RESPONSE OF DIFFERENT SOURCES OF POTASSIUM ON GROWTH, YIELD AND QUALITY OF FIVE POTATO VARIETIES

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CERTIFICATE

This is to certify that the thesis entitled, **"*Response of different sources of potassium on growth, yield and quality of five potato varieties*"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in the partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (M.S.) IN AGRONOMY,** embodies the result of a piece of *bona fide* research work carried out by ***SRABANTIKA SARKER,*** Registration No. **08-02787** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed during the course of this investigation has been duly acknowledged and style of this thesis have been approved and recommended for submission.

Dated- December, 2014
Dhaka, Bangladesh.

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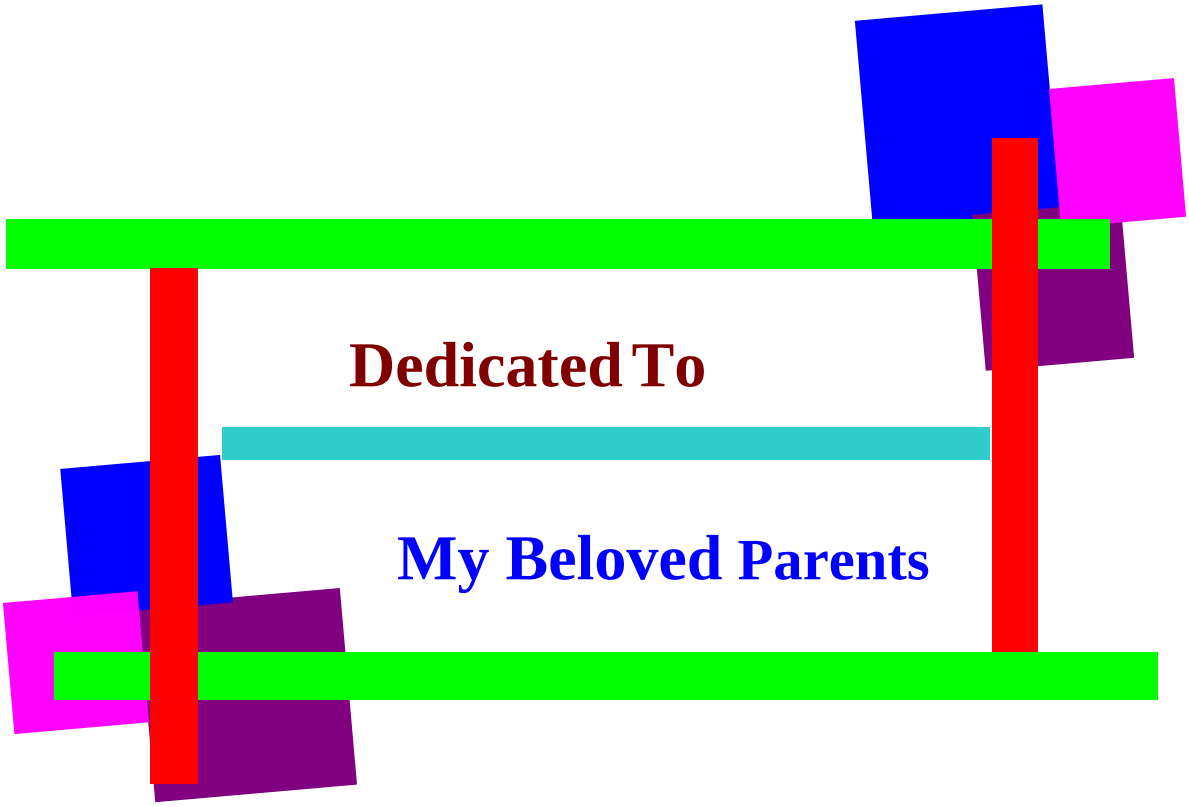
Dedicated To
My Beloved Parents

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ABSTRACT

A field experiment was conducted at the Agronomy research field of Sher-e-Bangla Agricultural University, Dhaka, during the period from November 2013 to March 2014, to study the response of different sources of potassium on growth, yield and quality of five potato varieties. The experiment comprised of two factors; Factor I: source of potassium fertilizer: 3 source; S_1 - Muriate of potash (MoP or KCl), S_2 - Potassium nitrate (KNO_3), S_3 - Potassium sulfate (K_2SO_4) and Factor II: potato: 5 variety; V_1 - Cardinal, V_2 - Asterix, V_3 - Carriage, V_4 - Diamant, V_5 - BARI TPS-1. The experiment was laid out in a split-plot design with three replications. The result revealed that different source of potassium and/or varieties had significant effects on most of the growth, yield and quality parameters. Among three different sources of potassium, potassium sulphate showed the best performance on most of the growth, yield and quality contributing characters. On the other hand among the five potato varieties, Diamant exhibited better performance in respect of yield, dry matter content, specific gravity and total soluble solids in tuber compared to those of other potato varieties. Among the fifteen treatment combinations, the 'Diamant' variety with the application of potassium sulfate produced maximum tuber yield (31.47 t ha^{-1}), highest dry matter content (22.30 %), maximum specific gravity (1.12 g cm^{-3}) and optimum total soluble solids (4.30 % brix). Although the combination of potassium sulphate and Diamant (S_3V_4) showed better growth, yield, quality performance but the combination of potassium nitrate and Diamant (S_2V_4) also demonstrated statistically similar results in sometime. So, planting potato variety 'Diamant' is suitable for producing good quality potato along with applying potassium sulfate or nitrate.

