EFFECT OF MULCHING AND FERTILIZER MANAGEMENT PRACTICES ON THE GROWTH AND YIELD OF POTATO (*Solanum tuberosum* L.)

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CERTIFICATE

This is to certify that thesis entitled, **"EFFECT OF MULCHING AND FERTILIZER MANAGEMENT PRACTICES ON THE GROWTH AND YIELD OF POTATO"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in HORTICULTURE,** embodies the result of a piece of bonafide research work carried out by **MD. SHAHIDUR RAHMAN**, Registration No. **27564/00726** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information availed during the course of this investigation has been duly acknowledged by him.

Place: Dhaka, Bangladesh

(Prof. Dr. Md. Nazrul Islam)
Supervisor

DEDICATED TO
MY BELOVED PARENTS

ABBREVIATIONS AND ACRONYMS

BADC	=	Bangladesh Agricultural Development Corporation
BARC	=	Bangladesh Agricultural Research Council
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
BCR	=	Benefit cost ratio
DAP	=	Days after Planting
FAO	=	Food and Agricultural Organization
LSD	=	Least Significant Difference
Max	=	Maximum
Min	=	Minimum
MP	=	Muriate of Potash
NS	=	Not significant
ppm	=	Parts per Million
RH	=	Relative humidity
t/ha	=	Tone per hectare
TSP	=	Triple Super Phosphate
OM	=	Organic matter
DM	=	Dry matter

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ABSTRACT

A field experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2006 to February 2007 to investigate the effect of mulching and fertilizer management practices on the growth and yield of potato. The experiment was conducted with three mulching treatments; No mulch (M_0), Black polythene mulch (M_1) and Water hyacinth (M_2) and three fertilizer management practices; organic fertilizer (cowdung) (F_1), inorganic fertilizer (F_2) and organic (cowdung) + inorganic (F_3). The experiment was laid out in RCBD with nine treatments combinations and three replications. The maximum plant height (77.09cm), number of main stem (4.09), number of tubers per hill (6.88), weight of tubers per hill (366.33g), extra large tuber (>55mm) both by number and weight high were recorded when M_1 treatment applied. On the other hand, maximum numbers of main stem (3.96), dry weight of haulm per hill (11.16g), number of tuber per hill (6.11) weight of tuber per hill (333.05g), mean tuber weight (54.22g) was found when F_3 treatment applied. The highest yield of tuber (19.30 t/ha) was obtained from the plants grown with M_1 treatment and the lowest (13.43 t/ha) from the M_0 treatment. The fertilizer treatment F_3 gave the highest yield (19.22 t/ha) while the minimum (13.54 t/ha) was obtained from F_2 treatment. The combination black polythene mulch with organic (cowdung) + inorganic fertilizer gave maximum yield (22.29 t/ha). On the basis of cost benefit analysis the highest benefit cost ratio was obtained from M_1F_3 treatment combination.

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CHAPTER 1

INTRODUCTION

Potato (*Solanum tuberosum* L.) is a tuber crop belongs to the family Solanaceae. It originated in the central Andean area of South America (Keeps, 1979). The crop is grown during the winter season. Potato is the third most important crop of Bangladesh followed by rice and wheat (Illias, 1998). Nutritionally, the tuber is rich in carbohydrates or starch and is a good source of protein, vitamin C and B, potassium, phosphorus, and iron. Being a carbohydrate rich crop, potato can partially substitute rice, which is our main food item. It is grown in almost all countries of the world. In many countries, including those of Europe, America, and Canada, potato is a staple food. Nearly 90% of the potato crop of the world is grown in Europe. In the last 2-3 decades, production of potato in Bangladesh has increased with the cultivation of high yielding varieties. Most of the seed tuber, which is used by the farmer for production, is not high quality. This results in poor yield in the following season.

Recent reports indicate that 4.161 million tons of potato was produced in this country from 302 thousand ha of land in 2005-2006 (BBS, 2007). The average yield of potato was 14.89 t/ha in Bangladesh (FAO, 2005). Which is very low in comparison to that of other leading potato growing countries in the world, such as, USA (43.49 t/ha), Denmark (39.41 t/ha) and UK (43.38 t/ha) (FAO, 2005). The reasons for low yield of potato in Bangladesh are climatic limitation, poor yielding seed tubers and unscientific production practices such as imbalanced fertilizer use and soil moisture regulation.

Potato is grown during the winter season when rainfall is scarce and irrigation becomes essential for providing sufficient moisture to the growing crop. Irrigation facilities are not uniform in all the regions of Bangladesh due to costly establishment of pumps and due to downfall of underground water layer. To minimize the cultivation cost mulching

could be effectively used instead of irrigation. Different kinds of mulch play important role in conserving soil moisture. Soil temperature is important for potato production, which is influenced by mulch. Artificial mulch such as crop residues, plant species, or polyethylene sheet is generally practiced for production of horticultural crops (Wilhoit *et al.,* 1990).

Potato production can be increased by the adoption of important cultural practices, among them use of fertilizer management practices is important. Continuous use of inorganic fertilizer in crop cultivation is causing health hazards and creating problems to the environment including the pollution of air, water and soil. The continuous use of chemical fertilizer is badly affecting the texture and structure of the soil, decreasing soil organic matter and hampering soil microorganism activity (Brady, 1990). The organic matter of most of the soils of Bangladesh is below 2% as compared to an ideal minimum value 4% (Bhuiya, 1994). The extensive use of chemical fertilizer and pesticides has become a matter of great concern in recent days. In different countries, organic farming is being practiced without the use of chemical fertilizer and pesticides for the production of different vegetable crops.

In recent years, the Tuber Crops Research Centre of BARI has collected many new varieties of potato from the International Potato Research Centre, Peru, and from other sources. These are being tested under Bangladesh field conditions, to determine whether they can be recommended for cultivation in the country. The Centre has already made good contribution towards the development of some high yielding potato varieties. Several dozens of high yielding varieties (HYV) of potato were brought to Bangladesh and tried experimentally under local conditions before being recommended for general cultivation. During the 1970s, about 16 varieties were initially selected, but subsequently 10 were dropped. Through constant evaluation of the traits, varietal performance, and considerations of other characteristics, about 10 HYV have been

released for cultivation in the country. However, the Bangladesh Agricultural Development Corporation (BADC) for distribution among farmers imports huge amount of potato seeds every year. 'Diamant' – a - variety from Holland with oval to oblong shape, pale yellow tubers, smooth skin and shallow eyes is quite disease resistant.

It is evident that uses of mulching and fertilizer management are the two very important variables in potato production. Depending on the above discussion, a research was undertaken to find out the effect of mulching and fertilizer management on the growth and yield of potato with the following objectives:

1. To determine a suitable mulch for maximizing the production of potato

2. To study the growth and yield of potato under different fertilizer management practices.

3. To evaluate the combined effects of mulch and fertilizer management practices on the growth and yield of potato.

CHAPTER 2

REVIEW OF LITERATURE

Mulching and fertilizer management practices both are important factor influencing the growth and yield of potato. The average yield of potato in Bangladesh is much lower than that of the other countries of the world. Many research works have been conducted on the effect of different mulches and fertilizer management practices on the growth and yield of potato in various parts of the world. Some of the important research reports regarding potato and some other related crops have been reviewed here in this chapter.

2.1 Influence of mulch on the growth and yield of potato

Khalak and Kumaraswamy (1992) conducted a field trial in 1985-1987 on red sandy soil at Bangalore, karantakea. Potatoes cv. Kufrijyoti was irrigated with 20 or 40 mm water and the crop was given no mulch, straw mulch or polythene mulch. Tuber yield and N uptake were the highest in both years with 20mm irrigation water. Mulching with straw and polythene gave average tuber yields of 18.2 and 16.7 t/ha respectively compared with 14.3 t/ha without mulching.

Jalil (1995) conducted an experiment at the Horticulture farm, Bangladesh Agricultural University, Mymensingh in order to study effect of mulch on potato. Black polythene mulched potato took minimum time to reach 80% emergence, resulted maximum coverage of area. However, yield was higher with water hyacinth mulch. Lang (1984) reported that the percentage of potato tuber production >6cm diameter was higher under polythene mulch. Polythene mulch conserved more moisture in the soil than control (Harris, 1965).

Manrique and Meyer (1984) found in a study of black and white plastic and various qualities of barley straw as mulches for non heat-tolerant potato variety at Manilla Agricultural Experiment Station, Lima, Peru, that during winter, soil temperature in plastic mulched plots ranged from 18 to 26°C. The condition gave relatively higher tuber yields in most of the varieties.

Rashid *et al.* (1981) conducted a trial at Joydeppur, Dhaka on potato cv. Cardinal cultivated with or without ridges, without mulching or mulching with water hyacinth, rices straw, or spike lets (Chitta). Tuber yield was the highest (17.6 t/ha) when the plants ridged and mulched with water hyacinth. Emergence in the no mulched plots was significantly lower than that of mulched plots.

Challaiah and Kulkani (1979) conducted an experiment in potato with irrigation at 13 to 15 days interval in combination with polythene mulch. Polythene mulch gave higher yield (30.64 t/ha). Bhattacharjee *et al.* (1979) demonstrated that potato yields were higher with straw mulch than that of without mulch on coarse textural soilin Patna, India. Burger and Nel (1984) reported that mulching by straw produced 30% more tubers than the no mulch potato crops. Similarly, Natheny *et al.* (1992) also found that white, pale blue and stripped straw mulch produced more than 15% marketable tubers of potato than the no much control plots.

Mulching helps in checking evaporation and thus soil can retain sufficient amount of moisture. Polyethylene film mulches reduce evaporation in vegetable cultivation (Lamont, 1993). In a separate experiment, Bieoral (1970) found that polythene sheets caused a 2% increase in the moisture content of the top 30cm of the soil. Black polythene, sawdust and dried grass mulch in tomato production improved

soil moisture retention but black polythene mulch had the best result (Patil and Basad, 1972).

Sutater (1987) found an increase in plant height and the number of potato leaf with different mulching treatments. Sarker and Hossain (1989) reported that one weeding just after emergence or mulching by paddy straw appeared optimal for the growth of a good potato crop. In another study, Taja *et al.* (1991) reported that mulching by rice straw with optimum inorganic fertilizer application of 50 kg N/ha were good for canopy coverage of potato. Sarker and Hossain (1989) studied the effect of weeding and mulching on potato cv. Cardinal and reported that the percentage of foliage coverage, which ranged from40.0 to 65.00, was significantly different among the treatments, the lowest coverage being obtained from the control (no weeding) treatment. Mulching also increased growth of leaf and stem (kim *et al.*1988). According to Devaux (1987), mulching reduced the soil temperature due to better ground cover.

Siddique and Rashid (1990) conducted experiments for 3 seasons (1987/88) to study the effect of irrigation and mulching on the yield of 3 varieties of potato (Challisha, Lalpakri and Pakri Lalita). Water hyacinth was used for mulching. From the results they found that the varieties responded very well to both irrigation and mulching. Mangaser *et al.* (1986) stated that mulch in potato improved yield and proportion of marketable size tubers compared to no mulch plants. They also reported that potato planting with mulch should be done from the last week of November up to second week of December to obtain the best yield.

