EFFECT OF DIFFERENT SEED TUBERS AND MULCH PRACTICES ON GROWTH AND YIELD OF POTATO

BY

FARHANA TABASSUM

Reg. No. 03-01172

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APPROVED BY:

Prof. M. A. Mannan Miah
Dept. of Horticulture and Postharvest Technology
Sher-e- Bangla Agricultural University , Dhaka.
Supervisor

Md. Hasznuzzaman Akand
Associate Professor
Dept. of Horticulture and Postharvest Technology
Sher-e- Bangla Agricultural University , Dhaka.
Co-Supervisor

Prof. A. K.M Mahtab Uddin
Chairman
Examination Committee

Sher-e-Bangla Agricultural University
Department of Horiculture and Postharvest Technology
Sher-e-Bangla Nagar Dhaka-1207

Ref: *Date:*

CERTIFICATE

This is to certify that thesis entitled, **" EFFECT OF DIFFERENT SEED TUBERS AND MULCH PRACTICES ON 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 *bona fide* research work carried out by **FARHANA TABASSUM**, **Registration No. 03-01172** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated : December, 2008
Dhaka, Bangladesh

Prof. M.A. Mannan Miah
Dept. of Horticulture and Postharvest Technology
Sher-e-Bangla Agricultural University
Supervisor

Dedicated to

My

Beloved Parents

ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro- Ecological Zone
And others	=	*et al.*
BADC	=	Bangladesh Agricultural Development Corporation
BARC	=	Bangladesh Agricultural Research Council
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
B B S	=	Bangladesh Bureau of Statistics
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
TPS	=	True Potato Seed
TSP	=	Triple Super Phosphate
OM	=	Organic matter

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SAU, Dhaka

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FARHANA TABASSUM

ABSTRACT

A field experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2007 to February 2008 to investigate the effect of different seed tuber and mulch practices on growth and yield of potato. The experiment was conducted with three types of seed tuber; seedling tuber from TPS (T_1), microtuber from tissue culture (T_2) and traditional tuber (T_3) and four mulching treatments; no mulch (M_0), straw (M_1), water hyacinth (M_2) and black polythene mulch (M_3) .The experiment was laid out in Randomized Complete Block Design (RCBD) with 12 treatments combinations and three replications. The highest yield of tuber (25.71 t/ha) was obtained from T_1 and T_3 gave lowest (21.46 t/ha).On the other hand M_3 gave maximum yield of tuber (27.92 ton/ha) and M_0 gave minimum (19.56 t/ha).For combined effect T_1M_3 gave maximum yield (31.67 t/ha) and minimum (14.70 t/ha) was obtained from T_2M_0. The highest benefit cost ratio (3.9) was obtained from T_1M_3 and the lowest (1.6) was obtained from T_2M_0 .So seedling tuber with black polythene was best for growth and yield of potato.

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Introduction

CHAPTER I
INTRODUCTION

Potato (*Solanum tuberosum* L.) belonging to the family Solanaceae is the 4th important food crop of the world. It contributes not only energy but also substantial amount of high quality protein and essential vitamins, minerals and trace elements to the human diet (Horton, 1987).

It was originated in the central Andean area of South America (Keeps, 1979). Recent reports indicate that 4.161 million tons of potato was produced in Bangladesh from 302 thousand ha of land in 2007-2008(BBS, 2008). The average yield of potato was 14.89 t/ha in Bangladesh(FAO,2008),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, 2008).

Potato is the third most important crop of Bangladesh followed by rice and wheat (Illias, 1998) and it grows almost in all districts of the country. The crop is grown during the winter season. 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. In Bangladesh potato is mainly used as vegetable and is available in the market throughout the year with responsible price as compared to other vegetables. According to Kadly (1972), among crops, the potato ranks first in protein production per gram per day. Biological value, which is an index of the protein of absorbed nitrogen retained in body for growth or maintenance or both, is 73 for potato compared to 54 for maize and 53 for wheat flour. Potato contributes appreciable quantity of energy as well as substantial amount high quality protein and essential vitamins, minerals and trace elements to the human diet (Horton,1987).

In our country farmers used seed tubers are not high quality and they get poor yield. Potato production can be increased by the use of proper seed tubers. About 94.6% is covered by the farmers themselves either by using the table potatoes as seed or by using the so called farmers' seed which are very poor in quality and give low yield (Siddique and Rabbani, 1998). For this reason 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. However, Bangladesh Agricultural Development Corporation (BADC) imports huge amount of potato seeds every year for distribution among farmers. In order to make the potato cultivation attractive to the farmers and to make the crop available to the consumers at a cheap price it is essential to increase supply and use of proper seed tubers (seedling tuber from TPS, microtuber from tissue culture etc.) which increase the yield per unit area and reduce the cost of production of potato.

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).

The reasons for low yield of potato in Bangladesh are climatic limitation, poor yielding seed tubers and unscientific production practices such as lack of quality seed and soil moisture regulation.

It is evident that uses of seed tuber and mulching are the two very important variables in potato production. Depending on the above discussion, the present investigation was undertaken to find out the effect of seed tuber and different mulch practices on the growth and yield of potato with the following objectives:

1. to determine the suitable seed tuber for better growth and yield of potato
2. to determine a suitable mulch for maximizing the production of potato
3. to evaluate the suitable combination of seed tubers and mulch material for ensuring the growth and higher yield of potato

Chapter II

Review of literature

CHAPTER II
REVIEW OF LITERATURE

Potato is one of the food crops of the world but in Bangladesh is mainly used as a vegetable. The average yield of potato in Bangladesh is very low compared to many potato growing countries of the world. The main limiting factor for potato production and its low yield in Bangladesh is the non availability of good quality seed. True potato seed can be used successfully for raising seed potato in order to mitigate the acute seed problem in Bangladesh. Seedling tubers derived from TPS offer a promise of getting healthy seed tuber at low cost which can maintain better yield potential for at least 2-3 successive clonal generations with higher or equivalent yield with that of standard potato varieties.

Good quality seed tuber and Mulch practices both are important factor influencing the growth and yield of potato. A good number of experiments have been conducted around the world in order to improve the production technology of TPS seedling tubers with mulches. The average yield of potato in Bangladesh is much lower than that of the other countries of the world. Sporadic research for the improvement of production practices of TPS seedling tubers and mulches have also been conducted in Bangladesh. But systematic studies in this context under Bangladesh condition are inadequate and inconclusive. However, the research findings and information related to the present study, so far collected from different relevant publications and sources have been reviewed below:

2.1 Influence of seed tuber on the growth and yield of potato

Hann (1953) reported that in Europe, during the year 1845 when the late blight epidemics wiped out most of the potato crops in the Netherlands, the country imported TPS from abroad.

Taleb *et al.* (1973) reported the results of an experiment with potato cv. Eigenheimer using large (42-57 g), medium (28-35 g), or small (14-21g) seed tubers. The use of large seed tubers gave the highest yield of 32.6 t/ha. Kushwah and Grewal (1990) stated that when the size of whole or cut seed was increased from 0.1 to 1.5 inches, the plants emerged earlier, were more vigorous and produced more stem and tubers per hill and give higher yield.

The International Potato Center (CIP) has initiated research work on TPS in 1977 and since then most potato producing countries are experimenting with TPS technology (Accatino,1979; Malagamba,1988). In Bangladesh, research on TPS technology did initiate in 1980-81 at the Bangladesh Agricultural Research Institute (BARI) in collaboration with CIP.

True Potato Seed or TPS is a unique propagule for raising the potato crop, as it is free of all diseases and pests known to affect yield (Upadhya,1979). International Potato Centre (CIP) has incorporated TPS into its mandate since the early 1970s, focusing on TPS technology development and the transfer of its components to developing countries as an alternative method for potato production. The three main components of TPS technology are breeding and selection of parental lines, production of hybrid TPS, and utilization of hybrid TPS for potato production. Research conducted on these three components has proven that TPS is a viable and successful propagule for potato production. However, surveys measuring on-farm profitability have borne out two major constraints to improving the adoption rate of the current technology: yield potential and tuber size distribution. To be appealing to farmers, TPS technology must (i) increase yield potential (particularly of TPS transplants) to exceed clonally propagated tuber seeds by more than 20%, and (ii) improve the size distribution in the produce of both seedling transplants and seedling tubers. Present and future research efforts at CIP are designed to overcome these two constraints and develop other desirable attributes to improve the adoption rate of TPS as a viable alternative for growing potatoes. Future mid-term research efforts being considered include: (a) the use of biotechnology to incorporate genes associated with diverse sources of resistance to pests and important diseases such as late blight (caused by Phytophthora infestans), and (b) exploitation of apomixis for TPS production without losing the homogeneity of the crop.

Karim and Hossain (1980) reported that the performance of imported seed was better than homegrown seed. Wang and Hu (1982) conducted an experiment on in vitro mass tuberization and virus free seed potato production in Taiwan. An estimated 36,000 dormant miniature tubers were harvested by them from the aseptic containers, incubated of a 10 m2 bench area in a four month period. After three successive planting in soil, 1800 kg of virus free potatoes were obtained from 36,000 micro tubers.

Karim and Hossain (1980) stated that larger seed had yield advantages over the smaller ones. Beukema and Vander Gaag (1979) observed that the size of seed tubers influenced the number of sprouts. Larger tubers produced more sprouts than the smaller ones. Kumar and Baijal (1979) observed that the larger tubers were superior to smaller ones in producing better plant growth development and higher yield. Kirienko (1977) found that planting of cut tubers decreased yield by 18%, and planting of medium of small tubers gave the highest net yield.

In China, potato production using TPS has been practiced successfully since 1967 in many communes and state farms in Inner Mongolia, Yunnan , Sichuan, Heilongjiang and Anhwei provinces (Li ,1983). In 1979, seedling tuber derived from TPS were planted on 21660 hectares of land in China with an average yield of 29-155 % more than standard cultivars (Li and Shen ,1979).In India, studies with TPS were carried out as early as the late forties (Upadhya,1979) while in the United Kingdom, potatoes were produced from directly sown TPS in the nineteen-sixties (Gray ,1979).

Tabibullah *et al.* (1982) reported that the period of germination was shorter in whole seed than those of cut halves. Kusumo (1980) reported that large seed tubers produced more main stems and small tubers than small seed tubers and the cut seed tubers of the same weight of whole tubers produced the same number of main stem. According to him total yield was not affected by seed tuber size. Iritani *et al.* (1972) reported that larger seed tubers provided a large number of eyes and produced more stems. The greater number of stems resulted in a larger foliage assimilation area which in term, resulted in higher yield.

Commercial potato production traditionally has been based on using tubers for propagation. This method, especially in developing countries, is a major limiting factor in potato production because of high cost and unavailability of good quality seed tuber for planting and rapid degeneration of seed tuber stocks due to pathological and physiological reasons (Accatino and Malagamba ,1983; Wiersema,1984). Among the various means of reducing the cost of production of potato and way of getting good quality seed, the use of seedling tuber from TPS has recently been emerged as a new technology (Accatino and Malagamba,1982; CIP, 1989,1992; Rashid *et al.*,1993; Singh, 1999).

Wattimena *et al.* (1983) conducted an experiment to compare the performances of conventional seed tubers and microtubers of cv. Red Pontiac. The plants from microtubers had a single main stem initially but eventually ground cover was equal to that of conventional tubers. They obtained 26.4 and 14.0 tubers per plant (cv.Red Pontiac) from microtubers and conventional tubers, respectively.

Potato has been propagated traditionally from tubers and rarely from true seeds. The history of TPS use in potato production system is very old. In the center of origin of potato, South American Indians used TPS to rejuvenate their potato stocks from time to time (Salaman,1949). A good number of Andean cultivers, presently being maintained at the CIP (CIP, 1981 & 1982), may also have resulted from selection of plants from TPS by ancient farmers (Wiersema , 1984).

Ahmed *et al.*(1986) An experiment was conducted an experiment in Pakistan to evaluate the performance of seedling tubers of potato cultivars TPS-9601, TPS-9602, TPS-9603, TPS-9604, TPS-9605, TPS-9606, TPS-9607, TPS-9608 and TPS-9609 raised from true seed in second generation compared with the tubers of local cultivars Diamant and Desiree. TPS progenies performed significantly better than the control for all the growth i.e plant height, number of stem/hill, fresh weight of haulm, number of tuber and yield parameters i.e. number and weight of large, medium and small tubers. TPS-9606 remained highest for the number and weight of large tubers/plant. The number and weight of medium tubers and number of small tubers were highest in TPS-9605. Desiree (control) gave the minimum number of large and medium tubers, and the lowest weight of medium tubers.

Siddique *et al.*(1987) observed in a study with cut seed pieces of potato cv. Ukama and Cardial that increasing seed piece weight increased tuber yield in both cultivars. Rashid (1993) stated that increase in plant emergence is associated with tuber size and generally it increases large seed tuber when are used as seed. But the effect was not significant. Khurana and Pandita (1985) reported that the number and tuber weight increased with the increase in seed tuber size, and it was primarily due to high food reserve in large seeds. Verma and Grewal (1983) reported that large tubers emerged faster and produced higher numbwrs of main stems and tubers/plant than small tubers.

