EFFECT OF POTASSIUM AND MAGNESIUM ON THE GROWTH AND YIELD OF POTATO

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JUNE, 2020

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A Thesis
Submitted to the Department of Soil Science
Sher-e-Bangla Agricultural University, Dhaka
In partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE (MS)

IN

SOIL SCIENCE

SEMESTER: JANUARY- JUNE, 2020

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CERTIFICATE

This is to certify that the thesis entitled **"EFFECT OF POTASSIUM AND MAGNESIUM ON THE GROWTH AND YIELD OF POTATO"** submitted to the Department of Soil Science, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTERS OF SCIENCE (M.S.)** in **SOIL SCIENCE**, embodies the result of a piece of bonafide research work carried out by **TANNA AFRUZ JHINUK**, Registration No. 13-05273 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

June, 2020

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Dedicated to

My

Beloved Parents

ACKNOWLEDGEMENTS

The author seems it a much privilege to express his enormous sense of gratitude to the almighty Allah for there ever ending blessings for the successful completion of the research work.

The author wishes to express her gratitude and best regards to his respected Supervisor, Prof. Dr. Md. Asaduzzaman Khan, Professor, Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka, for his continuous direction, constructive criticism, encouragement and valuable suggestions in carrying out the research work and preparation of this thesis.

The author wishes to express her earnest respect, sincere appreciation and enormous indebtedness to his reverend Co-supervisor, Prof. Dr. Saikat Chowdhury, Professor, Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka, for his scholastic supervision, helpful commentary and unvarying inspiration throughout the research work and preparation of the thesis.

The author feels to express her heartfelt thanks to the honorable Chairman, Prof. Dr. Alok Kumar Paul, Department of Soil Science along with all other teachers and staff members of the Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka, for their co-operation during the period of the study.

The author feels proud to express her deepest and endless gratitude to all of her course mates and friends to cooperate and help her during taking data from the field and preparation of the thesis. The author wishes to extend his special thanks to his lab mates, class mates and friends for their keen help as well as heartiest co-operation and encouragement.

The author expresses her heartfelt thanks to his beloved parents, elder sister and brother and all other family members for their prayers, encouragement, constant inspiration and moral support for his higher study. May Almighty bless and protect them all.

The Author

EFFECT OF POTASSIUM AND MAGNESIUM ON THE GROWTH AND YIELD OF POTATO

ABSTRACT

The experiment was carried out at the farm of Sher-e-Bangla Agricultural Univervisty, Dhaka, under the Department of Soil Science, during November 2018 to February, 2019 to study the effect of potassium and magnesium application on the growth and yield of potato. The experiment consisted of two factors *viz*. Factor A – three K levels as K_0 = Control (0 kg K ha^{-1}), K_1 = 100 kg K ha^{-1} and K_2 = 120 kg K ha^{-1} and Factor B: three Mg levels as M_0 = Control (0 kg Mg ha^{-1}), M_1 = 10 kg Mg ha^{-1} and M_2 = 20 kg Mg ha^{-1}. The experiment was laid out into Randomized Complete Block Design with three replications. Data were collected on different parameters and analyzed significantly using MSTAT software. In most of the cases treatment K_2 (120 kg K ha^{-1}) gave the best result and showed highest tuber yield (25.72 t ha^{-1}) whereas the lowest was obtained from control. Similarly, M_1 (10 kg Mg ha^{-1}) gave best results in most of the cases and showed highest tuber yield (22.26 t ha^{-1}). The treatment combination of K and Mg showed significant variation on different growth and yield parameters of potato. Results revealed that the highest tuber yield (26.56 t ha^{-1}) and stover yield (20.67 t ha^{-1}) were recorded from the treatment combination of K_2M_1 whereas the lowest tuber yield (14.96 t ha^{-1}) and stover yield (17.44 t ha^{-1}) were recorded from the treatment combination of K_0M_0.

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ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCSRI	=	Bangladesh Council of Scientific Research Institute
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAP	=	Days after planting
DMRT	=	Duncan's Multiple Range Test
et al.,	=	And others
e.g.	=	exempli gratia (L), for example
etc.	=	Etcetera
FAO	=	Food and Agricultural Organization
g	=	Gram (s)
i.e.	=	id est (L), that is
Kg	=	Kilogram (s)
LSD	=	Least Significant Difference
m^2	=	Meter squares
ml	=	MiliLitre
M.S.	=	Master of Science
No.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
var.	=	Variety
^oC	=	Degree Celceous
%	=	Percentage
NaOH	=	Sodium hydroxide
GM	=	Geometric mean
mg	=	Miligram
P	=	Phosphorus
K	=	Potassium
Ca	=	Calcium
L	=	Litre
µg	=	Microgram
USA	=	United States of America
WHO	=	World Health Organization

CHAPTER I

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important foods and cash crops cultivated worldwide under a wide range of climatic conditions. At present it is the fourth most important food crop in terms of its production in the world, after wheat, rice and maize (FAO, 2008). According to (FAO, 2009) report, potato is considered among the highly recommended food security crop that can safeguard low-income countries from the risks posed by rising international food prices. In the recent years potato is becoming one of the key components in the livelihood systems of small-scale farmers.

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 and vitamin – E, it contains allmost all vitamins. However, vitamin – B6 and vitamin – C are present in adequate amount and minerals like Fe, Ca, P, Mg, and S are also present in sufficient amount (Myers, 2011). According to FAO, consumption of 125 – 150 gm of potato daily fulfils the need of vitamins (FAO, 2008).

It is grown almost all countries of the world. Bangladesh is the seventh largest producer of the tuber crop. It produced a record high of 1.09 crore ton last year from 4.69 lach ha land with 14.74 tons of average yield ha^{-1} (DAE, 2019). It is considered as a vegetable crop and contributes as much 55% of the total vegetable production in Bangladesh (BBS, 2009).

Bangladesh has a great agro-ecological potential of growing potato. The area and production of potato in Bangladesh has been increasing during the last decades but the yield per unit area remains more or less static. The yield is very low in comparison to that of the other leading potato growing countries of the world, 40.16 t ha^{-1} in USA, 42.1 t ha^{-1} in Denmark and 40.0 t ha^{-1} in UK, (FAO, 2009). The reasons for such a low yield of potato in Bangladesh are due to that winter, imbalanced fertilizer application, use of low quality seed and use of sub-optimal production practices.

Available reports indicated that potato production in Bangladesh can be increased by improving cultural practices among which optimization of manure and fertilizer, planting time, spacing and use of optimal sized seed are important which influences the yield of potato (Divis and Barta 2001). Proper nutrient management is the most essential part for successful potato production. It requires different nutrients like N, P, K, S, Zn, B, Mg, Ca etc. Among them K and Mg are very important for higher potato yield.

Research revealed that potassium (K) is one of the most essential nutrients required for plant development. It plays vital role in several physiological processes such as photosynthesis, translocation of photosynthates, control of ionic balance, regulation of plant stomata and transpiration, activation of plant enzymes and many other processes (Thompson, 2010). Potassium also enhances N uptake and protein synthesis resulting in better foliage growth (Marschner, 1995). In a plant cell potassium maintains osmotic potential which enhances water uptake and root permeability and acts as a guard cell. Beside this, it also increases water use efficiency (Mehdi *et al*., 2007; Zekri and Obreza, 2009). Combined application of K and N increases foliage and leaf area index (Mrton, 2001, Saha *et al*., 2001). Potato plants require much more potassium than many other vegetable crops, therefore it is also regarded as an indicator crop for K availability (Al-Moshileh and Errebi, 2004). However, potato producing areas are more concerned about the use of nitrogen (N) and phosphorus (P) whereas potassium (K) application is ignored which causes serious decrease in yield and potassium content in soils (Pervez *et al*., 2013).

Magnesium (Mg) is involved in many physiological and biochemical processes; it is an essential element for plant growth and development and plays a key role in plant defence mechanisms in abiotic stress situations (Cakmak and Kirkby 2008; Cakmak 2013). The most commonly known function of Mg in plants is probably its role as the central atom of the chlorophyll molecule in the light-absorbing complex of chloroplasts and its contribution to photosynthetic fixation of carbon dioxide (Cakmak and Kirkby 2008; Cakmak and Yazici 2010; Gerendás and Führs 2013). However, the Mg bond to chlorophyll makes up only a small part of the total Mg fraction. Depending on the Mg status of the plant, ~20% (Marschner 2012; Gransee and Führs 2013) and up to 35% (Cakmak and Kirkby 2008; Cakmak and Yazici 2010) of the element is localised in the chloroplast, and the remaining Mg is present in more mobile forms (Marschner 2012). Because of its high phloem mobility, Mg can easily be translocated to active growing parts of the plant where it is needed for chlorophyll formation, enzyme activation for protein biosynthesis, and phloem export of photosynthates to ensure vegetative and generative growth. Therefore, first visual deficiency symptoms of Mg generally occur on older leaves (White and Broadley 2009; Gransee and Führs 2013).

Considering the above all situation a study was conducted with different levels of potassium and magnesium on the growth and yield of potato with the following objectives:

1. To study the effect of K and Mg on yield and quality of potato;
2. To study the application of K and Mg on the improvement of soil fertility.

CHAPTER II

REVIEW OF LITERATURE

Potato (*Solanum tuberosum* L.) is considered a major food crop in the world. Very few research are available regarding the requirement of potassium and magnesium for growth, and tuber production of potato. A brief review of these pertinent to the present study has been given below:

2.1 Effect of potassium

Abd El-Latif (2011) carried out two field experiments on potato (*Solanum tuberosum*, L.) for two successive seasons of 2009 and 2010. The study concerned the use of different rates of potassium fertilization (72, 96 and 120 kg K_2O/fed.) under different irrigation schedulings (40, 60 and 80 % from available water) on potato crop in alluvial soil. Generally, in most cases, the treatment of the medium or/and highest soil moisture level (60 and 80 % from available water) gave the highest significant values for plant height, dry matter and K content of potato plant at 90 days from planting and potato yield tuber (ton/fed) N, P and K contents in tuber in addition to, total soluble solids and protein content in tuber as well as consumptive use. While the lowest one were recorded when the lowest soil moisture level (40% from available water) was applied. Generally, all K rates gave the highest significant values for all parameters under study. The second level of potassium 96 kg K_2O/fed achieved the highest significant values of dry matter, content of N and K at 90 days from planting as well as N content in tuber. Whereas, the high values of tuber yield, protein content, water use efficiency and consumptive use were obtained when 120 kg K_2O/fed was applied. In most cases, the high levels of potassium under 80 % from available water gave highest significant values for all parameters under study in both seasons.