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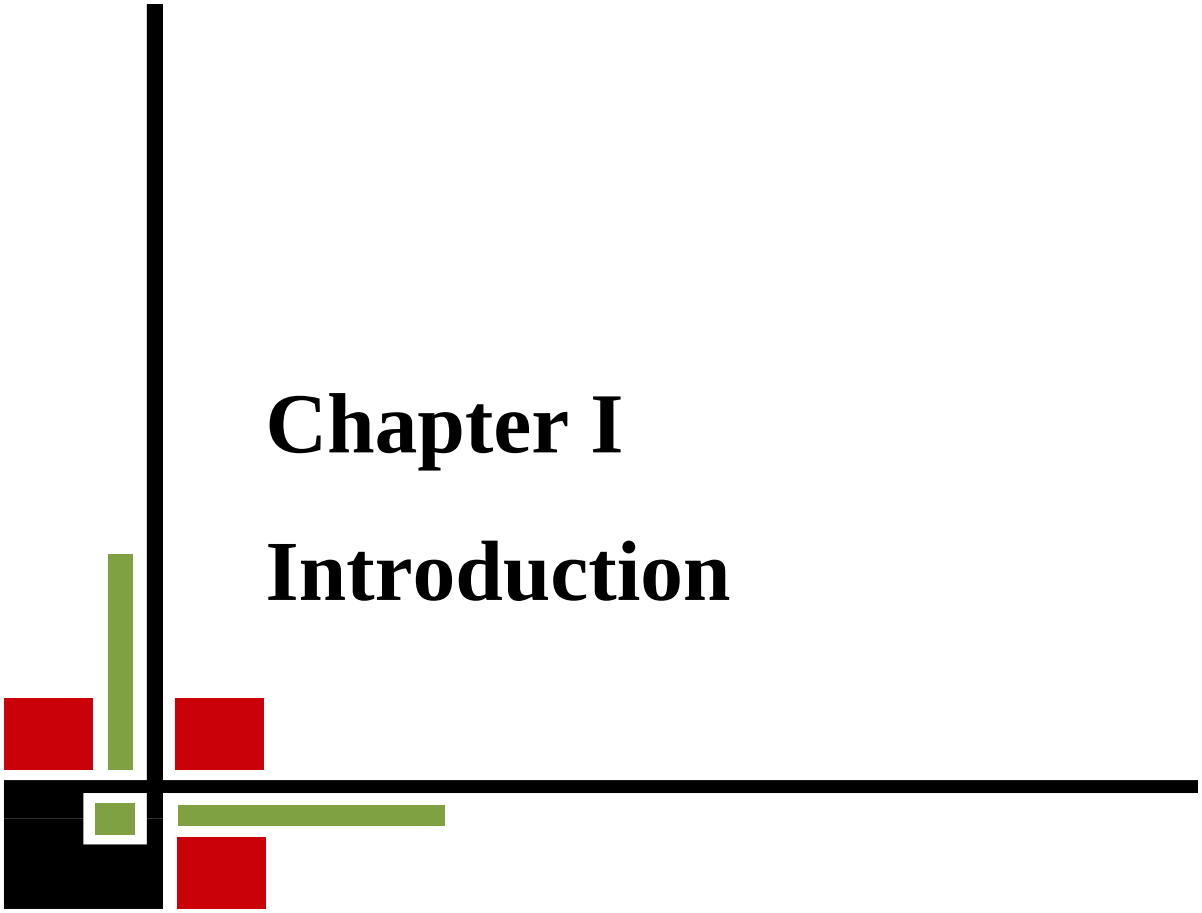
LIST OF ACCRONYMS AND ABBREVIATIONS

AEZ	Agro-Ecological Zone
Agric.	Agriculture
Agril.	Agricultural
Anon.	Anonymous
As	Arsenic
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BCF	Bio Concentration Factors
cm	Centi-meter
cm^2	Square centi-meter
CV	Coefficient of Variance
DAP	Days After Planting
Dev.	Devlopment
DMRT	Duncan's Multiple Range Test
Environ.	Environmental
et al.	And others
Expt.	Experimental
FAO	Food and Agriculture Organization
g	Gram (s)
$hill^{-1}$	Per hill
i.e.	*id est* (L), that is
j.	Journal
kg	Kilogram (s)
mg	Milligram
m^2	Meter squares
M.S	Master of Science
Res.	Research
SAU	Sher-e-Bangla Agricultural University
Sci.	Science
SE	Standard Error
$t\ ha^{-1}$	Ton per hectare
TSS	Total Soluble Solids
UNDP	United Nations Development Programme
viz	Namely
WHO	World Health Organization



Chapter I

Introduction

CHAPTER I

INTRODUCTION

Potato (*Solanum tuberosum* L.) is a tuber crop belongs to the family Solanaceae. It originated in the central Andean area of South America (Keeps, 1979). It is the fourth world crop after wheat, rice and maize. Bangladesh is the seventh potato producing country in the world (FAOSTAT, 2012). It contributes not only energy but also substantial amount of high quality protein and essential vitamins, minerals and trace elements to the diet (Horton, 1987).

In Bangladesh, it ranks second after rice in terms of production. The total area under potato crop, national average yield and total production in Bangladesh are 4,30,446 hectares, 19.071 t ha^{-1} and 82,05,470 metric tons, respectively. The total production is increasing over time as such consumption also rapidly increasing in Bangladesh (MOA, 2013). It is considered as a vegetable crop and contributes as much 55% of the total vegetable production in Bangladesh (BBS, 2013). The yield is very low in comparison to that of the other leading potato growing countries of the world, for instance, 40.16 t ha^{-1} in USA, 42.1t ha^{-1} in Denmark and 40.0 t ha^{-1} in UK (FAO, 2013).

Potato has acquired great importance in rural economy in Bangladesh. It is not only a cash crop but also an alternative of food crop to rice and wheat. 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 reasons for such a low yield of potato in Bangladesh are imbalanced source 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 source, planting time, spacing and use

of optimal sized seed are important which influence the yield of potato (Divis and Barta, 2001).

Potassium is the only essential plant nutrient that is not a constituent of any plant part. Potassium is a key nutrient in the plants tolerance to stresses such as cold/hot temperatures, drought, and waterlogged and pest problems. Potassium (K) in soil is present in three different forms that is total K, exchangeable K and K in soil solution (Mengel and Kirkby, 1987). Soil solution K has a high chance of leaching and thus loss from the soil system. Exchangeable K plays an important role in soil plant availability. Potassium from mica as dominant mineral in Nepalese soil (Schrier *et al.*, 1994) and K from mica contributes a part of soil K (Mengel and Rahmatullah 1994; Baeumler *et al.*, 1997).