Polythene mulch conserved more moisture in the soil than control (Harris, 1965). Mulching conserved the soil moisture better in potato cultivation (Prihar, 1986; Devaux and Haverkort, (1987) and Ifenkwe *et al.* (1987). Yamaguchi *et al.* (1964) also reported that average minimum

temperature fall within the range in bare soil than from clear and black polythene, which delay mergence.

Collins (1997) reported that transparent black polythene and polythene coated black paper mulches increased soil temperature and advanced emergence of potato. He also reported that transparent black polythene and polythene coated black paper mulches non significantly reduced the yield of potato from bare soil of 46.9 and 48.3 t/ha and clear polythene mulch.

Chowdhury *et al.* (2000) conducted a field experiment in the rabi season of 1997-1998 on a clay terrace soil in Salna, Gazipur, Bangladesh, to study the effect of rice straw mulching and irrigation on the yield total water use and water use efficiency of an indigenous low yielding cultivar of potato, Lalpakri. Irrigation is indispensable in the rabi season of Bangladesh and the yield was significantly lowest in the treatment of no irrigation after seedlings establishment. Rice straw mulch conserved soil moisture and maintained a higher moisture regime in each irrigation level through the cropping period. The treatments of rice straw mulching and the single irrigation at 30 days after sowing were the best combination with a satisfactory high yield.

Bhuyan (2003) conducted a field experiment at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh during the period from November 2002 to March 2003 to investigate the effect of mulching, variety and crop management practices on growth and yield of potato. T6he experiment was conducted with four mulching treatments, (no mulch no irrigation, irrigation, saw dust and straw mulch); two varieties ('Diamant' and 'Cardinal') and use of organic manure without pesticides application). Mulching treatments showed significant effect on most of the yield and yield components. The highest yield (21.31 t/ha) was obtained from straw mulch followed by sawdust (19.47 t/ha),

irrigation treatment (19.06t/ha) and no mulch no irrigation treatment (15.29t/ha). The variety also caused significant variations on most of the parameters. The variety Diamant gave the higher yields (19.07 t/ha) and compare to Cardinal (18.51t/ha) yield.

2.2 Influence of different fertilizer management practices on the growth and yield of potato

Vos *et al.* (2000) managed comparably to conventional farming practice in the Nederland. There were four nutrient treatments (T_1 –T_4). Treatments T_1 received chemical fertilizer only. T_2 received processed organic manure, supplying 50% of the crop N requirement, supplemented by chemical fertilizers. In treatments, T_1 and $T_2$the soil was grow during winter. In T_3 and T_4 the crops were fertilized as in T_1 and T_2 respectively, nitrogen catch crops were grown in autumn and winter. The initially high soil fertility indices for both P and K declined over the experimental period. Catch crops and organic manure did not affect crop yields or nutrient balances, except that their combination in T_4 resulted in 1.5t/ha extra dry matter yield of sugar beet roots. Between spring and harvest, potato and sugar beet showed positive N balances and the cereals negative N balances.

Koppel (2001) set an experiment with special emphasis organic agriculture on the choice of cultivars where adaptation regional soil, climate and production systems are important characteristics. The necessary traits for a potato variety suitable for organic farming include stronger rooting system, quicker haulm development, high and durable resistance to the main diseases and pests. A trial consisting of 45 potato cultivars and advanced clones was established at Jogeva Plant Breeding Institute in Estonia in 2000 to identify the most suitable cultivar for organic farming in the country. Organic manure at 60 t/ha and mechanical weed control were used no pest and disease control measures were undertaken in both years. Both growing seasons were very suitable for

late blight development. High late blight pressure was the main cause of yield reduction from 9.9 to 37.4 t/ha. The higher marketable tuber yields were obtained from the early cultivars or from the late cultivars that are resistant to late blight.

Ghosh and Das (1998) reported that the potatoes grown at Sriniketan (West Bengal) in winter 1995-96 and 1996-97 were given different biofertilizers and growth regulators. Treatments included combinations of Buckup (Well matured cattle manure containing vesicular arbuscular mycorrhizas and phosphate solu7bilizing bacteria), Elecra (liquid organic manure extracted from marigold plants), Bioplin (liquid suspension of Azotobecter), Micrin (liquid organic manure containing humic and fulvic acid), Vitormone (liquid suspension of several dormant Azotobecter species) and protein hydrolysate (plant growth regulators containing amino acids). Plant height and number of shoots/plant increased considerably when the crop received both biofertilizer and growth regulators together. Crop growth rate, tuber bulking rate, large and medium sized tubers and total tuber yield were greatest from combinations of both biofertilizers and growth regulator. Among the single applications, Vitormone gave the greatest yield improvement (22.6%) followed by protein hydrolysate (22.1%). Combined application of Bioplin along with protein hydrolysate or Micrin and Elecra along with Vitormone, gave 38-42% yield improvement over controls.

Blecharczyk and Skrzypczak (1995) observed that FYM reduced tuber dry matter and starch contents, but increased their yield. Anither field experiment was conducted by Khalak and Kumaraswamy (1994) in red loam soil at Bangalore, potatoes cv. Kufri Jyoti to assess the effect on dry mater accumulation and growth attributes of potato as influenced by irrigation and fertilizer (50, 100, or 150 kg/ha each of N, P_2O_5 and K_2O).

They found that leaf area index, leaf area duration, total dry matter accumulation increased with the rate of $N+P_2O_5+K_2O$ application.

Siddique and Rashid (1990) stated that under Bangladesh Agricultural University farm condition, fertilizer does of 207 kg Urea, 139 kg TSP and 242 kg MP for indigenous potato varieties. Hussain (1985) reported that use of oil cake at the rate of 700-900kg/ha is better for higher potato production. Kehr *et al.* (1964) mentioned that potato tubers develop and maintain their normal shape better in soils with high organic matter. A field experiment was carried out by Sarker *et al.* (1996) at the Gangachra Series of Mithapukur, Rangpur to assess the effect of fertilizers alone and in combination with cow dung on the growth and yield potato. They found that the highest tuber yields of 29.97 and 28.72 t/ha were produc3d by the combined effect of 150kg N + 60kg P + 120kg K + 20 kg S + 40 kg Zn + 2 kg B + 15 kg Mg/ha + 5 t/ha of cow dung respectively.

Belous (1996) worked on fertilizer for zero, single or double doses, 40 t FYM + 60 Kg N + 60Kg P+60 Kg K, 80 t FYM + 120 Kg N + 120 Kg P+120Kg K and 120t FYM +180kg P +180 Kg K per hectare. They found that NPK without FYM was highly effective especially if straw or green manure had been ploughed in and the use of FYM greatly reduces the effectiveness of complete NPK.

Guarda and Tassoni (1994) carried out an experiment on a clay-loam soil where they applied 0, 100, 200 or 300Kg N/ha in organic or mineral forms. Farmyard manure was applied in two split doses (30% immediately often planting and the rest 50 days later). They found that yield responses to N rate were dissimilar between the N sources. However, potatoes given organic nitrogen yielded 1-2 t/ha less than where mineral nitrogen was applied.

In another experiment Zavalin *et al.* (1993) also stated that them optimum potato yield of 27.1 t /ha was given by the plants having 90 Kg N+ 60KgP + 120 Kg K+ 50t peat manure compost/ha. Karmanpov *et al.* (1982) conducted an experiment with 0-135 Kg N, 0-210 Kg P_2O_5 and 0-165 Kg K_2O/ha on a leached chernozem soil given 20 t FYM /ha in the penza region and found that application of 135 Kg N +210 Kg P_2O_5+165 Kg K_2O/ha gave the highest average yields of 36 t/ha without irrigation and 42 t with irrigation.

Krishnamurthy *et al.* (2001) conducted field experiments in Bangalore, Karnataka, India, during the rabi seasons of 1996-97 and 1997-98 and investigated the effect of integrated use of organic manures and fertilizers on potato crops grown from true seed. The experiments consisted of 12 treatments combinations of organic sources: green pus at four tones/ha (organic manure), biofertilizers (Azotobecter chroococcum), city compost and control (no organic manure) and fertilizer levels (100, 125 and 150 % of recommended dose of NPK). The highest seed yield of 20.8% was recorded with green and followed by city compost (13.9%) and biofertilizer application (11.6%). The highest total tuber yield of 28.7 tones /ha was observed with city compost, followed by green plus (27.4% tones/ha) and biofertilizer (20.4% tones/ha). Application of 150 %recommended dose of NPK recorded the highest seed yield of 33.3 Kg /has and tuber yield of 29.8 tones/ha, closely followed by application of 125 % of recommended doses of NPK. Combination of city compost and 150% recommended dose of NPK recorded the highest seed and tuber yield compared to all other treatment combinations.

Toomsoo and leedu (2002) investigated the effect of a combined fertilizer. Hydro complex (12:11:18), on the yield of Potato cv. Anti, grown in potato spring wheat springy barely rotation, in along term field experiment established in autumn 1989, in Tartu, Estonia. Five rates of

mineral N (0, 40, 80, 120 and 160 Kg/ha) were used against three backgrounds of organic manure (no manure, cattle manure + Liter and straw). The results of three experimental years (1999-2001) showed that the yield of cv. Anti was stable during 1999-2001. Yield was found to depend on the fertilizer rather than on the weather conditions. The optimum N rate was 95-120 Kg/ha. In rainy seasons, the use of chemicals to control potato late blight (*Phytopthora infestans*) was very important to improve the yield of potato cv. Anti.

Krupkin *et al.* (1994) carried out an experiment to study effect of poultry manure, a mixture of poultry manure plus hydrolysis lignin, and a compost of poultry manure plus hydrolysis lignin organic fertilizers for potatoes, carrots and cabbage with and without irrigation. The results should that these organic fertilizers improved yield and quality of the crop, especially on soil having a low content of nitrate N, but had only little effect on soils well supplied with nitrate N. the lignin based fertilizers i.e. a mixture of poultry manure hydrolysis lignin and a compost of poultry manure plus hydrolysis lignin were similar in their effect to poultry manure.

Datta and Chakraborty (1995) conducted a field experiment with 0.50 or 100 Kg/ha each of N, P_2O_5, K_2O, and manure with 5 tons rice husk ash, 0.5 tons mustard oilcake or 10 tons FYM/ha. The highest potato tuber yield (27 t/ha) was obtained from the highest NPK rate used. Amongst the manures the tuber yield were in the under of FYM > rice husk ash> mustard oil cake.

Adhikari *et al.* (1992) in a field trial on potatoes cv. Kufri gave 150 Kg nitrogen as urea or ammonia sulphate + 40 tons cowdung manure 302 tons mustard oilcake or 20 tons poultry litter or 230 Kg nitrogen as urea or ammonium sulphate + 20 tons cowdung manure 1.6 tons mustard

oilcake or 10 tons poultry litter /ha to gave total nitrogen application in each treatment of about 310 Kg /ha. Tuber yield percentage of tuber > 45 mm and net profit were maximum with the application of 150 Kg nitrogen as ammonium sulphate + 20 tons poultry litter/ha.