Area and production cost of seedling tubers from true potato seed may be reduced significantly by raising two successive crops of seedling tubers in the autumn and spring seasons. In trials at Modipuram, Uttar Pradesh, true potato seed was sown in a 10 x 10 cm spacing in autumn and spring for seed tuber production (Kadian, 1987). After 10 days the seedlings were thinned to100 plants/msuperscript 2. Performance of seedlings was better in autumn than in spring with average yields of 4.74-5.89 and

2.34-2.61 kg/msuperscript 2, respectively. Numbers of seed tubers produced followed the same trend. In spring, a higher proportion of stolons were converted into aerial stems, reducing yields. Production of seed tubers in both spring and autumn reduced the area required to produce seed tubers for 1 ha from 178-264 msuperscript 2 to 121-161 msuperscript 2. Total and marketable yield (>35 mm size) of all families except cv. HPS-II/13 from seedling tubers produced in the autumn and spring seasons were equivalent.

Seedling tubers derived from TPS offer a promise of getting healthy planting material at low cost for the resource poor farmers in their own environment (Brown,1987).Again Pande *et al*.,1990; Hussain *et al* .,1992; Hussain *et al* .,1994; Anonymous,2001 conducted an experiment and found that TPS seedling tubers produced higher or equivalent yield with that of standard potato varieties and can maintain better yield potential for at least 2-3 successive clonal generations of tuber production without much reduction in yield.

Lommen *et al*. (1990) carried out an experiment on production of potato minitubers by repeat harvesting. They found that with three harvests the largest quantity of minitubers is formed under screen of glass house condition. Hussain and Rashid (1974) observed in field trials with cv. Gloria (early), Bintje (mid-early), Desiree (mid-late) and Morene (late), crops grown from conventional 28-35 or 35-45 mm sizes and from various sources, that has been produced in vitro. Crops grown from microtubers weighing less than 0.5 g yielded much less than crops grown from conventional seed crops but their yields were increased by each treatment.

Vecchio *et al*. (1991) studied with potato cv. Desiree, Nicola, Salurna and Sieglinde were planted at 7.5,15 or 30 microtubers or 7.5 certified conventional seed tubers/m2. In a second trial, 10 cm tall Desiree and Salurna plants raised from microtubers in plots were transplanted to field plots at 13 plants per m2. Plant emergence was better from seed tuber than from microtubers from all cultivars but decreased with increasing microtubers planting density. Average tuber weight and number of tubers per stem were greater with seed tubers than with microtubers.

Data of field experiments conducted in 1991-93 in Burundi with true potato seed are presented. Berrios, 1995 found that tuber yield in 1992 from first-generation seedling tubers from 17 advanced selected progenies was in the range 34.7-91.9 t/ha and the marketable yield was in the range 60-95%. Tuber yield in 1993 from the second seedling tuber generation from 12 advanced progenies selected from the previous 17 was in the range 24.4-34.8 t.

Byszewska Wzorek *et al.*(1993) conducted field trials on light sandy clay soil at Chylice in 1988-89, potatoes cv. Lotos and Foka were grown from elite seed tubers (3-4 cm) or microtubers (1-2 cm) planted at spacings of 10 or 20 cm in rows 62.5 cm apart (80 000 or 160 000 plants/ha). After 75 d growth, the FW of plants from microtubers was 422-461 g and that of those from traditional seed tubers was 439-608 g. The number of stems/plant was 1.1-1.5 and 3.2-5.5 in the 2 groups, respectively. Total yields from microtubers ranged from 34.5 t/ha (Lotos, dry year) to 55.0 t (Foka, wet year) at 160 000 plants/ha and from 30.5 t (Lotos, dry year) to 42.5 t (Lotos, wet year) at 80 000 plants/ha. Yields from traditional seed tubers were 51.6-58.4 and 46.9-57.6 t/ha at the 2 plant densities, respectively. In the early cv. Lotos, plants from microtubers were more sensitive to unfavorable weather conditions than those from traditional seed tubers. Net tuber yields from microtubers averaged 46.8 and 38.8 t/ha at high and low plant densities, respectively, compared with 47.9 and 48.5 t from traditional seed tubers.

Podowska *et al.*(1993) conducted a field trials on light sandy clay soil at Chylice in 1988-89, potatoes cv. Lotos and Foka were grown from elite seed tubers (3-4 cm) or microtubers (1-2 cm) planted at spacings of 10 or 20 cm in rows 62.5 cm apart (80 000 or 160 000 plants/ha). Plants from microtubers were less infected with PLRV [potato leaf roll luteovirus] and PVY [potato Y potyvirus] than those from traditional seed tubers. Seed tuber yield was 19.7-27.0 t/ha from microtubers and 23.0-36.9 t from traditional seed tubers. The proportion of seed tubers in the yield was not affected by planting material or spacing but was higher in the dry year 1989 than in 1988. On a number basis, multiplication factors were 7.3 for microtubers and 8.2 for traditional seed tubers. Corresponding values on a weight basis were 116.2 and 6.4 and corresponding ratios of the area producing seed tubers to that of the commercial crop were 16.3 and 18.1.

Percentage survival and average yield of seedling tubers (F1C1) of 5 TPS (true potato seed) families were similar to the commercial cv. Kufri Chandramukhi. However, hybrid HPS7/13 gave the highest yield and produced the most seed-size tubers (below 50 g). The tubers of this hybrid family were also the most uniform in shape, size and colour (Sangar, R.B .S and M. D.Upadhya.1994).

Research on true potato seed at CIP, Lima, Peru as well as New Zealand, India, Korea, Egypt and by few seed producing companies in USA demonstrated the potentiality of using seedling tuber as planting material, especially in developing countries (Sadik,1983). The TPS technology has been well established in china and extensive adoption of this technology seemed likely in India, Bangladesh, Indonesia, Egypt, Nepal, Srilanka, Paraguay and Vietnam (CIP, 1992; Pallias,1994). In Egypt,much progress has been made on the development of tuber production based on TPS seedling tubers (El-Bedewy and Cortbaoui,1994).

Sikka *et al.*(1994) reviews the major production constraints for extension of potato production and the role of potato as an important food crop. Breeding techniques to develop tropical potato varieties with higher yield, wider adaptability, and better resistance to late blight (*Phytophthora infestans*) and bacterial wilt (*Pseudomonas solanacearum*) are discussed. Genotypes, 381381.20, 374080.5-P3, 575049-CEW 69.1 and 381379.9 were identified in different stages of assessment for high yield, disease resistance and drought tolerance. True potato seed (TPS) both as seedling tubers and transplants seems to be a promising alternative to costly tuber production. TPS progenies exhibited better resistance to both late blight and bacterial wilt than the conventional seed tubers. Viable, commercial seed schemes and appropriate low cost storage methods are discussed.

Ware potatoes were produced from true potato seed by transplanting seedlings to the field in different growing periods to evaluate environmental constraints of this production method in the Nile delta (Engels,1994). In the autumn season, with high temperatures and long-day conditions during seedling culture in the nursery and transplant establishment in the field, seedling development was fast, and transplants resumed growth within 5 d of transplanting in the field. Tuber yields ranged between 12 and 16 t ha-1. In the spring season, with low temperatures and short-day conditions during the initial growing phase, seedling development in the nursery was slow and biomass partitioning between aboveground organs and tubers shifted towards the tubers. This partitioning was further enhanced by transplanting the seedlings in the field. Seedlings recovered only slowly from transplanting or died. It is concluded that potato production via transplants is poor in the spring season when premature tuberization of seedlings in the nursery leads to slow field establishment and low tuber yield.

Potato production from true potato seed (TPS) can be carried out either by transplants or by seedling tubers. Carputo, D and L. Frusciante (1995) conducted field trials in Camigliatello Silano (southern Italy) to compare the effect of planting method on tuber yield of hybrid families from 4x x 4x and 4x x 2x crosses. Fifteen families were evaluated in 1991 and 24 families in 1992. Results obtained in both years indicated that families from seedling tubers had a significantly higher tuber yield than families from transplants; this could be the result of better early vigour of plants grown from seedling tubers. The 4x x 2x families as a group always performed better than the 4x x 4x group in terms of mean tuber yield, confirming the benefits of heterozygosity on tuber yield itself.

Rasul *et al*. 1997 conducted experiment with two true potato seed (TPS) progenies (HPS-II/67 and HPS-7/67) were evaluated using small (>5 g) seedling tubers under nine planting systems at Jessore during rabi 1994-95. HPS-II/67 showed superiority in performance to HPS-7/67 for all characters studied except stems/hill. The yield of HPS-II/67 was significantly higher (31.75 t/ha) than that of HPS-7/67. The yield under the various clump planting systems varied from 27.81 to 33.58 t/ha, which was statistically non-significant. The results indicated that small tubers (>5 g) derived from TPS are useful as seed tubers.

Subrata Maity and Upadhya (1997) founded True potato seed (TPS) families TPS-2 (OP), TPS-1/13, TPS-1/67, TPS-7/13 and TPS-7/67 were evaluated for seedling tuber production, and for ware tuber production from the seedling tubers, at 3 sites in West Bengal (Hooghly, 24 Parganas (N) and Nadia). Average seedling tuber yield was in the range 3.39-3.86 kg/msuperscript 2 with TPS-7/13 giving the highest yield of 4.98 kg/msuperscript 2 at Hooghly. The mean ware tuber yield from the seedling tubers was highest from TPS-1/13, which gave a yield of 36.7 t/ha, reaching 41.2 t/ha at Hooghly. Ware tuber yields from planting seed tuber cv. Kufri Jyoti and Kufri Badshah were lower (average yield 27.9 t/ha) with the highest yield of 30.9 t. The cost of using TPS was also found to be lower than seed tubers.

In field trials in 1986/87 and 1987/88 at sites in Uttar Pradesh, Madhya Pradesh, Gujarat and Tripura, India, seedlings and seedling tubers of 3 hybrid TPS families were compared. Except in Tripura, the overall growth, tuber yield and percentage marketable yield (tubers >20 g) were significantly higher from seedling tubers than seedlings (Patel *et al.*1998).

Potato cultivation based on true potato seed (TPS) technology was found successful in mid hill conditions of Uttar Pradesh (Khan,1998). TPS families namely HPS 1/13, HPS 7/13 and HPSI/III can be commercially cultivated in the mid hill region of Pithoragarh. The highest yield of seedling tubers was recorded in HPS 1/3 (4.25 kg/m2), followed by HPS I/III (3.970 kg/m2) and HPS 7/13 (3.650 kg/m2). Moreover, vegetative growth i.e. plant height, number of main stem/hill, fresh weight of haulm, number of tuber and yield of TPS families from seedling tubers in the first and second clonal generations was statistically superior than Kufri Jyoti. Seedling tubers can also used as seed tubers for at least two years for commercial production.

Chilver *et al.*(1999) reported that the on farm profitability of TPS related technologies was assessed in several agro ecologies in Egypt, India, Indonesia and Peru based on results on farm research conducted in the mid 1990s. TPS technology was found substantially more profitable than clonal propagation. TPS seedling tubers gave minimum time to emergence, mean tuber weight, dry tuber weight and heavy yields compared to standard cultivars. They also suggested that prospects for TPS technologies were reasonably good when the cost of planting material in the conventional system exceeds 22% of the value of production.

According to Hussain (2000), in Bangladesh major breakthrough in disease free seed potato production has taken place by the efforts of private sector companies through adopting 1) Tissue culture technique and 2) True potato seed technology .If these technologies are fully exploited , cost of seed potato will be reduced at the farmers level. Illias (1998) suggested that under Bangladesh condition only 40-45g of TPS is needed to sow 200 m of nursery bed area which will produce sufficient amount of seedling tubers necessary to plant one hectare of land in the next year to produce seed potato or ware potato.

Production of potatoes from botanical seeds or true potato seed (TPS) offers a good alternative to traditional seed tubers due to low transmission of pathogens, high multiplication rate and good tuber yield (Rashid, 2000).On-station research results since 1980s and on-farm trials of TCRC scientists since 1985 have shown that seedling tuber production system or in other words, seed tuber production in beds from TPS is very convenient for Bangladeshi farmers. As much as 1000 seedling tubers weighing only about 10 kilos can be obtained out of a m2 bed in 100 days, the average being 5-6 kilos/m2. Using these seedling tubers as seed, 25-30 tonnes of table potatoes can easily be obtained per hectare in the following season. The most limiting factor, availability of true seed, has already been solved by the researchers.

Commercial hybrid TPS has been produced under the climatic conditions of Bangladesh by applying flower inducing techniques. Some private entrepreneurs were trained who have started producing commercial hybrid TPS. Some elite farmers have also started business of seedling tubers.

Potato is an important food crop as well as a cash crop in South and West Asia with the highest annual growth rate in production over the past three decades. Potato could play an even more important role in food security in the region if yields could be improved. Yields in South and West Asia are a bit over the average of the developing countries (13 t/ha) and all except India is below the world's average (14 t/ha) (Hidalgo and Sarath-Ilangantileke,2000).At present, the low quality of seeds still utilized by farmers and disease are the major factors for the seed 'degeneration' and low yields. Significant progress has been made in the formal and traditional potato seed systems of South and West Asia. The 'modern' seed scheme (in vitro - pre-basic - field and certification) programmes of potato. The traditional system predominates in the majority of countries in South and West Asia and over 90% of the seed utilized comes from the traditional system.