The quality parameters such as dry matter, specific gravity, starch contents, vitamin-C and ash contents are affected with application of P and K (Khan *et* *al*., 2012). Application of potassium is not only responsible to increase K concentration but also affects the concentration of N and P in potato tubers (Muhammad *et al*., 2015). According to Singh and Lal (2012) found potassium affect significantly higher plant height, number of leaves per plant and marketable yield of potato tubers.

Application of potassium fertilizer plays vital role in yield of potato. Researcher have shown that increasing the levels of potassium increases the potato tubers yield (El-Gamal, 1985; Humadi, 1986). Such increases in yield of potato tubers is either due to the formation of large size tubers or increasing of the number of tubers per plant or both. Westennann (2005) stated that insufficient K resulted in smaller-sized tubers. Potassium increases the size but not the total number of tubers (Trehan *et al*., 2001). Potassium helps to increase the content of carbohydrate significantly which ultimately helps to increase the tuber size (Al-Moshileh and Errebi, 2004).

Research performed by Khan *et al*. (2010) recorded highest yield of 17.18 ton ha^{-1} at 150 kg K ha^{-1} + 1% K foliar spray of SOP whereas 16.9 ton ha^{-1} at 150 kg K ha^{-1} + 1% K foliar spray from MOP source while lowest yield was recorded at 250 kg N ha^{-1}. Furthermore, application of 225 kg K ha^{-1} was found to be less effective than 150 kg K ha^{-1}. Yield increase was only 6% from applied 225 kg K ha^{-1} with SOP and 4% with MOP over 150 kg K ha^{-1}. In another study, application of 100 kg K ha^{-1} significantly increased tuber yield over control (Adhikari and Sharma, 2004).

Another research, conducted on different doses of potassium, 0, 150 and 225 kg K ha^{-1}, from sulphate and muriate of potash and doses of nitrogen (N) and phosphorus (P) applied uniformly, showed significant increase in tuber yield at 150 kg K ha^{-1} from both the sources over control. Increase in tuber yield with 225 kg K ha^{-1} was statistically non-significant compared to 150 kg ha^{-1}. This result have indicated, application of K at 150 kg ha^{-1} enhance the marketable potato tuber yield significantly. Also, the increase in yield was more with MOP as compared to SOP (Khan *et al*., 2010).

In a pot experiment designed to evaluate potato responsiveness to increasing rates of K was supplied with either as K_2SO_4 or KCl at the rate of 0, 200, 400 and 600 mg K/ kg soil. Ammonium nitrate and triple superphosphate were also added to all variants to provide 200 mg/ kg N and 150 mg/ kg P_20_5 respectively. The result showed that effect was more pronounced in treatments with KCl where the decrease of dry matter content reached 15% at the highest K level (K_{600}) when compared to the control (Manolov *et al*., 2015). Bansali and Trehan (2011) observed similar result of reduction of dry mater content in tubers when fertilized with KCl.

Yield attributes on potato is not only affected by rate of potassium, is also affected by source of potassium fertilizer. K_2SO_4 have showed best result over KCl. Plants treated with K_2SO_4 translocated more photosynthates from the leaves and stems to the tubers compared with plants treated with KCl (Bansali Trehan, 2011). Also, foliar spray of K @ 1% contributed to increase potato tuber yield. Hence, application of K through foliar spray is recommended along with soil application (Khan *et al*., 2010). Also, to achieve high tuber quality it is recommended to fertilize less with nitrogen and increase phosphorus and potassium fertilizer rates (Vos, 1999).

Roy *et al.* (2007) carried out an experiment to find out the relationship of nitrogen and potassium on quality of TPS. Three levels of nitrogen (0, 225 and 300 kg N ha^{-1}) and 4 levels of potassium (0, 125, 175 and 225 kg K ha^{-1}) fertilizers were applied to potato mother plants (MF-II) for the production of high quality True Potato Seed (TPS). Results showed that, increase in K application significantly increased N, P and K concentrations, while decreases in Ca, Mg and Na concentrations in TPS. Increase in N application significantly increased N, P, Ca, Mg and Na concentrations in TPS but K did not increase. Tuber weight was the highest (10.4 g) when 300 kg N and 125 kg K ha^{-1} were applied. Large TPS also showed high emergence rate (94%), seedling vigor (4.8) and dry matter content (10.5%) in nursery beds when 300 kg N and 125 kg K ha^{-1} was applied. Large TPS always showed better performance than small TPS. In conclusion, the combination of 300 kg N and 125 kg K ha^{-1} was the best combination for application to potato mother plants for the production of high quality TPS.

Karam *et al. (*2005) conducted a field experiment to determine the response of yield and tuber quality of four potato cultivars ('Spunta', 'Derby', 'Shepody' and 'Umatilla') to added potassium rates: K_0 (0 potassium), K_1 (96 kg K ha^{-1}), K_2 (192 kg K ha^{-1}) and K_3 (288 kg K ha^{-1}) in absence of water and nitrogen limitations. The significant increases of tuber yield in response to K rates. However, while for 'Shepody' tuber yield increase was associated with an increase in dry matter content, no increase in this parameter was obtained with 'Umatilla'. Finally, results showed no significant differences between the two potassium levels K_2 and K_3 either for tuber yield or dry matter content. In terms of cultivars potassium fertilization significantly increased the yield of medium (25-75 g) and large size tubers (>75 g) at the cost of small size tubers (<25 g).

Wijkmark *et al.* (2005) showed that, site-specific K fertilizer application led to improved potato quality with regards to after-cooking darkening, strong sogginess and weak sogginess. On the other hand, site-specific k fertilizer application had no influence on yield levels. The economic and qualitative effects of site-specific application of potassium fertilizer to potato fields based from the farmer's perspective was studied in a pilot experiment conducted in Holland, Sweden, during the 2002, 2003 and 2004 cropping seasons. In 2003, 3 ordinary plot trials with different K fertilizer applications (90, 120 and 150 kg K ha^{-1}) were performed and in 2004, the trial was performed once again, this time in a different field. K fertilizer @ 120 kg ha^{-1} showed highest tuber yield in both the year.

Moinuddin and Shahid (2004) carried out an experiment in a sand culture, potato (*Solanum tuberosum* L.) was grown to maturity in the greenhouse to study the effects of factorial application of four levels, each of potassium (2, 4, 8, and 12 meq L^{-1}) and sulfur (1, 2, 4, and 6 meq L^{-1}), on yield, quality, and storage behavior of tubers. In general, the effect of K was more pronounced than that of S on overall crop performance. Increasing K and S levels in the nutrient medium increased tuber yield as well as dry matter content. As compared to the lowest S level, application at 4 and 6 meq S L-1 enhanced average tuber yield and percent dry matter content by 28 and 0.41%, respectively.

Khandakhar *et al.* (2004) conducted a study to investigate the effect of different application rates of lime (0, 0.5, 1.0 and 2.0 t ha^{-1}) and potassium fertilizer (0, 60, 80 and 100 kg K ha^{-1}) on tuber yield of potato cv. Cardinal. Lime and potassium treatments significantly increased tuber yield. The highest increased yield was recorded ~86.54% over the control. The optimum rate of lime and potassium in acidic sandy-loam soils that could be recommended for potato cultivation is 2 t ha^{-1} and 100 kg ha^{-1}, respectively.

Jenkins and Mahmood (2003) examined effects on growth, dry matter partitioning and nutrient uptake in potato plants grown in large pots under different combinations of adequate and deficient levels of nitrogen, phosphorus and potassium. N supply affected the growth of all leaves, with low N reducing both the size of individual leaves and the extent of branch growth. P and K availability affected the growth of later formed leaves and only when both were deficient was branch growth substantially reduced. At later stages of growth, total green leaf area was significantly reduced by deficiency of each of the nutrients. Partitioning of dry matter to tubers was markedly reduced by K deficiency and increased in one experiment by P deficiency. When both P and K were deficient, partitioning approximated that under non-limiting conditions.

Sobhani *et al.* (2002) showed that yield and some agronomic characteristics of potato, potassium had a minimal effect on plant height and number of stems and tubers per plant, but increased the average tuber weight. An experiment was conducted in Iran to determine the effects of water deficit and potassium nutrition on the yield and agronomic characteristics of potato. Water deficit decreased crop yield and biological yield, while potassium application increased both yields. Water deficit had a negative effect on the number of stems and tubers per plant, average tuber weight, and plant height.

Lalitha *et al.* (2000) conducted a field experiment to determine the effects of different potassium (100, 125 and 150 kg ha^{-1}) and sulfur rates (0 and 25 kg ha^{-1}) on the concentration and uptake of nutrients of true potato seed and seed tuber cultivars HPS-1/13 and Kufri Jyothi. Results showed that, potassium fertilizer application reduced the nitrogen concentration, HPS-1/13 produced more dry matter than Kufri Jyothi. Kufri Jyothi had more nitrogen, phosphorus, potassium and sulfur content than HPS-1/13. However, uptake of these nutrients was higher in HPS-1/13 than in Kufri Jyothi.

2.2 Effect of magnesium

Rahman (2011**)** conducted a field experiment to study the effects of zinc and manganese on growth and yield of potato cv. Granola. The experiment was laid out in Randomized Complete Block Design with three replications. There were four levels of Zinc. *viz*. 0, 3, 4 and 5 kg Zn ha^{-1} and also 4 levels of Mn, i.e. 0, 1, 2 and 3 kg Mn ha^{-1}. The results of the experiment revealed that the tallest plant, maximum number of leaves $plant^{-1}$, maximum number of main stems $hill^{-1}$, highest number of tubers $hill^{-1}$, maximum weight of tubers $hill^{-1}$ and the highest weight of tubers $plot^{-1}$ and $hectare^{-1}$ were found with 4 kg Zn ha^{-1}, while Mn had no significant effect on the growth and yield of potato. Increasing doses of Zn resulted in higher yield than the control. The results also showed that the plant height, number of leaves $plant^{-1}$, number of main stems $hill^{-1}$, number of tubers $hill^{-1}$, weight of tubers $hill^{-1}$, weight of tubers $plot^{-1}$ as well as weight of tuber ha^{-1} were maximum at 4 kg Zn + l kg Mn ha^{-1}, while the minimum values were recorded from the control treatment. The maximum yield of tuber (23.82 t ha^{-1}) was recorded in the combination of 4kg Zn + l kg Mn ha^{-1}.

