EFFECT OF POTASSIUM AND MULCHING ON GROWTH AND YIELD OF POTATO

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TO

MY BELOVED PARENTS

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CERTIFICATE

This is to certify that the thesis entitled **"EFFECT OF POTASSIUM AND MULCHING ON GROWTH AND YIELD OF POTATO"** submitted to the faculty of agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, 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 **ASMA BEGUM**, Registration No. **17-08182** 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 available during the course of this investigation has duly been acknowledged.

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The Author

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ABSTRACT

The field experiment was conducted during the period from November 2017 to March 2018 at Horticultural farm of Sher-e-Bangla Agricultural University, Dhaka. The variety "Diamant" was used as a test crop. Four levels of potassic fertilizer (KCl) *viz.* K_0: (Control), K_1: 110 kg/ha, K_2: 140 kg/ha, K_3: 170 kg/ha and three types of mulches *viz*. M_0: (Control), M_1: Straw, M_2: Black polythene was used for the present study. The experiment was laid out in Randomized Complete Block Design with three replications. Different potassium level showed significant influence on most of the parameters and the treatment. The highest yield (27.20 t ha^{-1}) of potato was obtained in K_2 treatment whereas the lowest (12.25 t ha^{-1}) was obtained from K_0. For mulches, the highest yield (24.57 t ha^{-1}) was obtained in M_1 and the lowest (17.68 t ha^{-1}) was obtained from the M_0 treatment. In terms of combined effect of potassium and mulching, most of the studied parameters were influenced significantly. The highest yield (31.75 t ha^{-1}) was recorded from the treatment combination of K_2M_1 whereas the lowest yield (9.74 t ha^{-1}) was found in the treatment combination K_0M_0 . So, 140 kg/ha potassium fertilizer with straw mulch gave the maximum yield.

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ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro Ecological Zone
BADC	=	Bangladesh Agricultural Development Corporation
BARC	=	Bangladesh Agricultural Research Council
BARI	=	Bangladesh Agricultural Research Institute
BAU	=	Bangladesh Agricultural University
DAP	=	Days after Planting
FAO	=	Food and Agricultural Organization
FYM	=	Farm Yard Manure
KCl	=	Potassium di Cloride
LSD	=	Least Significant Difference
MP	=	Muriate of Potash
RH	=	Relative humidity
SE	=	Significance Error
SS	=	Sum of Square
t/ha	=	Tone per hectare
TSP	=	Triple Super Phosphate
Wt.	=	Weight

CHAPTER I

INTRODUCTION

Potato (*Solanum tuberosum* L.) is a tuber crop under the family Solanaceae. It is originated in the central Andean area of South America (Keeps, 1979). The crop is grown during the winter season. Potato, the third most important crop of Bangladesh, is followed by rice and wheat (Illias, 1998). Nutritionally, the tuber is rich in carbohydrates or starch and is a good source of protein, vitamin C and B, potassium, phosphorus, and iron. As it is carbohydrate-rich crop, it can partially substitute for rice, which is our main food item. It is the most popular crop which is cultivated 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 cultivated in Europe. It is a source of both food and income in many of the densely populated countries like Bangladesh. Because of this double purpose, the potato crop plays an important role in the improvement of rural livelihood system of many countries (Gildemacher, 2012). In the last 2-3 decades, the production of potato in Bangladesh has increased with the cultivation of high yielding varieties. Recent reports indicate that 10,216 million tons of potato were produced in this country from 1,235 thousand acres of land in 2016-17 (BBS, 2017). The reasons for the low yield of potato comparing to another country in Bangladesh are a climatic limitation, poor yielding seed tubers and cultural practices such as imbalanced fertilizer uses and soil moisture regulations. However, the dose, time and methods of application are so different among the farmers and in different areas of production.

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 the costly establishment of pumps and due to the downfall of the underground water layer. To minimize the cultivation cost mulching could be effectively used instead of irrigation. Different kinds of mulch play an important role in conserving soil moisture. Soil temperature is important for potato production, which is influenced by mulch. Mulching is one of the important agronomic practice beneficial in conserving the soil moisture, suppressing the weeds, improving soil fertility (when organic mulch is used) and modifying the soil physical environment (Yoo-Jeong *et al.*,2003). Artificial mulch such as crop residues, plant species, or polyethylene sheet is generally used for the production of horticultural crops (Wilhoit *et al*., 1990).

Potato production can be increased by the adoption of important cultural practices, among them the use of fertilizer management practices is important. Potassium (K) is one of the major nutrient element in potato cultivation and its uptake is highest among nutrient elements. In many potato producing areas, N and P fertilizers are widely used while K is usually ignored causing a serious decrease of potassium level in the soils (Dampney *et al.*, 2011). K influences synthesis, location, transformation and storage of carbohydrates, tuber quality and processing characteristics as well as plant resistance to stress and diseases (Ebert, 2009). According to Blagoeva *et al*. (2004), potatoes are K preferring crop because they absorb 1.5-fold more K than nitrogen and 4-fold more K than phosphorus. K increases the size of potato tubers and not the number (Trehan *et al*., 2001). So, it increases the yield by increasing the number and yield of large sized tubers.

In recent years, the Tuber Crops Research Centre of BARI has collected many new lines of potato from the International Potato Research Centre, Peru, and from other sources, The Centre has already made a 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. Through constant evaluation of the traits, varietal performance, and considerations of other characteristics, about 10 HYV has been released for cultivation in the country. However, the Bangladesh Agricultural Development Corporation (BADC) for distribution among farmers imports a huge amount of potato seeds every year. 'Diamant' a variety from Holland with oval to oblong shape, pale yellow tubers, smooth skin, and shallow eyes is quite disease resistant.

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

i. To find out the suitable mulch on the maximum growth and yield of potato;

ii. To optimize the potassium fertilizer on the growth and yield of potato; and

iii. To evaluate the interaction effects of mulch and potassium fertilizer on the growth and yield of potato.

CHAPTER II

REVIEW OF LITERATURE

Potassium and mulching both are an important factor influencing the growth and yield of potato. Comparing with another country, the average yield is much lower in Bangladesh. Many research works have been conducted on the effect of potassium and different mulches on the growth and yield of potato in various parts of the world. Some of the important research reports regarding potato and some other related crops have been reviewed here in this chapter.

2.1 Influence of potassium fertilizer on the growth and yield of potato

Zeru, D. *et al.* (2016) set an experiment on the effect of potassium levels on growth and yield of potato in Eritriya. He stated that potato requires a variety of balanced plant mineral nutrients for growth and development without which yield and qualities of tubers are reduced. Potato growers in Eritrea commonly use Di-ammonium Phosphate, Urea and Farmyard manure while potassium fertilizers are overlooked assuming that the soil is developed from K rich parent material and contains sufficient amount of K to support crop growth. However this assumption is based on the result obtained forty-seven years ago. As a result the yield and quality of potato produced is very low as compared with international standards. Therefore the present experiment was conducted to assess the effect of potassium levels on growth and productivity of potato varieties at Hamelmalo Agricultural College, Eritrea. The experiment was conducted in factorial Randomized Complete Block Design with fifteen treatment combinations of three varieties (Ajiba, Zafira and Picasso) and five potassium levels (0, 75, 150, 225 and 300 kg K_2O/ha) replicated thrice. The results of the study showed that both variety and potassium had significant effect on growth and yield parameters. Aerial stem number, leaf number per plant and plant height were increased with increasing K levels from 0 to 150 kg while number of days to maturity was increased in the range of 0 - 300 kg K_2O/ha. The result also indicated that variety Ajiba treated with 300 kg K_2O/ha produced significantly highest tuber weight (1.14 kg) per plant and tuber yield of 49.38 t/ha. The economic analysis result revealed that maximum gross margin 13,665.816 USD/ha was obtained from the application of 300 kg K_2O/ha. On the whole, it gives an impression that using potassium fertilizer according to soil requirements will have good influence on growth and tuber yield.

Bishwoyog *et al.* (2016) found the effect of potassium on the quality and growth of potato in Nepal. He stated that potassium (K) aids in maintaining osmotic potential which enhances water uptake and root permeability, control ionic balances, regulate plant stomata and activate enzymatic processes. Potassium (K) plays significant role in quality as well as yield attributes of potato such as reducing sugar, Vitamin C content, specific gravity, shelf life and total yield. K application has found to increase reducing sugar content in potato tubers to threshold level and tends to decrease after that. The reason behind this is conversion of sugar to starch at high rate of K application. Vitamin C content is found to increase at moderate level of K application and tends to decrease in high concentration. Among the different sources of K, use of Muriate of Potash (MoP) is found better than Sulphate of Potash (SOP) for increasing Vitamin C content. Specific gravity and dry matter content are found to decrease with higher dose of K application. K lowers down senescence and reduces physiological disorders, increasing shelf life in potato tubers. Potassium Chloride (KCl) is more effective in reducing the incidence of physiological disorders during postharvest compared to other source of K. K application plays significant role in increasing yield of potato tubers which is either due to formation of large sized tubers or increasing number of tubers per plants or both by helping in accumulation of carbohydrate. There is low replenish and high loss of Potassium by leaching in soil and shows wide spread deficiency in intensively potato growing areas. Therefore, careful attention should be given in Potassium fertilization to maximize the quality and yield of potato tuber. Potatoes are used for a variety of purposes: as a fresh vegetable, as raw material for processing into food products or in different food ingredients, to manufacture starch and alcohol and as fodder for animals. From the nutritional point of view, potato is the best source of energy and vitamin. It contains high amount of carbohydrate (19.4%) in the form of starch, protein (2%) and fat (0.1%). In comparison to cereal crops, starch and protein in potato has high digestibility. Except vitamin – A & vitamin – E, it contains all most all vitamins. However, vitamin – B_6 and vitamin – C are present in adequate amount and minerals like Fe, Ca, P, Mg, and S are also present in sufficient amount. According to FAO, consumption of 125 – 150 gm of potato daily fulfils the need of vitamins.