Potassium is necessary to many plant functions, including carbohydrate metabolism, enzyme activation, osmotic regulation and efficient use of water, nitrogen (N) uptake and protein synthesis and translocation of assimilates (Lindhauer, 1985). It also has a role in decreasing certain plant diseases and in improving tuber quality (Cordova and Valverde, 2001). Potato is highly K demanding crop (Ayalew and Beyene, 2011). Foliar application of K had a significant effect on potato plant growth, tuber weight and total yield (Jasim *et al.*, 2013). Many researchers recorded an increase in yield of potato tubers yield as a result of increasing the levels of K source (Humadi, 1986). Increase in potassium application then decrease the weight loss and rottage of tubers (Singh and Lal, 2012).

Of the essential elements, K is the third most likely, after N and phosphorus, to limit plant productivity (Brady and Weil, 2002). It plays a critical role in lowering cellular osmotic water potentials, thereby reducing the loss of water from leaf stomata and increasing the ability of root cells to take up water from the soil (Havlin *et al.*, 1999) and maintain a high tissue water content even under drought

conditions (Marschner, 2002). Potassium is essential for photosynthesis, N fixation in legumes, starch formation, and the translocation of sugars. It is also important in helping plants adapt to environmental stress (Havlin *et al.*, 1999). As a result of several of these functions, a good supply of this element promotes the production of plump grains and large tubers. When K is deficient, growth is retarded, and net retranslocation of K^+ is enhanced from mature leaves and stems, and under severe deficiency these organs become chlorotic and necrotic (Marschner, 2002). Potassium deficiency causes lodging to crops (Mengel and Kirkby, 1987). K deficient plants are highly sensitive to fungal attack (Marschner, 2002), bacterial attack, and insect, mite, nematode and virus infestations (Havlin *et al.*, 1999). Potassium deficiency affects nutritional and technological (processing) quality of harvested products particularly fleshy fruits and tubers. In potato tubers, for example, a whole range of quality criteria are affected by the potassium content in tuber tissue (Marschner, 2002).

It is evident that uses of potassium are a very important variables in potato production. The aim of this work was to evaluate the response of different potassium source on growth, yield and quality of five potato varieties which have an effect on potato production in Bangladesh with the following objectives:

1. To study the response of K on yield and quality of potato varieties.
2. To find out suitable type of K for yield and quality of potato.
3. To study the interaction effects of potassium sources and potato varieties on growth, yield and quality of potato varieties.

Chapter II

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

Potato is the most important tuber crop in the world as well as in Bangladesh. Numerous experiments have been conducted throughout the world on potato crop but information regarding potassium in potato varieties and their effects on growth, yield and quality parameters are still inadequate. Brief reviews of available literature pertinent to the present study have been presented in this chapter.

2.1 Effect of potassium on growth and yield of potato

Roy *et al.* (2007) conducted an experiment to find out the relationship of N and K on quality of TPS. Three levels of N (0, 225 and 300 kg N ha^{-1}) and 4 levelss of K (0, 125, 175 and 225 kg K ha^{-1}) sources were applied to potato mother plants (MF-II) for the production of high quality True Potato Seed (TPS). The author 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 content in True Potato Sees but K did not increase. Tuber weight was the highest (10.4g) 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) showed that, in some cultivars K 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). A Field experiments were conducted in 1999 and 2001 at Tal Amara Research Station in the Bekaa Valley of Lebanon 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. Data from this study showed that responsive K treatments were evident in both years. The significant increases of tuber yield in response to K rates that were observed in 1999 for 'Spunta' and 'Derby' were associated with a lowering, for the former, and an increase, for the later, in tuber dry matter. Similar increases in tuber yield were obtained in 2001 in the K treatments for 'Shepody' and 'Umatilla'. 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 K levels K_2 and K_3 either for tuber yield or dry matter content.

Lalitha *et al.* (2002) showed that, application of 150 kg K ha^{-1} gave the highest tuber yield. The productivity of potato cultivars HPS-1/13 and Kufri Jyothi, propagated through true seeds and seed tubers, was evaluated on alfisol in Bangalore, Karnataka, India, under 3 K levels (100, 125 and 150 kg ha^{-1}) and 2 S levels (0 and 25 kg ha^{-1}). The tuber yield of both cultivars did not differ significantly (20.22 and 20.08 t ha^{-1} for HPS-1/13 and Kufri Jyothi, respectively). HPS-1/13 produced higher C (25-50 g) and D (<25 g) grade tubers with higher starch and protein contents, while A (75 g) and B (50-75 g) grade tubers, bulking rate and harvest index were higher with Kufri Jyothi. Dry matter production of HPS-1/13 was higher than Kufri Jyothi. Application of 25 kg S ha^{-1} increased the yield and quality, but not to the significant levels.

A field experiment was conducted in Karnataka, India in 1994 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. Lalitha *et al.* (2000a) showed that, K source application reduce 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.

Kanzikwera *et al.* (2001) showed that, K application significantly decreased shoot dry matter yield in some genotypes of potato. Field experiments were conducted at Namulonge, Uganda, during 1995-96 and 1999 to assess the effect of N and K on dry matter yield and nutrient partitioning in true potato (*Solanum tuberosum*) seed (TPS) mother plants. Three N (0, 120, 240 kg ha^{-1}) and K (0, 132.8 and 265.6 kg ha^{-1}) rates were applied to mother plants of three potato genotypes, CIP 800212, CIP 381379.9 (Kisoro) and CIP 381403.1. N application, however, had no significant effect on shoot dry matter yield although N x genotype interactions were significant on the parameter. Fresh tuber yield ranged from 21.0 to 37.5 t ha^{-1}, and was significantly ($P \leq 0.05$) increased by both N and K application. Leaf N concentration varied significantly ($P \leq 0.05$) among genotypes and K rates higher than 132.8 kg ha^{-1} increased this parameter in potato genotype CIP 381403. High N and K rates also increased stem N concentration in this genotype. Nitrogen application significantly ($P \leq 0.05$) increased foliar Ca concentration.