Mousavi (2007) conducted an experiment to study effect of foliar application of Zn and Mn on yield and quality of potato crop. All combinations of 4 levels of both elements (including 0, 2, 4 and 8 ppm solution as sulfate compound ($ZnSO_4$, $MnSO_4$), which formed 16 different treatments, were distributed randomly in each block. Solutions were sprayed 10 days before and 20 days after flowering. Plants were harvested after ripened and plant characteristics including tuber weight, number of tuber per plant, tuber yield, percent of dry matter, specific weight, protein and starch percent on tuber were measured. Results showed that Zn and Mn application increased all plant characteristics relating to yield and quality of potato crop. These were tuber yield per plant, dry matter percentage, specific weight, protein and starch contents of the tuber. Application of Zn at 8 ppm increased yield to 34170 kg ha^{-1} which, was 25% higher compare with control, meanwhile application of Mn at 4 ppm level increased yield to 33866 kg ha^{-1} which was only 15% higher than control. However application of Mn at 8 ppm decreased both quality and yield of potato tuber compare with 2 and 4 ppm. maximum yield (38950 kg ha^{-1}) was obtained at 8 ppt of Zn and 4 ppm of Mn foliar application. Fertilizers were significantly affected on elements percentage in tuber. Zinc increased Zn percentage and decrease phosphorus percentage in tuber. Manganese increased Mn percentage of tuber, but no significantly effected on Zn, P and K in tuber. Zn and Mn fertilizers together increased Zn and Mn percentage and decreased P percentage in tubers, that were non-significant.

Zengin (2008) carried out a study on with trial of 15.15.15, gypsum, kieserite, potassium sulphate, kalimagnesia and ammonium sulphate materials in two locations of Nevsehir and Nigde provinces in 2005 and 2006 years. According to the results, in every two years in all locations effects of fertilizers used on tuber yields, tuber size distribution, dry matter content of tuber and K, Mg and

S contents of leaves were significant changing depending on the locations. An important relation between K, Mg and S nutrition of plant and tuber yields were found in all locations. In two years, tuber yields obtained in all locations increased changing ratios between 2.4 and 132.9 % by fertilizer treatments with K, Ca, Mg and S by the side of N and P according to control treatment contained only N and P. In every two years, in all locations the highest tuber yield was obtained by treatment 6 having CAN + DAP + kalimagnesia + urea fertilizers that were given 650 kg N, 120 kg K_2O, 68 kg S and 40 kg MgO per ha and treatment 5 having CAN + DAP + potassium sulphate + urea followed to this. At the same time, tuber yield having < 35 mm size decreased in ratio of 22.9 % as mean of all locations in treatment 6 according to control.

Talukder (2009) conducted an experiment in the farmers’ field for three consecutive Rabi seasons (2002-03 to 2004-05). The potato variety Cardinal was tested with 5 levels of magnesium *viz*., 0, 5, 10, 15, and 20 kg/ha to observe its effects on potato and to find out the optimum and economic dose of Mg for potato. The three years’ results revealed that magnesium had significant effects on tuber yield of potato. Significantly higher tuber yield (32.33, 31.63, and 28.03 t/ha, respectively in three successive years) was obtained from 10 kg/ha of Mg. Tuber yield tended to decrease with increasing rate of Mg beyond 10 kg/ha. Tuber yields increased over control by 18 and 31 % when magnesium was applied @ 5 and 10 kg/ha, respectively. Yield response to added Mg was quadratic in nature. The regression with Mg levels indicate that maximum tuber yield (30.32 t/ha) could be obtained at 13 kg/ha of Mg and the economic dose was also 13 kg/ha of Mg. Use efficiency of Mg was 512.25 kg tuber of potato per kg Mg per ha. After optimum level of Mg (13 kg/ha) tuber yield reduced by 3.83 kg for additional use of one kg Mg/ha.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka-1207 during November 2018 to February, 2019 to study the effect of potassium and magnesium on the growth and yield of potato. The materials used and methodology followed in the investigation have been presented details in this chapter.

3.1 Description of the experimental site

3.1.1 Geographical location

The experimental area was situated at $23^0 77'$ N latitude and $90^0 33'$ E longitude at an altitude of 9 meter above the sea level (Anon., 2005).

3.1.2 Agro-ecological region

The experimental field belongs to the Agro-ecological zone of “The Madhupur Tract”, AEZ-28 (Anon., 1989). This was a region of complex relief and soils developed over the Madhupur clay, where floodplain sediments buried the dissected edges of the Madhupur Tract leaving small hillocks of red soils as ‘islands’ surrounded by floodplain (Anon., 1989). The experimental site was shown in the map of AEZ of Bangladesh in Appendix I.

3.1.3 Soil

The soil of the experimental site belongs to the general soil type, shallow red brown terrace soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH ranged from 5.6-6.5 and had organic matter 1.10-1.99%. The experimental area was flat having available irrigation and drainage system and above flood level. The physico-chemical properties of soil is presented in Appendix II.

3.1.4 Climate

The area has subtropical climate, characterized by high temperature, high relative humidity and heavy rainfall with occasional gusty winds in Kharif season (April- September) and scanty rainfall associated with moderately low temperature during the Rabi season (October-March). Climatic condition of the experimental site is presented in Appendix III.

3.2 Experimental details

3.2.1 Treatments

The two factor experiment considered as K and Mg are as follows:

Factor A: Potassium (K) - 3 levels

1. K_0 = Control (0 kg K ha^{-1})
2. K_1 = 100 kg K ha^{-1}
3. K_2 = 120 kg K ha^{-1}

Factor B: Magnesium (Mg) - 3 levels

1. M_0 = Control (0 kg Mg ha^{-1})
2. M_1 = 10 kg Mg ha^{-1}
3. M_2 = 20 kg Mg ha^{-1}

Treatment combinations: Nine treatment combinations

K_0M_0, K_0M_1, K_0M_2, K_1M_0, K_1M_1, K_1M_2, K_2M_0, K_2M_1 **and** K_2M_2.

3.2.2 Layout of the experiment

The experiment was laid out into Randomized Complete Block Design (RCBD) with three replications. There were 9 treatment combinations, in total 27 plots for 3 replications. Each block consisted of 9 unit plots. The size of each unit plot was 5 m × 3 m. The distance maintained between two replications and two plots were 0.5 m and 0.5 m, respectively. The layout of the experiment is shown in Appendix III.

3.2.3 Planting materials

In this research work, potato genotype - Cardinal (BARI Alu-8) variety was used as plant material and the tubers were collected from BADC, sales centre Kashimpur, Gazipur.

3.3 Preparation of the experimental field

The land was opened with the help of a tractor drawn disc harrow on November 2, 2018, and then ploughed with rotary plough twice followed by laddering to achieve a medium tilth required for the crop under consideration. All weeds and other plant residues of previous crop were removed from the field. Immediately after final land preparation, the field layout was made on November 10, 2018 according to experimental specification. Individual plots were cleaned and finally prepared the plot.

3.4 Fertilizer application

During final land preparation, the land was fertilized according to BARI, (2014).

Fertilizer	Nutrient	Doses ha^{-1}
Urea	N	100 kg ha^{-1}
TSP	P	35 kg ha^{-1}
MoP	K	As per treatment
Gypsum	S	20 kg ha^{-1}
$ZnSO_4$	Zn	5 kg ha^{-1}
Boric acid	B	2 kg ha^{-1}
$MgSO_4.7H_2O$	Mg	As per treatment

The total amount of nitrogen in the form of urea was divided into three equal portions; one third was applied during final land preparation. The rest two portions were applied as split doses at 25 DAP and 50 DAP, respectively. Whole amount of TSP, MOP, Gypsum, $ZnSO_{4,}$ boric acid and $MgSO_4$ were applied at the time of final land preparation.

3.5 Preparation of planting materials

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

3.6 Planting of tuber

Sprouted, healthy and disease free seeds were planted in furrows on 11 November 2018 at 5-7cm depth maintaining a spacing of 60 cm × 20 cm. After planting, the seeds were covered with soil.

3.7 Intercultural operations

3.7.1 Weeding

The crop field was infested with some weeds during the early stage of crop establishment. Two hand weedings were done; first weeding was done at 25 days after planting followed by second weeding at 45 days after planting.

3.7.2 Earthing up

Earthing up 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.

3.7.3 Irrigation and drainage

Irrigation water was added to each plot, first irrigation was done as pre-planting and other two were given at 30 and 50 days after planting. Drainage channels were properly prepared to easy and quick drained out of excess water.

3.7.4 Plant protection measures

Dithane M-45@ 2.25 kg ha^{-1} was sprayed after complete emergence of the crop at an interval of 15 days to protect the incidence of late blight disease. Furadan 5G was applied against soil insects during final land preparation at the rate of 10 kg ha^{-1}.

3.8 Recording of data

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

3.8.1 Growth parameters

1. Plant height
2. Number of stems hill^{-1}
3. Number of leaves hill^{-1}
4. Days to 100% emergence

3.8.2 Yield and yield contributing parameters

1. Number of tuber hill^{-1}
2. Individual tuber weight (g)
3. Tuber weight hill^{-1} (g)

3.8.3 Yield parameters

1. Tuber yield plot^{-1} (kg)
2. Tuber yield ha^{-1} (t)
3. Stover yield ha^{-1} (kg)
4. Harvest index (%)

3.9 Procedures of recording data

A brief outline of the data recording procedure followed during the study is given below:

3.9.1 Growth characters

Plant height (cm)

Plant height was recorded at 30, 50 and 70 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).

Number of stems hill^{-1}

The number of main stems per hill of the sample plants was recorded at 30, 50 and 70 days after planting (DAP), and the average number of stems produced per hill was recorded.

Number of leaves hill^{-1}

The number of leaves per hill of the sample plants was recorded at 30, 50 and 70 days after planting (DAP), and the average number of leaves produced per hill was recorded.

Days to 100% emergence

This was achieved by recording the number of days required to 100% plant emergence from the date of operation carefully.

Fresh weight of haulm at harvest (g)

Fresh weight of haulm was measured at harvest. Sample plants from each plot were collected. The average weight of haulm was recorded from selected plants for each plot at the time of harvesting. The mean values were recorded.

Dry weight of haulm at harvest (g)

Dry matter content of haulm was measured at harvest. Sample plants from each plot were collected. The plant parts were packed in paper packets then kept in the oven at 80°C for 72 hrs to reach a constant weight. Then the dry weights were taken with an electric balance. The mean values were determined.

Percent dry matter of fresh tuber (g)

Sample 100 g tuber from each plot were collected then it was preserved in paper packets and kept in the oven at 80°C for 72 hrs to reach a constant weight. Then the dry weights were taken with an electric balance. The mean values were recorded in percentage.

Number of tuber hill^{-1}

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

Tuber weight hill^{-1} (g)

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

Tuber yield plot^{-1} (kg)

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.

Tuber yield ha^{-1} (ton)

After collection of tuber weight per plot, it was converted to ton per ha.

Stover yield ha^{-1} (ton)

Weight cleaned and well dried stover were collected from each plot were taken and converted into hectare and were expressed in t ha^{-1}.

Harvest Index (%)

It denotes the ratio of economic yield to biological yield and was calculated with following formula.

$$\text{Harvest Index (\%)} = \frac{\text{Tuber yield}}{\text{Tuber yield + Stover yield}} \times 100$$

3.10 Statistical analysis

The data obtained for yield contributing characters and yield were statistically analyzed to find out the significance of the differences among the treatments.