Ruiz- Machuca *et al*. (2014) found that Cultivation of potato – use of plastic mulch and row covers on soil temperature, growth, nutrient status, and yield. Potato is one of the most important crops in the world because of its high nutritional value; however, traditional cultivation in bare soil may render low yields and poor quality. Crop production efficiency can be increased by using plastic mulching and row covers to modify root zone temperature and plant growth, in addition to reduction in pest damage and enhance production in cultivated plants. However, there is little information demonstrating the effect of row covers in combination with plastic mulch on potato. The aim of this study was to assess the change in root zone temperature and its effect on growth, leaf nutrient, and yield of potato using plastic mulch of different colors, in combination with row covers. Seed of cultivar Mondial was planted in May 2012. The study included four plastic films: black, white/black, silver/black, aluminum/black, and a control with bare soil, which were evaluated alone and in combination with row covers removed at 30 days after sowing in a split-plot design. Higher yields were obtained when no row cover (43.2 t ha^{-1}) and the white/black film (42.2 t ha^{-1}) were used. Leaf nitrogen, sulfur, and manganese concentration were higher in plants when row cover was used; in contrast, no–row cover plants were higher in Fe and Zn. Mulched plants were higher in Mn concentration than control plants. There was a quadratic relationship between mean soil temperature and total yield (R^2 = 0.94), and between plant biomass and total yield (R^2 = 0.98), between leaf area with total yield (R^2 = 0.98).

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

Koppel (2001) set an experiment with special emphasis organic agriculture on the choice of cultivars where adaptation regional soil, climate and production systems are important characteristics. The necessary traits for a potato variety suitable for organic farming include stronger rooting system, quicker haulm development, high and durable resistance to the main diseases and pests. A trial consisting of 45 potato cultivars and advanced clones was established at Jogeva Plant Breeding Institute in Estonia in 2000 to identify the most suitable cultivar for organic fanning in the country. Organic manure at 60 t/ha and mechanical weed control were used no pest and disease control measures were undertaken in both years. Both growing seasons were very suitable for late blight development. High late blight pressure was the main cause of yield reduction from 9.9 to 37.4 t/ha. The higher marketable tuber yields were obtained from the early cultivars or from the late cultivars that are resistant to late blight.

Ghosh and Das (1998) reported that the potatoes grown at Sriniketan (West Bengal) in winter 1995-96 and 1996-97 were given different biofertilizers and growth regulators. Treatments included combinations of Buckup (Well matured cattle manure containing vesicular arbuscular mycorrhizas and phosphate solution 7 bilizing bacteria), Elecra (liquid organic manure extracted from marigold plants), Bioplin (liquid suspension of Azotobecter), Micrin (liquid organic manure containing humic and fulvic acid), Vitormone (liquid suspension of several dormant Azotobecter species) and protein hydrolysate (plant growth regulators containing amino acids). Plant height and number of shoots/plant increased considerably when the crop received both bio fertilizer and growth regulators together. Crop growth rate, tuber bulking rate, large and medium sized tubers and total tuber yield were greatest from combinations of both bio fertilizers and growth regulator. Among the single applications, Vitormone gave the greatest yield improvement (22.6%) followed by protein hydrolysate (22.1%). Combined application of Bioplin along with protein hydrolysate or Micrin and Elecra along with Vitormone, gave 38-42% yield improvement over controls.

Another field experiment was conducted by Khalak and Kumaraswamy (1994) in red loam soil at Bangalore, potatoes cv. Kufri Jyoti to assess the effect on dry mater accumulation and growth attributes of potato as influenced by irrigation and fertilizer (50, 100, or 150 kg/ha each of N, P_20_5 and K_20).

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

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

Blecharezyk (1995) worked on fertilizer for zero, single or double doses, 40 t FYM + 60 Kg N + 60 Kg P + 60 Kg K, 80 t FYM + 120 Kg N + 120 Kg P+120 Kg K and 120 t FYM + 180 kg P +180 Kg K per hectare. They found that N P K without FYM was highly effective especially if straw or green manure had been ploughed in and the use of FYM greatly reduces the effectiveness of complete N P K.

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

Zavalin *et al*. (1993) also stated that optimum potato yield of 27.1 t /ha was given by the plants having 90 Kg N + 60Kg P + 120 Kg K+ 50 t peat manure compost/ha. Karmanpov *et al*. (1982) conducted an experiment with 0-135 Kg N, 0-210 Kg P205 and 0- 165 Kg K_20/ha on a leached chernozem soil given 20 t FYM /ha in the penza region and found that applieation of 135 Kg N +210 Kg P_2O_5+I65 Kg K_20/ha gave the highest average yields of 36 t/ha without irrigation and 42 t with irrigation.

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

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

Datta and Chakraborty (1995) conducted a field experiment with 0.50 or 100 Kg/ha each of N, P_20_5, K_20, and manure with 5 tons rice husk ash, 0.5 tons mustard oilcake or 10 tons FYM/ha. The highest potato tuber yield (27 t/ha) was obtained from the highest NPK rate used. Amongst the manures the tuber yield were in the under of FYM > rice husk ash> mustard oil cake.

Adhikari *et al*. (1992) in a field trial on potatoes cv. Kufri gave 150 Kg nitrogen as urea or ammonia sulphate + 40 tons cowdung manure 302 tons mustard oilcake or 20 tons poultry litter or 230 Kg nitrogen as urea or ammonium sulphate + 20 tons cowdung manure 1.6 tons mustard oilcake or 10 tons poultry litter /ha to give total nitrogen application in each treatment of about 310 Kg /ha. Tuber yield percentage of tuber >45 mm and net profit were maximum with the application of 150 Kg nitrogen as ammonium sulphate + 20 tons poultry litter/ha.

Naher (1999) conducted a field experiment at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during the period from November 1997 to February, 1998 in order to study the effect of fertilizer viz., no fertilizer, organic, inorganic, organic +inorganic and irrigation viz. no irrigation, irrigation at 20, 15 and 10 days interval. The results demonstrated that fertilizer management practices had significant effects on the yield and yield contributing characters. The maximum plant highest (52.0 cm), fresh weight of haulm (0.102 Kg/hill, dry weight of haulm (10.078 g/hill), weight of tuber (396g/hill) and yield of tuber (27.09t/ha) were recorded when inorganic fertilizer managements were applied. However, the maximum number of main stems (3.65) per hill and dry matter of tubers (21.08 %) were obtained from organic fertilizer management practices. Inorganic fertilizer management practices gave the highest percentage of >55 mm (20.27) and 4655 mm (47.49) grade tubers. Inorganic fertilizer management practices gave significantly better result compared to other treatment.

Arafa (2004) conducted an experiment with different NPK treatments on growth, yield, quality and chemical components of two potato cultivars. The effects of 3 levels of NPK fertilizers, i.e. 125+30+100, 150+45+150 and 175+60+200 Kg/ha, on the growth, yield and its components, quality as well as chemical compositions(N, P, K, Fe, Mn, Zn, reducing, no reducing and total sugars) of foliage and tubers of 2 potato cultivars(lady Rosetta and Hermis) were investigated under sandy soil conditions in Ismaalia Governorate, Egypt, during the summer seasons of 2002 and 2003. The second level of NPK significantly increased plant height, number of branches per plant, fresh and dry weights of plant foliage, numbers of tubers per plant, tuber weight, plant yield, total yield, marketable yield, large (more than 55 mm in diameter) tuber percentage and chemical composition of foliage and tubers. Hermis compared with Lady Rosetta significantly increased the vegetative growth, yield and its components as well as chemical composition of plant foliage and tubers.

The data concerning the interaction showed that Hochmuth *et al*. in combination with the second level of N P K significantly increased all the studied character; Lady Rosetta in combination with the highest level of N P K increased the percentage of medium sized (35- 55 mm in diameter) tubers and dry matter content of tubers.

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

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

2.2 Influence of mulch on the growth and yield of potato

Azad *et al.* (2015)conducted a factorial experiment based on randomized complete block design with three replications was conducted in Asadabad, Hamedan (Iran). The experimental treatments consisted of mulch in five levels (clear mulch, white mulch, black mulch, double layer mulch and control, without mulch) and cultivar in two levels (Agria and Sante). The effect of mulch on the fresh and dry weight of weed was significant, so that the black and double layer mulches had greatest impact on reducing the fresh and dry weight of weed, respectively. As compared to control, clear mulch treatments could reduce the period of tuber formation by 6.33 days. Double layer mulches showed the highest number of stolons at 60-day after planting. In comparison to the control, mulch could reduce the days to harvest, while the clear (104.83 days), double layer (105 days), and white (105.16 days) mulches all had significant differences when compared to the control (108.16 days). Cultivar Sante and double layer mulch also had the greatest impact on early potato crop. Mulch was not, however, seen to have significant effect on yield per plant. Based on the overall results, cultivar Sante and double layer mulch are suggested for the purpose of further study in Asadabad, Hamedan (Iran).

