum yield (31.20 t/ha).

**Key words:** Potato, organic fertilizers, Inorganic fertilizers, mulch

### Introduction

The growth and yield of potato largely depends on the soil, climatic condition and different production practices. Potato production can be increased by the adoption of improved cultural practices, among them use of different types of fertilizer is important. Inorganic fertilizer also increases the production of crops. But continuous use of inorganic fertilizers in crop cultivation is causing health hazards, and creating problems to the environment including the pollution of air, water, soil, etc. Indiscriminate use of chemical fertilizer is badly affecting texture and structure of soil, decreasing soil organic matter and hampering soil microbial activity due to soil toxicity (Brady, 1990). The use of organic manures improve texture, structure, humus, aeration, water holding capacity and microbial activity of soil. This is predominantly related to organic matter content, especially in the light textured soils. In drought prone areas, a massive effort to increase the organic matter status of soil is an important attempt to combat drought condition. In general, the OM content of Bangladesh soil is below 1% in about 60% cultivable land as compared to an ideal minimum value of 4%. In the areas of continuous cropping OM-supply to crop fields through cowdung, & oil cake, compost green manuring etc. are made only to a maximum extent (Islam and Hossain, 1992). Now a days, gradual deficiencies in soil organic matter and reduced yield of crop are an important factor for the farmers and agriculturists. Mulching is another important practice which greatly influences potato production through soil moisture control. In Bangladesh, potato is grown during winter season when rainfall is scarce and irrigation becomes essential for providing sufficient moisture to the growing crop. But limited numbers of crops enjoy irrigation facilities. In such situation mulching could be a good substitute for retaining moisture in soil. Different kinds of mulch play important role in conserving soil moisture. Mulching is a practice which acts as a barrier to the evaporation of water or heat from soil surface. It may be natural or artificial. In artificial mulching soil surface is covered with crop residues, plant species or polyethylene sheet which are generally practiced in the production of horticultural crops (Wilhoit et al., 1990). Mulching bins conserving soil moisture from 2.1 to 2.8% more than non mulched one

(Suh and Kim, 1991). In view of the above situation, the present study was undertaken with the following objectives i) to observe the effect of organic and inorganic fertilizers on the growth and yield of potato, ii) To study the effect of mulching on the growth and yield of potato as an alternative to irrigation, iii) to evaluate the combined effects of appropriate types of fertilizer and mulching practices on the yield of potato.

### Materials and Methods

The present piece of research work was carried out to study the effect of organic and inorganic fertilizers and mulching on the growth and yield of potato at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during the period November 2000 to February 2001. The experiment consisted of 2 factors: (A) Types of fertilizers, (B) Mulching. There were 4 types of fertilizers viz, i) No fertilizer ( $F_0$ ); ii) Organic ( $F_1$ ); iii) Inorganic ( $F_2$ ); iv) organic + inorganic ( $F_3$ ) and i) No mulch ( $M_0$ ); ii) Water hyacinth ( $M_1$ ); iii) Black polythene ( $M_2$ ). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. There were 36 plots in total each measuring  $2.4\text{m} \times 1.5\text{m}$ . The distance maintained between two plots was 50 cm, and between two blocks was 1m. The experimental plot, except the control received a constant dose of 125 kg N, 43 kg  $P_2O_5$  and 120 kg,  $K_2O$  hectare (BARC, 1997). Doses of different manures and fertilizers treatments were determined by keeping the same rate of NPK. As per types of fertilizer the doses of N,  $P_2O_5$ , and  $K_2O$  for the organic, inorganic and organic + inorganic treatment were the same (125 kg N, 43 kg  $P_2O_5$  and 120 kg,  $K_2O$ /ha). The seed tubers of the variety Diamant were procured from BADC sales center, Jamalpur and kept under diffused light condition in order to obtain healthy and good sprouts. The damaged tubers were sorted out and discarded and well sprouted whole seed tubers were used for planting. Cut seed tuber pieces were planted on 22 November 2009 in furrows made with country plough. Forty cut seed tubers were planted in each unit plot maintaining a spacing of  $60\text{cm} \times 15\text{cm}$ . The depth of planting were 5-7 cm. In case of black polythene mulching, sheets were spread over the plot before planting keeping holes at proper spacing into which dibbing were done.

Date were recorded on a) Days required to 80% emergence; b) Height of plant; c) foliage coverage (%); d) Number of Main stems hill<sup>-1</sup>; e) Fresh weight of haulm hill<sup>-1</sup>; f) Dry weight of haulm hill<sup>-1</sup>; g) Number of tubers hill<sup>-1</sup>; h) Weight of tubers hill<sup>-1</sup> at harvest; i) Mean tuber weight; j) Dry weight of tubers (%); k) Yield of tuber plot<sup>-1</sup> at; l) Yield of tuber hectare<sup>-1</sup>; m) Grade of tubers.