A field study was conducted during kharif 1994 in Mandya, Karnataka, India, on red sandy loam soil (alfisols) to determine the effect of seedling tuber from TPS , on vegetative growth and total yield, survivability and number of marketable potato tubers raised from TPS seedling cv. HPS 1/3 (Girish *et al.*2004). Improvement in the growth parameters and tuber size with increased survivability was observed by using seedling tuber from TPS. This increased the tuber size by 31% and yield was on a par with that of Kufri Jyothi (13.5 q/ha). Hence, it can be used to increase the tuber yield, size and marketability of potatoes.

Central Potato Research Station, Sahaynagar, Patna has initiated research work on TPS in 2005 and found a total of 21 new true potato seed (TPS) populations planted as seedling including seedling tuber generation were evaluated for total and marketable tuber yield during 2001-02 and 2002-03 in Patna, Bihar, India. The best populations were CP 2262/13, CP 3360/13, CP 2378/13, CP 3276/13, CP 3382/13, CP 2291/13, CP 3356/13, CP 3379/13, CP 2386/13, CP 3156/13 and 92 PT-27 (control). CP 2263/13 gave the highest total tuber yield (149.9 q/ha) and marketable tuber yield (107.7 q/ha) while CP 3276/13 gave the highest total tuber yield (453.7 q/ha) and marketable tuber yield (404.9 q/ha) (Surya-Prakash and Shambhu-Kumar,2005).

Eight true potato seed (TPS) progenies along with controls (TPS/C-3 and 92PT-27) were evaluated at Patna, Bihar, India during 2002-05 for their yield potential as transplants and seedling tuber crops. Highest survival percentage of seedlings as well as total and marketable tuber yields were recorded in population JX-214 x TPS/D-150. This population also showed a high degree of resistance to late blight (Phytophthora infestans) and tuber uniformity comparable with the controls. Thus, JX-214 x TPS/D-150 may be suitable for commercial cultivation in Bihar plains (Kumar *et al.* 2005).

Kawakami *et al.* (2006) stated that Tuber yields of potato plants grown from microtubers in fields are more variable than yields from conventional tubers (CT). One reason could be their higher susceptibility to water stress. This study clarified the effect of soil water stress from 1 month after emergence on the growth and yield of plants grown from conventional seed tubers and microtubers in fields. Microtubers (0.5-3 g) and conventional seed tubers (50 g) were grown in Hokkaido, Japan, over three field seasons. One month after emergence, poly-shelters were placed over the plots to prevent rainfall, and either irrigated (wet plot) or non-irrigated (dry plot) treatments were formed. At mid-flowering (about 50 days after emergence) leaf area index (LAI) in microtuber plants was decreased relatively more due to soil water stress than LAI in conventional seed tuber plants. However, at maximum shoot growth (about 80 days after emergence) both microtuber and conventional seed tuber plants had a similar relative decrease in LAI due to soil water stress. At mid-flowering and maximum shoot growth microtuber and conventional seed tuber plants had reduced stomatal conductance due to soil water stress, but the reduction in stomatal conductance was greater in conventional seed tuber plants than in microtuber plants. Microtuber and conventional seed tuber plants had similar root development at maximum shoot growth. Tuber production from mid-flowering until plant maturity was similarly affected by soil water stress in microtuber and conventional seed tuber plants. At harvest, plants affected by soil water stress had about 87% of the tuber dry weight of irrigated plants. We conclude, that the greater variation on tuber yield of microtuber plants cannot be attributed to soil water stress from 1 month after emergence.

2.2 Influence of mulch on the growth and yield of potato

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 and Tong (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.

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.

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.

Ghuman *et al.* (1983) reported that straw mulch at 6 t/ha had a higher leaf water potential (LWP) than non irrigated plants of sweet potato, black plastic mulching increased sweet potato yield.

Hochmuth and Howell (1983) reported that leaf area, leaf number and shoot dry weight of sweet potato cv. Jewel were significantly higher in mulched than in unmulched plots. They also reported that the highest marketable yield (18.6 t/ha) was obtained from mulched raised beds. According to Asandhi and Suryadhi (1982) potato plant height and leaf area was markedly increased by rice straw mulching but had no effect on the number of stems/plant and dry matter production.

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 the best germination rate, growth rate and yield s in most of the varieties.

Vander *et al.* (1986) conducted 4 experiments to evaluate the effects of soil mulch on potato growth and yield. All mulch resulted in faster emergence and canopy development, earlier tuber initiation, more tuber produce and significantly higher tuber yield.

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 and Vander Zaag (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 with polythene also increased growth of leaf, number of main stem, fresh and dry weight of haulm, increase tuber size and number of tuber (kim *et al.*1988). According to Devaux and Haverkort (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.

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 growth of plants and tuber yields of 18.2 and 16.7 t/ha respectively compared with 14.3 t/ha without mulching.

Datta and Chakraborty, conducted a field experiment in 1991-93 at Sriniketan, West Bengal, potatoes cv. Kufri Jyoti were given 0, 50 or 100 kg/ha each of N, P2O5 and K2O, and mulched with 5 t L. leucocephala leaves/ha or manured with 5 t rice husk ash, 0.5 t mustard oilcake or 10 t FYM. Tuber yield was highest (21.6 and 27.6 t/ha in the 2 seasons) at the highest NPK rate. Amongst the mulches/manures, the tuber yields were in the order L. leucocephala > FYM > rice husk ash > mustard oil cake.

Paul *et al.* (1993) reported that, potato tuber yields in earthing up and mulching techniques were 7.04 and 8.09 t/ha, respectively, compared with 5.9 t/ha obtained from the control. In a field trial on potato cv. Kufrijyoti with straw mulch and no mulch, the tuber yields were 26.6 and 19 t/ha, respectively (Unial *et al.*, 1994).

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).

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 100% emergence, resulted maximum coverage of area, produce more main stem, increase fresh weight of haulm. 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).

Results of 6 field trials in 1990-96 on sandy loam in the Aadorf region using differing procedures and machines are reported (Spiess *et al.*1997). Direct and indirect mulching with Phacelia, mustard or rape were compared using different cultivation and weed control (chemical or mechanical methods). Although green manuring and mulching had environmental benefits such as reduction in nitrate leaching, soil and ridge erosion, work peaks and soil management, and yield potential was similar to traditional cultivation methods, risks were somewhat greater and weed control was particularly important. Not all standard machinery was suitable for mulching procedures and manufacturers should develop more specialized and efficient machines.

Chen-GoLing (1997) conducted field experiments in 1995-96, plastic film mulches increased plant height, leaf area index, fresh weight of haulm, dry matter accumulation and tuber yield of potatoes. The percentages of large and medium sized tubers were also increased.

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 nonsignificantly 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.

Kang-BongKyoon *et al.* (2003) conducted an experiment that Normal seed tubers and plug seedlings raised from stem cuttings and mini-tubers (10+or-3 g) were planted or transplanted on 20 August 2001 in bare soil or under transparent and black polyethylene film mulches to evaluate the effects of mulch material and seedling type on the growth and tuber yield of fall-grown potato (cv. Dejima) in Jeju, Korea Republic. The total tuber number per plant was 4.6, regardless of mulch treatment, and direct planting of seed potatoes resulted in the highest number of tubers (5.14) per plant, followed by transplanting seedlings raised from cuttings and mini-tubers (4.15 and 5.15 tubers per plant, respectively). Transparent and black polyethylene film mulches increased total tuber yield by 16 and 8%, respectively, and average tuber weight by 14 and 12%, respectively, compared with no mulch (21.16 t/ha and 72.2 g/tuber). Transplanting plug seedlings raised from cuttings had the highest tuber yield, followed by transplanting plug seedlings raised from mini-tubers, and direct planting seed potatoes.

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.

Five locally available mulch materials, i.e. wheat straw, green twigs, farmyard manure (FYM), piltu (dry leaves of Pinus roxburghii) and forest litter, were applied to potato cv. Kufri Jyoti grown under mid-hill conditions of Uttaranchal, India, during summer 1998, 1999 and 2000. The mulches had significant influence on soil moisture, soil temperature, plant height, fresh shoot weight, tuber weight, number of tubers per plant, and tuber yield. Mulching with FYM was found most efficient in increasing soil moisture, soil temperature, plant height, fresh shoot weight, tuber weight, and tuber yield, followed by forest litter (Uniyal and Mishra, 2003).Cutworm incidence in tubers was low in plots mulched with green twigs, piltu, forest litter, and wheat straw. Correlation coefficients indicated that higher tuber yield in plots mulched with FYM and forest litter was due to the ability of these mulches to conserve high soil moisture and reduce maximum soil temperature, favouring plant growth and tuber bulking, respectively.

Xu KangLe *et al.*(2004) conducted experiment to determine the effect of different plastic film mulches on the growth and yield of potato, black film, spectrum transformation film and colour combination film mulches were better than the control in reducing soil temperature. Both spectrum transformation film and colour combination film mulches gave the best germination rate, growth rate and yield of potatoes.

Rahaman *et al.*(2004) was carried out a study in Noakhali, Bangladesh, during winter 1999-2000 and 2000-01 to observe the effect of different mulches at 4.0 tonnes/ha on the production of potato (Solanum tuberosum). Treatments with different mulches (rice straw, water hyacinth [Eichhornia crassipes] and wastage of rice straw) significantly increased potato yield over the control. Salinity was higher in the treatment without mulch than under different mulch materials during the experimental period. The highest yield (23.02 tonnes ha-1) and gross margin (TK 69425) were recorded from rice straw mulch followed by water hyacinth mulch with yield of 22.23 tonnes ha-1 and gross margin of TK 66084. The benefit cost ratio was highest (2.51) in rice straw followed by water hyacinth (2.46), wastage of rice straw (2.08) and no mulch (1.69). The results indicate that potato could be cultivated in saline soil by minimizing salinity through application of mulch.

Chapter III

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

3.1 Site of the experiment

The experiment was conducted at Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during the period from November 2007 to February 2008. The experimental site was previously used as vegetable garden and recently developed for research work. The location of the site was 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 was 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 (Seedling tuber from TPS, Micro tuber from tissue culture and traditional tuber) 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 seed tubers

i. Seedling tuber from TPS (T_1)
ii. Microtuber from tissue culture (T_2)
iii. Cut pieces of traditional tuber (T_3)

Factor B: Types of mulches

i. No mulch (M_0)
ii. Straw (M_1)
iii. Water hyacinth mulch (M_2)
iv. Black polythene mulch (M_3)

3.6 Design and layout of the experiment

The two-factor experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. An area of 315 m^2 (31.5m 10m) was divided into three equal block. A block consisted of 12 unit plots, each for a combination of seed tubers and mulching. The total number of plots was 36. The treatment combinations of the experiment were assigned randomly in each block. The size of unit plot was 2.0m×2.0m. The gap between the plots was 50cm and between the blocks was 50cm.

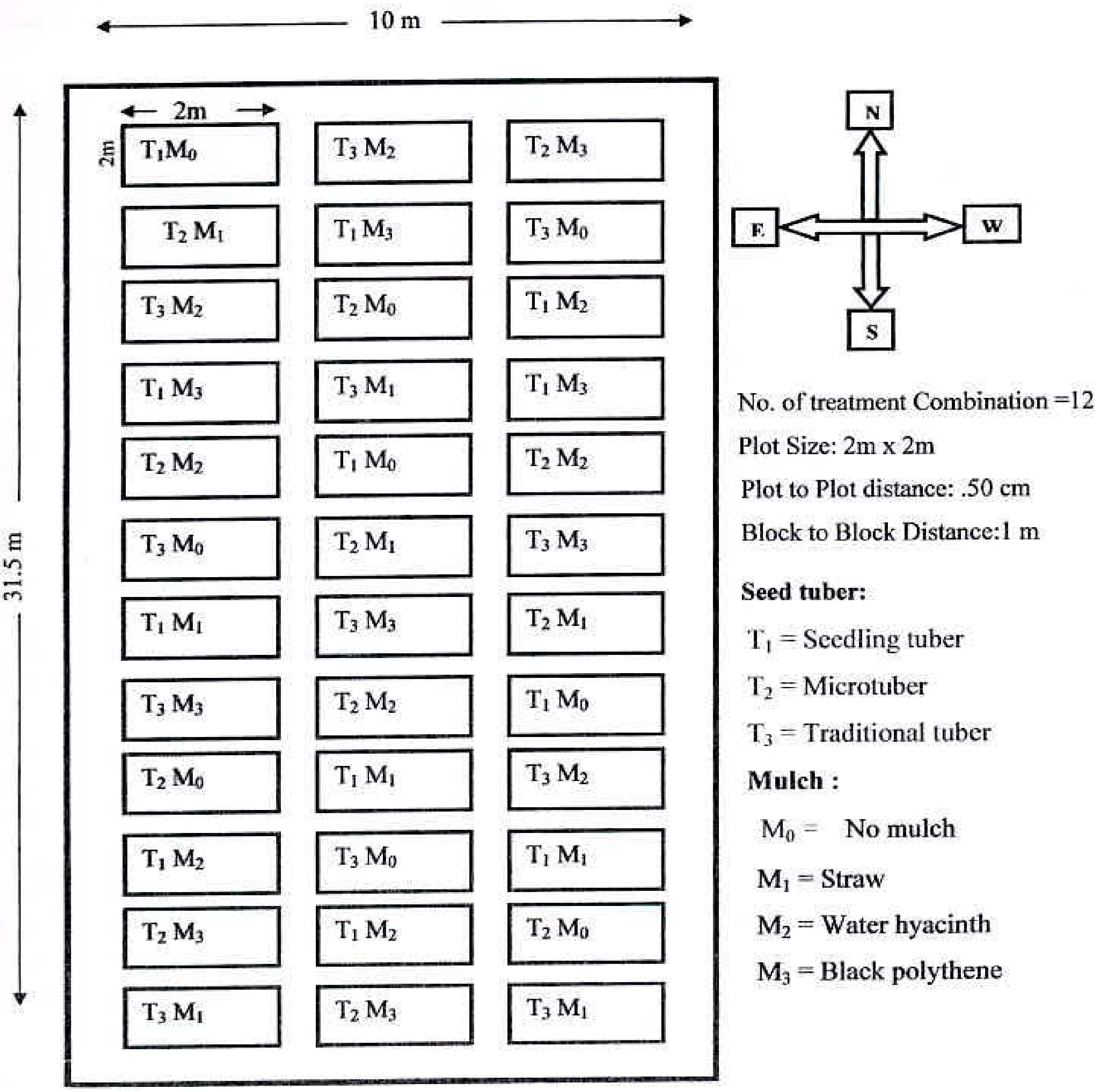

Figure 1. Field layout of the two factors experiment in the Randomized Complete Block Design (RCBD)

3.7 Preparation of the main field

The land was opened on 12th November 2007 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. According to design and layout the plots were prepared.