Chettri *et al.* (2018) cited that Northern China is a major potato production region, and water-saving measures that can enhance both potato yield and quality play an important role in this region due to general water shortages. Plastic mulch has been used as an effective water-saving measure for potato cultivation in China. This chapter reviews the case studies on the effects of plastic mulching on potato growth, conducted at two areas of North China. Data from these experiments indicated that plastic mulching could save irrigation water and reduce evapotranspiration in most cases. Daily mean soil temperature under mulch was 2–9 ^{0} C higher than that without mulch, especially during the early growth stage. However, as the plant canopy enlarged, the soil temperature difference between mulched and non-mulched plots became smaller. Plastic mulch could restrain or enhance potato plant growth during the early growth, dependent on the micro environmental air and soil temperatures. The possible negative effects of plastic mulching included a lower emergence, lower potato tuber yield, and poorer tubers quality, which may be attributable to the poorer soil aeration and detrimentally high soil temperature associated with plastic mulch when the air temperature is high. As mulch duration is an influential factor, data from these case studies suggested that 60 days of mulching duration was most favorable for potato production in the tested areas. Mulch removal after 60 days was proposed to avoid subsequent negative effects. To complement the current knowledge on the plastic mulching research, future research should be focused on the hydrothermal dynamics and its effect on potato growth with different drip irrigation regimes under plastic mulching conditions

Chettri *et al*. (2018) was carried out to study the effect of mulches and irrigation scheduling on the growth and yield of ZT potato under rain fed low land rice ecosystem. The experiment was laid out in split plot design taking three levels of irrigation viz. Single irrigation at 40 DAP (I1), Splash irrigation at 15 days interval (I2) and Irrigation at IW/CPE = 0.6 (IW = 4cm) (I_3) in the main plots and three types of mulch management viz. Paddy straw mulch @ 5 t/ha (on dry weight basis) (M1), Water hyacinth @ 5 t/ha (on dry weight basis) (M_2) and Soil cover (ridge and furrow) (M_3) in the sub plots in different combinations, each combination being replicated thrice.Among the different irrigation schedules single irrigation at 40 DAP (I_1) gave maximum fresh tuber yield (8.62 t/ha) followed by splash irrigation (7.14 t/ha) at 15 days interval. Single irrigation (I_1) recorded the higher total dry matter production (221.84 g/m2) and no. of tubers per hill (4.7) at harvest. Among the mulches water hyacinth (M_2) recorded the highest tuber yield (9.64 t/ha) followed by paddy straw mulch (8.36 t/ha),which might be attributed to higher plant height (45.1 cm), more number of haulms per hill (and tuber dry matter production (141.6 g/ m^2).

Ramakrishnaa *et al*. (2006) conducted an experiment on the effect of mulch on soil temperature, moisture, weed infestation and yield of groundnut in northern Vietnam Groundnut (*Arachis hypogaea* L.) is one of the chief foreign exchange earning crops for Vietnam. However, owing to lack of appropriate management practices, the production and the area under cultivation of groundnut have remained low. Mulches increase the soil temperature, retard the loss of soil moisture, and check the weed growth, which are the key factors contributing to the production of groundnut. On-farm trials were conducted in northern Vietnam to study the impact of mulch treatments and explore economically feasible and eco-friendly mulching options. The effect of three mulching materials (polythene, rice straw and chemical) on weed infestation, soil temperature, soil moisture and pod yield were studied. Polythene and straw mulch were effective in suppressing the weed infestation. Different mulching materials showed different effects on soil temperature. Polythene mulch increased the soil temperature by about 6 ^{0}C at 5 cm depth and by 4 ^{0}C at 10 cm depth. Mulches prevent soil water evaporation retaining soil moisture. Groundnut plants in polythene and straw mulched plots were generally tall, vigorous and reached early flowering. Use of straw as mulch provides an attractive and an environment friendly option in Vietnam, as it is one of the largest rice growing countries with the least use of rice straw. Besides, it recycles plant nutrients effectively.

Rahman (2007) conducted an experiment in Sher-e-Bangla Agriculture University, on the effect of mulching and fertilizer management practices on the growth and yield of potato and investigate the effect of mulching and fertilizer management practices on the growth and yield of potato. The experiment was conducted with three mulching treatments; No mulch (M0), Black polythene mulch (M_1) and Water hyacinth (M_2) and three fertilizer management practices; organic fertilizer (cowdung) (F_1), inorganic fertilizer (F_2) and organic (cowdung) + inorganic (F_3). The experiment was laid out in RCBD with nine treatments combinations and three replications. The maximum plant height (77.09cm), number of main stem (4.09), number of tubers per hill (6.88), weight of tubers per hill (366.33 g), extra-large tuber (>55mm) both by number and weight high were recorded when Mi treatment applied. On the other hand, maximum numbers of main stem (3.96), dry weight of haulm per hill (11.16 g), number of tuber per hill (6.11) weight of tuber per hill (333.05 g), mean tuber weight (54.22 g) was found when F_3 treatment applied. The highest yield of tuber (19.30 t/ha) was obtained from the plants grown with M_1 treatment and the lowest (13.43 t/ha) from the M_0 treatment. The fertilizer treatment F_3 gave the highest yield (19.22 t/ha) while the minimum (13.54 t/ha) was obtained from F_2 treatment. The combination black polythene mulch with organic (cowdung) + inorganic fertilizer gave maximum yield (22.29 t/ha). On the basis of cost benefit analysis the highest benefit cost ratio was obtained from M_1F_3 treatment combination.

Kaur *et al*. (2017) found mulching plays an important role in production of agricultural and horticultural crops in the current scenario of declining water table, soil degradation and climate change. The main objectives of mulching are to prevent loss of water by evaporation, prevention of soil erosion, weed control, to reduce fertilizer leaching, to promote soil productivity, to enhance yield and quality of field and fruit crops. So, mulching is useful to save our underground water resource, soil and environment for sustainable crop production. In this review paper, the literature clearly shows pronounced effects of mulching on soil health by improving the soil structure, soil fertility, biological activities, avoid soil degradation in addition to moisture conservation, regulating temperature, encouraging change in favourable micro-climate, check weed growth and ultimately increasing the productivity, quality, profitability and sustainability of crops and cropping systems irrespective of the system/situation.

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

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

Manrique and Meker (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 ^{0}C. The condition gave relatively higher tuber yields in most of the varieties.

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

Challaiah and Kulkani (1979) conducted an experiment in potato with irrigation at 13 to 15 days interval in combination with polythene mulch. Polythene mulch gave higher yield (30.64 t/ha). Bhattacharjee *et al*. (1979) demonstrated that potato yields were higher with straw mulch than that of without mulch on coarse textural soilin Patna, India. Burger and Nel (1984) reported that mulching by straw produced 30% more tubers than the no mulch potato crops. Similarly, Natheny *et al.* (1992) also found that white, pale blue and stripped straw mulch produced more than 15% marketable tubers of potato than the no much control plots.Mulching helps in checking evaporation and thus soil can retain sufficient amount of moisture. Polyethylene film mulches reduce evaporation in vegetable cultivation (Lamont, 1993). In a separate experiment, Bieoral (1970) found that polythene sheets caused a 2% increase in the moisture content of the top 30cm of the soil. Black polythene, sawdust and dried grass mulch in tomato production improved soil moisture retention but black polythene mulch had the best result (Patil and Basad, 1972).

Sutater (1987) found an increase in plant height and the number of potato leaf with different mulching treatments. Sarker and Hossain (1989) reported that one weeding just after emergence or mulching by paddy straw appeared optimal for the growth of a good potato crop. In another study, Taja *et al*.

(1991) reported that mulching by rice straw with optimum inorganic fertilizer application of 50 kg N/ha were good for canopy coverage of potato.

Sarker and Hossain (1989) studied the effect of weeding and mulching on potato cv. Cardinal and reported that the percentage of foliage coverage, which ranged from40.0 to 65.00, was significantly different among the treatments, the lowest coverage being obtained from the control (no weeding) treatment. Mulching also increased growth of leaf and stem (Kim *et al.* 1988). According to Devaux (1987), mulching reduced the soil temperature due to better ground cover.

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

Polythene mulch conserved more moisture in the soil than control (Harris, 1965). Mulching conserved the soil moisture better in potato cultivation (Prihar, 1986; Devaux and Haverkort, (1987) and Ifenkwe *et al*. (1987). Yamaguchi *et al.* (1964) also reported that average minimum temperature fall within the range in bare soil than from clear and black polythene, which delay emergence.

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

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

Bhuyan (2003) conducted a field experiment at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh during the period from November 2002 to March 2003 to investigate the effect of mulching, variety and crop management practices on growth and yield of potato. The 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 (18.51 t/ha) yield.

Bhagat *et al*. (2016) found the impact of straw mulch and different doses of recommended nitrogen was studied on soil microbial flora, soil physico-chemical properties and plant growth parameters of potato at different time intervals under field conditions. Maximum bacterial population (75× 107 cfu g-1 soil), plant growth promoting rhizobacteria count (63× 105 cfu g^{-1} soil) and fungal population (69× 103 cfu g^{-1} soil) were observed with the treatment having rice straw mulch @ 6 tonnes/ha and 100% N-level while diazotrophic count (42× 105 cfu g^{-1} soil) was found with treatment having mulch (6 t) but no nitrogen fertilizer at 30 DAS.Mulched soil samples gave statistically higher microbial population. The soil pH and the electrical conductivity of soil were not significantly affected by the different applications. A slight improvement in soil organic content was observed in mulched (0.32%) over unmulched (0.24%) soil samples at 90 DAS. The mineral nitrogen content of soil i.e. ammonical (235.2 kg/ha) and nitrate (156.8 k/ha) nitrogen were greatly affected at 90 DAS by mulching and higher doses of nitrogen fertilization. The altered microbial population helps in improving the various growth parameters of potato plants. Maximum chlorophyll content (1.84 mg/g), maximum dry root-shoot biomass (0.7 g/pl and 5.8 g/pl) and maximum yield (366.8 q/ha) were observed with the treatment having mulch and 100% N-level. It is also concluded that mulch increased the minimum soil temperature by 2-30 C and lower down the maximum by 2 to 80 C. ng on soil environment, microbial flora and growth of potato under field conditions.