### Results and Discussion

**Effect of types of fertilizers:** The effect of different types of fertilizer on 80% emergence of potato plant was found to be significant. The time (13.61 days) required for 80% emergence of crop was noted with organic + inorganic fertilizer treatment, while the maximum time (16.00 days) was required in no fertilizer (control) treatment. Plant height, foliage coverage, number of main stem hill<sup>-1</sup>, fresh weight of haulm hill<sup>-1</sup>, dry weight of haulm hill<sup>-1</sup>, number of tubers plot<sup>-1</sup>, number of tubers (%), weight of tuber (%) and yield hectare<sup>-1</sup> were significantly influenced by

different types of fertilizer. This effect was probably due to the fact that manure and fertilizer supplied adequate plant nutrients for better vegetative growth of potato plants which ultimately increased in all the studied parameters. Similar result was found by Widajanto and Widodo (1982). The tallest (71.12cm) plant, the highest (78.31%) foliage coverage, the maximum (4.56) number of main stem hill<sup>-1</sup>, fresh weight of haulm (31.24 g/hill), dry weight of (12.06 g/hill), number of tuber hill<sup>-1</sup> (7.11), weight of tuber hill<sup>-1</sup> (357.27g) mean tuber weight (54.11g), dry weight of tuber (15.50g), yield of tuber plot<sup>-1</sup> (9.33 kg) and yield hectare<sup>-1</sup> (25.91 t/ha) respectively, were found from organic + inorganic fertilizer treatment, while the lowest values were found for all the maintained parameter from no fertilizer treatment (Table 1). Similar results were found by Blecharczyk and Skrzepczak (1995). So organic fertilizer might be assumed to play a vital role together with inorganic fertilizers exhibiting the best performance in respect of yield.

**Table 1.** Main effect of different fertilizer management practice on plant emergence, growth of plants and development of tubers in potato cv. Diamant

Treatments	Days to 80% emergence	No. of main stem/hill	Fresh weight of haulm/hill (g)	Dry weight of haulm /hill (g)	No. tubers/hill	weight of tubers/hill (g)	Mean tuber weight (g)	% dry weight of tuber (g)	Yield of tuber/plot* (kg)	yield (t/ha)
F <sub>0</sub> (No Fertilizer)	16.00	3.24	94.62	4.50.	5.47	189.92	35.76	14.58	5.29	14.17
F <sub>1</sub> (Organic)	15.28	4.56	109.01	9.61	6.29	233.92	37.48	14.28	6.60	18.33
F <sub>2</sub> (Inorganic)	14.22	4.28	129.20	10.63	7.11	304.07	42.74	15.59	8.20	21.65
F <sub>3</sub> (Organic + Inorganic)	13.61	3.44	131.34	12.06	6.66	357.27	54.11	15.38	9.33	25.91
LSD (0.01)	0.541	0.142	10.880	0.213	0.120	0.656	0.879	1.131	0.179	0.365

\* = plot size = 24m × 1.5m

**Table 2.** Main effect of different mulches on plant emergence, growth of plants and development of tubers in potato cv. Diamant

Treatments	Days to 80% emergence	No. of main stem/hill	Fresh weight of haulm/hill (g)	Dry weight of haulm/ hill (g)	No. tubers/hill	weight of tubers/hill (g)	Mean tuber weight (g)	% dry weight of tuber (g)	Yield of tuber/plot* (kg)	yield (t/ha)
M <sub>0</sub> (No Mulch)	14.58	3.88	99.08	8.61	6.98	236.57	33.50	15.03	4.92	13.68
M <sub>1</sub> (Water hyacinth)	15.83	3.48	118.13	10.41	6.42	265.86	45.90	14.70	7.96	22.38
M <sub>2</sub> (Black polythene)	13.92	4.26	130.83	11.58	5.75	311.46	48.17	15.15	9.19	28.17
LSD (0.01)	0.469	0.123	9.420	0.185	0.104	0.568	0.761	0.979	0.155	0.147