3.8 Application of manure and fertilizers

The following doses of manures and fertilizers were used in the experiment following the fertilizer recommendation guide (2005).

Table 1. Application rate of manure and fertilizers

Manure and fertilizer treatments	Doses /ha	Doses /plot (2m×2m)
a) Organic (cowdung)	10t	4.8kg
b) Inorganic		
Urea	326kg	160g
TSP	232kg	110g
MP	275kg	130g

Source: Fertilizer recommendation guide,2005

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 form by dissolving fertilizer into water and spray over the plots to 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 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 23 rd November 2007 at 5-7 cm depth maintaining a spacing of 50cm × 20cm. After planting, the seeds were covered with loose 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 was done in selected plots (except water hyacinth and black polythene plots) 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 and after 20 days after planting and 30 days after planting.

3.12.2 Height of plant

Plant height was measured at 30, 45, 60 and 75days after planting (DAP) with a meter scale. 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 Number of main stems per hill

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

3.12.4 Fresh weight of haulm per hill

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

3.12.5 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.

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

3.12.6 Number of tubers per hill at harvest

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

3.12.7 Weight of tubers per hill at harvest

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

3.12.8 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.

3.12.9 Dry weight of tubers (%)

One 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.

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

3.12.10 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.

3.12.11 Yield of tuber per hectare

The yield of tuber per hectare was calculated from converting the yield per plot.

3.12.12 Grade of tubers

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

3.12.13 Harvesting

The crop was harvested after 90 days on 23 rd February 2008 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.

3.13 Statistical analysis

The collected data were statistically analyzed to find out the significance of the difference among the treatments. The analysis was performed by Duncan's Multiple Range Test (DMRT) and the significance of the difference between pairs of treatment means were evaluated by the 5% levels of significance.

3.14 Economic 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 IV
Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Time required for 100%emergence of the plant

The effect of different types of seed tuber practices on the 100% emergence of potato plant the minimum time (15.83days) required was noted with T_1 (seedling tuber from TPS) treatment while the maximum time (18.67 days) was required by T_3 (traditional tuber) treatment (Table 2). Because larger seed produced more sprouts than the smaller ones. Beukema and Vander Gaag, (1979) found similar trends of results in their studies.

The time required for 100% emergence of the crop was significantly influenced by different mulch used (Appendix III). M_3 (black polythene mulch) took the shortest time (13.67 days) and M_0 (no mulch) needed maximum time (19.45days) to emerge (Table 2). 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), Manrique and Meyer (1984), Jalil (1995) and Collins (1977) found similar trends of results in their studies.

Combined effect of seed tuber and mulch practices was found to be significant (Appendix III). The minimum time (12.00 days) of 100% emergence was recorded from the treatment T_1M_3 (seedling tuber with black polythene mulch) and the maximum time (20.67 days) was noticed in T_3M_0 (traditional tuber with no mulch) treatment (Table 3).

Table 2. Effect of different seed tubers and mulch practices on days required to 100% emergence of potato

Treatments	Days required to 100 % emergence
Seed tubers	
T_1	15.83 c
T_2	17.00 b
T_3	18.67 a
LSD at 5%	0.282
Mulches	
M_0	19.45 a
M_1	18.44 b
M_2	17.45 c
M_3	13.67 d
LSD at 5%	0.326
Level of significance	**
CV(%)	1.94

In a column means having similar letter(s) are statistically similar and those dissimilar letter (s) differ significantly as per 0.05 level of probability

4.2 Plant height

Plant height was significantly influenced by different seed tuber at different days after planting (Appendix III). At 30 DAP, the highest plant height (35.12 cm) was measured in T_1 (seedling tuber) treatment while the lowest plant height (19.78 cm) was found from T_2 (microtuber) treatment (Fig. 2). At 45 DAP, the longest plant height (46.18 cm) was measured from T_1 (seedling tuber) while the shortest plant height (38.48 cm) was measured from T_2 (microtuber) treatment (Fig. 2). At 60 DAP, T_1 (seedling tuber) gave the maximum plant height (49.31 cm) and T_2 (microtuber) gave the minimum plant height (48.14 cm) (Fig. 2). At 75 DAP; it was observed that T_1 (seedling tuber) gave the longest plant height (58.53 cm) where as T_3 (traditional tuber) gave the shortest plant height (53.25 cm) (Fig. 2) It was observed that seedling tuber from TPS played a significant role in maximizing plant height. This effect was probably due to the fact that sufficient storage of plant nutrients for better vegetative growth of potato plants which ultimately increased plant height. Khan (1998), Girish *et.al* (2004), Ahmed *et. al* (1986) found similar trends of results in their studies.

Different mulches showed significant variation in plant height at different days after planting viz.30,45,60 and 75 DAP. At 30 DAP (Appendix III). The highest plant height (29.18 cm) was measured from M_3 (black polythene mulch) treatment while the lowest (25.06 cm) in M_1 (straw mulch) treatment (Fig. 3). At 45 DAP, the maximum plant height (43.76 cm) was measured from M_3 (black polythene mulch) while the minimum (42.13cm) in M_1 (straw mulch) treatment (Fig. 3). At 60 DAP, the longest plant height (51.72 cm) was measured with from M_3 (black polythene mulch) treatment while the shortest (46.80 cm) in M_0 (no mulch) treatment. (Fig.3). At 75 DAP, the longest plant height (59.53 cm) was measured with from M_3 (black polythene mulch) while the shortest (53.18 cm) in M_0 (no mulch) treatment (Fig.3). 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), Khalak and Kumarswamy (1972) and Chen Go Ling (1997) reported that, the height of mulched potato plant was taller than the control.

Combined effect of seed tubers and mulch practices was found statistically significant on plant height (Appendix III).At 30 DAP, the tallest plant (40.03 cm) was measured from T_1M_3 (seedling tuber with black polythene) whereas the shortest plant height (19.20 cm) was recorded from T_2M_0 (microtuber with no mulch) treatment which was statistically similar (19.37 cm) with T_2M_1 (microtuber with straw mulch) treatment (Table 3). At 45 DAP, the tallest plant (48.00 cm) was measured from T_1M_3 (seedling tuber with black polythene) whereas the shortest plant height (36.43 cm) was recorded from T_2M_0 (microtuber with no mulch) treatment (Table 3). At 60 DAP, the tallest plant (55.93 cm) was measured from T_1M_3 (seedling tuber with black polythene) whereas the shortest plant height (42.80 cm) was measured from T_3M_0 (traditional tuber with no mulch) treatment (Table 3). At 75 DAP, the tallest plant (61.53 cm) was measured from T_1M_3 (seedling tuber with black polythene) whereas the shortest plant height (50.00 cm) was recorded from T_2M_0 (microtuber with no mulch) treatment which was statistically similar (50.80 cm) with T_3M_0 (traditional tuber with no mulch) treatment (Table 3).

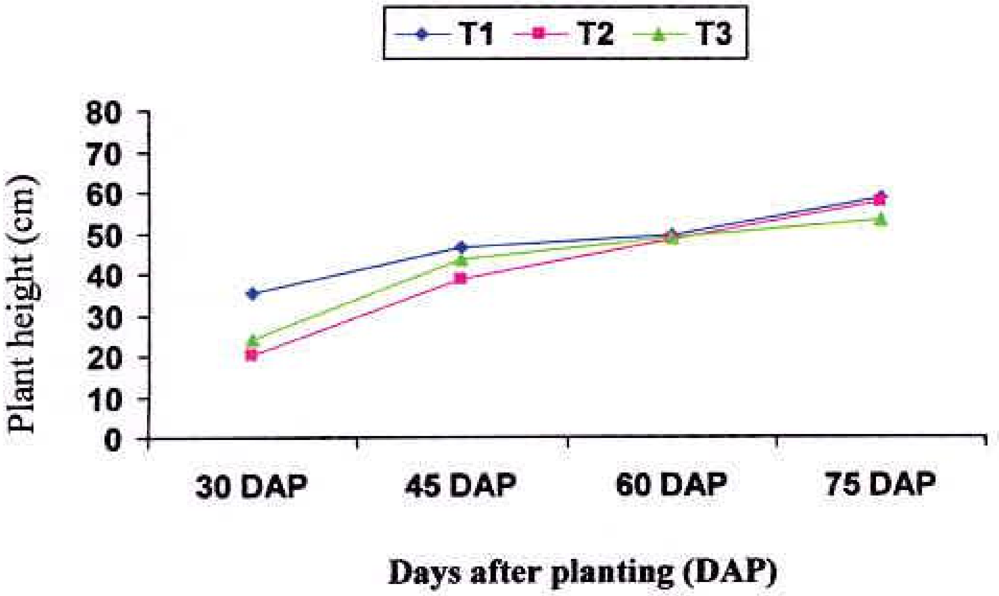

Figure 2. Effect of seed tuber on plant height of Potato

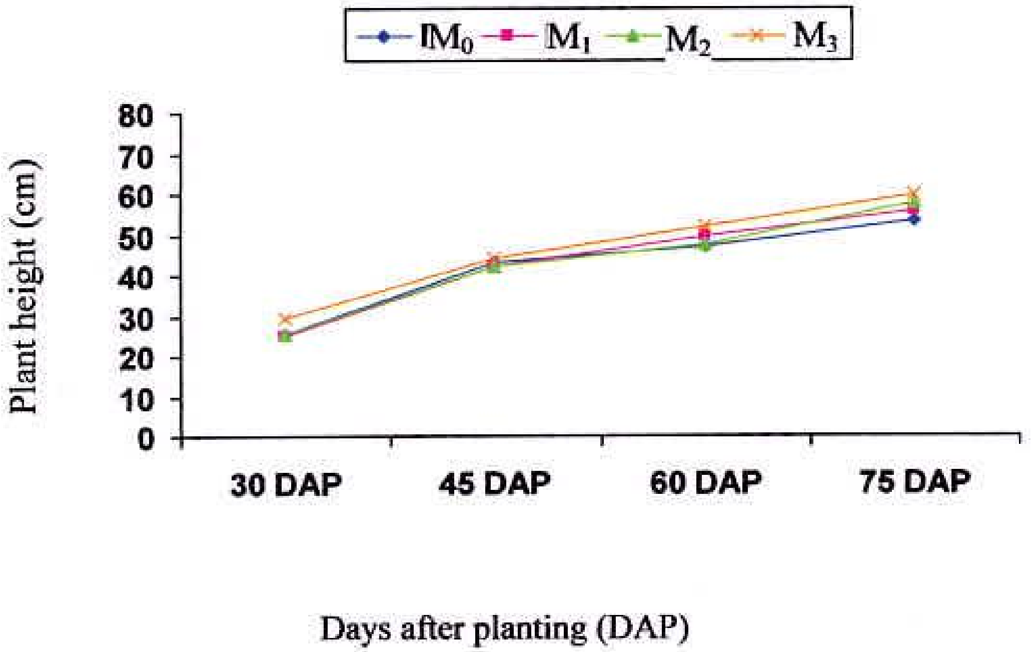

Figure 3. Effect of mulches on plant height of Potato

Table 3. Combined effect of different seed tuber and mulches on the days required for 100% emergence and plant height (cm) of potato.