Thomas *et al.* (2005) conducted an experiment straw mulch to organic seed potatoes (*Solanum tuberosum* L.) has been shown to reduce virus incidence. In order to determine the associated agronomic effects of straw mulch, applied at 2.5–5 t ha^{-1}, on soil nitrate dynamics, weed development, tuber yield and soil erosion, 12 field experiments were evaluated. Experiments were conducted on organic farms over 3 years at two locations in a temperate climate (635–709 mm precipitation/year; 8.1 ^{0}C mean air temperature) on loamy silt soils. Tuber yield and tuber size distribution were not influenced significantly by mulching. However, the risk of undesirable postharvest N-leaching was significantly reduced due to the immobilization of nitrate–N after harvest at 6.8–7.0 kg N t^{-1} straw in two experiments (18–34 kg NO_3–N ha^{-1}). There was no consistent effect of straw mulch on number of weeds, weed cover and above ground biomass of weeds. The fact that yield and weed development were not significantly affected by straw mulch is mainly attributed to the relatively low amounts of straw applied. Soil erosion was reduced by > 97% in a rain simulation experiment on a potato field of 8% slope with 20% crop cover. Soil loss was greatest (1606 g m^{-2}) in the un-mulched treatment, and 31, 42 and 26 g m^{-2} in treatments with chopped straw at 1.25, 2.5 and 5 t ha^{-1}, respectively.

Ruimin *et al.* (2018) found the physiological and growth responses of potato cultivars to heat stress. Climate warming is subjecting plants to heat stress, which can affect their physiological processes thereby impacting their growth, development, and productivity. Potato (*Solanum tuberosum* L.) is a staple food worldwide, but potato crops are very sensitive to heat stress. We have studied the effects of heat stress on the leaf chlorophyll content, plant growth, and tuber yield of 55 commercial potato cultivars in clonal tests under heat-stress conditions [HS; 35 ^{0}C (day), 28 ^{0}C (night)] and control (non-stress) conditions [CK; 22 ^{0}C (day), 18 ^{0}C (night)]. The potato cultivars varied in their response to heat stress. Overall, heat stress reduced leaf size, increased the SPAD index values for leaf chlorophyll by up to 65%, and increased plant height by 64%, but severely reduced (by 93%) the mass of the largest tuber. The HS: CK SPAD ratios positively correlated with the HS: CK plant height ratio, the mass of the largest tuber under heat stress, and the HS: CK ratio for the mass of the largest tuber. Potato cultivars displayed a correlated response to heat stress for their leaf chlorophyll content, plant height, and tuber mass. We have identified the most heat-tolerant and heat-susceptible cultivars for these traits. Under heat-stress conditions, potato cultivars tend not to show as much reduction in tuber mass if the plants have greater increases in leaf chlorophyll content and plant height.

Rykaczewska *et al*. (2015) found the effect of the physiological age of potato plants on chosen chlorophyll fluorescence parameters. Chlorophyll a fluorescence kinetics is an informative tool for studying the effects of different environmental stresses on photosynthesis. The aim of this work was to study the response of selected potato cultivars to meteorological conditions during the growing season and physiological age of plants using chlorophyll a fluorescence parameters. The pot experiment was carried out over the course of 2 years with six early cultivars. Chlorophyll a fluorescence measurements were performed on the plants with a Pocket plant efficiency analyzer determined parameters were: Fv/Fm (the ratio of variable to maximal chlorophyll fluorescence) and PI (the performance index of photosystem II). In total 2040 measurements of each parameter were made. Final harvest was performed after full maturity of plants. The results of the experiments were analyzed with ANOVA. Changes of chlorophyll a fluorescence parameters in terms of physiological age were analyzed using a polynomial regression model. A significant negative correlation between the maximum air temperature and the PI parameter was found as well as a significant negative correlation between the physiological age of potato plants and both chlorophyll a fluorescence parameters.

CHAPTER III

MATERIALS AND METHODS

The materials and method used in the execution of the experiment have been presented in this chapter.it deals with a short description of the location of the experimental site, climatic condition, materials used for the experiment, treatment of the experiment, data collection procedure and statistical analysis.

3.1 Site of the experiment

The experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during the period from November 20017 to February 2018 . The experimental site was previously used as a vegetable garden and recently developed for research work. The location of the site is 23° 74' N latitude and 90° 35' E longitude with an elevation of 8.2 meters from sea level (Anon, 1981).

3.2 Climate

The climate of the experimental site is subtropical, characterized by heavy rainfall , high temperature and relatively long day period during the months from (April-September) “Kharif 1” season and scarce rainfall,low temperature and short day period during “Rabi” .The total rainfall of the experimental site was 218 mm during the period of the experiment. The average maximum and the minimum temperatures were 29.5°C and 13.9°C, respectively during the experimental period. The maximum and minimum temperature, humidity, and rainfall during the study period were collected from the Weather station of Bangladesh Meteorological Department, Agargaon, Dhaka (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 the pH of the soil was 5.6. The morphological characters of the soil of the experimental plots as indicated by FAO (1988) are given below - AEZ No. 28 Soil series – Tejgaon General soil- Shallow red-brown terrace soil .

3.4 Planting materials

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

3.5 Treatments of the experiment

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

Factor A: Four levels of potassium fertilizer(K_2O)

(i) No potassium (K_0)

(ii) 110 kg/ha (K_1)

(iii) 140 kg/ha (K_2)

(iv) 170 kg/ha(K_3)

Factor B: Different mulching treatments

i. No mulch (M_0)

ii. Straw mulch (M_1)

iii. Black polythene (M_2)

The treatment combinations were

K_0M_0, K_0M_1, K_0M_2, K_1M_0, K_1M_1, K_1M_2, K_2M_0, K_2M_1, K_2M_2, K_3M_0, K_3M_1, K_3M_2

3.6 Preparation of the main field

The land was opened on 12th November 2017 with a power tiller and was exposed to the sun for 7 days prior to next ploughing. It was prepared afterward by ploughing and cross ploughing followed by laddering. Big clods were broken by hand mallet. The weeds and stubbles were completely removed from the field. The soil particles were well pulverized and the land was leveled evenly during final land preparation.

3.7 Design and layout of the experiment

The two-factor experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. A block consisted of 12 unit plots, each for a combination of potassium and mulching . The total number of plots was 36. The treatment combinations of the experiment were assigned randomly in each block. The size of the unit plot was 2m x 1.5m. The gap between the plots was 50cm and between the blocks was 100cm. the field was laid out on 19th November 2017.

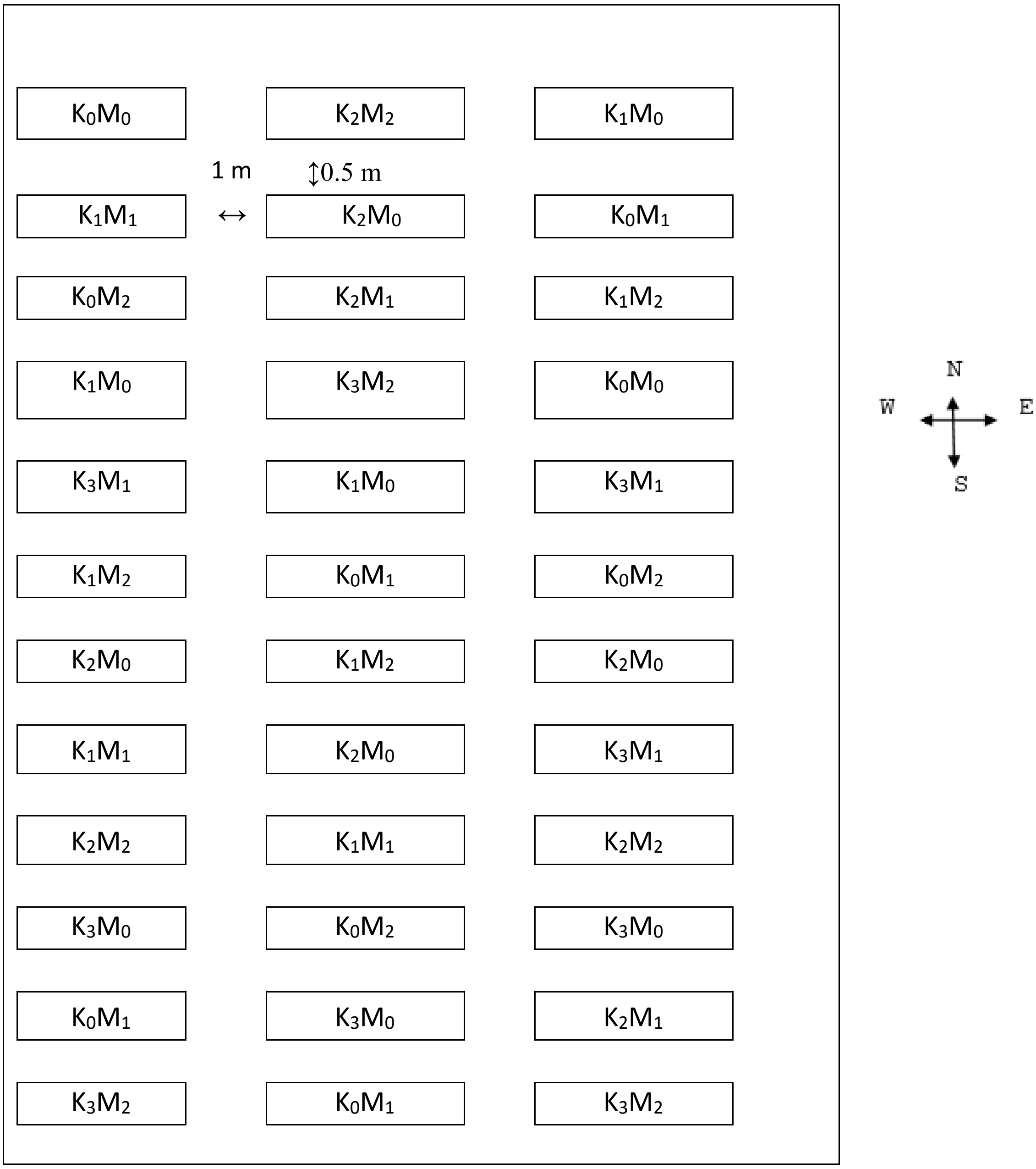

Fig. 1. Field layout of the two factor experiment in the Randomized Complete Block Design (RCBD).