The collected data from the experimental plot on growth, yield and yield contributing characters are compiled and analyzed using the MSTAT-C package program. Morphological variation and yield performance among the treatments were studied by Analysis of Variance (ANOVA) by F-test. The significance of the difference between pairs of treatment means was evaluated by least significant difference (LSD) test at 5% and 1% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The present experiment was conducted to determine the effect of potassium and magnesium on the growth and yield of potato. Data on different growth and yield contributing characters were recorded. The results of the present experiment have been presented and discussed through table and possible interpretations given under the following headings:

4.1 Growth parameters

4.1.1 Plant height (cm)

Effect of potassium on plant height of potato

Significant variation was observed on plant height at different growth stages of plants as influenced by the application of different K levels (Table 1 and Appendix V). Results revealed that the highest plant height (20.26, 60.31 and 65.94 cm at 30, 50 and 70 DAP, respectively) was recorded from the treatment K_2 (120 kg K ha^{-1}), which was significantly different from other treatments at all growth stages. The lowest plant height (17.23, 54.60 and 60.70 cm at 30, 50 and 70 DAP, respectively) was recorded from the control treatment K_0 (0 kg K ha^{-1}). Similar result was also observed by Abd El-Latif (2011), Sobhani *et al.* (2002) who found significant effect potassium on plant height of potato.

Effect of magnesium on plant height of potato

The recorded data on plant height at different growth stages was affected significantly with the application of different Mg levels (Table 1 and Appendix V). It was found that the highest plant height (19.71, 59.36 and 64.70 cm at 30, 50 and 70 DAP, respectively) was recorded from the treatment M_1 (10 kg Mg ha^{-1}), which was statistically identical with M_2 (20 kg Mg ha^{-1}) at all growth stages (at 30, 50 and 70 DAT). The lowest plant height (17.44, 55.29 and 61.24 cm at 30, 50 and 70 DAP, respectively) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}) which was significantly different from other treatments. Similar result was also observed by Rahman (2011) who observed that plant height was significantly influenced by magnesium.

Combined effect of K and Mg on plant height of potato

Significant variation was found due to combined effect of potassium and magnesium on plant height of potato at different DAP (Table 1 and Appendix V). Results showed that the highest plant height (21.44, 62.47 and 68.06 cm at 30, 50 and 70 DAP, respectively) was recorded from the treatment combination of K_2M_1. At 30 DAP, highest plant height was significantly similar with K_2M_2 but at 50 DAP, it was also significantly same with K_2M_2 and at the time of harvest it was significantly different from other treatment combinations. Conversely, treatment combination of K_0M_0 gave the lowest plant height (16.33, 53.45 and 59.37 cm at 30, 50 and 70 DAP, respectively) and also the treatment combination of K_0M_1 showed significantly same result with K_0M_0 at 50 DAP and 70 DAP.

Table 1. Plant height of potato as influenced by potassium and magnesium at different days after planting

Treatments	Plant height (cm)		
	30 DAP	50 DAP	70 DAP
Effect of K			
K_0	17.23 c	54.60 c	60.70 c
K_1	18.97 b	58.27 b	63.46 b
K_2	20.26 a	60.31 a	65.94 a
$LSD_{0.05}$	0.365	0.788	1.103
CV(%)	6.52	7.88	10.37
Effect of Mg			
M_0	17.44 b	55.29 b	61.24 b
M_1	19.71 a	59.36 a	64.70 a
M_2	19.31 a	58.53 a	64.15 a
$LSD_{0.05}$	0.565	1.044	1.151
CV(%)	6.52	7.88	10.37
Combined effect of K and Mg			
K_0M_0	16.33 f	53.45 e	59.37 f
K_0M_1	17.36 e	53.87 e	60.18 f
K_0M_2	18.00 de	56.48 cd	62.54 d
K_1M_0	17.52 e	55.67 d	61.44 e
K_1M_1	19.12 c	59.25 b	64.22 c
K_1M_2	20.27 b	59.88 b	64.73 c
K_2M_0	18.48 d	56.74 c	62.91 d
K_2M_1	21.44 a	62.47 a	68.06 a
K_2M_2	20.87 ab	61.73 a	66.84 b
$LSD_{0.05}$	0.6360	0.9575	1.030
CV(%)	6.52	7.88	10.37

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

K_0 = Control (0 kg K ha^{-1}), K_1 = 100 kg K ha^{-1}, K_2 = 120 kg K ha^{-1}

M_0 = Control (0 kg Mg ha^{-1}), M_1 = 10 kg Mg ha^{-1}, M_2 = 20 kg Mg ha^{-}

4.1.2 Number of stems hill^{-1}

Effect of potassium on number of stems hill^{-1}of potato

Significant variation was observed on number of stems hill^{-1} at different growth stages influenced by the application of different K levels (Table 2 and Appendix VI). Results revealed that the highest number of stems hill^{-1} (3.70, 4.42 and 4.62 at 30, 50 and 70 DAP, respectively) was recorded from the treatment K_2 (120 kg K ha^{-1}), which was significantly different from other treatments at all growth stages followed by K_1 (100 kg K ha^{-1}) whereas the lowest number of stems hill^{-1} (2.82, 3.02 and 3.13 at 30, 50 and 70 DAP, respectively) was recorded from the control treatment K_0 (0 kg K ha^{-1}). Sobhani *et al.* (2002) and Bansali Trehan (2011) also found similar result which supported the present study.

Effect of magnesium on number of stems hill^{-1}of potato

The recorded data on number of stems hill^{-1}at different growth stages was affected significantly with the application of different Mg levels (Table 2 and Appendix VI). Results revealed that the highest number of stems hill^{-1} (3.35, 3.81 and 4.03 at 30, 50 and 70 DAP, respectively) was recorded from the treatment M_1 (10 kg Mg ha^{-1}), which was significantly different from other treatments followed by M_2 (20 kg Mg ha^{-1}) whereas the lowest number of stems hill^{-1} (3.00, 3.43 and 3.58 at 30, 50 and 70 DAP, respectively) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}). Rahman **(**2011) also found similar result with the present study.

Combined effect of K and Mg on number of stems hill^{-1}of potato

There was significant variation on number of stems hill^{-1} of potato at different DAP affected combined effect of potassium and magnesium (Table 2 and Appendix VI). Result showed that the highest number of stems hill^{-1} (4.05, 4.73 and 5.00 cm at 30, 50 and 70 DAP, respectively) was recorded from the treatment combination of K_2M_1 which was significantly different from other treatments at all growth stages followed by K_2M_2. The lowest number of stems hill^{-1} (2.78, 2.92 and 3.02 cm at 30, 50 and 70 DAP, respectively) was recorded from the treatment combination of K_0M_0 which was statistically similar with K_0M_1 and K_0M_2 at all growth stages of potato.

Table 2. Number of stems hill^{-1} of potato as influenced by potassium and magnesium at different days after planting

Treatments	Number of stems hill^{-1}		
	30 DAP	50 DAP	70 DAP
Effect of K			
K_0	2.82 c	3.02 c	3.13 c
K_1	3.03 b	3.45 b	3.63 b
K_2	3.70 a	4.42 a	4.62 a
$LSD_{0.05}$	0.107	0.326	0.245
CV(%)	3.97	5.36	5.52
Effect of Mg			
M_0	3.00 c	3.43 c	3.58 c
M_1	3.35 a	3.81 a	4.03 a
M_2	3.20 b	3.65 b	3.78 b
$LSD_{0.05}$	0.044	0.052	0.048
CV(%)	3.97	5.36	5.52
Combined effect of K and Mg			
K_0M_0	2.780 f	2.920 g	3.020 f
K_0M_1	2.860 ef	3.030 fg	3.200 ef
K_0M_2	2.830 ef	3.120 fg	3.180 ef
K_1M_0	2.960 e	3.280 ef	3.480 e
K_1M_1	3.140 cd	3.670 d	3.880 d
K_1M_2	3.000 de	3.400 e	3.520 e
K_2M_0	3.270 c	4.100 c	4.240 c
K_2M_1	4.050 a	4.730 a	5.000 a
K_2M_2	3.780 b	4.430 b	4.630 b
$LSD_{0.05}$	0.1642	0.2508	0.3144
CV(%)	3.97	5.36	5.52

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

K_0 = Control (0 kg K ha^{-1}), K_1 = 100 kg K ha^{-1}, K_2 = 120 kg K ha^{-1}

M_0 = Control (0 kg Mg ha^{-1}), M_1 = 10 kg Mg ha^{-1}, M_2 = 20 kg Mg ha^{-1}

4.1.3 Number of leaves $hill^{-1}$

Effect of potassium on number of leaves of potato $hill^{-1}$

Non-significant variation was observed on number of leaves of potato $hill^{-1}$ at different growth stages influenced by the application of different K levels (Table 3 and Appendix VII). However, the highest number of leaves $hill^{-1}$ (12.75, 29.26 and 30.69 at 30, 50 and 70 DAP, respectively) was recorded from the treatment K_2 (120 kg K ha^{-1}) whereas the lowest number of leaves $hill^{-1}$ (9.77, 26.06 and 28.15 at 30, 50 and 70 DAP, respectively) was recorded from the control treatment K_0 (0 kg K ha^{-1}). Similar result was also observed by Lal in (2012).

Effect of magnesium on number of leaves of potato $hill^{-1}$

The recorded data on number of leaves of potato $hill^{-1}$ at different growth stages was not affected significantly with the application of different Mg levels (Table 3 and Appendix VII). However, the highest number of leaves $hill^{-1}$ (11.73, 28.04 and 29.81 at 30, 50 and 70 DAP, respectively) was recorded from the treatment M_1 (10 kg Mg ha^{-1}) whereas the lowest number of leaves $hill^{-1}$ (10.82, 27.35 and 28.86 at 30, 50 and 70 DAP, respectively) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}). Similar result was also observed by Rahman (2011).

Combined effect of K and Mg on number of leaves of potato $hill^{-1}$

There was significant variation on number of leaves of potato $hill^{-1}$ at different DAP affected by combined effect of potassium and magnesium (Table 3 and Appendix VII). Result revealed the highest number of leaves $hill^{-1}$ (12.92, 29.71 and 31.60 at 30, 50 and 70 DAP, respectively) was recorded from the treatment combination of K_2M_1, which was statistically identical with K_2M_2 at 30 DAP but at 50 and 70 DAP it was significantly different from other treatment combinations. On the other hand, the lowest number of leaves $hill^{-1}$ (9.25, 25.44 and 27.94 at 30, 50 and 70 DAP, respectively) was recorded from the treatment combination of K_0M_0, which was statistically identical with K_0M_1 at 70 DAP.