Treatments	Days required for100% emergence	Plant height (cm) at			
		30 DAP	45 DAP	60 DAP	75 DAP
$T_1 M_0$	18.67 cd	24.57 e	43.59 c	46.97 f	55.13 f
$T_1 M_1$	17.00 e	20.87 g	41.50 d	49.87 c	60.47 b
$T_1 M_2$	15.67 f	22.83 f	42.43 cd	49.27 d	57.00 e
$T_1 M_3$	12.00 h	40.03 a	48.00 a	55.93 a	61.53 a
$T_2 M_0$	19.00 c	19.20 i	36.43 g	46.87 f	51.00 i
$T_2 M_1$	19.00 c	19.37 i	39.70 e	50.63 b	58.25 d
$T_2 M_2$	16.67 e	20.03 h	39.77 e	46.97 f	59.67 c
$T_2 M_3$	13.33 g	20.53 gh	38.03 f	51.13 b	58.47 d
$T_3 M_0$	20.67 a	32.67 c	45.70 b	42.80 h	50.80 i
$T_3 M_1$	18.33 d	35.10 b	46.87 ab	50.87 b	56.72 e
T_3M_2	20.00 b	32.67 c	43.17 c	46.20 g	53.40 g
T_3M_3	15.67 f	26.97 d	46.70 ab	48.10 e	52.07 h
LSD at 5%	0.5642	0.5642	1.402	0.5642	0.2833
Level of significance	**	**	**	**	**
CV(%)	1.94	2.27	3.94	2.68	3.30

In a column means having similar letter(s) are statistically similar and those dissimilar letter(s) differ significantly as per 0.05 level of probability

4.3 Number of main stem per hill

The number of main stem per hill was also significantly affected by different seed tubers (Appendix III). The number of main stems per hill was the highest (2.29 cm) in T_1 (seedling tuber from TPS) and T_3 (traditional tuber) treatment gave the lowest (1.50) number of main stem (Table 4). It was observed that seedling tuber from TPS played a significant role to increase number of main stem per hill. This effect was probably due to the fact that sufficient storage of plant nutrients for better vegetative growth of potato plants which ultimately increased main stem. Khan (1998) and Ahmed *et.al* (1986) found similar trends of results in their studies.

The number of main stem per hill varied significantly among different mulch materials (Appendix III). The maximum number of main stem per hill (2.55) was produced by M_3 (black polythene mulch) while the minimum number of main stem (1.16) was found in M_0 (no mulch) treatment (Table 4). Because polythene film mulches reduce evaporation in vegetable cultivation and polythene sheets caused a 2% increase in the moisture content of the top 30 cm of the soil. So mulching with polythene increased number of main stem. Lamont (1993),Bieoral (1970) and Kim *et.al* (1988) found the similar trends of results in their studies.

Combined effect of seed tuber and mulches showed significant variation on the number of main stems per hill (Appendix III). The maximum numbers of stems (3.33) were given by the T_1M_3 (seedling tuber from TPS with black polythene mulch) treatment and the lowest (1.00) were recorded from the T_2M_0 (microtuber with no mulch) and T_3M_0 (traditional tuber with no mulch) treatment (Table 5).

4.4 Fresh weight of haulm (g/hill)

Fresh weight of haulm per hill varied significantly due to use of different seed tuber (Appendix III). The highest fresh weight of haulm (329.6 g/hill) was obtained from T_1 (seedling tuber from TPS) and the lowest (229.2 g/hill) was produced by T_3 (cut pieces of traditional tuber) treatment (Table 4).Khan (1998) and Girish *et al.* (2004)

supported that seedling tuber improved growth parameter such as fresh weight of haulm.

Significant variation was found among different mulches on fresh weight of haulm per hill (Appendix III). M_3 (black polythene mulch) produced the highest (288.9 g/hill) fresh weight of haulm. On the other hand, the lowest (245.0 g/hill) was found in M_0 (no mulch) treatment (Table 4). 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. Kim *et al.* (1988) and Chen Go Ling (1997) found similar trends of results.

Different seed tuber and mulches in respect of fresh weight was found statistically significant (Appendix III).The highest fresh weight of haulm (416.7 g/hill) was recorded from T_1M_3 (seedling tuber with black polythene mulch) and the lowest (183.3 g/hill) from T_3M_0 (cut piece of traditional tuber with no mulch) treatment (Table 5).

4.5 Dry weight of haulm (g/hill)

Different seed tuber using showed significant variation in respect of haulm (Appendix III). The maximum dry weight of haulm (19.12 g/hill) was obtained from T_1 (seedling tuber). The minimum (12.30 g/hill) was obtained from T_3 (traditional tuber) treatment (Table 4). It was observed that seedling tuber from TPS played a significant role in maximizing dry weight of haulm. This effect was probably due to the fact that sufficient storage of plant nutrients for better vegetative growth of potato plants which ultimately increased dry weight of haulm.

There was a significant effect of mulch on dry weight of haulm of potato (Appendix III). The highest dry weight of haulm (16.05 g/hill) was found in M_3 (black polythene mulch). The lowest dry weight of haulm (15.08 g/hill) was recorded from M_2 (water hyacinth mulch) treatment which was statistically similar (15.19 g/hill) to M_0 (no mulch) treatment (Table 4). Black polythene mulch probably conserved adequate soil moisture, which increased plant height, number of leaves and chlorophyll content of the plant and ultimately fresh and dry weight of plant. Chen Go Ling (1997) and Hochmuth and Howell (1983) found similar trends of results.

Combined effect of seed tuber and mulch materials showed significant variation on the dry weight of haulm (Appendix III). The maximum dry weight of haulm (21.23 g/hill) was obtained from T_1M_3 (seedling tuber with black polythene mulch) and the minimum dry weight of haulm (10.73 g/hill) was obtained from T_3M_0 (traditional tuber with no mulch) treatment (Table 5).

4.6 Number of tubers per hill

The number of tubers per hill was significantly influenced by different seed tubers (Appendix III). The highest number of tubers per hill (11.08) was given by T_1 (seedling tuber), while the lowest (6.25) was produced by the plants grown from T_3 (traditional tuber) treatment (Table 4). It was observed that seedling tuber from TPS played a significant role in increasing number of tubers. This effect was probably due to the fact that sufficient storage of plant nutrients for better formation of tubers of potato plants which ultimately increased numbers of tubers. Khan (1998) and Ahmed *et al.* (1986) found similar trends of results in their studies.

The number of tubers per hill was significantly affected by mulch treatments (Appendix III). The highest number (10.45) was found in plants under M_3 (black polythene mulch) treatment and the lower number (6.44) was found in M_2 (water hyacinth mulch) treatment (Table 4).Because polythene film mulches reduce evaporation in vegetable cultivation and polythene sheets caused a 2% increase in the moisture content of the top 30 cm of the soil. So mulching with polythene increased number of tubers per hill. Bieoral (1970),Patil and Basad (1972) and Kim *et.al* (1988) also supported that polythene mulch increased number of tubers per hill.

Table 4. Effect of different seed tubers and mulch practices on the growth and yield contributing characters of potato

Treatments	No. of main stems/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
Seed tubers							
T_1	2.29 a	329.6 a	19.12 a	11.08 a	321.4 a	44.03 a	24.27a
T_2	1.92 b	266.7 b	15.07 b	8.08 b	301.9 b	34.23 b	20.12c
T_3	1.50 c	229.2 c	12.30 c	6.25 c	290.0 c	31.23 c	22.85b
LSD at 5%	0.065	0.705	0.286	0.136	0.983	0.281	0.2821
Mulches							
M_0	1.16 d	245.0 c	15.19 c	9.67 b	239.0 d	38.45 c	20.37d
M_1	1.89 c	283.3 b	15.67 b	7.33 c	287.1 c	40.88 b	22.65b
M_2	2.00 b	283.3 b	15.08 c	6.44 d	313.9 b	30.72 d	21.32c
M_3	2.55 a	288.9 a	16.05 a	10.45 a	377.8 a	43.53 a	25.31a
LSD at 5%	0.075	0.8144	0.330	0.158	1.135	0.324	0.326
Level of significance	**	**	**	**	**	**	**
CV(%)	4.12	3.30	2.81	4.91	5.38	3.86	4.49

In a column means having similar letter(s) are statistically similar and those dissimilar letter(s) differ significantly as per 0.05 level of probability

The number of tubers per hill was varied due to combined effect of different seed tuber and different mulch materials (Appendix III).However the maximum number of tubers per hill (13.67) was produced by T_1M_3 (seedling tuber with black polythene mulch) treatment. The lowest number of tubers per hill (5.33) was produced by T_3M_0 (traditional tuber with no mulch) and T_2M_2 (microtuber with water hyacinth) treatment (Table 5).

4.7 Weight of tuber per hill

Significant difference was found on weight of tuber per hill due to use of different seed tubers (Appendix III). The maximum tuber weight per hill (321.4g) was recorded from the crop was grown by T_1 (seedling tuber) treatment while the minimum tuber weight (290.0g) was noted from T_3 (traditional tuber) treatment (Table 4).

Weight of tubers per hill was significantly affected by the mulching treatments (Appendix III).The highest weight of tubers per hill (377.8g) was found from M_3 (black polythene mulch). On the other hand, the lowest weight of tubers per hill (239.0 g) was found in M_0 (no mulch) treatment (Table 4).

There was statistically a significant combined effect of seed tubers and mulch materials on the weight of tuber per hill (Appendix III).The maximum tuber weight per hill (423.3 g) was produced from T_1M_3 (seedling tuber with black polythene mulch) while the minimum (233.3 g) was obtained from the treatment combination of T_3M_0 (traditional tuber with no mulch) treatment (Table 5).

4.8 Mean tuber weight

A significant variation was found in mean tuber weight due sowing of different seed tuber (Appendix III). The maximum mean tuber weight (44.03 g) was obtained when the crop was grown under T_1 (seedling tuber) treatment. The minimum mean tuber weight (31.23g) was found from T_3 (traditional tuber) treatment (Table 4).Chilver *et al.* (1999) found similar trends of result.

Statistically significant influence was observed due to the effect of mulching treatment on the tuber weight (Appendix III). The maximum (43.53g) weight of mean tuber was obtained from M_3 (black polythene mulch) and the lowest (30.72g) was recorded from M_2 (water hyacinth mulch) treatment (Table 4). 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 and ultimately increased mean tuber weight.

Combined effect of seed tuber and mulch practices showed statistically significant on the mean tuber weight (Appendix III). The maximum mean tuber weight (50.92 g) was found from T_1M_3 (seedling tuber with black polythene mulch) and the lowest (23.48 g) was from T_1M_2 (seedling tuber with water hyacinth mulch) treatment (Table 5).

4.9 Dry weight of tuber

Dry weight of tuber was not significantly affected by different seed tuber practices (Appendix III). The maximum dry weight of tubers (24.27%) was obtained from T_1 (seedling tuber) whereas T_2 (microtuber) gave lower dry weight (20.12%) of tuber (Table 4).

Dry weight of tuber was statistically significant as affected by different mulches treatments (Appendix III) and that was ranged 20.37% to 25.31 % (Table 2).The maximum dry weight of tubers (25.31%) was obtained from M_3 (black polythene mulch) whereas M_0 (no mulch) gave lower dry weight (20.37%) of tuber (Table 4).

There was statistically significant combined effect of seed tuber and mulch materials (Appendix III). The maximum dry weight of tuber (28.30 %) was found from T_1M_3 (seedling tuber with black polythene mulch) and the minimum dry weight of tuber (16.80 %) from T_2M_3 (microtuber with black polythene) treatment (Table 5).

Table 5. Combined effect of different seed tuber and mulchs on growth, yield and yield contributing characters of potato.

Treatments	No. of main stems/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	Yield of tuber /plot (kg)	Yield of tuber (t/ha)
$T_1 M_0$	1.49 f	251.7 e	16.85 d	7.65 e	245.7 i	33.64 g	24.57 b	7.13ef	18.35 ef
$T_1 M_1$	2.33 c	300.0 c	18.27 c	10.33 c	290.7 g	28.59 h	23.87 c	6.67 f	17.20 f
$T_1 M_2$	2.00 d	350.0 b	20.13 b	12.67 b	326.7 c	23.48 j	23.63cd	7.50 e	18.75 e
$T_1 M_3$	3.33 a	416.7 a	21.23 a	13.67 a	423.3 a	50.92 a	28.30 a	12.67 a	31.67 a
$T_2 M_0$	1.00 h	250.0 f	15.73 e	6.33 g	238.0 j	36.93 f	23.07de	5.67 g	14.70 h
$T_2 M_1$	1.67 e	300.0 c	16.40 d	8.00 d	251.3 h	47.16 b	22.60 ef	9.50 c	23.75 c
$T_2 M_2$	1.33 g	250.0 f	13.27 g	5.33 i	308.3 e	24.85 i	18.00 i	6.23 f	15.57 g
$T_2 M_3$	2.00 d	266.7 d	14.87 f	12.67 b	410.0 b	47.86 b	16.80 j	10.67 b	26.67 b
$T_3 M_0$	1.00 h	183.3 h	10.73 i	5.33 i	233.3 k	44.44 c	19.33 h	6.23 f	15.57 g
$T_3 M_1$	1.67 e	266.7 d	13.47 g	6.33 g	320.0 d	38.89 e	21.47 g	8.50 d	20.42 d
T_3M_2	2.67 b	233.3 g	13.00 g	6.00 h	306.7 e	44.86 c	22.33 f	8.00 de	20.00 de
T_3M_3	2.33 c	233.3 g	12.00 h	7.33 f	300.0 f	40.97 d	24.97 b	7.50 e	18.75 e
LSD at 5%	0.131	1.411	0.5717	0.273	1.967	0.8733	0.5642	0.2730	1.135
Level of significance	**	**	**	**	**	**	**	**	**
CV(%)	4.12	6.30	5.81	4.91	5.38	6.86	4.49	4.73	5.87

In a column means having similar letter(s) are statistically similar and those dissimilar letter(s) differ significantly as per 0.05 level of probability

4.10 Yield of tuber per plot

Significant difference in yield was noticed due to the effect of different seed tubers (Appendix III). The highest yield of tubers (10.23 kg/plot) was obtained from T_1 (seedling tuber) treatment and the lowest yield of tuber (8.59 kg/plot) was obtained from T_3 (traditional tuber) treatment (Fig.4).Therefore seedling tuber produced heavier and larger sized tuber resulting in the highest weight and get more yield. Similar results were also reported by Pande *et al,* (1990); Hossain *et al.*(1992); Hossain *et al* .(1994); Girish *et al*.(2004) and Anonymous (2001).