3.8 Application of manure and fertilizers

Name of Fertilizer	**Doses/ha**
Cowdung	5 ton/ha
Urea	266 kg/ha
TSP	110 kg/ha
Zinc Sulphate	22 kg/ha
Gypsum	55 kg/ha
Boron	12 kg/ha
Treatment of Potassic fertilizer(K_2O)	
K_0	No fertilizer
K_1	110 kg/ha
K_2	140 kg/ha
K_3	170 kg/ha

Source: Fertilizer recommendation guide,2016.

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.

3.9 Preparation of planting materials

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

3.10 Planting of seed tuber

Sprouted, healthy and disease free seeds were planted in furrows on the 24 November 2017 at 5-7 cm depth maintaining a spacing of 60cm x 20cm. After planting, the seeds were covered with soil. Each plot accommodated 40 seed tubers in 4 rows. In case of black polythene mulching, sheets were spread over the plot before planting keeping holes at proper spacing into which dibbling was done.

3.11 Intercultural operations

3.11.1 Weeding

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

3.11.2 Earthing up

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

3.11.3 Plant protection

3.11.3.1 Disease

Dithane M-45 @ 2.25 kg/ha was sprayed after complete emergence of the crop at an interval of 15 days to protect the incidence of late blight disease.

3.11.3.2 Insect pest

Furadan 5G was applied against soil insects during final land preparation at the rate of l0 kg/ha.

3.12 Collection of Data

Six plants were more select randomly from each plot to avoid border effect and tagged in the field. Data were recorded on the following parameters from the sample plants during the course of the experiment.

3.12.1 Height of plant

Plant height was recorded at 35, 55 and 75 days after planting (DAP). The height was measured from the base of the plant to the longest end of the stem and was expressed in centimeter (cm).

3.12.2 Foliage coverage

The area covered by the plant's canopy in a unit plot of (2m x 1.5m) was calculated and converted into a percentage.

3.12.3 Number of main stems per hill

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

3.12.4 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.

3.12.6 Number of tubers per hill at harvest

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

3.12.7 Weight of tubers per hill at harvest

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

3.12.8 Mean tuber weight

Mean tuber weight was recorded from a total weight of tubers from sample plants divided by a 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.

3.12.10 Yield of tuber per plot

To obtain yield per hill weight of tuber was taken from six 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 and expressed in gram (g).

3.12.11 Yield of tuber per hectare

The yield of tuber per hectare was calculated from that of per plot yield and expressed in the ton.

3.12.12 Harvesting

The crop was harvested after 90 days on 11 February 2018 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 data collected on various parameters were statistically analyzed using SPSS software (Version 20.00) to find out the statistical significance of the treatment effect. The mean values of all the treatments were calculated and analyses of variance for all the characters were performed by the F-test. The significance of the difference among the treatments and combinations of means was estimated by DMRT (Duncan's Multiple Range Test) at 5% level of significance (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was considered to investigation of different level of potassium and mulch on the growth and yield of potato. The analysis of variances for different characters have been present in (Appendix III to XV). Data of the different parameters analyzed statically and the results have been presented in the this chapter. The results of the present study have been presented and discussed in this chapter under the following headings

4.1 Plant height

Plant height is an important parameter which reflects the vegetative growth of the plant. The plant height was significantly influenced by different levels of potassium (Figure 2 and Appendix III, IV, V). It was found that there was a significant effect on plant height among the treatments at 35, 55, and 75 days after planting (DAP). At 35 DAP, the tallest plant (69.98 cm) was measured from K_2 and the shortest (66.90 cm) was recorded from the control treatment (K_0). At 55 DAP, the tallest plant (73.94 cm) was recorded from K_2 and the shortest (68.12 cm) was measured from K_0. At 75 DAP, the tallest plant (75.16 cm) was recorded from K_2 and the shortest (70.23 cm) was recorded from K_0 treatment. It was revealed that the plant height increased with the increase in days after planting (DAP) i.e. 35, 55 and 75 DAP and also revealed that the plant height increased with different levels of potassium application as well. The result might be due to the fact that potassium enhances the growth of potato . Potassium fertilizer provided synergistic effects on plant height of potato plant. This result agreed by Taposh Kumar Ghosh (2006) .

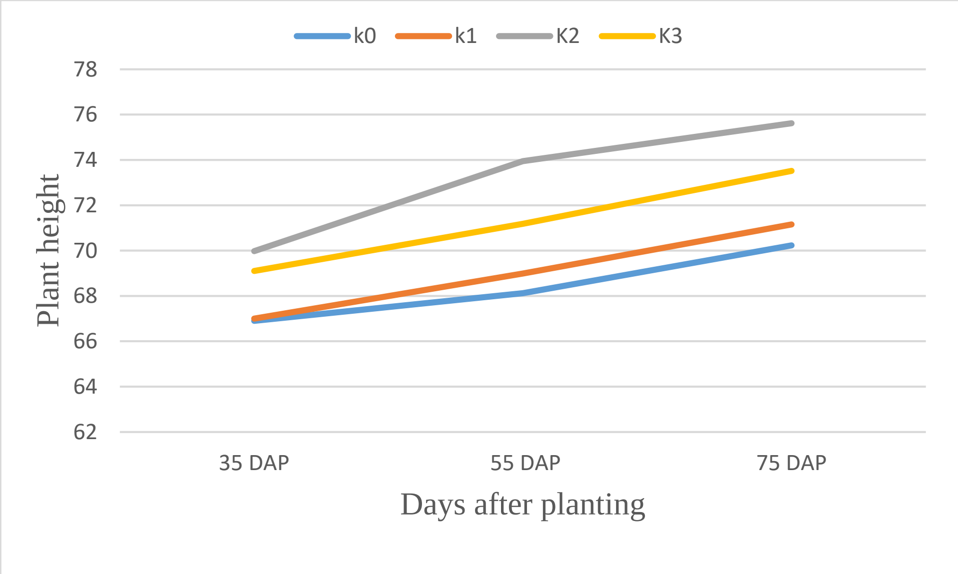

Fig. 2. Effect of different levels of potassium on plant height of potato at 35 DAP, 55 DAP and 75 DAP .

Whereas, K_0= No potassium fertilizer, K_1=110 kg/ha K_2O, K_2=140 kg/ha K_2O and K_3=170 kg/ha K_2O

Different mulches showed significant variation in plant height at different days after planting. At 35 DAP, the highest plant height (71.67 cm) was measured with the plants grown over M_1 (straw mulch) while the lowest (65.806 cm) in M_0 (control). Similarly at 55 DAP ,the highest (74.41 cm) plant height was found in M_1 and lowest (67.6 cm) in M_0 .At 75 DAP, the highest (76.1 cm) plant height was found in M_1 and lowest (69.6 cm) in M_0 (Figure 3 and Appendix-III,IV,V). The effect of straw 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) observed that the height of mulched potato plant was taller than the control.

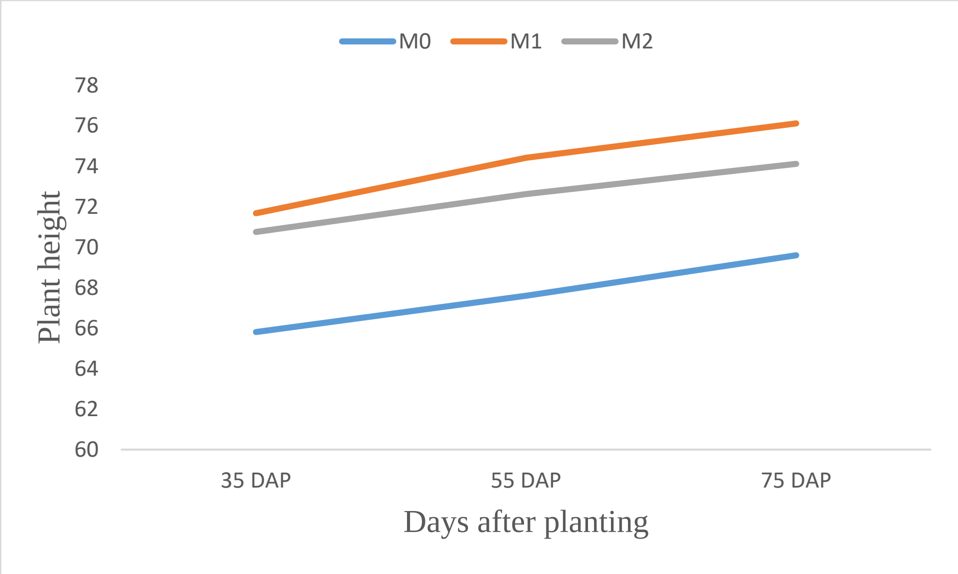

Fig. 3. Effect of different mulching on plant height of potato at 35 DAP, 55 DAP and 75 DAP .

Whereas, M_0=No mulch (Control), M_1=Straw mulch and M_2=Black Polythene

Combined effect of potassium and mulching on plant height

Interaction effect of potassium and mulching was found positively significant variation in this respect of plant height at 35 DAP , 55 DAP and 75 DAP. (Appendix -III, IV, V and Table 1). Among the treatment combinations it was observed that straw mulch with K_2 treatment gave maximum plant height (82.27 cm, 84.48 cm and 86.48 cm) and it was minimum (60.72 cm, 63.17 cm and 65.87 cm) with no mulch and no potassium. Straw mulch conserved sufficient soil moisture that may encourage more growth of potato producing the tallest plant .