Table 3. Number of leaves $hill^{-1}$ of potato as influenced by potassium and magnesium at different days after planting

Treatments	Number of leaves $hill^{-1}$		
	30 DAP	50 DAP	70 DAP
Effect of K			
K_0	9.77	26.06	28.15
K_1	11.42	27.74	29.18
K_2	12.75	29.26	30.69
$LSD_{0.05}$	NS	NS	NS
CV(%)	5.20	6.73	8.94
Effect of Mg			
M_0	10.82	27.35	28.86
M_1	11.73	28.04	29.81
M_2	11.40	27.67	29.34
$LSD_{0.05}$	NS	NS	NS
CV(%)	5.20	6.73	8.94
Combined effect of K and Mg			
K_0M_0	9.250 f	25.44 e	27.94 f
K_0M_1	10.20 e	26.42 d	28.36 f
K_0M_2	9.870 e	26.33 d	28.14 f
K_1M_0	10.75 d	27.48 c	28.88 e
K_1M_1	12.07 b	28.00 c	29.47 cd
K_1M_2	11.44 c	27.73 c	29.18 de
K_2M_0	12.46 b	29.12 ab	29.77 c
K_2M_1	12.92 a	29.71 a	31.60 a
K_2M_2	12.88 a	28.94 b	30.71 b
$LSD_{0.05}$	0.4022	0.6144	0.4926
CV(%)	5.20	6.73	8.94

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

K_0 = Control (0 kg K ha^{-1}), K_1 = 100 kg K ha^{-1}, K_2 = 120 kg K ha^{-1}

M_0 = Control (0 kg Mg ha^{-1}), M_1 = 10 kg Mg ha^{-1}, M_2 = 20 kg Mg ha^{-1}

4.1.4 Days to 100% emergence

Effect of potassium on days to 100% emergence of potato

Significant variation was observed on days to 100% emergence of potato influenced by the application of different K levels (Table 4 and Appendix VIII). Results revealed that the lowest days to 100% emergence (14.11 days) was recorded from the treatment K_2 (120 kg K ha^{-1}) which was significantly different from other treatments followed by K_1 (100 kg K ha^{-1}) whereas the highest days to 100% emergence (16.00 days) was recorded from the control treatment K_0 (0 kg K ha^{-1}).

Effect of magnesium on days to 100% emergence of potato

The recorded data on days to 100% emergence of potato was affected significantly with the application of different Mg levels (Table 4 and Appendix VIII). The lowest days to 100% emergence (14.78 days) was recorded from the treatment M_1 (10 kg Mg ha^{-1}) which was statistically identical with M_2 (20 kg Mg ha^{-1}). The highest days to 100% emergence (15.44 days) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}).

Combined effect of K and Mg on days to 100% emergence of potato

Significant influence was recorded on days to 100% emergence of potato affected by combined effect of potassium and magnesium (Table 4 and Appendix VIII). The lowest days to 100% emergence (13.67 days) was recorded from the treatment combination of K_2M_2 and the second lowest days to 100% emergence was observed in K_2M_1. The highest days to 100% emergence (16.33 days) was recorded from the treatment combination of K_0M_0 which was significantly different from all other treatment combinations.

Table 4. Days to 100% emergence, of potato as influenced by potassium and magnesium

Treatments	Days to 100% emergence
Effect of K	
K_0	16.00 a
K_1	15.11 b
K_2	14.11 c
$LSD_{0.05}$	0.384
CV(%)	4.77
Effect of Mg	
M_0	15.44 a
M_1	14.78 b
M_2	15.00 b
$LSD_{0.05}$	0.247
CV(%)	4.77
Combined effect of K and Mg	
K_0M_0	16.33 a
K_0M_1	15.67 c
K_0M_2	16.00 b
K_1M_0	15.33 d
K_1M_1	14.67 e
K_1M_2	15.33 d
K_2M_0	14.67 e
K_2M_1	14.00 f
K_2M_2	13.67 g
$LSD_{0.05}$	0.2508
CV(%)	4.77

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

K_0 = Control (0 kg K ha^{-1}), K_1 = 100 kg K ha^{-1}, K_2 = 120 kg K ha^{-1}

M_0 = Control (0 kg Mg ha^{-1}), M_1 = 10 kg Mg ha^{-1}, M_2 = 20 kg Mg ha^{-1}

4.1.5 Fresh weight of haulm hill^{-1} at harvest (g)

Effect of potassium on fresh weight of haulm hill^{-1} of potato

Significant variation was observed on fresh weight of haulm hill^{-1} at harvest influenced by the application of different K levels (Table 5 and Appendix IX). Results revealed that the highest fresh weight of haulm hill^{-1} (235.70 g) was recorded from the treatment K_2 (120 kg K ha^{-1}) followed by K_1 (100 kg K ha^{-1}) whereas the lowest fresh weight of haulm hill^{-1} (192.80 g) was recorded from the control treatment K_0 (0 kg K ha^{-1}).

Effect of magnesium on fresh weight of haulm hill^{-1} of potato

The recorded data on fresh weight of haulm hill^{-1} at harvest was affected significantly with the application of different Mg levels (Table 5 and Appendix IX). Results indicated that the highest fresh weight of haulm hill^{-1} (221.93 g) was recorded from the treatment M_2 (20 kg Mg ha^{-1}) which was significantly different from other treatments followed by M_1 (10 kg Mg ha^{-1}). The lowest fresh weight of haulm hill^{-1} (201.53 g) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}).

Combined effect of K and Mg on fresh weight of haulm hill^{-1} of potato

Significant influence was found on fresh weight of haulm hill^{-1} at harvest of potato affected by combined effect of potassium and magnesium (Table 5 and Appendix IX). The highest fresh weight of haulm hill^{-1} (246.9 g) was recorded from the treatment combination of K_2M_2, which was statistically identical with K_2M_1 whereas the lowest fresh weight of haulm hill^{-1} (188.5 g) was recorded from the treatment combination of K_0M_0, which was significantly different from other treatment combinations.

4.1.6 Dry weight of haulm hill^{-1} at harvest (g)

Effect of potassium on dry weight of haulm hill^{-1} of potato

Significant variation was observed on dry weight of haulm hill^{-1} at harvest influenced by the application of different K levels (Table 5 and Appendix IX). Results revealed that the highest dry weight of haulm hill^{-1} (37.72 g) was recorded from the treatment K_2 (120 kg K ha^{-1}) followed by K_1 (100 kg K ha^{-1}) whereas the lowest dry weight of haulm hill^{-1} (31.24 g) was recorded from the control treatment K_0 (0 kg K ha^{-1}). Jenkins and Mahmood (2003) found similar result which supported the present study.

Effect of magnesium on dry weight of haulm hill^{-1} of potato

The recorded data on dry weight of haulm hill^{-1} at harvest was affected significantly with the application of different Mg levels (Table 5 and Appendix IX). The highest dry weight of haulm hill^{-1} (35.58 g) was recorded from the treatment M_2 (20 kg Mg ha^{-1}) which was statistically identical with M_1 (10 kg Mg ha^{-1}) whereas the lowest dry weight of haulm hill^{-1} (33.47 g) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}). Mousavi (2007) found similar result which supported the present study.

Combined effect of K and Mg on dry weight of haulm hill^{-1} of potato

Significant variation was recorded on dry weight of haulm hill^{-1} at harvest of potato affected by different doses of potassium and magnesium (Table 5 and Appendix IX). The highest dry weight of haulm hill^{-1} (38.75 g) was recorded from the treatment combination of K_2M_2 which was statistically identical with K_2M_1 whereas the lowest dry weight of haulm hill^{-1} (30.61 g) was recorded from the treatment combination of K_0M_0 which was statistically identical with K_0M_1 and K_0M_2**.**

Table 5. Fresh weight and dry weight of haulm hill^{-1} at harvest as influenced by potassium and magnesium

Treatments	Weight of haulm hill^{-1}	
	Fresh weight (g)	Dry weight (g)
Effect of K		
K_0	192.80 c	31.24 c
K_1	210.63 b	35.12 b
K_2	235.70 a	37.72 a
$LSD_{0.05}$	6.389	1.052
CV(%)	8.78	5.94
Effect of Mg		
M_0	201.53 c	33.47 b
M_1	215.67 b	35.03 a
M_2	221.93 a	35.58 a
$LSD_{0.05}$	3.374	0.479
CV(%)	8.78	5.94
Combined effect of K and Mg		
K_0M_0	188.5 g	30.61 e
K_0M_1	193.7 f	31.84 e
K_0M_2	196.2 f	31.26 e
K_1M_0	201.8 e	33.88 d
K_1M_1	207.4 d	34.77 cd
K_1M_2	222.7 b	36.72 b
K_2M_0	214.3 c	35.93 bc
K_2M_1	245.9 a	38.48 a
K_2M_2	246.9 a	38.75 a
$LSD_{0.05}$	5.237	1.344
CV(%)	8.78	5.94

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

K_0 = Control (0 kg K ha^{-1}), K_1 = 100 kg K ha^{-1}, K_2 = 120 kg K ha^{-1}

M_0 = Control (0 kg Mg ha^{-1}), M_1 = 10 kg Mg ha^{-1}, M_2 = 20 kg Mg ha^{-1}

4.2 Yield contributing parameters

4.2.1 Dry matter of potato (%)

Effect of potassium on percent dry matter of potato

Significant variation was observed on percent dry matter of potato influenced by the application of different K levels (Table 6 and Appendix X). Results revealed that the highest percent dry matter (19.89%) was recorded from the treatment K_2 (120 kg K ha^{-1}) followed by K_1 (100 kg K ha^{-1}). On the other hand, the lowest percent dry matter (17.96%) was recorded from the control treatment K_0 (0 kg K ha^{-1}). The result obtained from the present study was similar with the findings of Jenkins and Mahmood (2003).

Effect of magnesium on percent dry matter of potato

The recorded data on percent dry matter of fresh potato tuber was affected significantly with the application of different Mg levels (Table 6 and Appendix X). The highest percent dry matter of fresh tuber (19.17%) was recorded from the treatment M_1 (10 kg Mg ha^{-1}) which was statistically identical with M_2 (20 kg Mg ha^{-1}) whereas the lowest percent dry matter of fresh tuber (18.42%) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}). Supported result was also observed by Mousavi (2007).

Combined effect of K and Mg on percent dry matter of potato

Significant influence was recorded on percent dry matter of fresh tuber of potato affected by combined effect of potassium and magnesium (Table 6 and Appendix X). The highest percent dry matter of fresh tuber (20.76 %) was recorded from the treatment combination of K_2M_1 which was significantly different from other treatments. Again, the lowest percent dry matter of fresh tuber (17.69 %) was recorded from the treatment K_0M_0 which was significantly different from any other treatments.