Neher (1999) conducted a field experiment at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during the period from November 1997 to February, 1998 in order to study the effect of fertilizer viz., no fertilizer, organic, inorganic, organic +inorganic and irrigation viz. no irrigation, irrigation at 20, 15 and 10 days interval. The results demonstrated that fertilizer management practices had significant effects on the yield and yield contributing characters. The maximum plant highest (52.0cm), fresh weight of haulm (0.102 Kg/hill0, dry weight of haulm (10.078 g/hill), weight of tuber (396g/hill) and yield of tuber (27.09t/ha) were recorded when inorganic fertilizer managements were applied. However, the maximum number of main stems (3.65) per hill and dry matter of tubers (21.08%) were obtained from organic fertilizer management practices. Inorganic fertilizer management practices gave the highest percentage of >55mm (20.27) and 46-55mm (47.49) grade tubers. Inorganic fertilizer management practices gave significantly better result compared to other treatment.

Arafa (2004) conducted an experiment of different NPK treatments on growth, yield, quality and chemical components of two potato cultivars. The effects of 3 levels of NPK fertilizers, i.e. 125+30+100, 150+45+150 and 175+60+200 Kg/ha, on the growth, yield and its components, quality as well as chemical compositions(N, P, K, Fe, Mn, Zn, reducing, no reducing and total sugars) of foliage and tubers of 2 potato cultivars(lady Rosetta and Hermis) were investigated under sandy soil conditions in Ismaalia Governorate, Egypt, during the summer seasons of 2002 and 2003. The second level of NPK significantly

increased plant height, number of branches per plant, fresh and dry weights of plant foliage, numbers of tubers per plant, tuber weight, plant yield, total yield, marketable yield, large (more than 55 mm in diameter) tuber percentage and chemical composition of foliage and tubers. Hermis compared with Lady Rosetta significantly increased the vegetative growth, yield and its components as well as chemical composition of plant foliage and tubers. The data concerning the interaction showed that Hermis in combination with the second level of NPK significantly increased all the studied character; Lady Rosetta in combination with the highest level of NPK increased the percentage of medium sized (35-55mm in diameter) tubers and dry matter content of tubers.

Marks and Krzysztofik (2001) observed the effect of different forms of organic manure and cultivation techniques on the quality of potato tuber yield. The application of organic manure (processed biomass form) and patch growing of potatoes improved the quality of potato yield compared with farmyard manure and ridge cultivation.

Gladkikh *et al.* (2001) conducted a trial with mineral fertilizer (various rates and combinations of N, P and K) and organic fertilizer in a farm of pet/manure compost. The crop rotations comprised tomatoes, cabbage, carrots, potatoes and cucumbers. The results were given from the 10^{th} rotation (1993-98). Yields were greatest in the treatments with complete mineral fertilizer, and with combined mineral and organic fertilizer.

CHAPTER 3

MATERIALS AND METHODS

3.1 Site of the experiment

The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during the period from November 2006 to February 2007. The experimental site was previously used as vegetable garden and recently developed for research work. The location of the site is 23° 74´N latitude and 90° 35´E longitude with an elevation of 8.2 meter from sea level (Anon., 1981).

3.2 Climate

The climate of the experimental site is subtropical, characterized by heavy rainfall during the months from April to September (Kharif season). The total rainfall of the experimental site was 218 mm during the period of the experiment. The average maximum and the minimum temperature were 29.5°C and 13.9°C respectively during the experimental period. Rabi season is characterized by plenty of sunshine. The maximum and minimum temperature, humidity and rainfall during the study period were collected from the Bangladesh Meteorological Department (climate division) and have been presented Appendix I.

3.3 Characteristics of soil

The soil of the experimental area belongs to the Modhupur Tract. The analytical data of the soil sample collected from the experimental area were determined in the SRDI, Soil Testing Laboratory, Dhaka have been presented in Appendix II.The experimental site was a medium high land and pH of the soil was 5.6. The morphological characters of soil of the experimental plots as indicated by FAO (1988) are given below –

AEZ No. 28

Soil series – Tejgaon

General soil- Shallow red brown terrace soil.

3.4 Planting materials

The seed tubers of 'Diamant' potato variety were collected from Bangladesh Agricultural Development Corporation (BADC) office, Kashimpur, Gazipur.

3.5 Treatments of the experiment

There were two factors in this experiment. They were as follows:

Factor A: Different mulching treatments

i. No mulch (M_0)
ii. Black polythene mulch (M_1)
iii. Water hyacinth mulch (M_2)

Factor B: Fertilizer management practices

i. Organic (cowdung) (F_1)
ii. Inorganic (F_2)
iii. Organic (cowdung) + inorganic (F_3)

3.6 Preparation of the main field

The land was opened on 12th November 2006 with a power tiller and was exposed to the sun for 7days prior to next ploughing. It was prepared afterwards by ploughing and cross ploughing followed by laddering. Big clods were broken by hand mallet. The weeds and stubbles were completely removed from the field. The soil particles were well pulverized and the land was leveled evenly during final land preparation.

3.7 Design and layout of the experiment

The two-factor experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. A block consisted of 9 unit plots, each for a combination of mulching and different fertilizer management practices. The total number of plots was 27. The treatment combinations of the experiment were assigned randomly in each block. The size of unit plot was 2.4m×2.0m. The gap between the

plots was 50cm and between the blocks was 100cm. the field was laid out on 19th November 2007.

3.8 Application of manure and fertilizers

The following doses of manures and fertilizers were used in the experiment following the recommendation by Rashid *et al.* (1997).

Manure and fertilizer treatments	Doses /ha	Doses /plot (2.4m×2m)
a) Organic (cowdung)	10t	4.8kg
b) Inorganic		
Urea	326kg	160g
TSP	232kg	110g
MP	275kg	130g
c) Organic (cowdung) + Inorganic		
Cow dung	5t	2.4kg
Urea	163kg	80g
TSP	116kg	55g
MP	137kg	65g

Source: Fertilizer recommendation guide, 1997

Cowdung was applied during final land preparation. One third urea, MP, and full doses of TSP were used in non-mulched and mulched plots as a basal dose. The rest of the urea and MP were applied in two installments at 30 and 60 days after planting. In case of mulch condition, the urea and MP were used in liquid formation by dissolving fertilizer into water and spray over the plots.

3.9 Preparation of planting materials

The seed tubers of the variety 'Diamant' were procured from BADC sales centre Kashimpur, Gazipur and kept under diffused light condition in order to obtain healthy and well sprouted whole seed tubers, which were used for planting.

3.10 Planting of seed tuber

Sprouted, healthy and disease free seeds were planted in furrows on the 19th November 2006 at 5-7 cm depth maintaining a spacing of 60cm × 20cm. After planting, the seeds were covered with soil. Each plot accommodated 40 seed tubers in 4 rows. In case of black polythene mulching, sheets were spread over the plot before planting keeping holes at proper spacing into which dibbling was done.

3.11 Intercultural operations

3.11.1 Weeding

Weeding was done in all the plots as and when required to keep the plant free from weeds.

3.11.2 Earthing up

Earthing up in selected plots (except water hyacinth and black polythene plots) was done twice during the growing period. The first earthing up was done after 30 days of planting and the second one after 25 days of first earthing up.

3.11.3 Plant protection

Dithane M-45 @ 2.25 kg/ha was sprayed after complete emergence of the crop at an interval of 15days to protect the incidence of late blight disease. Furadan 5G was applied against soil insects during final land preparation at the rate of 10kg/ha.

3.12 Collection of Data

Data were recorded on the following parameters from the sample plants during the course of experiment.

3.12.1 Days required to 100%emergence

This was achieved by recording the number of days taken for the emergence of 40 planted in each plot.

3.12.2 Height of plant

Plant height was recorded at 30, 45, 60, 75 and 90 days after planting (DAP). The height was measured from the base of the plant to the longest end of the stem and was expressed in centimeter (cm).

3.12.3 Foliage coverage (%)

The area covered by the plants canopy in a unit plot of 2.4m×2m was calculated and converted into percentage.

3.12.4 Number of main stems per hill

The number of main stems per hill of the sample plants was recorded at the time of harvesting, and the average number of stems produced per hill was recorded.

3.12.5 Fresh weight of haulm per hill

The average weight of haulm was recorded from selected plants for each plot at the time of harvesting.

3.12.6 Dry weight of haulm per hill

The fresh haulms of the sample plants were sun dried for two days and then oven dried at 65°C for 72 hours.

3.12.7 Number of tubers per hill at harvest

The number of tubers from 10 selected plants was counted and average number of tubers was calculated.

3.12.8 Weight of tubers per hill at harvest

The weight of tubers from 10 selected hills was recorded and average weight of tubers per hill was calculated.

3.12.9 Mean tuber weight

Mean tuber weight was recorded from total weight of tubers from sample plants divided by total number of tubers from these plants at harvest.

3.12.10 Dry weight of tubers (%)

Two hundred grams of potatoes from sample plants were sliced, sun dried for 2 days and then dried at 70°C in an oven for 72 hours. Just after oven drying the dried pieces were weighed and were expressed in percentage.

$$\text{Dry weight of tuber (\%)} = \frac{\text{Dry weight}}{\text{Fresh weight}} \times 100$$

3.12.11 Yield of tuber per plot

To obtain yield per hill weight of tuber was taken from ten harvested sample plants and the tuber yield per unit plot was found out as total tuber weight of all the plants from each unit plot.

3.12.12 Yield of tuber per hectare

The yield of tuber per hectare was calculated from that of per plot yield.

3.12.13 Grade of tubers

Tubers collected from ten plants in each plot the potato was graded by number and by weight on the basis of diameter:> 55mm, 40-55mm, 28-40mm and <28mm. The data were converted into percentage.

3.13 Harvesting

The crop was harvested after 90 days on 19th February 2007 when the 80-90 percent of the plants showed leaf senescence and the tops started drying up. Ten sample plants were harvested at first with the help of a spade from each plot and the whole plot was harvested with the help of country plough. Enough care was taken to avoid injury of potatoes during harvesting.

3.14 Statistical analysis

The collected data were statistically analyzed to find out the significance of the difference among the treatments. The analysis was performed by F-test and the significance of the difference between pairs of treatment means were evaluated by the Least Significance Difference (LSD) test at 5% and 1% levels of significance.

3.15 Cost benefit analysis

The cost of production was analyzed with a view to find out the most profitable combination of the treatments. All the non-material and material input costs and interests on running capital were considered for computing the cost of production. Cost and return analysis was done in details according to the procedure of Alam *et al.* (1989). Benefit cost ratio was calculated by the following formula:

$$\text{Benefit cost ratio} = \frac{\text{Gross return (Tk/ha)}}{\text{Total cost of production (Tk/ha)}}$$

CHAPTER 4
RESULTS AND DISCUSSION

The effect of mulching and fertilizer management practices and their interaction on the growth yield and yield-contributing characters have been presented and discussed in this chapter under the following headings and in tables 1-6 and figures1-7.