\* = plot size = 24m × 1.5m

**Effect of mulch:** Different mulches showed significant variation on all the studied parameters at different days after planting. The black polythene mulch took the shortest time (13.92 days) and the water hyacinth mulch needed maximum time (15.83 days) to emergence. The height (65.06 cm) of the maximum (75.64 cm) foliage, number of main stem hill<sup>-1</sup> (4.31), fresh weight of haulm hill<sup>-1</sup> (130.83 g hill<sup>-1</sup>) dry weight of haulm (11.58 g hill<sup>-1</sup>), number of tuber hill<sup>-1</sup> (6.98), weight of tuber hill<sup>-1</sup> 93.11.46g), mean tuber weight (48.17g), dry weight of tuber (14.07g), yield of tuber plot<sup>-1</sup> (9.19 kg) and yield hectare<sup>-1</sup> (25t/ha<sup>1</sup>), were obtained in black polythene treatments. On the other hand, the lowest values were found in all the in low mulch treatment. Black polythene mulch gave about double yield over no mulch treatment. This may be attributed to the availability of optimum growing condition provided through conservation of adequate soil moisture, efficient use of nutrients due to

mulching treatment. As a result, yield plot<sup>-1</sup> as well as hectare<sup>-1</sup> were increased. On the contrary, less vegetative growth as well as low yield was obtained from non mulched treatment. This was probably due to non-availability of insufficient water. Chalaich and Kulkarni (1977) mentioned that, the yield of potato was higher when polythene mulch was used. Khalak and Kumaraswaamy (1992) Hochmuth and Howell (1983) also mentioned similar results.

**Combined effect of types of fertilizer and mulching on the yield of Potato:** Combined effect of types of fertilizer and mulching on all the parameters were found to be statistically significant. The minimum time was required (12.50 days) by the combination of organic + inorganic fertilizer treatment and black polythene mulch, and the maximum time (17.00 days) was required by that of no fertilizer treatment and water hyacinth mulch. The tallest (74.60) plant, the maximum (85.32%) foliage coverage,

number of main stem (4.80), fresh weight of haulm (153.70 g hill<sup>-1</sup>), dry weight of haulm (13.58 g hill<sup>-1</sup>), number of tuber hill<sup>-1</sup> (7.39), weight of tuber hill<sup>-1</sup> (414.78 g), mean tuber weight (62.28 g), dry weight (16.76 g) of tuber, yield of tuber plot<sup>-1</sup> (11.23 kg) and yield hectare<sup>-1</sup> (31.20 t ha<sup>-1</sup>) were produced by the treatment combination of organic + inorganic fertilizer treatment with black polythene mulch and the lowest values on all the

parameters were found from no fertilizer with no mulch. It was expected that the effect of black polythene mulch may be accounted for conserving sufficient soil moisture resulting in maximum values for all the parameters. On the contrary, plants grown without mulch from water stress and can not accomplish full vegetative growth Hussain and Rashid (1974) reported that the height values of mulched potato plant were better than the control.

**Table 3.** Combined effect of types fertilizers and mulching on growth, yield contributing characters and yield of potato

Treatments	Days to 80% emergence	Plant height (cm) at					Foliage coverage (%) at				
		30 DAP	45 DAP	60 DAP	75 DAP	90 DAP	30 DAP	40 DAP	50 DAP	60 DAP	70 DAP
F <sub>0</sub> M <sub>0</sub>	15.83	13.25	25.63	39.42	37.57	38.50	17.87	30.15	37.17	39.90	48.82
F <sub>1</sub> M <sub>0</sub>	15.00	20.42	39.95	42.55	52.82	54.10	43.38	45.65	49.93	57.75	62.32
F <sub>2</sub> M <sub>0</sub>	14.00	17.67	34.77	44.48	58.63	59.62	41.15	49.20	56.13	64.65	67.05
F <sub>3</sub> M <sub>0</sub>	30.50	15.53	31.63	50.45	64.25	65.25	37.83	53.58	59.27	65.57	70.35
F <sub>0</sub> M <sub>1</sub>	17.00	14.77	34.40	38.53	45.47	46.50	27.47	36.28	45.57	50.60	57.33
F <sub>1</sub> M <sub>1</sub>	16.50	26.03	47.43	60.55	64.32	65.12	46.28	50.58	59.07	66.73	69.27
F <sub>2</sub> M <sub>1</sub>	15.00	23.37	44.13	63.15	66.25	67.27	44.00	58.12	67.03	73.87	75.97
F <sub>3</sub> M <sub>1</sub>	14.83	20.55	42.67	68.70	73.10	73.82	39.92	62.38	71.20	75.88	79.25
F <sub>0</sub> M <sub>2</sub>	15.17	15.92	35.30	46.93	51.73	52.78	33.22	42.72	53.98	58.08	62.80
F <sub>1</sub> M <sub>2</sub>	14.33	25.65	47.70	63.97	68.35	69.28	52.68	57.55	60.78	71.08	74.35
F <sub>2</sub> M <sub>2</sub>	13.67	23.98	43.55	66.72	70.85	71.48	49.02	63.32	70.18	74.08	80.08
F <sub>3</sub> M <sub>2</sub>	12.50	21.62	39.90	69.62	73.67	74.60	43.42	68.18	74.90	77.62	85.32
LSD (0.01)	0.937	1.25	1.190	1.250	1.280	6.89	1.090	1.50	1.180	1.370	1.228