4.2.2 Number of tuber hill^{-1}

Effect of potassium on number of tuber hill^{-1} of potato

Significant variation was observed on number of tuber hill^{-1} influenced by the application of different K levels (Table 6 and Appendix X). Results revealed that the highest number of tuber hill^{-1} (7.84) was recorded from the treatment K_2 (120 kg K ha^{-1}), which was statistically identical with K_1 (100 kg K ha^{-1}) whereas the lowest number of tuber hill^{-1} (5.08) was recorded from the control treatment K_0 (0 kg K ha^{-1}).

Effect of magnesium on number of tuber hill^{-1} of potato

The recorded data on number of tuber hill^{-1} was not affected significantly with the application of different Mg levels (Table 6 and Appendix X). However, the highest number of tuber hill^{-1} (6.86) was recorded from the treatment M_1 (10 kg Mg ha^{-1}) whereas the lowest number of tuber hill^{-1} (6.32) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}). The result obtained from the present study was similar with the findings of Mousavi (2007) and Rahman (2011).

Combined effect of K and Mg on number of tuber hill^{-1} of potato

Significant variation was found on number of tuber hill^{-1} of potato affected by different doses of potassium and magnesium (Table 6 and Appendix X). The highest number of tuber hill^{-1} (8.22) was recorded from the treatment combination of K_2M_1, which was significantly different from other treatments followed by K_2M_2. The lowest number of tuber hill^{-1} (4.75) was recorded from the treatment combination of K_0M_0.

4.2.3 Tuber weight hill^{-1} (g)

Effect of potassium on tuber weight hill^{-1} of potato

Significant variation was observed on tuber weight hill^{-1} influenced by the application of different K levels (Table 6 and Appendix X). Results revealed that the highest tuber weight hill^{-1} (297.97 g) was recorded from the treatment K_2 (120 kg K ha^{-1}) followed by K_1 (100 kg K ha^{-1}) whereas the lowest tuber weight hill^{-1} (205.10 g) was recorded from the control treatment K_0 (0 kg K ha^{-1}). Abd El-Latif (2011) also found similar result which supported the present study.

Effect of magnesium on tuber weight hill^{-1} of potato

The recorded data on tuber weight hill^{-1} was affected significantly with the application of different Mg levels (Table 6 and Appendix X). Results showed that the highest tuber weight hill^{-1} (269.33 g) was recorded from the treatment M_1 (10 kg Mg ha^{-1}), which was significantly different from other treatments whereas the lowest tuber weight hill^{-1} (239.03 g) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}). Similar result was also observed by Mousavi (2007).

Combined effect of K and Mg on tuber weight hill^{-1} of potato

Significant influence was observed on tuber weight hill^{-1} of potato affected by combined effect of potassium and magnesium (Table 6 and Appendix X). The highest tuber weight hill^{-1} (313.3 g) was recorded from the treatment combination of K_2M_1, which was statistically identical with K_2M_2 whereas the lowest tuber weight hill^{-1} (196.3 g) was recorded from the treatment combination of K_0M_0 which was significantly different from other treatments.

Table 6. Yield contributing parameters of potato as influenced by potassium and magnesium

Treatments	Yield contributing parameters of potato		
	Percent dry matter of fresh potato tuber (%)	Number of tuber $hill^{-1}$	Tuber weight $hill^{-1}$ (g)
Effect of K			
K_0	17.96 c	5.08 b	205.10 c
K_1	18.89 b	7.11 a	266.97 b
K_2	19.89 a	7.84 a	297.97 a
$LSD_{0.05}$	0.106	0.458	6.529
CV(%)	7.63	4.92	9.38
Effect of Mg			
M_0	18.42 b	6.32	239.03 c
M_1	19.17 a	6.86	269.33 a
M_2	19.16 a	6.84	261.67 b
$LSD_{0.05}$	0.233	NS	5.214
CV(%)	7.63	4.92	9.38
Combined effect of K and Mg			
K_0M_0	17.69 h	4.750 g	196.3 g
K_0M_1	17.96 g	5.360 e	211.7 f
K_0M_2	18.24 f	5.120 f	207.3 f
K_1M_0	18.53 e	6.870 d	248.4 e
K_1M_1	18.78 de	7.000 d	260.0 d
K_1M_2	19.37 c	7.470 c	292.5 b
K_2M_0	19.04 d	7.330 c	272.4 c
K_2M_1	20.76 a	8.220 a	313.3 a
K_2M_2	19.87 b	7.980 b	308.2 a
$LSD_{0.05}$	0.2681	0.1642	5.289
CV(%)	7.63	4.92	9.38

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

K_0 = Control (0 kg K ha^{-1}), K_1 = 100 kg K ha^{-1}, K_2 = 120 kg K ha^{-1}

M_0 = Control (0 kg Mg ha^{-1}), M_1 = 10 kg Mg ha^{-1}, M_2 = 20 kg Mg ha^{-1}

4.3 Yield parameters

4.3.1 Tuber yield plot^{-1} (kg)

Effect of potassium on tuber yield of potato plot^{-1}

Significant variation was observed on tuber yield plot^{-1} influenced by the application of different K levels (Table 7 and Appendix XI). Results revealed that the highest tuber yield plot^{-1} (38.59 kg) was recorded from the treatment K_2 (120 kg K ha^{-1}), which was significantly different from other treatments followed by K_1 (100 kg K ha^{-1}) whereas the lowest tuber yield plot^{-1} (23.40 kg) was recorded from the control treatment K_0 (0 kg K ha^{-1}).

Effect of magnesium on tuber yield of potato plot^{-1}

The recorded data on tuber yield plot^{-1} was affected significantly with the application of different Mg levels (Table 7 and Appendix XI). It was found that the highest tuber yield plot^{-1} (33.39 kg) was recorded from the treatment M_1 (10 kg Mg ha^{-1}) followed by M_2 (20 kg Mg ha^{-1}) whereas the lowest tuber yield plot^{-1} (31.09 kg) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}).

Combined effect of K and Mg on tuber yield of potato plot^{-1}

Tuber yield plot^{-1} was influenced significantly due to combined effect of potassium and magnesium (Table 7 and Appendix XI). Results exhibited that the highest tuber yield plot^{-1} (39.84 kg) was recorded from the treatment combination of K_2M_1, which was statistically similar with K_2M_2. The lowest tuber yield plot^{-1} (22.44 kg) was recorded from the treatment K_0M_0, which was significantly different from all other treatment combinations.

4.3.2 Tuber yield ha^{-1} (t)

Effect of potassium on tuber yield of potato ha^{-1}

Significant variation was observed on tuber yield ha^{-1} influenced by the application of different K levels (Table 7 and Appendix XI). Results revealed that the highest tuber yield (25.72 t ha^{-1}) was recorded from the treatment K_2 (120 kg K ha^{-1}), which was significantly different from other treatments followed by K_1 (100 kg K ha^{-1}). The lowest tuber yield (15.60 t ha^{-1}) was recorded from the control treatment K_0 (0 kg K ha^{-1}). Similar result was also observed by Khan, *et al*. (2010), Abd El-Latif (2011).

Effect of magnesium on tuber yield of potato ha^{-1}

The recorded data on tuber yield ha^{-1} was affected significantly with the application of different Mg levels (Table 7 and Appendix XI). It was observed that the highest tuber yield (22.26 t ha^{-1}) was recorded from the treatment M_1 (10 kg Mg ha^{-1}) followed by M_2 (20 kg Mg ha^{-1}). The lowest tuber yield (20.72 t ha^{-1}) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}). Similar results were also observed by Rahman **(**2011) and Mousavi (2007) which supported the present study.

Combined effect of K and Mg on tuber yield of potato ha^{-1}

Tuber yield ha^{-1} was influenced significantly due to combined effect of potassium and magnesium (Table 7 and Appendix XI). It was found that the highest tuber yield (26.56 t ha^{-1}) was recorded from the treatment combination of K_2M_1 which was statistically similar with K_2M_2 whereas the lowest tuber yield (14.96 t ha^{-1}) was recorded from the treatment K_0M_0 which was significantly different from other treatments.

4.3.3 Stover yield ha^{-1} (t)

Effect of potassium on stover yield of potato ha^{-1}

Significant variation was observed on stover yield ha^{-1} as influenced by the application of different K levels (Table 7 and Appendix XI). Results revealed that the significantly highest stover yield (19.52 t ha^{-1}) was recorded from the treatment K_2 (120 kg K ha^{-1}) followed by K_1 (100 kg K ha^{-1}) whereas the lowest stover yield (17.55 t ha^{-1}) was recorded from the control treatment K_0 (0 kg K ha^{-1}). Similar result was also observed by Khan *et al*. (2010) which supported the present study.

Effect of magnesium on stover yield of potato ha^{-1}

The recorded data on stover yield $ha^{-1}$was affected significantly with the application of different Mg levels (Table 7 and Appendix XI). The highest stover yield (18.80 t ha^{-1}) was recorded from the treatment M_1 (10 kg Mg ha^{-1}), which was statistically similar with M_2 (20 kg Mg ha^{-1}) but significantly different from M_0 treatment. On the other hand, the lowest stover yield (17.97 t ha^{-1}) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}). Similar result was also observed by Mousavi (2007) which supported the present study.

Combined effect of K and Mg on stover yield of potato ha^{-1}

Different doses of potassium and magnesium combination on stover yield ha^{-1} showed significant variation (Table 7 and Appendix XI). The highest stover yield (20.67 t ha^{-1}) was recorded from the treatment combination of K_2M_1, which was significantly different from all other treatment combinations followed by treatment combination of K_2M_2. The lowest stover yield (17.44 t ha^{-1}) was recorded from the treatment K_0M_0, which was statistically similar with K_0M_1 and K_0M_2.

4.3.4 Harvest index (%)

Effect of potassium on harvest index of potato

Significant variation was observed on harvest index influenced by the application of different K levels (Table 7 and Appendix XI). Results revealed that the highest harvest index (56.87%) was recorded from the treatment K_2 (120 kg K ha^{-1}), which was statistically identical with K_1 (100 kg K ha^{-1}). Reversely, the lowest harvest index (47.05%) was recorded from the control treatment K_0 (0 kg K ha^{-1}).

Effect of magnesium on harvest index of potato

The recorded data on harvest index was not affected significantly with the application of different Mg levels (Table 7 and Appendix XI). However, the highest harvest index (53.80%) was recorded from the treatment M_1 (10 kg Mg ha^{-1}) whereas the lowest harvest index (52.98%) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}).

Combined effect of K and Mg on harvest index of potato

Combined effect of different doses of potassium and magnesium showed significant variation on harvest index of potato (Table 7 and Appendix XI). The highest harvest index (57.36%) was recorded from the treatment combination of K_1M_2, which was statistically identical with K_2M_0 and K_2M_2 followed by K_2M_1. The lowest harvest index (46.17%) was recorded from the treatment combination of K_0M_0, which was significantly different from other treatment combinations.