4.1 Time required for 100%emergence of the plant

The time required for 100% emergence of the crop was significantly influenced by different mulch used. The black polythene mulch took the shortest time (14.3 days) and the no mulch needed maximum time (15.7 days) to emerge (Table 1). Increase of temperature and conservation of more soil moisture in the black polythene covered plot might have encouraged earlier tuber emergence. Yamaguchi et al., 1964; Volden, 1970; Balashev, 1972 and Collins, 1977 found similar results in their studies.

The effect of different levels of fertilizer management practices on the 100% emergence of potato plant minimum time (14.6 days) required was noted with organic (cowdung) + inorganic fertilizer treatment, while the maximum time (15.4 days) was required by organic fertilizer treatment (Table 1).

Interaction effect of mulching and fertilizer management practices was found to be non-significant. On the other hand, the combined effect of mulching and fertilizer management practices was significant in this respect. Minimum time (13.7 days) of 100% emergence was recorded from the treatment black polythene and organic (cow dung) + inorganic fertilizer and maximum time (16.3 days) was noticed in no mulch and organic fertilizer treatment (Table 2).

4.2 Plant height

Plant height was recorded at different days after planting (DAP) viz.30, 40, 45, 60, 75 and 90 DAP. Different mulches showed significant variation in plant height at different days after planting. At 90 DAP; the highest plant height (77cm) was measured with the plants grown over black polythene mulch while the lowest (71cm) in no mulch treatment (control) (Fig.1). The effect of black polythene mulch may be accounted for conserving sufficient soil moisture resulting in maximum plant height. On the contrary, plants grown without mulch may suffer from water stress and cannot accomplish full vegetative growth. Hussain and Rashid (1974) reported that, the height of mulched potato plant was taller than the control.

Plant height due to different levels of fertilizer management practices was significantly influenced at different days after planting. The maximum plant height (77.74 cm) was recorded from organic (cowdung) + inorganic fertilizer whereas the minimum (68.63 cm) was recorded from organic (cowdung) fertilizer treatment (Fig. 2). It was observed that organic (cowdung) + inorganic fertilizer played a significant role in maximizing plant height. This effect was probably due to the fact that manure and fertilizers supplied adequate plant nutrients for better vegetative growth of potato plants which ultimately increased plant height. Widiajanto and Widsodo (1982) found similar result.

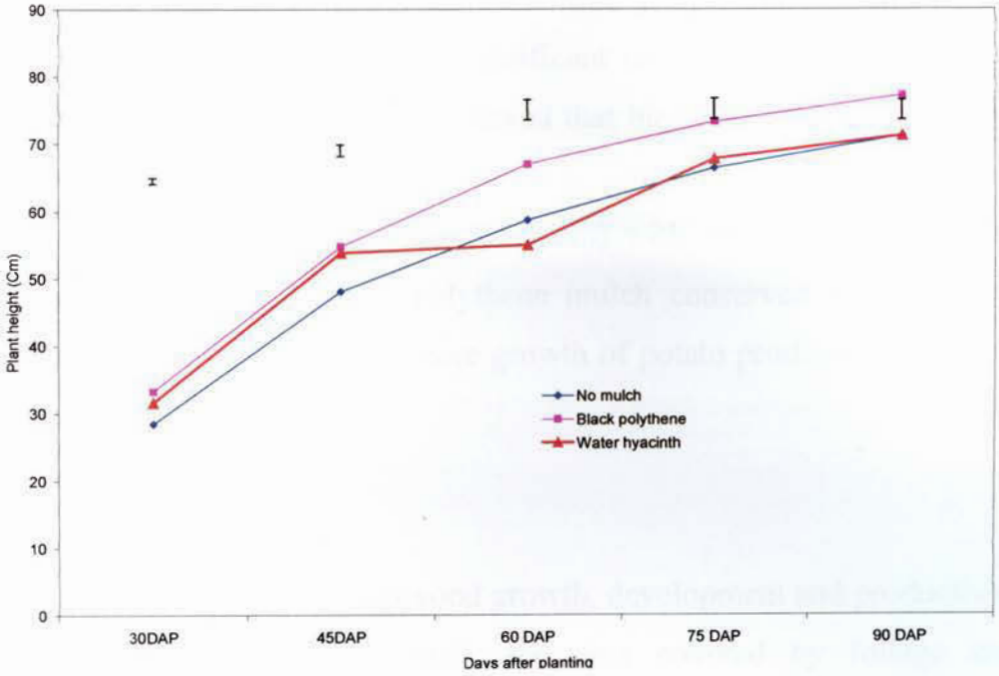

Fig 1. Main effect of different mulches on the plant height at different days after planting (DAP) (Vertical bar indicates LSD at 0.05)

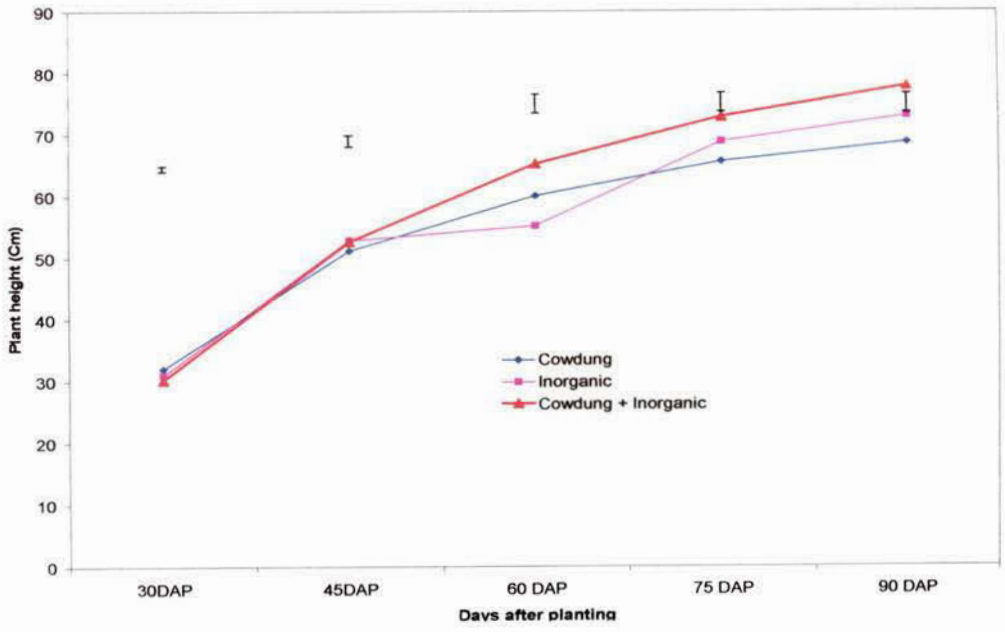

Fig 2. Main effect of different fertilizer management practices on the plant height at days after planting(DAP) (Vertical bar indicates LSD at 0.05)

The interaction effect of mulching and fertilizer management practices was found statistically significant on plant height. Among the treatment combinations it was observed that black polythene mulch with organic (cowdung) + inorganic fertilizer gave maximum plant height (80.8 cm) and it was minimum (66.5 cm) with no mulch and organic (cowdung) treatment. Black polythene mulch conserved sufficient soil moisture that may encourage more growth of potato producing the tallest plant (Table 1).

4.3 Foliage coverage

Good foliage indicates good growth, development and productivity of plants. In the present study the area covered by foliage was significantly influenced by mulching at 30,40,50,60 and 70 DAP. At 70 DAP, black polythene mulch treatments produced the maximum foliage coverage (82.84%) and the minimum area was covered (69.07%) by the no mulch (Fig. 3).

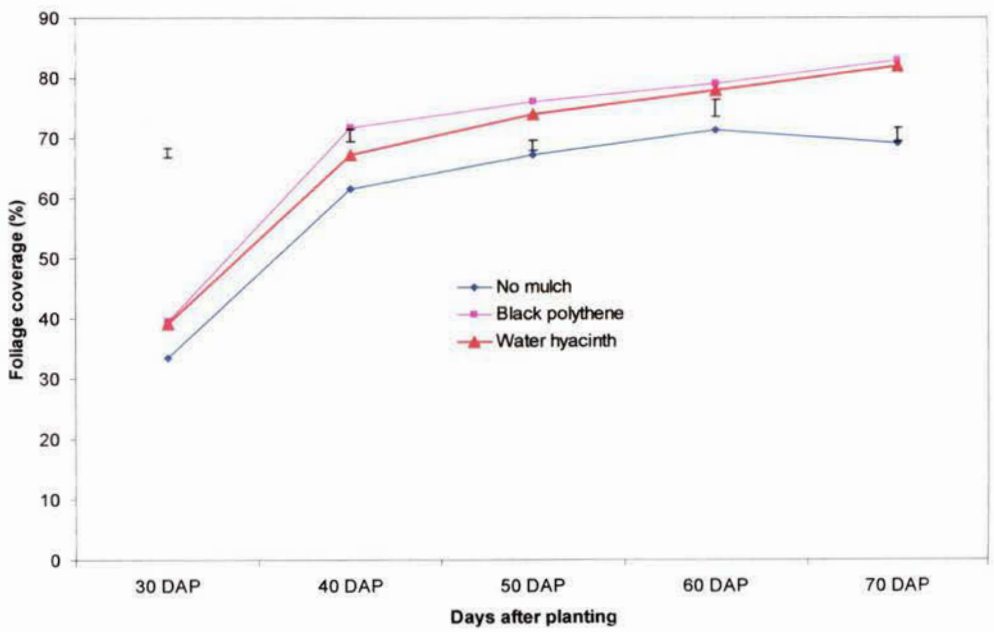

Fig 3. Main effect of different mulches on foliage coverage of potato at different days after planting (DAP) (Vertical bar indicates LSD at 0.05)

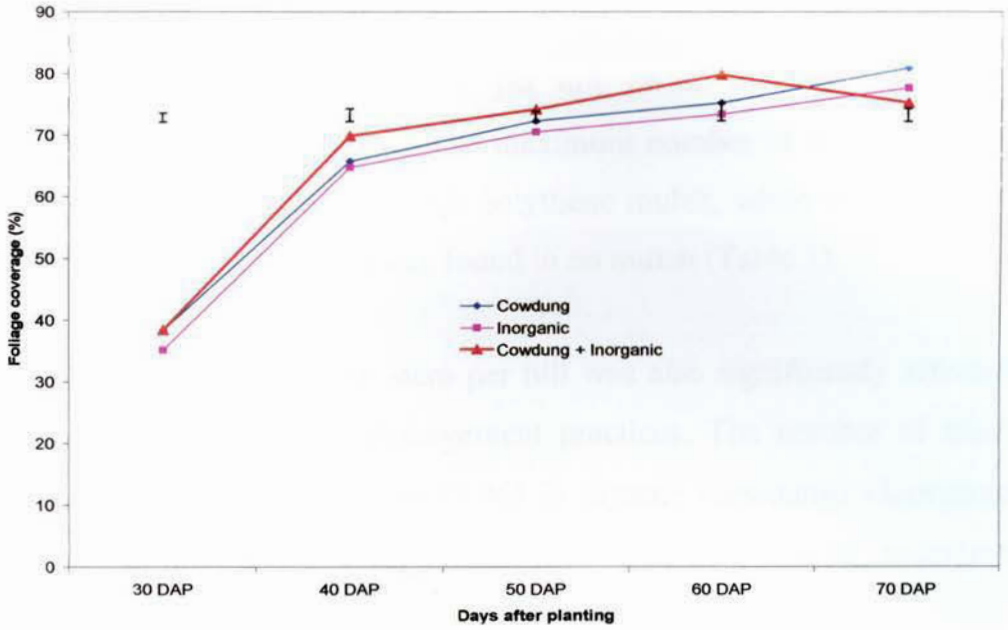

Fig 4. Main effect of different fertilizer management practices on foliage coverage of potato at different days after planting (DAP) (Vertical bar indicates LSD at 0.05)

Foliage coverage also significantly influenced by fertilizer management practices at 30, 40, 50, 60 and 70 DAP. At 70 DAP, organic (cowdung) treatments produced the maximum foliage coverage (80.86%) and the minimum area was covered (75.02%) by the organic (cowdung) + inorganic treatments (Fig.4).