**Table 3. (Cont'd)**

Treatments	No. of main stem/hill	Fresh weight of haulm/hill (g)	Dry weight of haulm/hill (g)	No. of tubers/hill	weight of tubers/hill (g)	Mean tuber weight (g)	% dry weight of tuber (g)	Yield of tuber/plot* (kg)	yield (t/ha)
F <sub>0</sub> M <sub>0</sub>	3.40	84.03	6.89	6.39	153.38	24.00	14.03	3.07	8.52
F <sub>1</sub> M <sub>0</sub>	4.53	91.97	8.25	6.96	205.45	29.48	15.35	4.46	10.32
F <sub>2</sub> M <sub>0</sub>	4.20	108.30	9.03	7.39	276.42	37.42	15.70	5.50	12.66
F <sub>3</sub> M <sub>0</sub>	3.40	112.03	10.28	7.20	311.02	43.10	15.04	6.65	18.66
F <sub>0</sub> M <sub>1</sub>	2.58	95.00	8.78	5.66	190.97	42.81	14.48	5.30	16.99
F <sub>1</sub> M <sub>1</sub>	4.33	115.03	9.76	6.28	226.22	39.99	15.01	7.12	24.33
F <sub>2</sub> M <sub>1</sub>	4.02	134.50	10.78	7.14	300.25	43.84	14.32	9.32	26.89
F <sub>3</sub> M <sub>1</sub>	3.02	128.00	12.32	6.70	346.02	56.94	14.99	10.10	28.66
F <sub>0</sub> M <sub>2</sub>	3.73	104.82	9.83	4.46	225.42	40.47	15.24	7.52	24.68
F <sub>1</sub> M <sub>2</sub>	4.80	120.02	10.81	5.64	270.10	42.97	12.49	8.23	25.98
F <sub>2</sub> M <sub>2</sub>	4.62	144.80	12.08	6.83	335.53	46.95	16.76	9.78	27.55
F <sub>3</sub> M <sub>2</sub>	3.90	153.70	13.58	60.07	414.78	62.28	165.10	11.23	31.20
LSD (0.01)	0.254	18.84	0.369	0.208	1.137	1.520	1.960	0.310	0.453

\* = plot size = 24m × 1.5m, M<sub>0</sub> = No Mulch, M<sub>1</sub> = Water hyacinth, M<sub>2</sub> = Black polythene; F<sub>0</sub> = No Fertilizer, F<sub>1</sub> = Organic, F<sub>2</sub> = Inorganic, F<sub>3</sub> = Organic + Inorganic

Different types of fertilizer showed significant effect on most of the characters. Plants grown from organic + inorganic fertilizer showed rapid (80%) emergence and maximum plant height, foliage coverage (%), fresh weight of haulm hill<sup>-1</sup>, dry weight of haulm weight of tuber hill<sup>-1</sup>, mean tuber weight, yield of tubers plot<sup>-1</sup> as well per hectare (25.91 t/ha). The highest number of main stems per hill and the highest number of tubers hill<sup>-1</sup> were obtained from the application of organic and inorganic fertilizer. Different mulching treatments, played important role on the growth and yield of potato. Results of the experiment showed that all the characters studied were significantly influenced by mulching except dry weight of tubers. Black polythene mulch took shortest time to 80% emergence. This mulching treatment 'gave maximum

plant height, foliage coverage (%), number of main stems hill<sup>-1</sup>, fresh weight of haulm hill<sup>-1</sup>, dry weight of haulm, weight of tubers hill<sup>-1</sup>, mean tuber weight, size grade of tubers, yield of tubers plot<sup>-1</sup> as well as hectare<sup>-1</sup> (25.53 t/ha) where as maximum number of tubers hill<sup>-1</sup> was obtained from no mulch treatment. Interaction effect of different, mulching and fertilizer management practices showed significant interaction effect on most of the characters studied but showed non significant influence on days require for 80% emergence, plant height at 90 DAP, and fresh weight of haulm. Black polythene mulch with organic + inorganic fertilizer gave 80% emergence in short days and produced maximum plant height at 90 P, foliage coverage (%) at 70 DAP, fresh weight of haulm, dry weight of haulm, weight of tubers, mean tuber weight,

highest yield of tubers plot<sup>-1</sup> as well as hectare<sup>-1</sup> (31.20 t ha<sup>-1</sup>). Highest number of stems and tubers were obtained from black polythene with organic and no mulch with inorganic fertilizer treatment. Highest dry weight of tuber was found in black polythene with inorganic fertilizer. The yield components and yield of potato were positively influenced by the use of water hyacinth and black polythene mulch. The highest yield was produced from black polythene mulch. Use of organic + inorganic fertilizer gave the highest yield.

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