Table 7. Yield parameters of potato as influenced by potassium and magnesium

Treatments	Yield of potato			
	Tuber yield plot^{-1} (kg)	Tuber yield (t ha^{-1})	Stover yield (t ha^{-1}) (dry basis)	Harvest index (%)
Effect of K				
K_0	23.40 c	15.60 c	17.55 c	47.05 b
K_1	35.25 b	23.50 b	18.34 b	56.14 a
K_2	38.59 a	25.72 a	19.52 a	56.87 a
$LSD_{0.05}$	1.107	0.633	0.436	2.087
CV(%)	8.57	7.42	8.33	9.52
Effect of Mg				
M_0	31.09 c	20.72 c	17.97 b	52.98
M_1	33.39 a	22.26 a	18.80 a	53.28
M_2	32.76 b	21.84 b	18.63 a	53.80
$LSD_{0.05}$	0.317	0.104	6.144	NS
CV(%)	8.57	7.42	8.33	9.52
Combined effect of K and Mg				
K_0M_0	22.44 f	14.96 f	17.44 g	46.17 f
K_0M_1	24.32 e	16.21 e	17.48 g	48.12 d
K_0M_2	23.45 ef	15.63 ef	17.72 fg	46.87 e
K_1M_0	33.78 d	22.52 d	18.00 ef	55.58 c
K_1M_1	34.13 d	22.75 d	18.26 de	55.47 c
K_1M_2	37.83 bc	25.22 bc	18.75 c	57.36 a
K_2M_0	37.04 c	24.69 c	18.48 cd	57.19 a
K_2M_1	39.84 a	26.56 a	20.67 a	56.24 b
K_2M_2	38.88 ab	25.92 ab	19.42 b	57.17 a
$LSD_{0.05}$	1.357	0.9575	0.4022	0.3284
CV(%)	8.57	7.42	8.33	9.52

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

K_0 = Control (0 kg K ha^{-1}), K_1 = 100 kg K ha^{-1}, K_2 = 120 kg K ha^{-1}

M_0 = Control (0 kg Mg ha^{-1}), M_1 = 10 kg Mg ha^{-1}, M_2 = 20 kg Mg ha^{-1}

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Research field of Sher-e-Bangla Agricultural University, Dhaka-1207 during November 2018 to February, 2019 to study the effect of effect of potassium and magnesium on the growth and yield of potato. The experiment consisted of two factors *viz*. Factor A - three K levels as K_0 = Control (0 kg K ha^{-1}), K_1 = 100 kg K ha^{-1} and K_2 = 120 kg K ha^{-1} and Factor B: three Mg levels as M_0 = Control (0 kg Mg ha^{-1}), M_1 = 10 kg Mg ha^{-1} and M_2 = 20 kg Mg ha^{-1}. The experiment was laid out into Randomized Complete Block Design (RCBD) with three replications. Data were collected on different parameter and analyzed significantly using MSTAT software.

Different K levels showed significant variation on different parameters of potato. In terms of growth parameters, results showed that the highest plant height (20.26, 60.31 and 65.94 cm at 30, 50 and 70 DAP, respectively), number of stems $hill^{-1}$ (3.70, 4.42 and 4.62 at 30, 50 and 70 DAP, respectively) and number of leaves $hill^{-1}$ (12.75, 29.26 and 30.69 at 30, 50 and 70 DAP, respectively) were recorded from the treatment K_2 (120 kg K ha^{-1}) while the lowest plant height (17.23, 54.60 and 60.70 cm at 30, 50 and 70 DAP, respectively) number of stems $hill^{-1}$ (2.82, 3.02 and 3.13 at 30, 50 and 70 DAP, respectively) and number of leaves $hill^{-1}$ (9.77, 26.06 and 28.15 at 30, 50 and 70 DAP, respectively) were recorded from the control treatment K_0 (0 kg K ha^{-1}).

In case of yield contributing parameters and yield of potato, affected by different K levels, the lowest days to 100% emergence (14.11 days) was recorded from the treatment K_2 (120 kg K ha^{-1}) whereas the highest days to 100% emergence (16.00 days) was recorded from the control treatment K_0 (0 kg K ha^{-1}). Similarly, the highest fresh weight of haulm $hill^{-1}$ (235.70 g), dry weight of haulm $hill^{-1}$ (37.72 g), percent dry matter of fresh tuber (19.89 %), number of tuber hill^{-1} (7.84), tuber weight hill^{-1} (297.97 g), tuber yield plot^{-1} (38.59 kg), tuber yield ha^{-1} (25.72 t), stover yield ha^{-1} (19.52 t) and harvest index (56.87%) were recorded from the treatment K_2 (120 kg K ha^{-1}). On the other hand the lowest fresh weight of haulm hill^{-1} (192.80 g), dry weight of haulm hill^{-1} (31.24 g), percent dry matter of fresh tuber (17.96 %), number of tuber hill^{-1} (5.08), tuber weight hill^{-1} (205.10 g), tuber yield plot^{-1} (23.40 kg), tuber yield ha^{-1} (15.60 t), stover yield ha^{-1} (17.55 t) and harvest index (47.05%) were recorded from the control treatment K_0 (0 kg K ha^{-1})

Different Mg levels showed significant variation on different parameters of potato. Regarding growth parameters, results showed that the highest plant height (19.71, 59.36 and 64.70 cm at 30, 50 and 70 DAP, respectively), number of stems hill^{-1} (3.35, 3.81 and 4.03 at 30, 50 and 70 DAP, respectively) and number of leaves hill^{-1} (11.73, 28.04 and 29.81 at 30, 50 and 70 DAP, respectively) was recorded from the treatment M_1 (10 kg Mg ha^{-1}) whereas the lowest plant height (17.44, 55.29 and 61.24 cm at 30, 50 and 70 DAP, respectively), number of stems hill^{-1} (3.00, 3.43 and 3.58 at 30, 50 and 70 DAP, respectively) and number of leaves hill^{-1} (10.82, 27.35 and 28.86 at 30, 50 and 70 DAP, respectively) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}).

In case of yield contributing parameters and yield of potato, affected by different Mg levels, the lowest days to 100% emergence (14.78 days) was recorded from the treatment M_1 (10 kg Mg ha^{-1}) while the highest days to 100% emergence (15.44 days) was recorded from the control treatment M_0 (0 kg Mg ha^{-1}). Similarly, the highest fresh weight of haulm hill^{-1} (221.93 g) and dry weight of haulm hill^{-1} (35.58 g) were recorded from the treatment M_2 (20 kg Mg ha^{-1}) while the highest percent dry matter of fresh tuber (19.17 %), number of tuber hill^{-1} (6.86), tuber weight hill^{-1} (269.33 g), tuber yield plot^{-1} (33.39 kg), tuber yield ha^{-1} (22.26 t), stover yield ha^{-1} (18.80 t) and harvest index (53.80%) were recorded from the treatment M_1 (10 kg Mg ha^{-1}). On the other hand, the lowest fresh weight of haulm hill^{-1} (201.53 g), dry weight of haulm hill^{-1} (33.47 g), percent dry matter of fresh tuber (18.42 %), number of tuber hill^{-1} (6.32), tuber weight hill^{-1} (239.03 g), tuber yield plot^{-1} (31.09 kg), tuber yield ha^{-1} (20.72 t), stover yield ha^{-1} (17.97 t) and harvest index (52.98%) were recorded from the control treatment M_0 (0 kg Mg ha^{-1})

Regarding, combined effect of K and Mg, significant variation was recorded for most of the parameters. Considering growth parameters, affected by combined effect of K and Mg, the the highest plant height (21.44, 62.47 and 68.06 cm at 30, 50 and 70 DAP, respectively), number of stems hill^{-1} (4.05, 4.73 and 5.00 cm at 30, 50 and 70 DAP, respectively) and number of leaves hill^{-1} (412.92, 29.71 and 31.60 at 30, 50 and 70 DAP, respectively) were recorded from the treatment combination of K_2M_1 whereas lowest plant height (16.33, 53.45 and 59.37 cm at 30, 50 and 70 DAP, respectively), number of stems hill^{-1} (2.78, 2.92 and 3.02 cm at 30, 50 and 70 DAP, respectively) and number of leaves hill^{-1} (9.25, 25.44 and 27.94 at 30, 50 and 70 DAP, respectively) were recorded from the treatment combination of K_0M_0.

Again, in case of yield contributing parameters, all the parameters are affected significantly. Results showed that the lowest days to 100% emergence (13.67 days) was recorded from the treatment K_2M_2 and this treatment combination also showed highest fresh weight of haulm hill^{-1} (246.9 g) but the highest dry weight of 100 g fresh tuber (20.76 g) and tuber weight hill^{-1} (313.3 g) were recorded from the treatment combination of K_2M_1. On the other hand, the highest days to 100% emergence (16.33 days) was recorded from the treatment combination of K_0M_0 and this treatment combination also showed lowest fresh weight of haulm hill^{-1} (188.5 g), dry weight of 100 g fresh tuber (17.69 g) and tuber weight hill^{-1} (196.3 g).

Regarding, yield parameters, K and Mg application showed significant influence on yield parameters. Results revealed that the highest tuber yield plot^{-1} (39.84 kg), tuber yield ha^{-1} (26.56 t) and stover yield ha^{-1} (20.67 t) were recorded from the treatment combination of K_2M_1 but the highest harvest index (57.36) was recorded from the treatment combination of K_1M_2. On the other hand, the lowest tuber yield plot^{-1} (22.44 kg), tuber yield ha^{-1} (14.96 t), stover yield ha^{-1} (17.44 t) and harvest index (46.17%) were recorded from the treatment combination of K_0M_0.

From the above results, it can be concluded that among the K levels, K_2 (120 kg K ha^{-1}) showed the best performance on all the studied parameters compared to control. Similarly, among the Mg levels, M_1 (10 kg Mg ha^{-1}) showed better performance on most of the studied parameters compared to control. In case of treatment combination of K and Mg, K_2M_1 showed the best performance in respect of yield and yield contributing characters. treatment combination of K_2M_2 also gave better results compared to other treatment combinations. So, the treatment combination of K_2M_1 can be considered as best treatment and next to K_2M_2 under the present study.