The variation among the mulches in respect of yield per plot was highly significant (Appendix III). The highest yield of tubers (11.17 kg/plot) was obtained from M_3 (black polythene mulch) and the lowest yield of tuber (7.75 kg/plot) was obtained from M_0 (no mulch) treatment (Fig. 5). 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 and ultimately increased yield of tuber. Similar trends of results were also reported by Patil and Basad (1972) and Hochmuth and Howell (1983).

Combined effect of different seed tubers and mulch materials showed significant variation on yield of tuber per plot (Appendix III). The highest yield (12.67 kg/plot) was found from T_1M_3 (seedling tuber with black polythene mulch) treatment and the lowest yield (5.67 kg/plot) were found from T_2M_0 (microtuber with no mulch) treatment (Table 5).

4.11 Yield of tuber per hectare

Yield of tuber per hectare showed significant effect due to use of different seed tubers (Appendix III).The maximum yield (25.71 t/ha) was recorded from T_1 (seedling tuber) and lowest yield (21.46 t/ha) was found from T_3 (traditional tuber) treatment (Fig.6). Similar trends of results were found by Subrata Maity *et al.*(1997) and Kadian (1996) and Sikka *et al*.(1990). Therefore, seedling tuber might be play strong role than other tubers.

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 (Appendix III). The maximum yield (27.92 t/ha) was found in M_3 (black polythene mulch) and the lowest yield (19.56 t/ha) was recorded from M_0 (control condition) treatment (Fig. 7). 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 trends of results.

Combined effect of different seed tubers and mulch materials on the yield of potato per plot as well as per hectare was highly significant (Appendix III). The highest yield (31.67 t/ha) of potato was obtained from T_1M_3 (seedling tuber with black polythene mulch) treatment. The lowest yield (14.70 t/ha) of potato was obtained from T_2M_0 (microtuber with no mulch) treatment (Table 5).

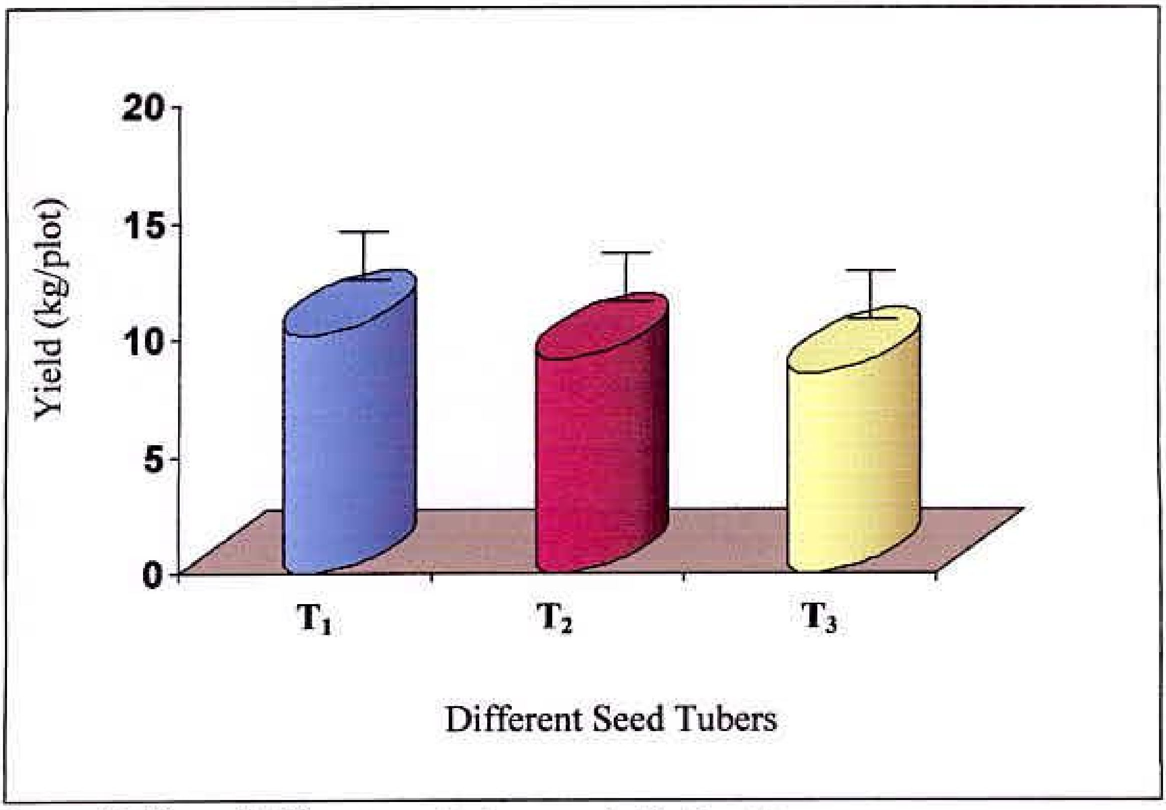

Figure 4. Effect of different seed tubers on yield of potato.

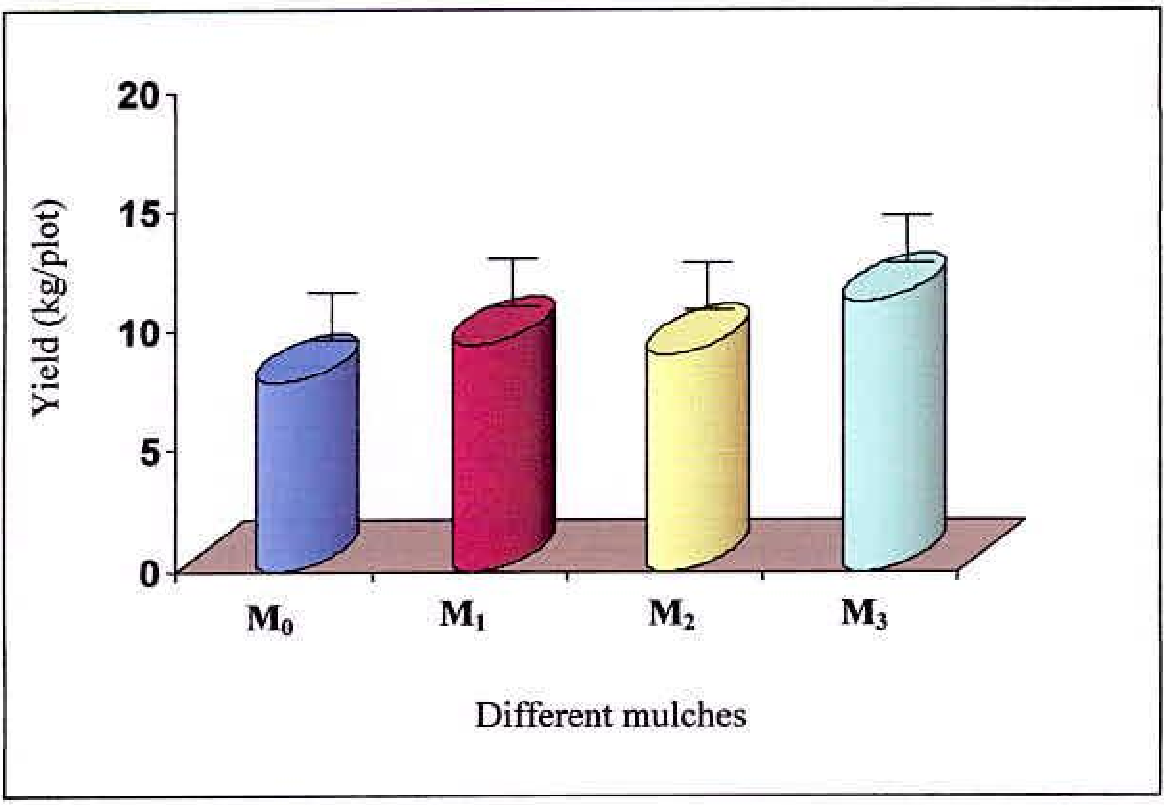

Figure 5. Effect of mulch on yield of potato.

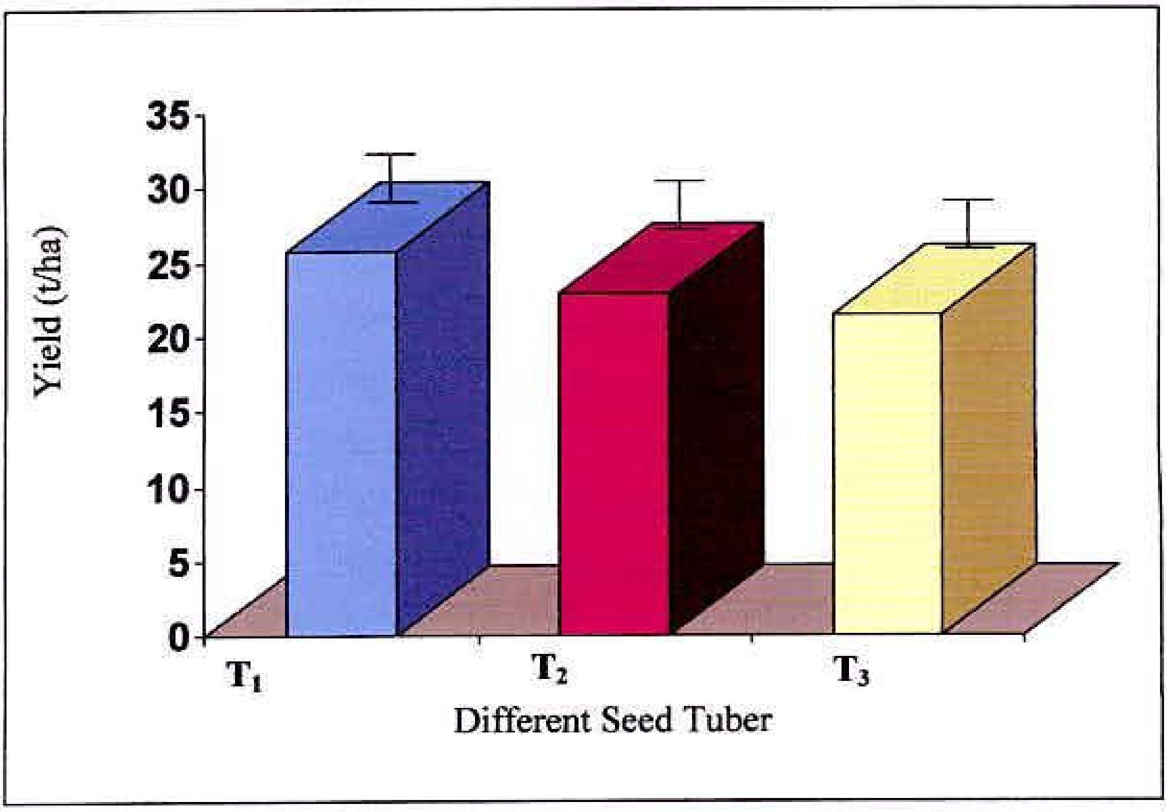

Figure 6. Effect of different seed tubers on yield of potato.

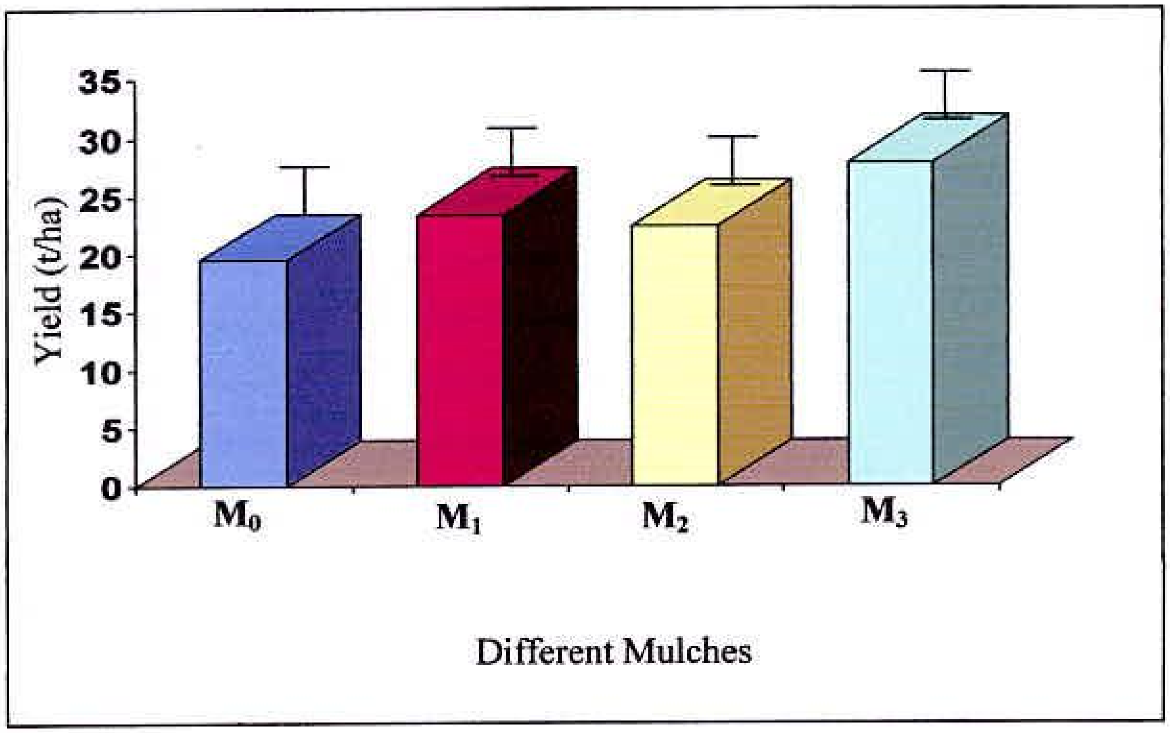

Figure 7.Effect of mulch on yield of potato.