A field experiment was conducted during the rabi season of 2000-01 and 2001-02 in the sandy clay loam soil of West Bengal, India, to investigate the effect of K source sources (KCl and K_2SO_4) and NPK rates (75 and 100% of the recommended, N:P:K at 180:150:150 kg ha^{-1}) with or without farmyard manure (FYM) at 10 t ha^{-1} on potato cv. Kufri Badshah production. Chettri and Thapa (2002) concluded that K as K_2SO_4 produced higher dry matter production compared to KCl. The highest dry matter production (360.3, 570.4 and 825.3 g/m at 60, 80 and 100 days after planting), tuber bulking rate (12.83 and 8.78 g/m per day at 80 and 100 days after planting, respectively) and yield (275.7 q ha^{-1}) were obtained with 100% NPK + FYM. Higher nutrient uptake was observed with high or low rates of NPK in combination with FYM.

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.

The K requirements of potato (*Solanum tuberosum*) cultivars Kufri Chipsona 1 and Kufri Chipsona 2 (intended for processing) were studied by during 2000-01 and 2001-02 in Modipuram, Uttar Pradesh, India, in relation to their processing grade tuber yield and quality parameters. Parveen *et al.* (2004) showed that, 124.5 kg K ha^{-1} give the highest yields of process grade tubers (32.8 and 29.5 t ha^{-1} in Kufri Chipsona 1 and Kufri Chipsona 2, respectively). The K levels (0, 41.5, 83.0, 124.5 and 166 kg K ha^{-1}) affected the yield of process grade tubers in both cultivars. However, K did not significantly affect the quality parameters for processing (tuber dry matter, specific gravity, reducing sugar content and chip colour). The K requirements of Kufri Chipsona 1 and Kufri Chipsona 2 (124.5 kg K ha^{-1}) were 50% higher than the K requirements of table-purpose potato cultivars, such as Kufri Bahar.

Moinuddin and Shahid (2004) showed that 8 meq L^{-1} K give the highest tuber yield and percent dry matter content. An experiment was carried out 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 (K) (2, 4, 8, and 12 meq L^{-1}) and sulfur (S) (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 levels, application at 4 and 6 meq L^{-1} S enhanced average tuber yield and percent dry matter content by 28 and 0.41%, respectively.

An experiment was conducted with the high-yielding and cold-resistant variety Mila field plots in Zhijin, Guizhou, China. Lu (2003) showed that K source increase plant height, stem diameter, branches/plant, weight/tuber and yield/plant, but decreased tubers/hill. The highest yield was recorded in the treatment with 150 kg K_2O ha^{-1}, followed by the treatment with 60 kg P_2O_5 and 100 kg K_2O ha^{-1}. The highest output: input ratio was noted in the treatment with 150 kg K_2O ha^{-1}, followed by the treatment with 60 kg P_2O_5 and 100 kg K_2O ha^{-1}. K source increased plant height, stem diameter, branches/plant, weight/tuber and yield/plant, but decreased tubers/hill. The highest starch and the highest crude protein contents were found in the treatment with 60 kg P_2O_5 and 100 kg K_2O ha^{-1}, followed by the treatment with 150 kg K_2O ha^{-1}. It is concluded that the balanced application of NPK sources can increase potato yield, improve tuber quality and promote plant growth, thus obtaining higher economic benefits.

A field experiment was conducted in Lithuania during 2000-2002 to study the effects of various sources on potato tuber yield, starch and dry matter content. Makaraviciute (2003) commented that Meteorological conditions during the vegetation period and varietal characteristics significantly affected the starch and dry matter contents of tubers. The sources had no significant effect on these indices. The application of compound mineral sources NPK at 90:90:180 kg ha^{-1} and complex mineral sources NPK at 90:90:180 with microelements resulted in the highest yields (20.6-26.1 t ha^{-1} and 21.4-27.4 t ha^{-1}, respectively). The complex mineral sources with microelements were superior to the compound mineral sources with regard to tuber yield. On average, the highest contents of starch and dry matter were recorded for Lady Rosetta (17.0-17.9% and 23.2-24.21%) and Saturna (17.1-17.4% and 23.5-23.8%). The highest starch and dry matter contents were observed in 2002 (14.9-21.0% and 21.3-27.1%). The application of manure

(40 t ha^{-1}) gave the highest starch and dry matter contents (14.9-17.9% and 21.2-24.2%) of tubers in most of the cultivars.

Cao (2003) showed that, top dressing of K source enhance tuber yield, starch content, tuber size and photosynthetic rate of leaves, chlorophyll content in leaves at late growth stage, as well as prolonged growth period .

A study was conducted to assess the effects of different levels of cow dung and NPK on growth, yield and postharvest behavior of TPS seedling tubers raised from true potato (*Solanum tuberosum*) seeds. Rahman *et al. (*2002) showed that, moderate dose of cow dung manure (50 t ha^{-1}) and the highest doses of NPK sources (375 kg urea, 225 kg TSP and 300 kg MoP ha^{-1}) increase Plant height, foliage coverage, number of seedling tubers per plant, size of seedling tubers and give highest yield 38.91 t ha^{-1}). The yield (37.14 t ha^{-1}) and net return (Tk.169 110 ha^{-1}) were significantly higher under the treatment combination receiving a moderate dose of cow dung manure (50 t ha^{-1}) and the highest doses of NPK sources (375 kg urea, 225 kg TSP and 300 kg MP ha^{-1}). Use of a moderate dose of NPK sources (275 kg urea, 185 kg TSP and 250 kg MP ha^{-1}) in presence of cow dung manure at 25 t ha^{-1} gave highest (2.36) benefit cost ratio with a moderate investment. The postharvest loss in weight and sprouting of tubers during storage increased significantly with increasing doses of cow dung manure and NPK sources applied during production.