Table 1: Interaction effect of potassium and mulching on plant height at different growth stage.

Treatment	35 DAP	55 DAP	75 DAP
K_0M_0	60.72 b	63.17 c	65.87 cd
K_0M_1	66.21 c	68.33 c	70.33 cd
K_0M_2	75.47 a-c	77.48 c	80.48 cd
K_1M_0	75.72 ab	77.87 ab	80.87 b
K_1M_1	68.88 a-c	70.94 c	71.94 cd
K_1M_2	67.38 a-c	69.64 c	72.64 cd
K_2M_0	66.36 ab	68.93 c	72.43 cd
K_2M_1	82.27 a	84.48 a	86.48 a
K_2M_2	68.77 ab	70.93 c	72.93 cd
K_3M_0	68.72 ab	71.22 c	73.22 cd
K_3M_1	71.33 a-c	73.91 bc	75.91 bc
K_3M_2	76.05 ab	78.42 ab	81.42 b
S.E	1.512	2.423	2.197
Significance Level	0.037	0.001	0.000

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability analyzed by DMRT.

S.E=Standard Error

K_0= No fertilizer(control)

K_1=110 kg/ha K_2O

K_2=140 kg/ha K_2O

K_3=170 kg/ha K_2O

M_0=No mulch (control)

M_1=Straw mulch

M_2=Black Polythene mulch

4.2 Foliage coverage

Foliage coverage also significantly influenced by potassic fertilizer management practices (Table 2 and Appendix VI). Potassium fertilizer (K_2) produced the maximum foliage coverage (84.30%) and the minimum area was covered (76.75%) by K_0 (control).

Good foliage indicates good growth, development and productivity of plants. In the present study ,the area covered by foliage was significantly influenced by mulching (Table 2 and Appendix-VI) .Straw mulch treatments produced the maximum foliage coverage (83.66 %) and the minimum area was covered (78.95%) by the black polythene mulch .

Interaction effect of mulching and potassium fertilizer practices showed significant effect on foliage coverage at different days after planting. The highest foliage coverage (89.33%) by the treatment combination of straw mulch with K_2 fertilizer treatment. The lowest foliage coverage (77.21%) was recorded in no mulch with no fertilizer (Table 3 and Appendix-VI).

4.3 Number of main stem per hill

The number of main stem per hill was also significantly affected by the different doses of potassium fertilizer practices (Table 2 and Appendix VII) . The number of main stems per hill was the highest (5.71) in K_2 and was the lowest (4.55) in K_0 (control) .

The number of main stem per hill varied significantly due to different mulching treatments (Table 2 and Appendix VII) The maximum number of main stem per hill (5.63) was produced by M_1 straw mulch, while the minimum number of main stem (5.02) was found in M_0 (control) .

There was a significant combination effect of potassium and mulching on the number of main stems per hill (Table 3 and Appendix VII). The maximum numbers of stems (6.98) were given by the treatment combination of K_2 fertilizer with straw mulch and the lowest (4.05) was recorded from the treatment combination of no mulch with no fertilizer .

4.4 Fresh weight of haulm (g/hill)

Fresh weight of haulm per hill varied significantly with different level of potassium. (Table 2 and Appendix-VIII). The highest fresh weight of haulm (33.62 g/hill) was obtained from K_2 and the lowest (16.80 g/hill) was produced by K_0 (control).

Significant variation was found among different mulches in fresh weight of haulm per hill (Table 2 and Appendix-VIII). Straw mulch produced the highest (29.189 g/hill) fresh weight of haulm. On the other hand, the lowest (24.99 g/hill) was found in no mulch treatment . Water supply probably hampered normal growth of potato under no mulch condition. On the other hand, sufficient soil moisture was conserved by straw mulch that increased plant height and greater thickness of the stem, which increased fresh weight of haulm.

Different mulching and potassium fertilizer management practices in respect of fresh weight were found statistically significant (Table 3 and Appendix VIII). The highest fresh weight of haulm was recorded from K_2M_1 treatment (43.45 g/hill) and the lowest (11.33 g/hill) from no potassium and no mulch.

Table 2: Main effect of potassium and fertilizer on foliage coverage,number of stem,weight of haulm

Treatment	Foliage coverage(%)	No. of Stem	Weight of Haulm (g)
Effect of potassium			
K_0	76.75 a	4.55 b	16.80 b
K_1	78.97 a	5.29 a	30.99 a
K_2	84.30 a	5.71 a	33.62 a
K_3	83.55 a	5.62 a	27.65 a
S.E	3.356	0.140	2.601
Significance level	0.414	0.020	0.004
Effect of Mulch			
M_0	78.95 a	5.02 b	24.99 a
M_1	83.66 a	5.63 a	29.18 a
M_2	80.07 a	5.23 b	27.63 a
S.E	1.099	0.121	2.253
Significance level	0.621	0.258	0.665

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability analyzed by DMRT.

S.E=Standard Error

K_0= No fertilizer(control)

K_1=110 kg/ha K_2O

K_2=140 kg/ha K_2O

K_3=170 kg/ha K_2O

M_0=No mulch (control)

M_1=Straw mulch

M_2=Black Polythene mulch

Table 3: Combined effect of potassium and fertilizer on foliage coverage, number of stem, weight of haulm.

Treatment	Foliage coverage (%)	No. of Stem	Weight of haulm (g)
K_0M_0	77.21 ab	4.05 f	11.33 e
K_0M_1	77.84 ab	4.71 ef	25.43 b-d
K_0M_2	82.22 ab	4.88 de	13.66 de
K_1M_0	86.41 a	6.11 bc	34.77 a-c
K_1M_1	84.11 ab	5.27 de	27.66 b-d
K_1M_2	78.41 ab	4.49 ef	30.55 a-c
K_2M_0	79.05 ab	5.16 de	29.99 a-c
K_2M_1	89.33 a	6.98 a	43.55 a
K_2M_2	81.52 ab	4.99 de	27.33 b-d
K_3M_0	81.13 ab	4.77 d-f	23.88 c-e
K_3M_1	87.36 ab	5.55 cd	20.10 c-e
K_3M_2	86.16 a	6.55 ab	38.97 ab
S.E	5.813	0.24	4.505
Significance Level	0.191	0.000	0.001

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability analyzed by DMRT.

S.E=Standard Error

K_3=170 kg/ha K_2O

K_0= No fertilizer(control)

M_0=No mulch (control)

K_1=110 kg/ha K_2O

M_1=Straw mulch

K_2=140 kg/ha K_2O

M_2=Black Polythene mulch

4.5 Dry weight of haulm

Different fertilizer management practices showed significant variation in respect of dry weight of haulm(Table 4 and Appendix-IX). The maximum dry weight of haulm (13.07 g/hill) was obtained from K_2 treatment practices. The minimum (8.37 g/hill) was obtained from no potassium fertilizer

There was a significant effect of mulch on the growth and yield of potato (Table 4 and Appendix-IX). The highest dry height of haulm (10.95g/hill) was found from the straw mulch. The lowest dry weight of haulm was recorded in no mulch treatment (9.93 g/hill) . Straw mulch probably conserved adequate soil moisture, which increased plant height, number of leaves and chlorophyll content of the plant (El-Okash *et al*., 1993).

There was significant interaction between mulching and potassium fertilizer practices on the dry weight of haulm (Table 5 and Appendix-IX). The maximum dry weight of haulm (16.81 g/hill) was obtained from the combination of straw mulch and K_2 treatment fertilizers, and the minimum dry weight of haulm (7.93 g/hill) was obtained from the combination of no mulch and no potassium.

4.6 Number of tuber per hill

The number of tubers per hill was significantly influenced by different potassium fertilizer management practices (Table 4 and Appendix X). The highest number of tubers per hill (7.79) was given by K_3 treatment of potassium fertilizer, while the lowest (5.35) was produced by the plants in no potassium application . The increase in number of tubers per hill might be due to increased photosynthetic activity and translocation of photosynthesis to axillary shoots, which might have helped in the initiation of more stolons (Anand and Krishnappa, 1988).

The number of tubers per hill was significantly affected by mulching treatments (Table 4 and Appendix-X). The highest number (7.29) was found in plants under black polythene mulched condition (M_2) and the lower number (6.59) was found in no mulch .

There was a statistically significant combined effect of potassium and mulching on the number of tubers per hill (Table 5 and Appendix-X). The maximum number of tubers per hill (8.33) was produced by K_3 fertilizer and black polythene mulch. The lowest number of tubers per hill (4.72) was produced by the treatment combination of no potassium with no mulch .

4.7 Weight of single tuber

The number of tubers per hill was significantly affected by potassium treatments (Table 4 and Appendix XI).The maximum weight of single tuber (43.51 g) was recorded with the crop was grown with K_2 fertilizer. While the minimum tuber weight (27.32 g) was found in no potassium .

Weight of single tuber per hill was significantly affected by the mulching treatments (Table 4 and Appendix XI). The statistical result was not significant. The highest weight of single tuber per hill was found in straw mulch (41.31 g). On the other hand, the lowest weight of tubers per hill was found in no mulch treatment (31.77 g).

There was a statistically significant combined effect of potassium and mulching on the number of tubers per hill (Table 5 and Appendix XI). Combined effect of potassium and mulching was found maximum (52.51 g) K_2 with straw mulch and the lowest (24.77 g) was from no potassium and no mulch .