Mulching and fertilizer management practices showed significant effect on foliage coverage at different days after planting. The highest foliage coverage (87%) by the treatment combination of black polythene mulch with organic (cowdung) + inorganic fertilizer. The lowest foliage coverage (75.60%) was recorded in no mulch with inorganic fertilizer treatment (Table 2).

4.4 Number of main stem per hill

The number of main stem per hill varied significantly among different mulching treatments. The maximum number of main stem per hill (4.09) was produced by black polythene mulch, while the minimum number of main stem (3.57) was found in no mulch (Table 1).

The number of main stem per hill was also significantly affected by the different fertilizer management practices. The number of main stems per hill was the highest (3.96) in organic (cowdung) +inorganic fertilizer and was the lowest (3.72) in organic fertilizer treatment (Table 1).

There was a significant interaction effect of mulching and fertilizer management practices on the number of main stems per hill. The maximum numbers of stems (4.50) were given by the treatment combination of black polythene mulch with organic (cowdung) fertilizer and the lowest (3.03) was recorded from the treatment combination of no mulch with organic (cowdung) (Table 3).

4.5 Fresh weight of haulm (g/hill)

Significant variation was found among different mulches in fresh weight of haulm per hill. Black polythene mulch produced the highest (143.2 g/hill) fresh weight of haulm. On the other hand, the lowest (105.9g/hill) was found in no mulch treatment (Table 1). Water supply probably hampered normal growth of potato under no mulch condition. On the other hand, sufficient soil moisture was conserved by black polythene mulch that increased plant height and greater thickness of the stem, which increased fresh weight of haulm.

Fresh weight of haulm per hill varied significantly with different fertilizer management practices. The highest fresh weight of haulm (131.2 g/hill) was obtained from inorganic fertilizer and the lowest (118.1 g/hill) was produced by organic (cow dung) treatment (Table 1).

Different mulching and fertilizer management practices in respect of fresh weight were found statistically significant. The highest fresh weight of haulm was recorded from black polythene mulch with inorganic fertilizer (150.2 g/hill) and the lowest (89.3g/hill) from no mulch with organic (cowdung) treatment (Table 3).

4.6 Dry weight of haulm

There was a significant effect of mulch on the growth and yield of potato. The highest dry height of haulm (11.6g/hill) was found from the black polythene mulch. The lowest dry weight of haulm was recorded in no mulch treatment (9.7 g/hill) (Table 1). Black polythene mulch probably conserved adequate soil moisture, which increased plant height, number of leaves and chlorophyll content of the plant (EI-Okash *et al.*, 1993).

Different fertilizer management practices showed significant variation in respect of haulm. The maximum dry weight of haulm (11.1 g/hill) was obtained from organic (cowdung) +inorganic fertilizer management practices. The minimum (10.3 g/hill) was obtained from inorganic fertilizer management practices (Table 1).

There was significant interaction between mulching and fertilizer management practices on the dry weight of haulm. The maximum dry weight of haulm (12.8 g/hill) was obtained from the combination of black

polythene mulch and organic (cowdung) fertilizers, and the minimum dry weight of haulm (8.9 g/hill) was obtained from the combination of no mulch and inorganic fertilizer treatment (Table 3).

4.7 Number of tuber per hill

The number of tubers per hill was significantly affected by mulching treatments. The highest number (6.88) was found in plants under black polythene mulched condition and the lower number (5.18) was found in water hyacinth mulched condition (Table 1).

The number of tubers per hill was significantly influenced by different fertilizer management practices The highest number of tubers per hill (6.11) was given by organic (cowdung) +inorganic fertilizers, while the lowest (5.72) was produced by the plants grown in organic (cowdung) fertilizers management (Table 1). The increase in number of tubers per hill might be due to increased photosynthetic activity and translocation of photosynthesis to axillary shoots, which might have helped in the initiation of more stolons (Anand and Krishnappa, 1988).

There was a statistically significant interaction effect of mulching and fertilizer management practices on the number of tubers per hill. The maximum number of tubers per hill (7.20) was produced by black polythene mulch with organic fertilizer. The lowest number of tubers per hill (4.50) was produced by the treatment combination of water hyacinth with organic fertilizers (Table 3).

Table 1. Main effect of different mulches and fertilizer management practices on the growth, yield and yield contributing charecters of potato cv.'Diamant'.

Treatments	Days required for 100% emergence	Number of main stems per hill	Fresh weight of haulm per hill (g)	Dry weight of haulm per hill (g)	Number of tubers per hill	Weight of tubers per hill(g)	Mean tuber weight (g)	%dry weight of tuber	Yield of tuber per plot*(kg)
M_0	15.72	3.57	105.92	9.70	5.78	258.10	44.60	15.02	6.45
M_1	14.34	4.09	143.25	11.66	6.88	366.33	53.62	15.78	9.25
M_2	14.77	3.93	119.04	10.86	5.18	273.96	53.03	15.01	7.71
F_1	15.40	3.72	118.26	10.73	5.72	276.72	49.90	15.27	7.68
F_2	14.82	3.90	131.82	10.34	6.00	288.62	47.13	15.11	6.50
F_3	14.62	3.96	118.14	11.16	6.11	333.05	54.22	15.42	9.23
LSD (0.05)	1.006	0.155	7.495	0.499	0.434	20.03	4.997	1.000	0.473
(0.01)	1.386	0.213	10.33	0.688	0.598	27.60	6.884	1.378	0.578
CV (%)	6.69	4.04	6.11	4.65	4.21	6.69	9.92	6.55	5.38

*=Plot size=2.4m×2m
DAP=Days after Planting

Mulches
M_0=No mulch
M_1= Black polythene mulch
M_2= Water hyacinth

Fertilizers
F_1= Organic (cowdung)
F_2= Inorganic
F_3= Organic (cowdung) +Inorganic

4.8 Weight of tuber per hill

Weight of tubers per hill was significantly affected by the mulching treatments. The highest weight of tubers per hill was found in black polythene mulch (366.3g). On the other hand, the lowest weight of tubers per hill was found in no mulch treatment (258.1 g) (Table 1).

The variation in weight, of tuber per hill due to different fertilizer management practices was observed to be statistically significant. The maximum tuber weight per hill (333.1g) was recorded with the crop was grown with organic (cowdung) +inorganic fertilizer. While the minimum tuber weight (276.7g) was found in organic (cowdung) fertilizer treatment (Table 1).

There was statistically a significant interaction effect of mulching and fertilizer management practices on the weight of tuber per hill. The maximum tuber weight per hill (396.7g) was produced from black polythene mulch with inorganic fertilizer, while the minimum (189.4g) was obtained from water hyacinth with inorganic fertilizer treatment (Table 3).

4.9 Mean tuber weight

Statistically significant influence was observed due to the effect of mulching treatment on the tuber weight. The mean tuber weight was maximum (59.7g) in black polythene mulch. The mean tuber weight was the lowest (40.1g) in no mulch condition (Table 1). The optimum soil temperature and sufficient soil moisture conserved in mulched condition possibly enhanced vegetative growth and fresh plant weight thus contributing enough to produce bigger sized tuber.

The variations in mean tuber weight due to different fertilizer management practices were observed to be statistically significant. The maximum mean tuber weight (54.2g) was obtained when the crop was grown under organic (cowdung) + inorganic fertilizer. The minimum mean tuber weight (47.1g) was found in the treatment of inorganic fertilizer (Table 1).

Table 2. Combined effect of different mulches and different fertilizer management practices on the days required for 100% emergence, plant height (cm), foliage coverage (cm) of potato cv.'Diamant'.

Treatments	Days required for100% emergence	Plant height (cm) at					Foliage coverage (cm) at				
		30 DAP	45 DAP	60 DAP	75 DAP	90 DAP	30 DAP	40 DAP	50 DAP	60 DAP	70 DAP
M_0F_1	16.30	30.00	49.30	55.53	62.66	66.56	34.99	63.32	70.20	75.60	79.66
M_0F_2	15.50	29.06	47.26	59.03	66.46	70.86	31.29	61.08	66.44	68.43	75.60
M_0F_3	15.35	26.16	47.53	61.46	69.90	75.86	33.74	59.98	64.63	70.20	81.95
M_1F_1	14.50	34.50	53.43	62.63	66.70	70.50	41.75	69.20	73.83	73.86	80.20
M_1F_2	13.70	32.70	55.50	68.70	76.06	79.96	38.08	70.79	75.40	78.93	81.33
M_1F_3	14.83	32.43	55.26	69.43	76.86	80.83	38.66	75.09	78.84	84.16	87.00
M_2F_1	15.40	31.50	50.64	62.03	67.40	68.83	38.39	64.70	72.93	76.20	82.73
M_2F_2	15.25	31.13	55.63	57.90	63.96	67.93	35.98	62.27	69.77	72.83	76.10
M_2F_3	13.77	32.03	55.03	67.90	71.83	76.53	42.76	74.55	79.13	85.00	86.83
LSD (0.05)	1.743	2.596	5.193	8.665	8.783	8.654	4.329	6.058	5.045	8.654	6.099
(0.01)	2.401	3.577	7.154	11.940	12.100	11.920	5.964	8.347	6.950	11.920	8.433
CV (%)	6.69	4.83	5.75	8.31	7.24	6.84	6.71	5.24	4.15	6.57	4.52

*=Plot size=2.4m×2m

Mulches
M_0=No mulch
M_1= Black polythene mulch
M_2= Water hyacinth

Fertilizers
F_1= Organic (cowdung)
F_2=Inorganic
F_3= Organic (cowdung) +Inorganic

Interaction effect of mulching and fertilizer management practices was statistically significant on the mean tuber weight. The maximum mean tuber weight (68.9g) was found in water hyacinth mulch with organic (cowdung) fertilizer and the lowest (40.4g) was from no mulch with organic (cow dung) fertilizer treatment (Table 3).