4.12 Size grades of tubers

4.12.1 Grade size >55mm diameter

Different seed tubers indicated significant differences in the production of extra large tubers (>55mm) either by number and by the weight (Appendix III). The percentage of extra large tubers as influenced by seed tuber ranged between 23.75% to 26.59% by the number and 28.75% to 32.59% by weight (Table 6). The highest percentage of extra large tuber by number and by weight (26.59 % and 32.59 %) was found from T_1 (seedling tuber) which was statistically similar (26.52 % and 32.55 %) to T_2 (microtuber) treatment. Similar trends of results were also reported by Ahmed *et al.*(2001).

Various mulches showed significant variation in the production of extra large tubers (>55mm) either by number and by weight (Appendix III). The percentage of extra large tubers as influenced by mulching ranged 21.89% to 32.78% by number and 27.00% to 39.22% by weight (Table 6). The highest percentage of extra large tuber both by number and by weight (32.78 % and 39.22 %) was recorded from M_3 (black polythene mulch) and the lowest extra large tuber both by number and by weight (21.89 % and 27.00 %) was recorded from M_2 (water hyacinth mulch) treatment.

Combined effect of different seed tubers and mulches on the extra large tuber (>55mm) was found to be significant both by number and by weight (Appendix III). The percentage of extra large tubers ranged between16.67% to 36.67% by number and between 21.67% to 46.00% by weight (Table 5). The highest percentage of extra large tuber both by number and by weight (36.67 % and 46.00 %) was recorded from T_1M_3 (seedling tuber with black polythene mulch) and the lowest percentage of extra large tuber both by number and by weight (16.67 % and 21.67 %) from T_3M_0 (traditional tuber with no mulch) treatment (Table 7).

4.12.2 Grade size 40-55mm in diameter

Different seed tubers practices resulted significant differences in the percentage of large grade tuber either by number and by weight (Appendix III). The percentage of large tubers as influenced by different seed tuber ranged 21.08% to 28.59% by numbers and 26.92% to 35.75% by weight (Table 6). The highest percentage (28.59 % and 35.75 %) of large tuber by number and weight was recorded from T_1(seedling tuber from TPS) treatment and the lowest percentage (21.08 % and 26.92 %) of tuber was found in T_3 (traditional tuber) treatment.

Different mulches showed significant effect on the production of 40-55mm size (Appendix III).The highest percentage (30.00%) of large tuber by number was produced by M_3 (black polythene mulch) and the lowest (23.22%) was by M_2 (water hyacinth) treatment. The difference in the percentage of large tuber by weight was significant. The maximum percentage (37.67%) of large tubers by weight was produced from M_3 (black polythene mulch) and the minimum (29.33%) from M_1 (straw mulch) treatment (Table 6).

Combined effect of different seed tubers and mulch practices was statistically significant on large tuber by number and weight (Appendix III).The percentage of large tuber ranged between 18.33% and 38.67% by number and between 25.33% and 48.67% by weight (Table 5). The highest percentage of large tuber both by number and by weight (38.67 % and 48.67 %) was recorded from T_1M_3 (seedling tuber with black polythene mulch) and the lowest percentage of large tuber both by number (18.33 %) from T_3M_3 (traditional tuber with black polythene) and by weight (25.33 %) from T_3M_2 (traditional tuber with water hyacinth) which was statistically identical to T_3M_3 (traditional tuber with black polythene) treatment (Table 7).

4.12.3 Grade size, 28-40mm in diameter

Different seed tubers showed significant differences in the production of the medium tubers by number and weight (Appendix III). The percentage of medium tubers as influenced by different seed tubers were from 18.50% to 26.33% by number and 23.33% to 31.58% by weight (Table 6). The highest percentage (26.33 % and 31.58 %) of medium tuber by number and by weight was recorded from T_3(traditional tuber) treatment and the lowest percentage (18.50 % and 23.33 %) of tuber was found in T_2 (microtuber) treatment.

Various mulches clearly indicated significant differences in the production of medium tuber (28-40 mm) either by number and weight (Appendix III). The percentage of medium tubers as influenced by mulches ranged between 17.89% to 28.22% by number and 22.78% to 33.00% by weight (Table 6). The highest percentage of medium tuber both by number and by weight (28.22 % and 33.00 %) was found from M_0 (no mulch) and the lowest medium tuber both by number and by weight (17.89 % and 22.78 %) was recorded from M_3 (black polythene mulch) treatment 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.

Combined of different seed tubers and mulch practices was statistically significant on medium tuber by number and weight (Appendix III).The percentage of medium tuber ranged between 15.67% and 36.67% by number and between 21.33% and 41.67% by weight (Table 5). The highest percentage of medium tuber by number and by weight (36.67 % and 41.67 %) was recorded from T_3M_0 (traditional tuber with no mulch) and the lowest percentage of medium tuber by number (15.67 %) from T_1M_3 (seedling tuber with black polythene) and weight (25.33 %) from T_2M_3 (microtuber with black polythene mulch) treatment (Table 7).

4.12.4 Grade size <28 mm in diameter

Different seed tubers showed significant differences in the production of small tubers by number and weight (Appendix III). The percentage of small tubers as influenced by different seed tubers were from 25.42% to 25.83% by number and 23.67% to 32.67% by weight (Table 4). The highest percentage (25.83 % and 32.67%) of small tuber by number and by weight was recorded from T_3(traditional tuber) and the lowest percentage (25.42 % and 23.67%) of tuber was found from T_1 (seedling tuber) treatment (Table 6).

Different mulch showed significant difference in the percentage of small tubers either by number and weight (Appendix III). The percentage of small tubers as influenced by mulches ranged between 23.22% to 28.22% by number and 25.89% to 32.78% by weight (Table 4). The highest percentage of small tuber both by number and by weight (28.22 % and 32.78 %) was found from M_0 (no mulch) and the lowest small tuber by number (23.22 %) was recorded from M_3 (black polythene mulch) treatment and the lowest small tuber by weight (25.89 %) was recorded from M_2(water hyacinth) treatment (Table 6).

Combined of different seed tubers and mulch practices was statistically significant on small tuber by number and weight (Appendix III).The percentage of small tuber ranged between 21.33% and 33.65% by number and between 19.00% and 37.33% by weight (Table 5). The highest percentage of small tuber by number (33.65 %) was recorded from T_1M_0 (seedling tuber with no mulch) and by weight (37.33 %) was recorded from T_2M_3 (microtuber with black polythene) and the lowest percentage of small tuber by number (21.33 %) from T_1M_3 (seedling tuber with black polythene) and by weight (19.00 %) from T_1M_2 (seedling tuber with water hyacinth mulch) treatment (Table 7).

Table 6. Effect of different seed tubers and mulchs on tuber size grading by diameter of potato.

Treatments	Tuber size grading by diameter							
	Number of tuber (%)				Weight of tuber (%)			
	>55mm	40-55mm	28-40mm	<28mm	>55mm	40-55mm	28-40mm	<28mm
Seed tubers								
T_1	26.59 a	28.59 a	23.25 b	25.42 a	32.59 a	35.75 a	28.42 b	23.67 c
T_2	26.52 a	26.67 b	18.50 c	25.66 a	32.55 a	32.58 b	23.33 c	31.00 b
T_3	23.75 b	21.08 c	26.33 a	25.83 a	28.75 b	26.92 c	31.58 a	32.67 a
LSD (0.05)	0.4275	0.4275	0.2821	0.5603	0.2859	0.4191	0.1417	0.5603
Mulches								
M_0	22.56 c	23.78 c	28.22 a	28.22 a	28.78 c	29.77 bc	33.00 a	32.78 a
M_1	25.33 b	24.78 b	21.89 c	24.22 c	30.22 b	29.33 c	27.00 c	26.55 c
M_2	21.89 d	23.22 d	22.78 b	26.89 b	27.00 d	30.22 b	28.33 b	25.89 d
M_3	32.78 a	30.00 a	17.89 d	23.22 d	39.22 a	37.67 a	22.78 d	31.22 b
LSD (0.05)	0.4937	0.4937	0.3257	0.6470	0.3301	0.4839	0.1636	0.6470
Level of significance	**	**	**	**	**	**	**	**
CV (%)	1.97	1.98	1.47	2.58	1.08	1.56	3.60	2.27

In a column means having similar letter(s) are statistically similar and those dissimilar letter(s) differ significantly as per 0.05 level of probability

Table 7. Combined effect of different seed tubers and mulches on the tuber size grading by diameter of potato.

Treatments	Tuber size grading by diameter							
	Number of tuber (%)				Weight of tuber (%)			
	>55mm	40-55mm	28-40mm	<28mm	>55mm	40-55mm	28-40mm	<28mm
T_1M_0	24.68 e	23.68 e	29.67 b	33.65 a	29.35 d	28.32 h	34.33 b	30.00 d
T_1M_1	22.67 fg	25.67 cd	25.33 d	22.67 g	27.33 f	30.67 e	30.33 d	29.65 d
T_1M_2	22.33 g	26.33 c	22.33 e	25.00 de	27.67 f	35.33 c	28.33 e	19.00 h
T_1M_3	36.67 a	38.67 a	15.67 k	21.33 h	46.00 a	48.67 a	20.67 l	32.33 c
T_2M_0	26.33 d	25.00 d	18.33 i	26.00 cd	35.33 c	32.33 d	23.00 j	34.67 b
T_2M_1	30.00 c	26.00 c	19.00 h	24.00 ef	35.00 c	29.33 fg	24.00 i	34.00 b
T_2M_2	20.00 h	22.67 f	20.00 g	28.67 b	25.00 g	30.00 ef	25.00 h	33.33 bc
T_2M_3	31.67 b	33.00 b	16.67 j	24.67 ef	35.00 c	38.67 b	21.33 k	37.33 a
T_3M_0	16.67 i	22.67 f	36.67 a	25.00 de	21.67 h	28.67 gh	41.67 a	25.33ef
T_3M_1	23.33 f	22.67 f	21.33 f	26.00 cd	28.33 e	28.00 h	26.67 f	21.33g
T_3M_2	23.33 f	20.67 g	26.00 c	27.00 c	28.33 e	25.33 i	31.67 c	24.33f
T_3M_3	30.00 c	18.33 h	21.33 f	23.67 fg	36.67 b	25.67 i	26.33 g	26.00e
LSD(0.05)	0.8551	0.8551	0.5642	1.121	0.5717	0.8381	0.2833	1.121
Level of significance	**	**	**	**	**	**	**	**
CV (%)	1.97	1.98	1.47	2.58	1.08	1.56	3.60	2.27

In a column means having similar letter(s) are statistically similar and those dissimilar letter(s) differ significantly as per 0.05 level of probability

4.13 Economic analysis

Input costs for land preparation, seed cost, fertilization, irrigation and man power required for all the operations from sowing to harvesting of potato were recorded for unit plot and converted into cost per hectare. Prices of potato were considered in market of Agargaon, Dhaka rate basis. The economic analysis was done to find out the gross and net return and the benefit cost ratio in the present experiment and presented under the following headings-

4.13.1 Gross return

In the combination of seed tuber and mulches showed different gross return under the trial (table 8). The highest gross return (Tk. 6,33,400) per hectare was recorded from T_1M_3 (seedling tuber with black polythene mulch) and the second highest gross return (Tk. 5,33,400) was recorded from T_2M_3 (microtuber with black polythene). The lowest gross return (Tk. 3,11,400) was recorded from T_2M_2 (microtuber with water hyacinth) and T_3M_0 (traditional tuber with no mulch).

4.13.2 Net return

In case of net return different treatment combination showed different amount of net return. The highest net return (Tk.4,73,290/ha) was recorded from T_1M_3 (seedling tuber with black polythene mulch) and the second highest net return (Tk. 3,02,156/ha) was recorded from T_2M_3 (microtuber with black polythene). The lowest net return (Tk. 1,14,804/ha) was recorded from T_2M_0 (microtuber with no mulch) treatment (Table 8).

4.13.3 Benefit cost ratio

The combination of seed tuber and mulch materials for benefit cost ratio was different for treatment combination (Table 6). The highest (3.9) benefit cost ratio was recorded from T_1M_3 (seedling tuber with black polythene mulch) and the lowest benefit cost ratio (1.6) was recorded from T_2M_0 (microtuber with no mulch) treatment (Table 8). From economic point of view, it was apparent from the above results that the treatment combination of T_1M_3 was more profitable compare to other treatments.

Table 8. Cost and return of potato production as influenced by different seed tubers and mulchs.