A field test with potato cv. Kexin No. 1 was conducted by Song (2004) on chernozem in Baiyin, Gansu, China. N source was applied at 0 and 15 kg/mu, and K_2O at 0, 8, 16, 24 and 32 kg/mu. The relationships between application rates and tuber yield were studied. No N application combined with increasing K source rates did not increase tuber yield. However, combining 15 kg N/mu with increasing rates of K increased tuber yield. The highest fresh tuber yield (2600

kg/mu) was obtained with 12.25 kg K_2O/mu. The optimum applied amount of K_2O was 8.7 kg/mu, resulting in a fresh tuber yield of 2580 kg/mu. [1 mu = 0.067 ha]

A study was conducted by Khandakhar *et al.* (2004) in strongly acidic sandy loam soil at the Potato Breeder Seed Production farm, BARI, Debigonge, Panchogar, Bangladesh to investigate the effect of different application rates of lime (0, 0.5, 1.0 and 2.0 t ha^{-1}) and potassium source (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.

A field test with cv. Dabaihua was conducted by Qin-Fang in a semiarid region of Dingxi, Gansu, China, to investigate the yield-related indices under different K application rates. Qin (2003) showed that the highest tuber yield can be obtained by 90 kg K_2O ha^{-1}, followed by 75 and 60 kg K_2O ha^{-1}, and the lowest in the control. Seven treatments were used with $N:P_2O_5:K_2O$ ratios of 0:0:0 (control 1), 90:90:0 (control 2), 90:90:30, 90:90:45, 90:90:60, 90:90:75 and 90:90:90 kg ha^{-1}. The tuber yields in the treatments with K source were significantly higher than those in the control treatments. The highest tuber yield was recorded at 90 kg K_2O ha^{-1}, followed by 75 and 60 kg K_2O ha^{-1}, and the lowest in the control 1. The highest economic benefits was found for 75 kg K_2O ha^{-1}, followed by 60 and 90 kg K_2O ha^{-1}, and the lowest in the control 1. The highest marketable tuber percentage was found at 75 kg K_2O ha^{-1}, followed by 60 and 90 kg K_2O ha^{-1}, and the lowest in the control 1. The optimum K application rate was 60-90 kg ha^{-1} in this semiarid region.

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.

The effects of different levels of NPK sources on seedling tuber production from true potato seeds were investigated on a sandy loam soil in Sriniketan, West Bengal, India. Nandi *et al.* (2002) Shows that Tuber yield increased with increasing source rates up to 210 kg N ha^{-1}, 175 kg P ha^{-1} and 175 kg K ha^{-1}. Increasing the source rates to 300 kg N ha^{-1}, 250 kg P ha^{-1} and 250 kg K ha^{-1} had no beneficial effect and, in most cases, exhibited a declining trend. Tuber yield increased with increasing source rates up to 210 kg N ha^{-1}, 175 kg P ha^{-1} and 175 kg K ha^{-1} in all three years of study. The highest yield (17.67 t ha^{-1}) was recorded with the application of 240 kg N ha^{-1}, 200 kg P ha^{-1} and 200 kg K ha^{-1}, which was at par with the yield (17.24 t ha^{-1}) obtained with 210 kg N ha^{-1}, 175 kg P ha^{-1} and 175 kg K ha^{-1}. Based on the pooled data, the optimum source rates were set at 242 kg N ha^{-1}, 202 kg P ha^{-1} and 202 kg K ha^{-1}, and these rates were expected to yield 14.51 ton of tubers ha^{-1}, with a net profit of Rs. 89.173 ha^{-1} and benefit cost ratio of 3.31.

Wijkmark *et al.* (2005) showed that, site-specific K source application led to improved potato quality with regards to after-cooking darkening, strong sogginess and weak sogginess. On the other hand, site-specific K source application had no influence on yield levels. The economic and qualitative effects of site-specific application of potassium (K) source 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 source 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.

2.2 Effect of variety on growth and yield of potato

Kassim *et al.* (2014) found that reducing physiological functions of above ground part of potato plant (leaf area and total chlorophyll content), the number and the weight of tuber decreased, so the productivity of the plant decreased.

Abebe (2013) carried out an experiment at three distinct locations in the Amhara region of Ethiopia for evaluation of the specific gravity of 25 potato varieties. The pooled specific gravity values ranged from 1.058 to 1.102. The specific gravity of tubers of the improved variety Belete was the highest while that of Menagesha was the lowest. Furthermore, the specific gravity values for varieties grown at Debretabor were higher than those for the corresponding varieties grown at Adet and Merawi. He mentioned that specific gravity is the measure of choice for estimating dry matter and ultimately for determining the processing quality of potato varieties.

Behjati *et al.* (2013) conducted a field experiment to evaluate the yield and yield components on promising potato clones. Clone No. 397031-1, had the highest yield and Lady Rosetta variety had the lowest yield compared with other varieties. The lowest and highest average number of main stems per plant, related to Lady Rosetta and clone No. 397067-2. Lady Rosetta variety had the highest number of tube per plant and clone No. 397067-2 had the lowest number of tubers per plant. The lowest and highest average tuber weight per plant related to clone No. 397067-2 and Lady Rosetta variety respectively.