4.10 Dry weight of tuber

Dry weight of tuber was not statistically significant as affected by different mulching treatments and that was ranged 15.01% to 15.78 % (Table 1).

Dry weight of tuber was not significantly affected by different fertilizer management practices. The maximum dry weight of tubers (15.42%) was obtained from organic (cowdung) +inorganic fertilizer management practices whereas inorganic fertilizer gave lower dry weight (15.11%) of tuber (Table 1).

There was statistically significant interaction effect of mulching and fertilizer management practices. The maximum dry weight (16.10 %) black polythene mulch with inorganic fertilizer and the minimum dry weight of tuber (14.50%) water hyacinth with inorganic fertilizer treatment (Table 3).

4.11 Yield of tuber per plot

The variation among the mulching operation in respect of yield per plot was highly significant. The highest yield of tubers (9.2 kg/plot) was obtained from black polythene mulch. The lowest yield of tuber (6.4 kg/plot) was obtained from no mulch (Table 1).

The effect of different fertilizer management practices on yield of tubers per plot was significant. The highest yield of tubers (9.2kg/plot) was obtained from organic (cowdung) +inorganic fertilizer treatment. The lowest yield of tuber (6.5kg/plot) was obtained from inorganic fertilizer treatment (Table 1).

Table 3. Combined effect of different mulches and different fertilizer management practices on the growth, yield and yield contributing characters of potato cv.'Diamant'.

Treatments	Number of main stem per hill	Fresh weight of haulm per hill (g)	Dry weight of haulm per hill (g)	Number of tubers per hill	Weight of tubers per hill (g)	Mean tuber weight (g)	%dry weight of tuber	Yield of tuber per plot*(kg)	Yield of tuber (t/ha)
M_0F_1	3.03	89.36	9.86	5.46	219.16	40.14	15.27	6.16	12.83
M_0F_2	4.20	115.90	8.97	6.30	280.16	44.46	14.75	5.70	11.87
M_0F_3	3.50	112.50	10.28	5.59	275.00	49.19	15.04	7.50	15.62
M_1F_1	4.50	145.17	12.83	7.20	314.33	43.65	15.24	9.25	19.27
M_1F_2	4.02	150.25	10.80	6.90	396.67	57.48	16.10	7.80	16.25
M_1F_3	3.90	134.35	11.36	6.50	388.33	59.74	16.01	10.70	22.29
M_2F_1	3.80	120.25	9.50	4.50	296.67	68.92	15.30	7.65	15.93
M_2F_2	3.50	129.31	11.25	4.80	189.37	39.46	14.50	6.00	12.50
M_2F_3	4.50	107.57	11.85	6.25	335.83	53.73	15.22	9.50	19.79
LSD (0.05)	0.269	12.980	0.865	0.434	34.69	8.654	1.733	0.794	1.798
(0.01)	0.369	17.890	1.192	0.599	47.80	11.920	2.387	0.989	2.385
CV (%)	4.04	6.11	4.65	4.21	6.69	9.92	6.55	5.38	7.40

*=Plot size=2.4m×2m

Mulches
M_0=No mulch
M_1= Black polythene mulch
M_2= Water hyacinth

Fertilizers
F_1= Organic (cowdung)
F_2=Inorganic
F_3= Organic (cowdung) +Inorganic

There was significant interaction between different mulching and fertilizer management practices. The highest yield (10.7 kg/plot) was found in the treatment black polythene mulch with organic (cowdung) + inorganic fertilizer management practices and the lowest yield (5.7kg/plot) were found in no mulch with inorganic fertilizer treatment (Table 3).

4.12 Yield of tuber per hectare

When per plot yield was converted into per hectare and was expressed in ton, it was evident that the black polythene treatment was statistically highly significant. The maximum yield (19.2 ton/ha) was found in black polythene mulch and the lowest yield (13.4ton/ha) was found in no mulch treatment (Fig. 5). This may be attributed to be availability of optimum growing condition provided through conservation of adequate soil moisture, efficient use of nutrients due to mulching treatment. As a result yield per plot as well as per hectare were increased. Challaiah and Kulkarni (1979) mentioned that the yield of potato was higher when polythene mulch was used. Khalak and Kumaraswamy (1992) and Hochmuth and Howell (1983) mentioned similar results. The variations among the fertilizers treatment was also statistically significant. The maximum yield (19.2 ton/ha) was found in organic (cowdung) + inorganic fertilizer treatment and lowest yield (13.5 ton/ha) was found in inorganic fertilizer treatment. Similar results were found by Blecharczyk and Skrzpezak (1995) and Sarker et al. (1996). Therefore, organic fertilizers might be play strong role together with inorganic fertilizers (Fig. 6).

The interaction effect of different mulching and fertilizers management practices on the yield of potato per plot as well as per hectare was highly significant. The combination of different mulching and fertilizers management practices influenced significantly on the yield of potato. The highest yield (22.2 ton/ha) of potato was obtained from the treatment black polythene mulch with organic (cow dung) +inorganic

fertilizer. The lowest yield (11.8ton/ha) of potato was obtained from the treatment no mulch with inorganic fertilizer treatment (Fig. 7).

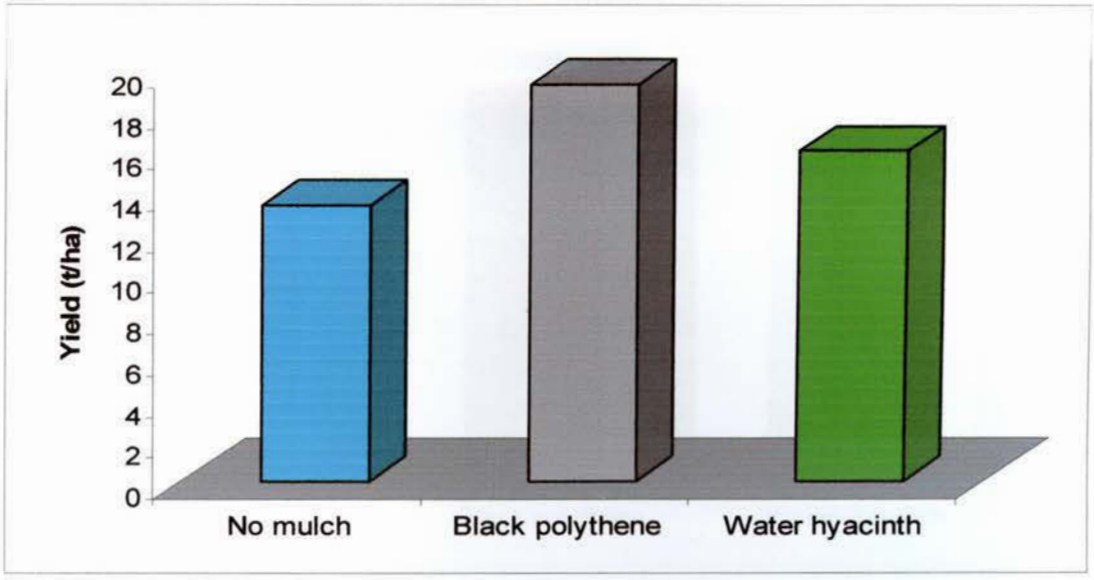

Fig 5. Main effect of different mulches on the yields of potato tubers.

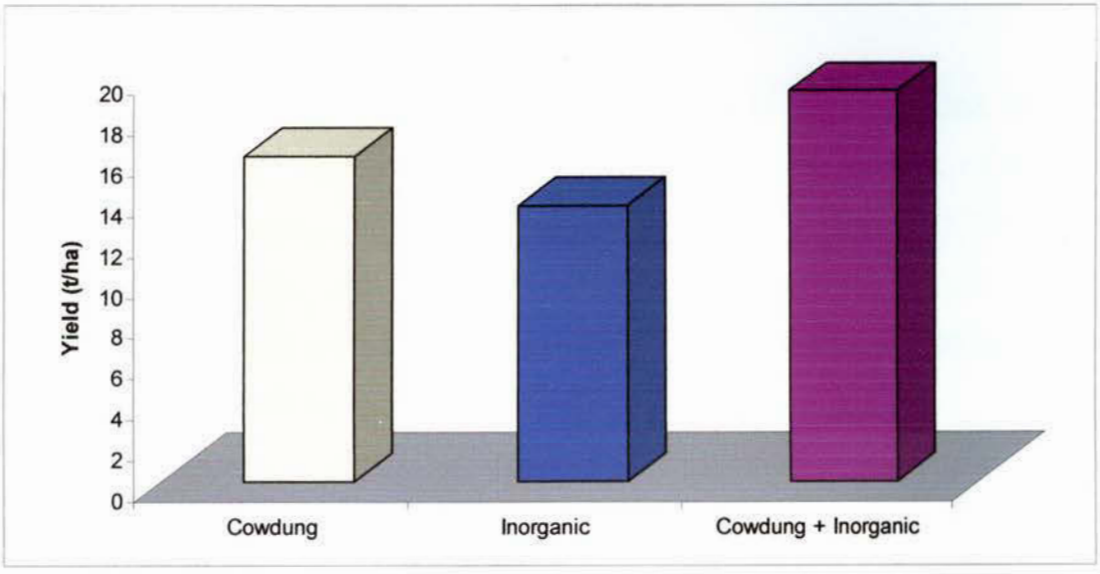

Fig 6. Main effect of different fertilizer management practices on the yield of potato tubers.