Table 4. Main effect of dry wt. of haulm,number of tuber/hill,weight of single tuber

Treatment	Dry Weightt of Haulm (g)	No of tuber/hill	Weight of Single Tuber (g)
Effect of potassium			
K_0	8.33 c	5.35 b	27.32 c
K_1	10.81 b	7.18 a	36.74 b
K_2	13.07 a	7.67 a	43.51 a
K_3	10.07 b	7.79 a	40.86 ab
S.E	0.309	0.161	1.12
Significance level	0.000	0.000	0.000
Effect of mulch			
M_0	9.93 b	6.59 a	31.77 b
M_1	10.95 a	7.10 a	41.31 a
M_2	10.83 a	7.29 a	38.24 ab
S.E	0.268	0.227	1.365
Significance level	0.590	0.441	0.023

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability analyzed by DMRT.

S.E=Standard Error

K_0= No fertilizer(control)

K_1=110 kg/ha K_2O

K_2=140 kg/ha K_2O

K_3=170 kg/ha K_2O

M_0=No mulch (control)

M_1=Straw mulch

M_2=Black Polythene mulch

Table 5. Combined effect of dry weight of haulm, number of tuber/hill, weight of single tuber.

Treatment	Dry weight of haulm (g)	No. of Tuber/Hill	Wteight of single tuber (g)
K_0M_0	7.93 gh	4.72 c	24.77 e
K_0M_1	8.43 f-h	5.62 bc	26.66 e
K_0M_2	8.65 f-h	5.71 bc	30.55 de
K_1M_0	11.53 b-d	6.68 ab	30.78 de
K_1M_1	10.94 c-e	7.81 a	36.00 cd
K_1M_2	9.97 d-f	7.05 ab	43.44 b
K_2M_0	10.69 c-e	7.50 ab	37.66 bc
K_2M_1	16.81 a	7.44 ab	52.55 a
K_2M_2	11.73 bc	8.09 a	40.33 ab
K_3M_0	9.59 e-g	7.49 ab	33.88 cd
K_3M_1	7.65 h	7.55 ab	50.05 a
K_3M_2	12.98 b	8.33 a	38.66 bc
S.E	0.536	0.1666	0.626
Significance Level	0.000	0.004	0.000

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability analyzed by DMRT.

S.E=Standard Error

K_3=170 kg/ha K_2O

K_0= No fertilizer(control)

M_0=No mulch (control)

K_1=110 kg/ha K_2O

M_1=Straw mulch

K_2=140 kg/ha K_2O

M_2=Black Polythene mulch

4.8 Weight of tuber per hill

There was statistically a significant combined effect of potassium fertilizer management practices and mulching on the weight of tuber per hill (Table 6 and Appendix XII). The maximum tuber weight per hill (327.42 g) was recorded with the crop was grown with K_2 treatment. While the minimum tuber weight (147.06 g) was found in no potassium .

Weight of tubers per hill was significantly affected by the mulching treatments (Table 6 and Appendix XII). The highest weight of tubers per hill was found in straw mulch (295.60 g). On the other hand, the lowest weight of tubers per hill was found in no mulch treatment (212.55 g) .

There was statistically a significant combined effect of potassium and mulching on the weight of tuber per hill(Table 7 and Appendix-XII). The maximum tuber weight per hill (382.41 g) was produced from K_2 potassium fertilizer with straw mulch, while the minimum (116.90 g) was obtained from no potassium fertilizer no mulch treatment.

4.9 Dry weight of tuber

There was statistically a significant effect of potassium fertilizer management practices and mulching on the weight of tuber per hill(Table 6 and Appendix-XIII). The maximum dry weight of tuber (20.39 g) was obtained when the crop was grown on K_3 treatment. The minimum dry weight (18.58 g) was found in the no potassium fertilizer treatment (Table 6).

There was statistically a significant effect of mulch (Table 6, Appendix-XIII). The dry weight of tuber was maximum (20.41 g) in black polythene mulch. The dry weight of tuber was the lowest (19.0 g) in no mulch condition .

There was statistically a significant combined effect of fertilizer management practices and mulching on the weight of tuber per hill(Table 7 and Appendix

XIII). Combined effect of potassium and mulching was maximum (22.31g) in black polythene mulch with K_3 and the lowest (18.78g) was from no potassium with no mulch.

4.10 Yield of tuber per plot

There was statistically a significant effect of potassium on the weight of tuber per plot (Table 6 and Appendix-XIV). The highest yield of tubers (13.06 kg/plot) was obtained from K_2 fertilizer treatment. The lowest yield (5.88 kg/plot) of tuber was obtained from no potassium application.

There was statistically a significant effect of mulch on the yield of tuber per plot (Table 6 and Appendix-XIV). The highest yield of tubers (11.79 kg/plot) was obtained from straw mulch. The lowest yield of tuber (8.48 kg/plot) was obtained from no mulch (Table 6).

There was statistically a significant combined effect of potassium and mulching on the weight of tuber per hill (Table 7 and Appendix XIV). In combined effect, the highest yield (15.24 kg/plot) was found in the K_2 potassium fertilize practices with straw mulch and the lowest yield (4.68 kg/plot) were found in no potassium with no mulch (Table 7).

4.11 Yield of tuber per hectare

There was found statistically significant effect of potassium on the yield of potato.(Figure 4, Table 6 and Appendix XV).The maximum yield (27.20 ton/ha) was found in K_2 potassium fertilizer treatment and lowest yield (12.25 ton/ha) was found in K_0 no potassium. Effect of potassium showed positive result and presented its importance on the growth and yield of potato.

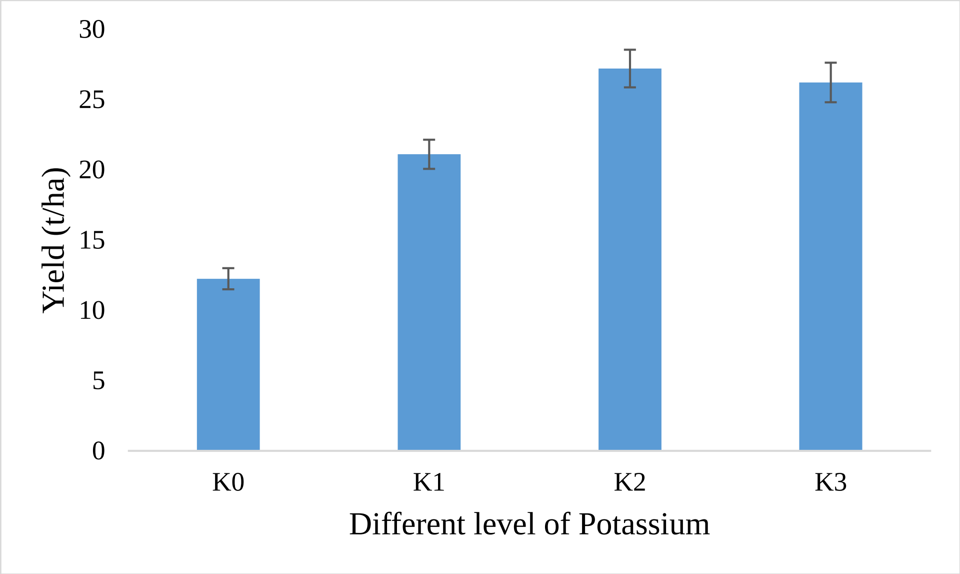

Fig. 4. Effect of different level of potassium on the yield of tuber of potato

Whereas, K_0= No potassium fertilizer, K_1=110 kg/ha K_2O, K_2=140 kg/ha K2O and K_3=170 kg/ha K_2O.

There was statistically significant effect of mulch on the yield of potato. (Figure 5, Table 6 and Appendix XV).The maximum yield (24.57 ton/ha) was found in straw mulch and the lowest yield (17.68 ton/ha) was found in no mulch treatment . 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

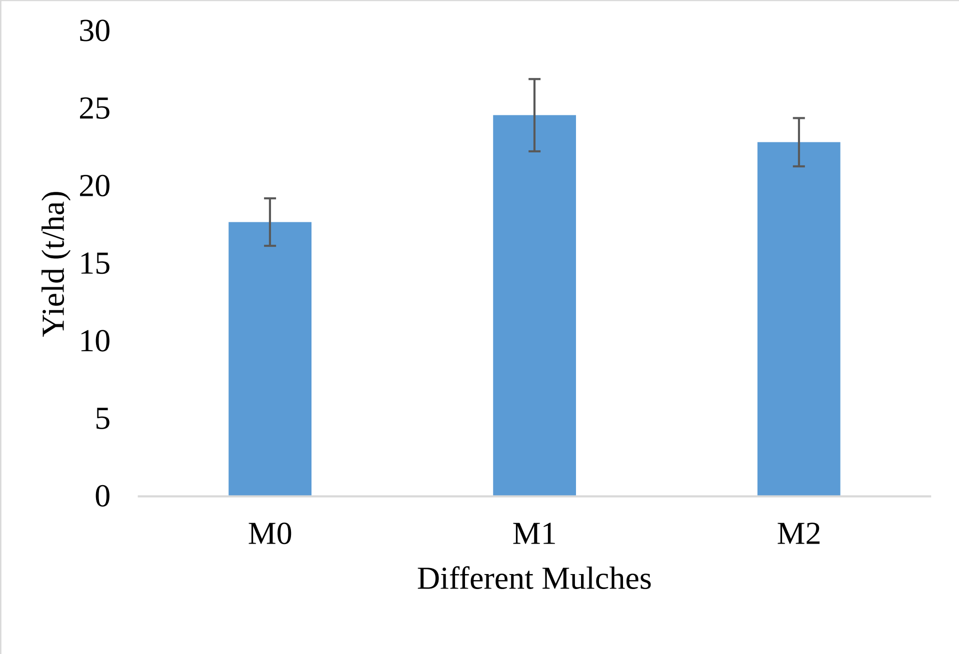

Fig. 5: Effect of different mulch on the yield of potato.