Hossain (2011) conducted three experiments with BARI released twelve potato varieties to determine the yield potentiality, natural storage behavior and degeneration rate for three consecutive years. He found that the highest emergence was observed in Granola at 34 DAP. At 50 DAP plant height (cm) of Diamant was (43.50), BARI TPS 1 (47.70), Felsina (52.00), Asterix (52.97), Granola (38.30), Cardinal (46.33). Foliage coverage (%) of Diamant was (83.33), BARI TPS 1 (85.56), Felsina (82.22), Asterix (89.44), Granola (85.56), Cardinal (81.67). No. of stems hill^{-1} of Diamant was (4.06), BARI TPS 1 (3.21), Felsina (3.14), Asterix (4.03), Granola (3.30), Cardinal (3.89). Tuber yield hill^{-1} (g) of Diamant was (244.2), BARI TPS 1 (227.9), Felsina (300.1), Asterix (276.9), Granola (277.0), Cardinal (316.9). Under the grade 28-40mm, the highest number (48.63%) of seed tubers was produced by Granola which was statistically identical with Asterix (46.43%). Under the same grade (28-40 mm), the highest weight (43.46%) of seed tubers was produced by Patrones followed by Asterix (37.16%), Granola (36.64%) and Multa (35.39%) among which there was no significant variation.

Karim *et al.* (2011) conducted an experiment with ten exotic potato varieties (var. All Blue, All Red, Cardinal, Diamant, Daisy, Granola, Green Mountain, Japanese Red, Pontiac and Summerset) to determine their yield potentiality. The highest total tuber weight per plant (344.60g) recorded in var. Diamant and total tuber weight plant^{-1} was the lowest (65.05 g) recorded in var. All red, all blue varieties showed the most potential yield in this experiment.

Anonymous (2009a) conducted an experiment with three potato varieties to observe their performance on yield under different soil moisture levels. The highest plant height (50.75 cm) was found in Cardinal which was similar to Diamant (48.88 cm). The lowest plant height was observed in Granola (38.50 cm). The highest foliage coverage (93.25%) was observed in Diamant followed by Cardinal (92.75%) and the lowest in Granola (90.33%). The highest no. of stems hill^{-1} (6.25) was observed in Cardinal which was similar to Diamant (5.42) and the

lowest in Granola (4.75). The highest no. of tubers hill^{-1} (13.83) was observed in Granola which was similar to Cardinal (13.33) and the lowest in Diamant (11.92).

Anonymous (2009b) conducted an experiment with twenty five varieties were evaluated at six locations. They found that, plant height (cm) in case of Diamant (47.87), Sagitta (56.20), Quincy (95.40); No. of stem hill^{-1} in Diamant (3.66), Sagitta (2.53), Quincy (2.26); Foliage coverage at 60 DAP (%) in Diamant (73.33), Sagitta (93.67), Quincy (92.00); No of tuber hill^{-1} in Diamant (6.72), Sagitta (3.94), Quincy (9.95); Weight of tuber hill^{-1} (kg) in Diamant (0.30), Sagitta (0.34), Quincy (0.35); Dry matter (%) in case of Diamant (19.54), Sagitta (20.10), Quincy (18.70).

Anonymous (2009c) conducted an experiment with twelve varieties were evaluated at six locations in their third generation. They found that, plant height (cm) in case of Diamant (50.93), Granola (69.10), Sagitta (41.33), Quincy (65.87); No. of stem hill^{-1} in Diamant (5.66), Granola (3.20), Sagitta (3.46), Quincy (4.86); Foliage coverage at 60 DAP (%) in Diamant (92.00), Granola (91.00), Sagitta (89.33), Quincy (96.00); No. of tuber hill^{-1} in Diamant (7.24), Granola (6.82), Sagitta (5.23), Quincy (5.76); Weight of tuber hill^{-1} (kg) in Diamant (0.38), Granola (0.26), Sagitta (0.33), Quincy (0.35); Dry matter (%) in case of Diamant (20.80), Granola (20.45), Sagitta (19.80), Quincy (18.40).

Anonymous (2009d) conducted an experiment with twenty eight varieties were evaluated at five locations. They found that, plant height at 60 DAP (cm) in case of Diamant (54.13), Sagitta (47.27), Quincy (80.93); No. of stem hill^{-1} in Diamant (4.66), Sagitta (5.40), Quincy (5.80); Foliage coverage at 60 DAP (%) in Diamant (93.67), Sagitta (90.67), Quincy (97.00); No. of tubers hill^{-1} in Diamant (8.11), Sagitta (5.41), Quincy (6.95); Weight of tubers hill^{-1} (kg) in Diamant (0.28), Sagitta (0.37), Quincy (0.45); Dry matter (%) in case of Diamant (19.91), Sagitta (20.60), Quincy (18.34).

Anonymous (2009e) conducted an experiment with four exotic potato varieties along with check Diamant, Cardinal and Granola were evaluated at six locations in Regional Yield Trial. They found that plant height (cm) in case of Diamant (51.20), Cardinal (48.27), Meridian (48.33) and Laura (41.00); No. of stem hill^{-1} in Diamant (5.93), Cardinal (6.20), Meridian (5.67) and Laura (4.73); Foliage coverage (%) in Diamant (88.33), Cardinal (90.33), Meridian (95.67) and Laura (86.67); No. of tuber hill^{-1} in Diamant (9.48), Cardinal (9.81), Meridian (9.63) and Laura (7.50); Weight of tuber hill^{-1} (kg) in case of Diamant (0.313), Cardinal (0.377), Meridian (0.490) and Laura (0.430); Dry matter (%) in case of Diamant (22.69), Cardinal (21.03), Meridian (19.49) and Laura (20.22).

Anonymous (2009f) conducted an experiment with seven potato varieties were evaluated at MLT site. They found that plant height (cm) in case of Diamant (43.00), Lady Rosetta (37.00), and Courage (44.47); No of stem plant^{-1} in Diamant (3.57), Lady Rosetta (2.80), and Courage (3.67); No of tuber plant^{-1} in Diamant (8.07), Lady Rosetta (5.67), and Courage (6.70).

Anonymous (2009g) conducted adaptive trails with new potato varieties at eleven districts. The mean yield of varieties over locations arranged in order of descending as BARI TPS-1 (23.87 t ha^{-1}), Granola (23.68 t ha^{-1}), Diamant (23.63 t ha^{-1}), Asterix (20.83 t ha^{-1}) and Raja (18.28 t ha^{-1}).