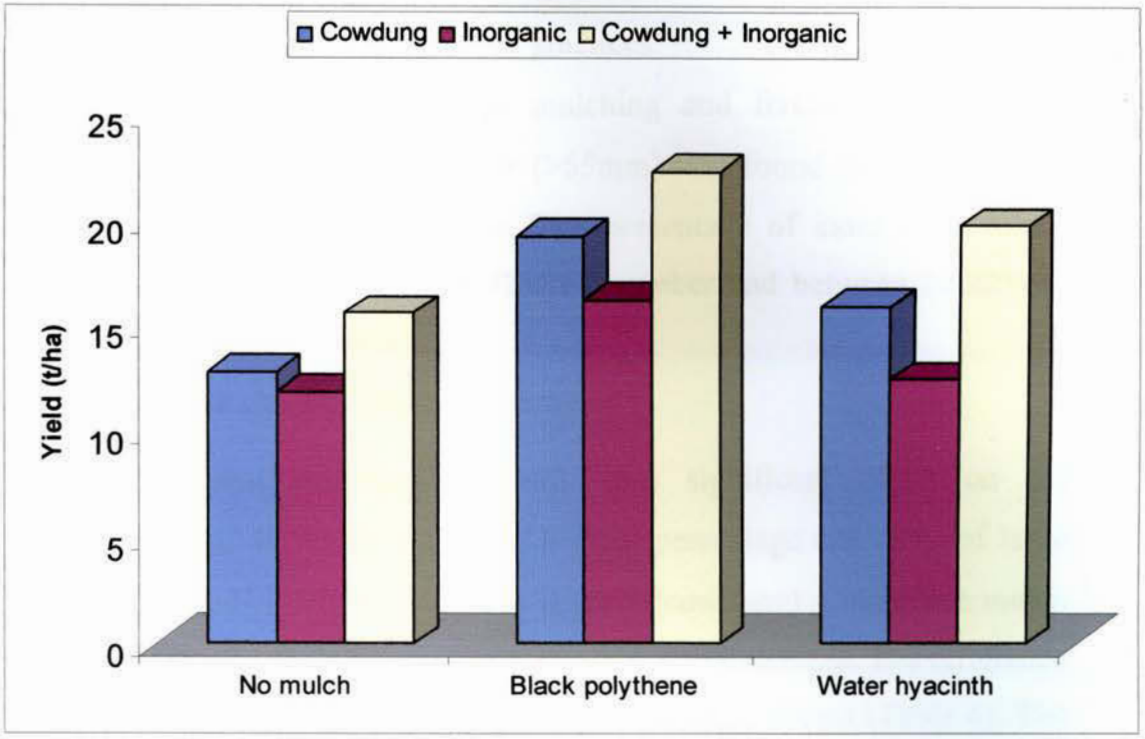

Fig 7. Combined effect of different mulches and different fertilizer management practices on the yield of potato tubers.

4.13 Size grades of tubers

4.13.1 Grade size >55mm diameter

Various mulches showed significant variation in the production of extra large tubers (>55mm) either by number or by weight. The percentage of extra large tubers as influenced by mulching ranged 21.77% to 32.91% by number and 23.63% to 34.28% by weight (Table 4). The highest percentage of extra large tuber both by number and by weight was found in black polythene mulch.

Different fertilizer management practices indicated significant differences in the production of extra large tubers (>55mm) either by number or by the weight. The percentage of extra large tubers as influenced by the fertilizer ranged between 25.85% to 28.54% by the number and 28.95% to 29.17% by weight (Table 4). The highest

percentage of extra large tuber both by number and by weight was found in inorganic fertilizer management practices.

The interaction effect of mulching and fertilizer management practices on the extra large tuber (>55mm) was found to be significant both by number and by weight. The percentage of extra large tubers ranged between 19.76% to 35.82% by number and between 22.22% to 37.76% by weight (Table 5).

4.13.2 Grade size 40-55mm in diameter

Different mulching did not have significant effect on the production of 40-55mm size. The highest percentage (29.77%) of large tuber by number was produced by organic (cowdung) + inorganic mulch and the lowest (27.84%) were in water hyacinth treatment. The difference in the percentage of large tuber by weight was significant (Table 4). The maximum percentage (27.38%) of large tubers by weight was produced by water hyacinth mulch and the minimum (22.47%) in black polythene mulch.

Fertilizer management practices resulted significant differences in the percentage of large grade tuber either by number or by weight. The percentage of large tubers as influenced by different fertilizer ranged 26.02% to 32.13% by numbers and 22.25% to 27.24% by weight (Table 4). The highest percentage of large tuber in organic (cowdung) treatment by number and the lowest percentage of tuber in organic (cowdung) by weight.

The interaction effect of mulching and fertilizer management practices was statistically significant on large tuber by weight but not by number. The percentage of large tuber ranged between 24.73% and 33.30% by number and between 18.28% and 28.07% by weight (Table 5).

4.13.2 Grade size, 28-40mm in diameter

Various mulches clearly indicated significant differences in the production of medium tuber (28-40 mm) either by number or by weight. The percentage of medium tubers as influenced by mulches ranged between 19.73% to 25.95% by number and 18.76% to 21.08% by weight (Table 4). The highest percentage of medium tuber by number and by weight was found in no mulch treatment. Rashid et al. (1981) found that highest productions of tubers of 28-45 mm were produced by no mulching treatments.

Different fertilizer management practices showed significant differences in the production of the medium tubers by number or by weight. The percentage of medium tubers as influenced by different fertilizer management was from 19.02% to 25.32% by number and 18.70% to 20.49% by weight (Table 4). The highest percentage of medium tuber both by number and by weight was found in organic (cowdung) + inorganic fertilizer treatment.

The interaction effect of mulching and different fertilizer management practices was found statistically significant both by number and by weight. The percentage of medium tubers ranged 17.99% to 28.97% by number and 14.94 % to 24.00% by weight (Table 5).

4.13.4 Grade size <28 mm in diameter

Different mulch showed significant difference in the percentage of small tubers either by number or by weight. No mulch produced the highest percentage (22.80%) of small tubers by number and the lowest percentage (17.07%) was produced by black polythene mulch. No mulch produced the highest percentage (31.40%) of small tubers by weight and the lowest percentage (23.76%) was produced by water hyacinth (Table 4).

Fertilizer management practices were significantly affected small tubers production either by number or by weight. The percentage of

Table 4. Main effect of different mulches and fertilizer management practices on the tuber size grading by diameter of potato cv.'Diamant'.

Treatments	Tuber size grading by diameter							
	Number of tuber (%)				Weight of tuber (%)			
	>55mm	40-55mm	28-40mm	<28mm	>55mm	40-55mm	28-40mm	<28mm
M_0	21.77	29.62	25.95	22.80	23.63	23.41	21.08	31.40
M_1	32.91	29.77	19.73	17.07	34.28	22.47	18.76	24.45
M_2	27.33	27.84	21.57	22.14	29.33	27.38	19.61	23.76
F_1	28.54	32.13	19.02	22.80	28.95	22.25	18.70	29.27
F_2	27.62	29.08	22.90	17.07	29.02	27.24	20.25	23.46
F_3	25.85	26.02	25.32	22.13	29.17	23.78	20.49	26.89
LSD (0.05)	1.501	3.442	2.506	2.356	1.499	2.503	2.750	1.499
(0.01)	2.069	2.498	3.453	3.246	2.065	3.448	3.788	2.065
CV (%)	5.49	8.60	11.19	11.38	5.16	10.25	7.57	5.65

Mulches
M_0=No mulch
M_1= Black polythene mulch
M_2= Water hyacinth

Fertilizers
F_1=Organic (cowdung)
F_2= Inorganic
F_3= Organic (cowdung) +Inorganic

Table 5. Combined effect of different mulches and different fertilizer management practices on the tuber size grading by diameter of potato cv.'Diamant'.

Treatments	Tuber size grading by diameter							
	Number of tuber (%)				Weight of tuber (%)			
	>55mm	40-55mm	28-40mm	<28mm	>55mm	40-55mm	28-40mm	<28mm
M_0F_1	21.66	33.30	20.02	25.08	24.61	21.75	19.86	31.36
M_0F_2	23.88	28.04	28.97	19.52	24.07	28.07	19.39	28.43
M_0F_3	19.76	27.53	28.88	23.81	22.22	20.42	24.00	34.41
M_1F_1	30.78	32.10	19.06	18.04	37.37	18.28	14.94	29.38
M_1F_2	32.13	32.49	18.47	15.41	27.70	25.95	23.83	22.47
M_1F_3	35.82	24.73	21.66	17.77	37.76	23.19	17.50	21.51
M_2F_1	33.17	31.00	17.99	17.83	24.88	26.71	21.32	27.06
M_2F_2	26.84	26.70	21.29	25.14	35.29	27.68	17.52	19.48
M_2F_3	21.97	25.81	25.44	26.77	27.53	27.72	19.98	24.74
LSD(0.05)	2.600	4.327	4.340	4.080	2.596	4.335	4.762	2.596
(0.01)	3.583	5.962	5.980	5.622	3.577	5.972	6.561	3.577
CV (%)	5.49	8.60	11.19	11.38	5.16	10.25	7.57	5.65

Mulches
M_0=No mulch
M_1=Black polythene mulch
M_2=Water hyacinth

Fertilizers
F_1= Organic (cowdung)
F_2=Inorganic
F_3= Organic (cowdung) +Inorganic

small tubers as influenced by different fertilizer management practices 17.07% to 22.80% by number and 23.46% to 29.27% by weight (Table 4). The highest percentage of small tubers by number and by weight was found in organic (cowdung) fertilizer treatment.

The interaction effect of mulching and fertilizer management practices on small tuber was not significant by number but significant by weight. The percentage of small tubers ranged 15.44% to 26.77% by number and 19.48% to 34.41% by weight (Table 5).

4.14 Cost Benefit analysis

Cost benefit analysis was done with a view to observing the comparative cost and benefit trend of potato cultivation as influenced by mulching and fertilizer management practices. The details of economic analysis have been presented in Appendix IV. The total cost of production ranged between Tk.85,389/ha to Tk.114,190/ha.Among the treatment combinations, the variation occurred due to the cost of seed tuber, different mulching and fertilizer management practices. The highest cost of production Tk 114,190/ha was involved when black polythene mulch and organic (cow dung) +inorganic fertilizer were used. The highest gross return Tk.568,395/ha was found from black polythene combination with organic (cowdung) + inorganic fertilizers and the lowest gross return Tk.302,685/ha was obtained from the treatment combination of no mulch and inorganic fertilizer.

Black polythene mulch and organic (cowdung) +inorganic fertilizer gave the highest net return Tk. 456,446, followed by Tk. 413,614 and Tk. 382,068 from the treatment combination of water hyacinth and organic (cowdung) + inorganic fertilizer, and black polythene and organic (cowdung) fertilizer respectively.

Table 6. Cost and return of potato production as influenced by mulching and fertilizer management practices.

Treatment combination	Yield (t/ha)	Gross return (Tk/ha)	Total cost of production (Tk/ha)	Net return (Tk/ha)	Benefit cost ratio (Gross return÷total cost)
M_0F_1	12.83	327165	85389	241776	3.83
M_0F_2	11.87	302685	90262	212423	3.35
M_0F_3	15.62	398310	88021	310289	4.52
M_1F_1	19.27	491385	109317	382068	4.49
M_1F_2	16.25	414375	114190	300185	3.62
M_1F_3	22.29	568395	111949	456446	5.07
M_2F_1	15.93	406215	88400	317815	4.59
M_2F_2	12.50	318750	90844	227906	3.50
M_2F_3	19.79	504645	91031	413614	5.54

Price of potato Tk 25,500 /ton

Mulches
M_0=No mulch
M_1= Black polythene
M_2= Water hyacinth

Fertilizers
F_1= Organic (cowdung)
F_2=Inorganic
F_3= Organic (cowdung) +Inorganic

The benefit cost ratio was found to be the highest (5.54) in the treatment combination of water hyacinth and organic (cowdung) + inorganic fertilizer. On the other hand, the lowest benefit cost ratio (3.35) was obtained from the treatment combination no mulch and inorganic fertilizer.