M_0=No mulch (control) , M_1=Straw mulch, M_2=Black Polythene mulch

There was statistically a significant combined effect of potassium and mulching on the yield of potato.The combination of different potassium and mulching influenced significantly on the yield of potato. (Table 7 and Appendix XV) .The highest yield (31.75 ton/ha) of potato was obtained from the treatment straw mulch with K_2 potassium fertilizer and lowest yield (9.74 ton/ha) was obtained from no fertilizer with no mulch.

Table 6: Main effect of weight of tuber/hill, dry weight of tuber, yield/Plot.

Treatment	Weight of tuber/hill (g)	Dry weight of tuber (g)	Yield/Plot (Kg)
Effect of potassium			
K_0	147.01 c	18.58 b	5.88 c
K_1	253.34 b	20.45 a	10.13 b
K_2	327.42 a	19.96 a	13.06 a
K_3	315.08 a	20.39 a	12.58 a
S.E	6.814	0.309	0.306
Significance level	0.000	0.034	0.000
Effect of mulch			
M_0	212.55 b	19.01 b	8.48 b
M_1	295.60 a	20.03 a	11.79 a
M_2	273.99 ab	20.49 a	10.96 ab
S.E	12.727	0.268	0.525
Significance level	0.032	0.050	0.040

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability analyzed by DMRT.

S.E=Standard Error

K_0= No fertilizer(control)

K_1=110 kg/ha K_2O

K_2=140 kg/ha K_2O

K_3=170 kg/ha K_2O

M_0=No mulch (control)

M_1=Straw mulch

M_2=Black Polythene mulch

Table 7. Interaction effect of potassium and mulching on weight of potato/hill, dry weight of potato, yield/plot, yield/ha.

Treatment	Weight of tuber/hill (g)	Dry weight of tuber (g)	Yield/Plot (kg)	Yield/ha (ton)
K_0M_0	116.90 j	17.28 e	4.68 h	9.74 h
K_0M_1	149.77 i	19.04 d	5.99 gh	12.48 g
K_0M_2	174.37 h	19.42 cd	6.97 fg	14.53 f
K_1M_0	205.59 g	20.81 a-c	8.22 f	17.13 e
K_1M_1	281.05 d	19.32 cd	11.24 de	23.42 c
K_1M_2	273.38 e	21.24 ab	10.94 e	22.78 cd
K_2M_0	273.72 e	19.10 cd	10.89 e	22.69 cd
K_2M_1	382.41 a	21.76 a	15.24 a	31.75 a
K_2M_2	326.15 c	19.02 d	13.05 bc	27.18 b
K_3M_0	254.02 f	18.86 d	10.16 e	21.17 d
K_3M_1	369.17 b	20.02 b-d	14.71 ab	30.65 a
K_3M_2	322.06 c	22.31 a	12.88 cd	26.84 b
S.E	0.608	0.536	0.166	0.166
Significance Level	0.000	0.000	0.000	0.000

In a column having similar letter (s) are statistically identical and those having dissimilar letter (s) differ significantly as per 0.05 level of probability analyzed by DMRT.

S.E=Standard Error

K_0= No fertilizer(control) K_2O

K_1=110 kg/ha K_2O

K2=140 kg/ha K_2O

K_3=170 kg/ha

M0=No mulch(control)

M_1=Straw mulch

M_2=Black Polythene mulch

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 2017 to February 2018 to study the effect of potassium and mulching on the growth and yield of potato (cv. 'Diamant'). The experiment comprised with two factors namely, 1) Potassium application at different level K_0:No potassium (control) , K_1:110 kg/ha of K_2O, K_2 :140 kg/ha of K_2O, K_3:170 kg/ha of K_2O. 2) Three different mulch practices M_0:No mulch (control), M_1:straw mulch, and M_2: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 (1.5 m x 2 m). and twenty-four plants were accommodated in each plot following a spacing of 50 cm x 25 cm. Sprouted seed tubers were planted in the field on 24 November 2017. Six plants were randomly selected in each plot to record data on yield contributing characters, tuber growth and yield. Observations were made on plant height, foliage coverage (%), number of main stem per hill, fresh weight of haulm per hill, dry weight of haulm per hill, weight of tubers per hill, number of tubers per hill, single tuber weight, dry weight of tuber, yield of tubers per plot as well as per hectare. The results of the experiment have been summarized below.

Different levels of potassium fertilizer showed a significant effect on most of the characters. Plants grown from K_2 (140 kg/ha) treatment showed maximum plant height, foliage coverage (%), fresh weight of haulm per hill, dry weight of haulm, weight of tuber per hill, single tuber weight, yield of tubers per plot as well as per hectare (27.20 t/ha) except number of tuber/hill and dry weight of potato.

Different mulching treatments played an important role in the growth and yield of potato. Results of the experiment showed that most of the character studied was significantly influenced by the treatments except foliage coverage, number of tuber/hill and dry weight of tubers. This mulching treatment gave maximum plant height, number of main stems per hill, fresh weight of haulm per hill, dry weight of haulm, weight of tubers per hill, yield of tubers per hill, single tuber weight, yield of tubers per plot as well as per hectare (24.57 t/ha) was highest whereas the lowest yield (17.68 t/ha) was obtained from no mulch treatment.

Combination effect of different mulching and fertilizer management practices were significant on most of the yield and yield contributing characters and was highest (31.75 t/ha) in K_2M_1 and lowest (9.74 t/ha) was with K_0M_0 (control)

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

1. For maximizing the yield, potassium is essential but excess amount give deleterious effect.

2. The yield components and yield of potato were positively influenced by the use of straw and black polythene mulch. The highest yield was produced from straw mulch.

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APPENDIX

Appendix I. Physical characteristics and chemical composition of the soil of the experimental plot

Soil characteristics	Analytical results
Agro Ecological Zone	Madhupur Tract
pH	6.00-6.63
Organic matter	0.84
Total N (%)	0.46
Available phosphorus	21 ppm
Exchangeable K	0.41 meq / 100g soil

Source: Soil resource and development institute (SRDI), Dhaka

Appendix II. Monthly recorded the average air temperature, rainfall, relative humidity and sunshine of the experimental site during the period from October 2017 to March 2018.

Month	Air temperature		Relative humidity (%)	Total rainfall (mm)	Sunshine (hr)
October, 2017	31.6	23.8	78	172.3	5.2
November, 2017	29.6	19.2	77	34.4	5.7
December, 2017	26.4	14.1	69	12.8	5.5
January, 2018	25.4	12.7	68	7.7	5.6
February, 2018	28.1	15.5	68	28.9	5.5
March, 2018	32.5	20.4	64	65.8	5.2

Source: Bangladesh Meteorological Department (Climate & Weather Division) Agargoan, Dhaka – 1212.

Appendix III. Analysis of variance of plant height at 35 DAP

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	87.138	87.138	87.138	0.023
Mulching	2	9.715	4.858	0.480	0.623
Potassium × Mulching	11	179.446	16.313	2.380	0.037

Appendix IV. Analysis of variance of plant height at 55 DAP

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	281.453	93.818	2.823	0.054
Mulching	2	48.839	24.419	0.622	0.543
Potassium × Mulching	11	922.115	83.829	4.758	0.001

Appendix V. Analysis of the variance of plant height at 75 DAP

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	286.639	95.546	2.929	.049
Mulching	2	76.409	38.204	1.005	.377
Potassium × Mulching	11	982.915	89.356	6.171	.000

Appendix VI. Analysis of variance of foliage coverage (%)

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	347.398	115.799	0.982	0.414
Mulching	2	117.187	58.593	0.483	0.621
Potassium × Mulching	11	1688.082	153.462	1.514	0.191

Appendix VII. Analysis of variance of the number of stems .

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	7.547	2.516	3.768	0.020
Mulching	2	2.279	1.140	1.412	0.258
Potassium × Mulching	11	24.692	2.245	12.771	0.000

Appendix VIII. Analysis of variance of weight of haulm .

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	1474.983	491.661	5.365	0.004
Mulching	2	107.725	53.862	0.413	0.665
Potassium × Mulching	11	2946.166	267.833	4.399	0.001

Appendix IX. Analysis of variance of dry weight of haulm .

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	104.182	34.727	8.345	0.000
Mulching	2	7.474	3.737	0.536	0.590
Potassium × Mulching	11	216.680	19.698	22.875	0.000

Appendix X. Analysis of variance of number of tuber/hill .

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	34.532	11.511	12.327	0.000
Mulching	2	3.121	1.560	0.840	0.441
Potassium × Mulching	11	40.413	3.674	3.674	0.004

Appendix XI. Analysis of variance of weight of single tuber .

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	1358.783	452.928	10.161	0.000
Mulching	2	569.617	284.808	4.242	0.023
Potassium × Mulching	11	2446.507	222.410	15.761	0.000

Appendix XII. Analysis of variance of the weight of potato/hill .

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	183503.152	61167.717	36.590	0.000
Mulching	2	44548.436	22274.218	3.819	0.032
Potassium × Mulching	11	236677.106	21516.101	1613.708	0.000

Appendix XIII. Analysis of variance of dry weight of tuber .

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	20.629	6.876	3.250	0.034
Mulching	2	13.862	6.931	3.072	0.060
Potassium × Mulching	11	67.660	6.151	7.143	0.000

Appendix XIV. Analysis of variance of yield/plot .

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	291.089	97.030	28.653	0.000
Mulching	2	71.000	35.500	3.567	0.040
Potassium × Mulching	11	375.453	34.132	34.132	0.000

Appendix XV. Analysis of variance of yield/ha .

Source	Degrees of freedom	Sum of square	Mean sum of square	F value	P value
Potassium	3	1263.639	421.213	34.542	0.000
Mulching	2	308.261	154.131	3.780	0.033
Potassium × Mulching	11	1629.853	148.168	148.168	0.000