Güler (2009) observed that first, second, third class tuber yields and total tuber yield, tuber number per plant, mean tuber weight and leaf chl were significantly influenced by potato cultivar. There were significant correlations between chl and yield and yield related characters. Total yield significantly correlated with leaf chl. Correlations between first class yield and total yield as well as total yield and tuber number per plant were highly significant.

Mahmud *et al.* (2009) assessed the yield of seed size tubers in five standard potato cultivars (Cardinal, Multa, Ailsa, Heera, and Dheera) in relation to dates of

dehaulming (65, 70, and 80 days after planting) in a Seed Potato Production Farm, Debijong, Panchagarh. The maximum seed tuber yield was recorded from Cardinal at 80 DAP followed by Heera and Cardinal at 70 DAP, Dheera and Ailsa at 75 DAP.

Haque (2007) conducted a field experiment with 12 exotic potato germplasm to determine their suitability as a variety in Bangladesh. He found that all the varieties gave more than 90% emergence at 20-35 DAP. He also observed that Plant height (cm) of Quincy was (87.8), Sagitta (65.8), Diamant (62.6); No. of stems hill^{-1} was counted in Diamant (7.2), Quincy (4.5), Sagitta (4.4); Plant diameter (cm) of Sagitta was (4.0), Quincy (3.7), Diamant (2.6) at 60 DAP; Foliage coverage (%) of Sagitta was (100.0), Diamant (98.3), Quincy (96.6); No. of tubers plant^{-1} of Diamant was (13.06), Sagitta (8.34), Quincy (6.71); Wt. of tubers plant^{-1} (kg) of Quincy was (0.64), Sagitta (0.63), Diamant (0.49); dry matter (%) of Sagitta was 20.8%, Diamant 20.1% and Quincy 18.5%.

Das (2006) carried out an experiment to study the physio-morphological characteristics and yield potentialities of potato varieties. He found that Foliage coverage (%) of Diamant was (93.3), Asterix (71.7), Granola (66.7), Quincy (90.0), Courage (63.3), Felsina (83.3), Lady Rosetta (83.3), Laura (78.3); No. of tubers hill^{-1} of Diamant (11.7), Asterix (8.00), Granola (11.3), Quincy (9.33), Courage (7.33), Felsina (8.00), Lady Rosetta (10.3), Laura (8.33); Tuber weight hill^{-1} (g) of Diamant (380), Asterix (285), Granola (275), Quincy (300), Courage (320), Felsina (333), Lady Rosetta (348), Laura (258); Dry matter (%) of Diamant (25), Asterix (17.5), Granola (23), Quincy (31), Courage (34.5), Felsina (22.5), Lady Rosetta (22.0), Laura (27.0); Regarding size grade distribution of tubers the varieties Courage, Espirit, Granola, Lady rosetta, Laura were found superior.

Anonymous (2005) evaluated twenty one varieties along with two standard checks Diamant and Granola at seven locations. The yields of the varieties varied from

location to location as well as within location. Of all the stations, except Pahartoli, none crossed the check variety Diamant but comparatively higher yields were produced by the varieties Espirit, Courage, Innovator, Quincy, Matador, Markies, Laura and Lady Rosetta.

Kumar *et al.* (2005) determined under water weight, specific gravity, dry matter and starch content of potatoes grown at Modipuram, Uttar Pradesh. He found that there was a positive correlation between under water weight and specific gravity (r=0.99), under water weight and dry matter (r=0.92).

Mondol (2004) conducted an experiment to evaluate the performance of seven exotic (Dutch) varieties of potato. He found that plant height (cm) of Diamant was (18.07 cm), Granola (13.47 cm); No. of main stem hill^{-1} of Diamant (4.36), Granola (4.90); No. of tubers hill^{-1} of Diamant (12.00), Granola (10.93); Weight of tubers plant^{-1} (kg) of Diamant (0.57), Granola (0.39); Dry matter (%) of Diamant (17), Granola (16.30).

Alam *et al.* (2003) conducted a field experiment with fourteen exotic varieties of potato under Bangladesh condition. The highest emergence (91%) was observed from Cardinal which was statistically identical with most of the varieties except the variety Granola (63%). The highest number of stem hill^{-1} was recorded in Ailsa (4.59) followed by Cardinal (4.50). Significantly maximum number of leaves hill^{-1} was produced from the plants of the variety Ailsa (53.80), which was followed by Cardinal (49.75). The yields ranged of exotic varieties were 19.44 to 46.67 t ha^{-1}. Variety Ailsa produced the maximum yield (46.67 t ha^{-1}) which was followed by Cardinal (42.21 t ha^{-1}).

Hossain (2000) conducted an experiment to study the effects of different levels of nitrogen on the yield of seed tubers in four potato varieties. He found that the tallest plants were produced by the seedling tubers of BARI TPS-1 (74.51 cm) and the shortest plants came from the variety Diamant (58.63 cm); Foliage coverage

(%) of Diamant at 75 DAP was (79.00), BARI TPS-1 (89.00); No. of stems hill^{-1} of Diamant was (3.50), BARI TPS-1 (2.71); No. of tubers hill^{-1} of Diamant was (7.85), BARI TPS-1 (9.55); Weight of tubers hill^{-1} of Diamant was (416.67), BARI TPS-1 (491.33); Dry matter of tuber (%) of Diamant was (19.71), BARI TPS-1 (18.18).

Rabbani and Rahman (1995) studied the performance of 16 Dutch potato varieties in their third generation. They reported that the height of the plants significantly varied among the varieties. The highest foliage coverage at maximum vegetative growth stage was found in the variety Cardinal (93.3%) followed by Diamant. The highest yield of tubers per hectare was obtained from Cardinal (35.19 t ha^{-1}) followed by Romano (30.09 t ha^{-1}) and the lowest from Stroma (11.11 t ha^{-1}).