CHAPTER 5
SUMMARY AND CONCLUSION

An experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2006 to February 2007 to study the effect of mulching and fertilizer management practices on the growth and yield of potato (cv. 'Diamant'). The experiment comprised two factors namely 1) three different mulching (no mulch, black polythene mulch and mulch with water hyacinth) 2) three fertilizer management practices (organic, inorganic and organic + inorganic). The experiment consisting of 9 treatment combinations was laid out in the Randomized Complete Block Design (RCBD) with three replications. The size of each unit plot was 2.4 m × 2 m. and forty plants were accommodated in each plot following a spacing of 60cm×20cm. Sprouted seed tubers were planted in the field on 19th November 2006. Ten plants were randomly selected in each plot to record data on yield contributing characters, tuber yield and tuber grading. Observations were made on % emergence, plant height, foliage coverage (%), number of main stem per hill, fresh weight of haulm per hill, dry weight of haulm per hill, weight of tubers per hill, number of tubers per hill, mean tuber weight, dry weight of tuber, grading of tubers, yield of tubers per plot as well as per hectare. The collected data were analyzed and the differences between means were evaluated by LSD test. The cost and economic returns as influenced by different treatments were also analyzed. The results of the experiment have been summarized below.

Different mulching treatments played important role on the growth and yield of potato. Results of the experiment showed that all the character studied was significantly influenced by the treatments except dry weight of tubers. Black polythene mulch took shortest time to

100%emergence. This mulching treatment gave maximum plant height, foliage coverage (%), number of main stems per hill, fresh weight of haulm per hill, dry weight of haulm, weight of tubers per hill, mean tuber weight, size grade of tubers, yield of tubers per hill, mean tuber weight, size grade of tubers, yield of tubers per plot as well as per hectare (19.3t/ha) whereas maximum numbers per hill was obtained from no mulch treatment.

Different fertilizer management practices showed significant effect on most of the characters. Plants grown from organic (cowdung)+inorganic fertilizer showed maximum plant height, foliage coverage (%), fresh weight of haulm per hill, dry weight of haulm, weight of tuber per hill, mean tuber weight, yield of tubers per plot as well as per hectare (19.2t/ha). The highest number of main stems per hill and the highest number of tubers per hill were obtained from the application of organic (cowdung) +inorganic fertilizer.

Interaction effect of different mulching and fertilizer management practices were significant on most of the yield and yield contributing characters but it was found not significant on days required for 100% emergence, plant height at 30, 45, 75 and 90 DAP, foliage coverage at 30, and 60 DAP, dry weight of tubers and 40-55mm tuber number.

Economic analysis showed that black polythene mulch and organic (cowdung) +inorganic fertilizer treatment combination was economically profitable over all other treatment combinations of the experiment and the highest benefit cost ratio was obtained from water hyacinth and organic (cowdung) + inorganic fertilizer treatment.

The following conclusions could be drawn from the results of the present experiment.

1. The yield components and yield of potato were positively influenced by the use of black polythene and water hyacinth mulch. The highest yield was produced from black polythene mulch.
2. For maximizing the yield, both the organic (cowdung) +inorganic fertilizer needs to be used.

Low cost material for mulching and manipulating the doses of manures and fertilizers may be investigated further for successful production of potato.

CHAPTER 6

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CHAPTER 7

APPENDICES

Appendix I. Monthly record of air temperature, rainfall, relative humidity and Sunshine of the experimental site during the period fromOctober 2006 to February 2007.

Year	Month	Air temperature (°c)			Relative humidity (%)	Rainfall (mm)
		Maximum	Minimum	Mean		
2006	October	30.97	23.31	27.14	75.25	208
	November	29.45	18.63	24.04	69.52	00
	December	26.85	16.23	21.54	70.61	00
2007	January	24.52	13.86	19.19	68.46	04
	February	28.88	17.98	23.43	61.04	03

Source: Bangladesh Meteorological Department (climate division) Agargoan, Dhaka-1212

Appendix II. Characteristics of Horticulture Farm soil is analyzed by Soil Resources Development Institute (SRDI), Khamar Bari, Farmgate, Dhaka.

A. morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Horticulture Garden ,SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

Appendix II (contd.)

B. Physical and chemical properties of the initial soil

Characteristics	Value
Partical size analysis	
% Sand	27
% Silt	43
% clay	30
Textural class	silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: SRDI

Appendix III. Analysis of variance of the data on the growth and yield of potato as influenced by mulching and fertilizer management practices

Sources of variation	Degrees of freedom	Mean sum of square									
		Days requirement For100% emergence	Plant height (cm) at					Foliage coverage(%)at			
			30DAP	45DAP	60DAP	75DAP	90DAP	30DAP	40DAP	50DAP	60DAP	70DAP
Replication	2	4.16	9.00	36.00	100.50	105.00	100.00	24.97	49.00	36.00	100.00	47.77
Mulching (M)	2	4.44*	53.58**	118.09**	338.04**	118.62**	108.06**	105.99**	238.12**	196.65**	152.79**	530.48**
Fertilizer (F)	2	1.41	7.29*	7.56	227.50**	119.61**	186.95**	32.00**	66.312**	30.20*	97.52**	72.35**
Interaction (M×F)	4	1.53	4.57	11.12	250.36**	31.08	21.77	12.91	48.75**	40.86**	71.18	362.48**
Error	16	1.01	2.05	9.00	25.06	25.75	25.00	6.25	12.25	8.49	25.00	12.41

**=Significant at 1% level
*=Significant at 5% level

Appendix III (cont'd).

Sources of variation	Degrees of freedom	Mean sum of square								
		Number of main stem per hill	Fresh weight of haulm per hill	Dry weight of haulm per hill	Number of tuber per hill	Weight of tuber per hill	Mean tuber weight	% dry weight of tuber	Yield of tuber per plot (kg)	Yield of tuber (t/ha)
Replication	2	0.124	225.00	1.00	0.25	1586.70	100.00	4.00	0.47	4.00
Mulching (M)	2	0.62**	3228.80**	8.74**	6.55**	30745.85**	229.58**	1.78	8.22**	50.87**
Fertilizer (F)	2	0.14**	556.54**	1.53**	0.36**	7933.84**	114.79**	0.21	0.42**	4.70**
Interaction (M×F)	4	0.92**	312.37**	3.79**	1.62**	9440.14**	350.24**	0.62	0.63**	4.46**
Error	16	0.02	56.25	0.25	0.06	401.70	25.00	1.00	0.12	1.00

**=Significant at 1% level
* =Significant at 5% level

Appendix III (cont'd).

Sources of variation	Degrees of freedom	Mean sum of square							
		Number of tuber (%)				Weight of tuber (%)			
		>55mm	40-55mm	28-40mm	<28mm	>55mm	40-55mm	28-40mm	<28mm
Replication	2	8.99	25.00	25.15	1.03	9.00	24.83	9.00	9.00
Mulching (M)	2	279.39**	10.45	91.75**	88.35**	255.11**	61.07**	12.47**	160.66**
Fertilizer (F)	2	16.76**	83.99**	90.97**	34.56**	0.11	59.01**	8.44*	76.88**
Interaction (M×F)	4	55.49**	13.53	19.25**	28.68**	94.91**	18.69*	42.42**	25.35**
Error	16	2.25	6.25	6.28	5.53	2.25	6.27	2.25	2.25

**=Significant at 1% level
*=Significant at 5% level

Appendix IV. Production cost of potato per hectare

A. Material Cost (Tk/ha)

Treatment combination	Seed (tuber) 1.5t/ha	Manure and fertilizer				Pesticide and fungicide	Mulching materials	Sub total (A)
		Cowdung	Urea	TSP	MP			
		10t/ha	326Kg/ha	232Kg/ha	275Kg/ha			
M_0F_1	37500	6000	-	-	-	2200	-	45700
M_0F_2	37500	-	2608	3712	4400	2200	-	50420
M_0F_3	37500	3000	1304	1856	2200	2200	-	48060
M_1F_1	37500	6000	-	-	-	2200	24000	69700
M_1F_2	37500	-	2608	3712	4400	2200	24000	74420
M_1F_3	37500	3000	1304	1856	2200	2200	24000	72060
M_2F_1	37500	6000	-	-	-	2200	2200	47900
M_2F_2	37500	-	2608	3712	4400	2200	2200	50442
M_2F_3	37500	3000	1304	1856	2200	2200	2200	50260

Cowdung @ 600tk/ton
Urea @ 8tk/Kg
TSP @ 16tk/Kg
MP @16tk/Kg

Seed 25 Tk/Kg
Black polythene 1200 m/ha, 18Tk/m
Water hyacinth 2200 Tk/ha

Appendix IV. (Cont'd).

B. Non material input cost:

Treatment combination	Land preparation and removal of weed	Manure and fertilizer spreading	Insecticide and fungicide application	Mulching practices	Tuber planting	Intercultural operation	Harvesting	Sub total cost (B)	Total Cost (A+B)
M_0F_1	2450	1470	560	-	3500	3850	5600	17430	63130
M_0F_2	2450	1120	560	-	3500	3850	5600	17080	67500
M_0F_3	2450	1470	560	-	3500	3850	5600	17430	65490
M_1F_1	2450	1470	560	560	3500	3150	5600	17290	86990
M_1F_2	2450	1120	560	560	3500	3150	5600	16940	91360
M_1F_3	2450	1470	560	560	3500	3150	5600	17290	89350
M_2F_1	2450	1470	560	700	3500	3850	5600	18130	66030
M_2F_2	2450	1120	560	700	3500	3850	5600	17780	68222
M_2F_3	2450	1470	560	700	3500	3850	5600	18130	68390

Labour cost 70 Tk/day

M_0: No mulch
M_1: Black polythene
M_2: Water hyacinth

F_1: Organic (cow dung)
F_2: Inorganic
F_3: Organic (cow dung) + Inorganic

Appendix IV. (Cont'd).

C. Overhead cost and total cost of production

Treatments Combination	Overhead cost			Sub total (Overhead cost)	Total cost of production (input cost + overhead cost)
	Land lease cost for 6 months	Interest on running capital for 6 months @ 13% of total input cost	Miscellaneous cost @ 5% of input cost		
M_0F_1	15000	4103.45	3156.5	22259.95	85389.95
M_0F_2	15000	4387.5	3375	22762.5	90262.5
M_0F_3	15000	4256.85	3274.5	22531.35	88021.35
M_1F_1	15000	5498.35	4229.5	24727.85	109317.85
M_1F_2	15000	5782.4	4448	25230.4	114190.4
M_1F_3	15000	5651.75	4347.5	24999.25	111949.25
M_2F_1	15000	4278.95	3291.5	22570.45	88400.45
M_2F_2	15000	4421.43	3401.1	22822.53	90844.53
M_2F_3	15000	4432.35	3409.5	22841.85	91031.85

Land lease value Tk. 30000/ha/year

M_0: No mulch
M_1: Black polythene
M_2: Water hyacinth

F_1: Organic (cow dung)
F_2: Inorganic
F_3: Organic (cow dung) + Inorganic