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)
$T_1 M_0$	18.35	367000	108261.9	258738.1	3.3
$T_1 M_1$	17.20	344000	113279.5	230720.5	3.0
$T_1 M_2$	18.75	375000	113614	261386	3.3
$T_1 M_3$	31.67	633400	160109.5	473290.5	3.9
$T_2 M_0$	14.70	294200	179395.6	114804.4	1.6
$T_2 M_1$	23.75	475000	184413.1	290586.9	2.5
$T_2 M_2$	15.57	311400	184747.1	126652.9	1.7
$T_2 M_3$	26.67	533400	231243.1	302156.9	2.3
$T_3 M_0$	15.57	311400	116677.9	194722.1	2.6
$T_3 M_1$	20.42	408400	121695.4	286704.6	3.3
T_3M_2	20.00	400000	122029.9	277970.1	3.3
T_3M_3	18.75	375000	168525.4	206474.6	2.2

Price of potato Tk 20,000 /ton

Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

An experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2007 to February 2008 to study the effect of seed tuber and mulch practices on growth and yield of potato. The experiment comprised two factors: Factor A: three types of seed tuber T_1: Seedling tuber from TPS, T_2: microtuber from tissue culture and T_3: traditional tuber Factor B: four different mulch materials M_0 :no mulch, M_1 :straw, M_2 :water hyacinth and M_3 :black polythene mulch. The experiment consisting of 12 treatment combinations was laid out in the Randomized Complete Block Design (RCBD) with three replications. The size of each unit plot was 2 m × 2 m. and forty plants were accommodated in each plot following a spacing of 50cm×20cm. Sprouted seed tubers were planted in the field on 23rd November 2007. 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, 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 DMRT test. The cost and economic returns as influenced by different treatments were also analyzed. The results of the experiment have been summarized below.

Different seed tubers showed significant effect on most of the characters. Plants grown from seedling tuber from TPS showed maximum plant height, 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 .Days required to 100% emergence T_1 took the shortest (15.83) time while T_3 took the longest time (18.67) . The longest (58.53 cm) plant height was obtained from T_1, while the shortest (53.25 cm) was recorded from T_3. The maximum (2.29) main stem per hill was obtained from T_1, while the minimum (1.5) was recorded from T_3. The maximum (329.6 g) fresh weight of haulm per hill was obtained from T_1, while the minimum (229.2 g) was recorded from T_3. The maximum (19.12 g) dry weight of haulm per hill was obtained from T_1, while the minimum (12.30 g) was recorded from T_3. The maximum (11.08) number of tubers per hill was obtained from T_1, while the minimum (6.25) was recorded from T_3. The maximum (321.4 g) fresh weight of tubers per hill was obtained from T_1, while the minimum (290 g) was recorded from T_3. The highest (44.03 g) mean tuber weight per hill was obtained from T_1, while the lowest (31.23 g) was recorded from T_3. The maximum (24.27 g) dry weight of tuber per hill was obtained from T_1, while the minimum (20.12 g) was recorded from T_2. The highest (10.23 kg/plot) yield was recorded from T_1 while the lowest (8.58 kg/plot) was found from T_3. The highest (25.71 t/ha) yield was recorded from T_1 while the lowest (21.46 t/ha) was found from T_3.

Different mulching treatments played important role on the growth and yield of potato. Days required to 100% emergence M_3 took the shortest (13.67) time while M_0 took the longest time (19.45). The longest (59.53 cm) plant height was obtained from M_3, while the shortest (53.18 cm) was recorded from M_0. The maximum (2.55) main stem per hill was obtained from M_3, while the minimum (1.6) was recorded from M_0. The maximum (288.9 g) fresh weight of haulm per hill was obtained from M_3, while the minimum (245 g) was recorded from M_0. The maximum (16.05 g) dry weight of haulm per hill was obtained from M_3, while the minimum (15.08 g) was recorded from M_2. The maximum (10.45) number of tubers per hill was obtained from M_3, while the minimum (6.45) was recorded from M_2. The maximum (377.8 g) fresh weight of tubers per hill was obtained from M_3, while the minimum (239.0 g) was recorded from M_0. The highest (43.53 g) mean tuber weight per hill was obtained from M_3, while the lowest (30.72 g) was recorded from M_2. The maximum (25.31 g) dry weight of tuber per hill was obtained from M_3, while the minimum (20.37 g) was recorded from M_0. The highest (11.17 kg/plot) yield was recorded from M_3 while the lowest (7.75 kg/plot) was found from M_0. The highest (27.92 t/ha) yield was recorded in M_3 while the lowest (19.56 t/ha) was found in M_0.

Combined effect of types of seed tubers and mulching also significant differences among treatment combinations.Days required to 100% emergence T_1M_3 took the shortest (13.33) time while T_3M_0 took the longest time (20.67).The longest (61.53 cm) plant height was obtained from T_1M_3, while the shortest (51.00 cm) was recorded from T_2M_0. The maximum (3.33) main stem per hill was obtained from T_1M_3, while the minimum (1.00) was recorded from T_2M_0 and T_3M_0. The maximum (416.7 g) fresh weight of haulm per hill was obtained from T_1M_3, while the minimum (233.3 g) was recorded from T_3M_2 and T_3M_3. The maximum (21.23 g) dry weight of haulm per hill was obtained from T_1M_3, while the minimum (10.73 g) was recorded from T_3M_0. The maximum (13.67) number of tubers per hill was obtained from T_1M_3, while the minimum (5.33) was recorded from T_2M_2 and T_3M_0. The maximum (423.3 g) fresh weight of tubers per hill was obtained from T_1M_3, while the minimum (238.0 g) was recorded from T_2M_0. The highest (50.92 g) mean tuber weight per hill was obtained from T_1M_3, while the lowest (23.48 g) was recorded from T_1M_2. The maximum (28.30 g) dry weight of tuber per hill was obtained from T_1M_3, while the minimum (16.80 g) was recorded from T_2M_3. The highest (12.67 kg/plot) yield was recorded from T_1M_3 while the lowest (5.67 kg/plot) was found from T_2M_0. The highest (31.67 t/ha) yield was recorded from T_1M_3 while the lowest (14.70 t/ha) was found in T_2M_0.

The highest gross return (Tk. 6,33,400) per hectare was recorded from T_1M_3 and the lowest gross return (Tk. 3,11,400) was recorded from T_2M_2 and T_3M_0. The highest net return (Tk.4,73,290/ha) was recorded from T_1M_3 and the lowest net return (Tk. 1,14,804/ha) was recorded from T_2M_0. The highest (3.9) benefit cost ratio was recorded from T_1M_3 and the lowest benefit cost ratio (1.6) was recorded from T_2M_0 treatment. Considering the present findings it was apparent that the treatment combination of T_1M_3 was more profitable compare to other treatments.

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

- For maximizing the yield of potato different healthy seed tuber may be used.
- The experiment was conducted under AEZ No. 28. So the trial should be conducted in different agro ecological zone of Bangladesh for final recommendation to the growers.
- It may be suggested that seedling tuber TPS with black polythene mulch may be used for higher yield of potato.

Better quality seed tubers and low cost material for mulching may be investigated further for successful production of potato.

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CHAPTER VI
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Appendices

CHAPTER VII

APPENDICES

Appendix I. Monthly record of air temperature, rainfall, relative humidity and Sunshine of the experimental site during the period fromOctober 2007 to February 2008

Year	Month	Air temperature0 C		Relative Humidity(%)	Total rainfall(mm)	Sunshine (hr)
2007	November	31.8	16.8	67	111	5.7
	December	28.2	11.3	63	0	5.5
2008	January	29.0	10.5	61.5	23	5.6
	February	30.6	10.8	54.5	56	5.8

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 different seed tuber and mulch practices

Sources of variation	Degrees of freedom	Days requirement For100% emergence	Mean sum of square			
			Plant height (cm) at			
			30DAP	45DAP	60DAP	75DAP
Replication	2	0.111	0.111	0.686	0.111	0.028
Seed tuber (T)	2	24.335**	758.509**	181.752**	4.284**	95.994**
Mulching (M)	3	55.235**	34.953**	6.988**	43.308**	64.009**
Interaction (T×M)	6	2.669**	11.226**	11.764**	36.393**	22.564**
Error	22	0.111	0.111	0.686	0.111	0.028

**=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	0.006	0.694	0.114	0.026	1.349	0.110	0.111	0.024	0.449
Seed tuber (T)	2	1.859**	30897.906**	41.152**	71.437**	3017.899**	512.333**	53.392**	8.358**	55.970**
Mulching (M)	3	2.944**	3695.432**	1.801**	32.306**	30153.054**	274.303**	41.527**	17.973**	108.034**
Interaction (T×M)	6	0.533**	8230.256**	9.730**	11.508**	4922.412**	140.772**	17.082**	4.119**	25.953**
Error	22	0.006	0.694	0.114	0.026	1.349	0.110	0.111	0.575	0.449

**=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	0.255	0.255	0.111	0.438	0.114	0.245	0.028	0.438
Seed tuber (T)	2	32.149**	182.276**	186.819**	0.528**	58.816**	240.157**	207.975**	275.055**
Mulching (M)	3	233.943**	86.662**	162.895**	48.164**	266.324**	141.404**	159.624**	104.441**
Interaction (T×M)	6	47.392**	62.390**	51.905**	31.357**	82.971**	84.699**	49.948**	49.819**
Error	22	0.255	0.255	0.111	0.438	0.114	0.245	0.028	0.438

**=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 t/ha	Manure and fertilizer				Pesticide and fungicide	Mulching materials	Sub total (A)
		Cowdung 10t/ha	Urea 326Kg/ha	TSP 232Kg/ha	MP 275Kg/ha			
$T_1 M_0$	29952	7000	5216	5800	6875	3200	-	58043
$T_1 M_1$	29952	7000	5216	5800	6875	3200	3500	61543
$T_1 M_2$	29952	7000	5216	5800	6875	3200	3800	61843
$T_1 M_3$	29952	7000	5216	5800	6875	3200	45000	103043
$T_2 M_0$	93749	7000	5216	5800	6875	3200	-	121840
$T_2 M_1$	93749	7000	5216	5800	6875	3200	3500	125340
$T_2 M_2$	93749	7000	5216	5800	6875	3200	3800	125640
$T_2 M_3$	93749	7000	5216	5800	6875	3200	45000	166840
$T_3 M_0$	37500	7000	5216	5800	6875	3200	-	65591
$T_3 M_1$	37500	7000	5216	5800	6875	3200	3500	69091
T_3M_2	37500	7000	5216	5800	6875	3200	3800	69391
T_3M_3	37500	7000	5216	5800	6875	3200	45000	110591

Cowdung @ 700tk/ton
Urea @ 16 tk/Kg
TSP @ 25 tk/Kg
MP @25 tk/Kg

Seedling tuber from TPS 30 Tk/Kg
Microtuber from tissue culture 900 Tk/kg
Traditional tuber 30 Tk/kg
Black polythene 1800 m/ha, 25Tk/m
Water hyacinth 3800 Tk/ha
Straw 3500 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)
$T_1 M_0$	3500	2100	1500	-	5000	5500	8000	25600	83643
$T_1 M_1$	3500	2100	1500	1000	5000	5500	8000	26600	88143
$T_1 M_2$	3500	2100	1500	1000	5000	5500	8000	26600	88443
$T_1 M_3$	3500	2100	1500	1500	5000	5500	8000	27100	130143
$T_2 M_0$	3500	2100	1500	-	5000	5500	8000	25600	147440
$T_2 M_1$	3500	2100	1500	1000	5000	5500	8000	26600	151940
$T_2 M_2$	3500	2100	1500	1000	5000	5500	8000	26600	152240
$T_2 M_3$	3500	2100	1500	1500	5000	5500	8000	27100	193940
$T_3 M_0$	3500	2100	1500	-	5000	5500	8000	25600	91191
$T_3 M_1$	3500	2100	1500	1000	5000	5000	8000	26600	95691
T_3M_2	3500	2100	1500	1000	5000	5000	8000	26600	95991
T_3M_3	3500	2100	1500	1500	5000	5000	8000	27100	137691

Labour cost 100 Tk/day

T_1: Seedling tuber from TPS
T_2: Microtuber from tissue culture
T_3: Traditional tuber

M_0: No mulch
M_1: Straw
M_2: Water hyacinth
M_3 : Black polythene

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		
$T_1 M_0$	15000	5436.7	4182.2	24618.9	108261.9
$T_1 M_1$	15000	5729.3	4407.2	25136.5	113279.5
$T_1 M_2$	15000	5748.8	4422.2	25171	113614
$T_1 M_3$	15000	8459.3	6507.2	29966.5	160109.5
$T_2 M_0$	15000	9583.6	7372	31955.6	179395.6
$T_2 M_1$	15000	9876.1	7597	32473.1	184413.1
$T_2 M_2$	15000	9895.6	7612	32507.1	184747.1
$T_2 M_3$	15000	12606.1	9697	37303.1	231243.1
$T_3 M_0$	15000	5927.4	4559.5	25486.9	116677.9
$T_3 M_1$	15000	6219.9	4784.5	26004.4	121695.4
T_3M_2	15000	6239.4	4799.5	26038.9	122029.9
T_3M_3	15000	8949.9	6884.5	30834.4	168525.4

Land lease value Tk. 30000/ha/year

T_1: Seedling tuber from TPS

T_2: Microtuber from tissue culture

T_3: Traditional tuber

M_0: No mulch

M_1:Straw

M_2: Water hyacinth

M_3 : Black polythene