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APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh showing the experimental location

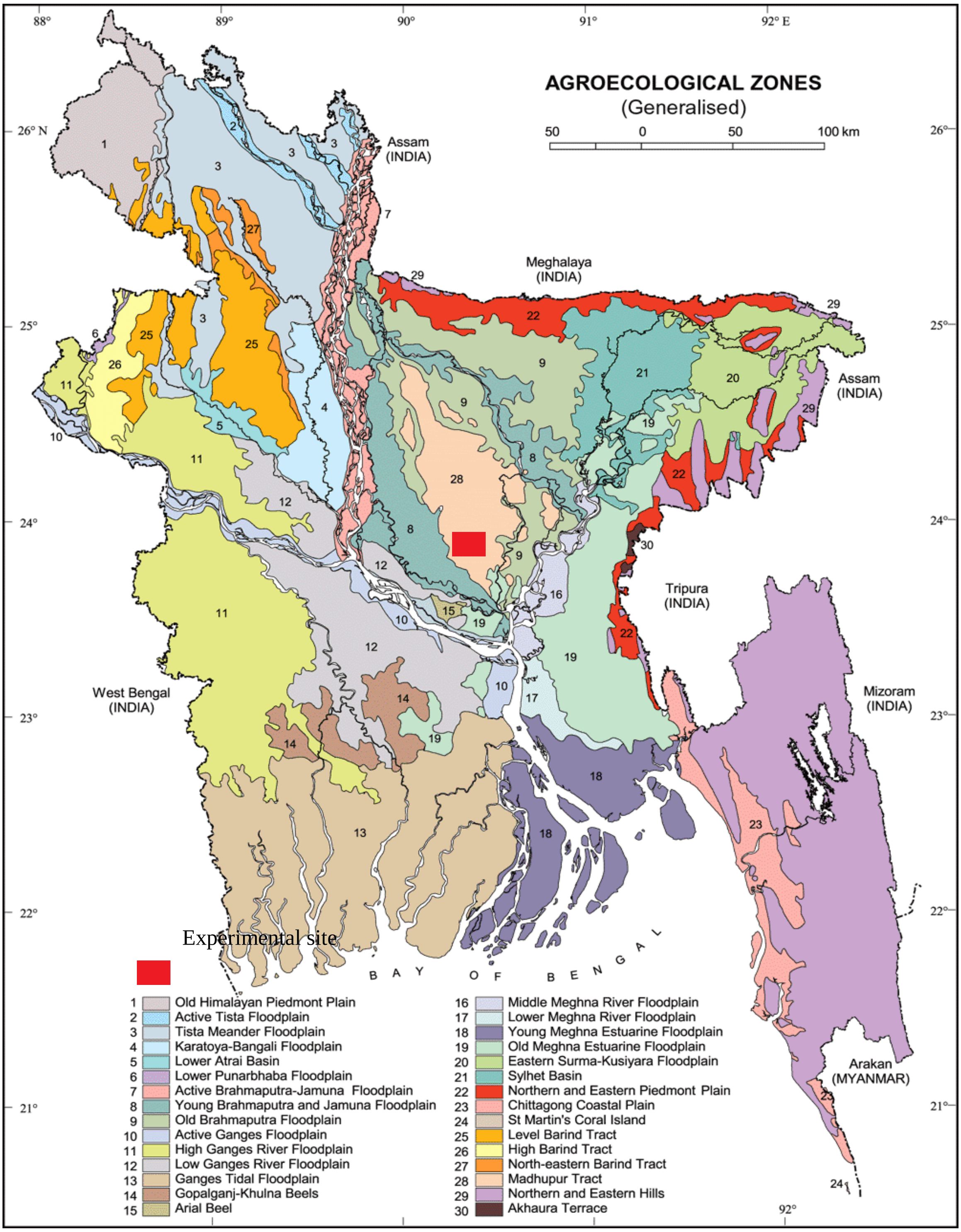

Figure 1. Experimental site

Appendix II. Monthly records of air temperature, relative humidity and rainfall during the period from November 2018 to February 2019.

Year	Month	Air temperature (°C)			Relative humidity (%)	Rainfall (mm)
		Max	*Min*	*Mean*		
2018	November	28.60	8.52	18.56	56.75	14.40
2018	December	25.50	6.70	16.10	54.80	0.0
2019	January	23.80	11.70	17.75	46.20	0.0
2019	February	22.75	14.26	18.51	37.90	0.0

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix III. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur 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
Cropping pattern	Not Applicable

Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Characteristics	**Value**
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam (ISSS)
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix IV. Layout of the experiment field

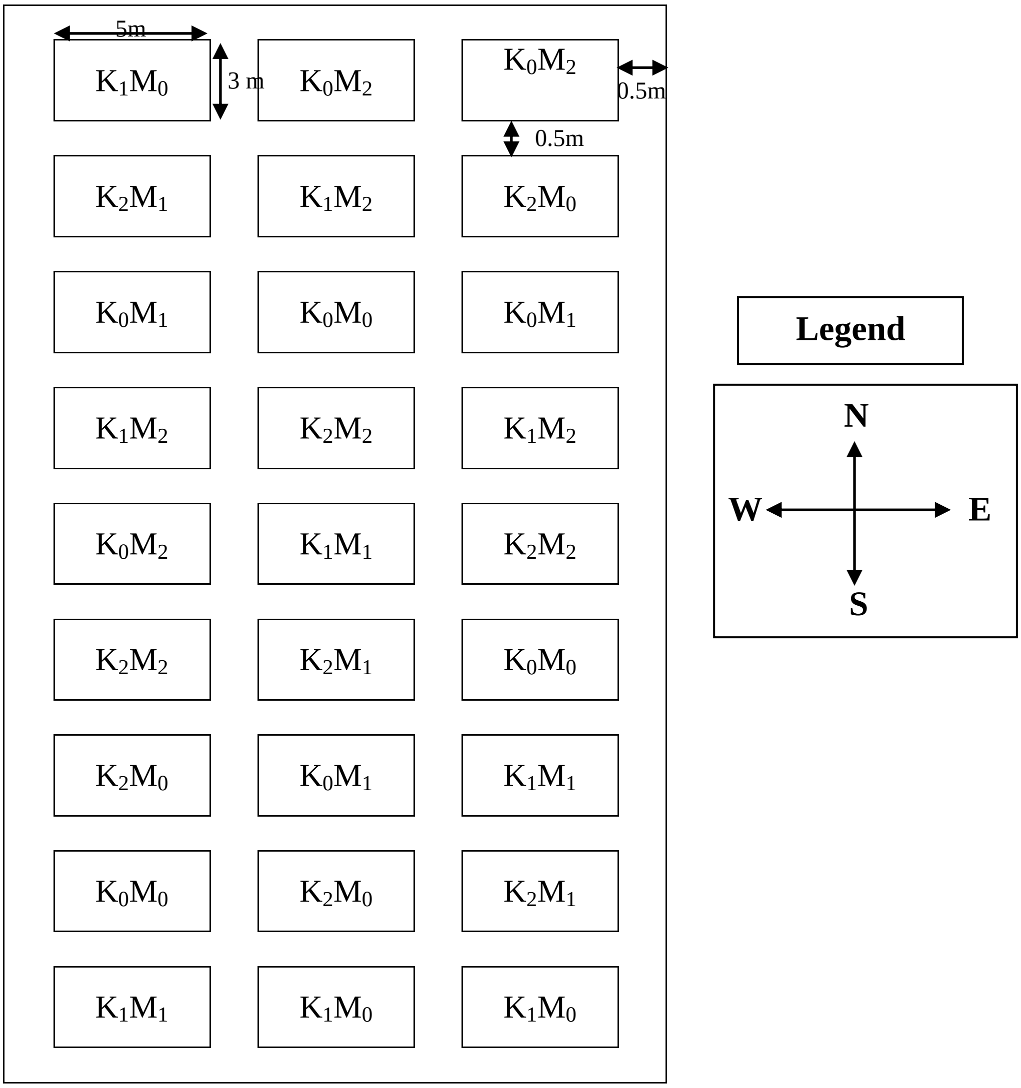

Figure 2. Layout of the experiment field

Appendix V. Plant height of potato as influenced by potassium and magnesium at different days after sowing

Sources of variation	Degrees of freedom	Mean square of plant height (cm)		
		30 DAP	50 DAP	70 DAP
Replication	2	1.023	2.144	2.647
Factor A	2	12.36*	8.524*	16.37*
Factor B	2	8.06	10.27*	12.49*
AB	4	3.32**	5.54*	11.32*
Error	16	1.052	2.133	4.014

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VI. Number of stems hill^{-1} of potato as influenced by potassium and magnesium at different days after sowing

Sources of variation	Degrees of freedom	Mean square of Number of stems hill^{-1}		
		30 DAP	50 DAP	70 DAP
Replication	2	0.047	0.112	0.143
Factor A	2	6.144*	4.871*	3.289**
Factor B	2	3.29**	6.332*	7.542*
AB	4	2.521**	2.356**	6.136*
Error	16	0.471	0.385	1.206

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VII. Number of leaves hill^{-1} of potato as influenced by potassium and magnesium at different days after sowing

Sources of variation	Degrees of freedom	Mean square of Number of leaves hill^{-1}		
		30 DAP	60 DAP	70 DAP
Replication	2	1.247	2.361	3.211
Factor A	2	NS	NS	NS
Factor B	2	NS	NS	NS
AB	4	33.24*	102.42*	127.15*
Error	16	1.051	2.366	2.174

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VIII. Days to 100% emergence of potato as influenced by potassium and magnesium

Sources of variation	Degrees of freedom	Mean square of Days to 100% emergence
Replication	2	0.299
Factor A	2	12.71*
Factor B	2	6.379**
AB	4	8.371*
Error	16	0.436

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix IX. Effect of potassium and magnesium on weight of haulm hill^{-1} of potato at harvest

Sources of variation	Degrees of freedom	Weight of haulm hill^{-1} at harvest	
		Fresh weight (g)	Dry weight (g)
Replication	2	4.287	1.178
Factor A	2	22.47*	7.363**
Factor B	2	14.36*	8.477*
AB	4	10.44*	12.46**
Error	16	4.89	1.27

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix X. Yield contributing parameters of potato as influenced by potassium and magnesium

Sources of variation	Degrees of freedom	Mean square of Yield contributing parameters		
		Percent dry matter of fresh tuber (%)	Number of tuber hill^{-1}	Tuber weight hill^{-1} (g)
Replication	2	1.36	0.577	3.293
Factor A	2	3.891**	11.93*	23.654*
Factor B	2	7.432**	NS	42.586*
AB	4	11.22*	3.491**	64.311*
Error	16	1.264	1.328	5.378

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix XI. Yield parameters of potato as influenced by potassium and magnesium

Sources of variation	Degrees of freedom	Mean square of Yield parameters			
		Tuber yield plot^{-1} (kg)	Tuber yield ha^{-1} (t)	Stover yield ha^{-1} (t)	Harvest index (%)
Replication	2	1.388	2.32	0.271	1.087
Factor A	2	42.563*	16.543*	22.75*	25.78*
Factor B	2	18.714*	10.571*	8.951*	NS
AB	4	11.896*	9.633**	6.258*	10.265*
Error	16	2.174	1.833	0..486	2.053

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level