Chapter III

Materials & Methods

CHAPTER III

MATERIALS AND METHODS

This chapter presents a brief description about experimental period, site, climatic condition, crop or planting materials, treatments, experimental design and layout, crop growing procedure, intercultural operations, data collection and statistical analysis. The details of experimental materials and methods are described below:

3.1 Experimental period

The experiment was conducted during the period from November 18, 2013 to March 20, 2014 in Rabi season.

3.2 Site description

3.2.1 Geographical location

The present piece of research work was conducted in the experimental plot of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the site is $23^0 74^/$N latitude and $90^0 35^/$E longitude with an elevation of 8.2 m from sea levels.

3.2.2 Agro-Ecological Region

The experimental site belongs to the agro-ecological zone of "Madhupur Tract", AEZ-28 (Anon., 1988a). 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., 1988b). The experimental site was shown in the map of AEZ of Bangladesh in Appendix 1.

3.2.3 Soil

Top soil was silty clay in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH was 5.6 and has organic carbon 0.45%. The experimental area was flat having available irrigation and drainage system and above flood levels. The selected plot was medium high land. The details were presented in Appendix 2.

3.2.4 Climate of the experimental site

Experimental site was located in the sub-tropical monsoon climatic zone, set aparted by winter during the months from November, 10 to March, 10 (Rabi season). Plenty of sunshine and moderately low temperature prevails during experimental period, which is suitable for potato growing in Bangladesh. The weather data during the study period at the experimental site are shown in Appendix 3.

3.3 Details of the Experiment

3.3.1 Experimental treatments

The experiment consisted of two factors such as varieties and different potassium sources. The treatments were as follows:

Factor I: Three different sources of potassium source
- S_1: Muriate of potash (MoP or KCl)
- S_2: Potassium nitrate (KNO_3)
- S_3: Potassium sulfate (K_2SO_4)

Factor II: Five potato variety
- V_1: Cardinal
- V_2: Asterix
- V_3: Carriage
- V_4: Diamant
- V_5: BARI TPS-1

Fifteen treatment combinations were as:

S_1V_1= Muriate of potash with Cardinal

S_1V_2= Muriate of potash with Asterix

S_1V_3 = Muriate of potash with Carriage

S_1V_4= Muriate of potash with Diamant

S_1V_5= Muriate of potash with BARI TPS-1

S_2V_1 = Potassium nitrate with Cardinal

S_2V_2= Potassium nitrate with Asterix

S_2V_3= Potassium nitrate with Carriage

S_2V_4= Potassium nitrate with Diamant

S_2V_5= Potassium nitrate with BARI TPS-1

S_3V_1= Potassium sulfate with Cardinal

S_3V_2= Potassium sulfate with Asterix

S_3V_3 = Potassium sulfate with Carriage

S_3V_4 = Potassium sulfate with Diamant

S_3V_5= Potassium sulfate with BARI TPS-1

3.3.2 Experimental design

The experiment was laid out in Split-Plot design with three replications thus comprised 45 plots. The layout of the experiment was prepared for distributing the combination of different potassium sources and variety. Source of potassium source assigned to main plot and variety to sub plot. The size of each unit sub plot was 1.0 m × 1.0 m. The spacing between blocks and plots were 0.5 m and 0.5 m, respectively.

3.4 Planting material

The planting materials comprised the first generation tubers of Cardinal, Asterix, Carriage, Diamant and BARI TPS-1.

3.5 Crop management

3.5.1 Collection of seed

All variety of seed potato (certified seed) was collected from, Tuber Crops Research Centre (TCRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

3.5.2 Preparation of seed

Collected seed tubers were kept in room temperature to facilitate sprouting. Finally sprouted potato tubers were used as a planting material.

3.5.3 Land preparation

The land of the experimental site was first opened in the last week of October with power tiller. Later on, the land was ploughed and cross-ploughed four times followed by laddering to obtain the desirable tilth. The corners of the land were spaded and weeds and stubbles were removed from the field. The land was finally prepared on 10 November 2013 three days before planting the seed. In order to avoid water logging due to rainfall during the study period, drainage channels were made around the land. The soil was treated with Furadan 5G @10 kg ha^{-1} when the plot was finally ploughed to protect the young plant from the attack of cut worm.

3.5.4 Source application

The crop was fertilized as per recommendation of TCRC (2004). The experimental plot was fertilized with following dose of urea, triple super phosphate (TSP), gypsum, zinc sulphate and boric acid.

Sources	Dose (kg ha^{-1})	Dose (g $plot^{-1}$)
Cowdung	10,000	1000
Urea	325	32.50
TSP	220	22.00
Gypsum	120	12.00
Zinc Sulphate	14	1.40
Boric Acid	6	0.60

Source: Mondal *et al.,* 2011.

Cowdung was applied 10 days before final land preparation. Total amount of triple superphosphate, gypsum, zinc sulphate, boric acid and half of urea was applied at basal doses during final land preparation. The remaining 50% urea was side dressed in two equal splits at 35 and 50 days after planting (DAP) during first and second earthing up. Different dose of MoP were applied as per treatment advised.

3.5.5 Planting of seed tuber

The well sprouted healthy and uniform sized potato tubers were planted and 8 potatoes were used for one plot. Seed potatoes were planted in such a way that potato does not go much under soil or does not remain in shallow. On an average, potatoes were planted at 4-5 cm depth in plot on November 18, 2013.

3.5.6 Intercultural operations

3.5.6.1 Weeding

Weeding was done to keep the plant free from weeds. The newly emerged weeds were uprooted carefully after complete emergence of sprouts and afterwards when necessary.

3.5.6.2 Watering

Frequency of watering was done upon moisture status of soil retained as requirement of plants. Excess water was not given, because it always harmful for potato plant.

3.5.6.3 Earthing up

Earthing up process was done in the plot at two times, during crop growing period. First was done at 35 DAP and second was at 50 DAP.

3.5.6.4 Plant protection measures

Dithane M-45 was applied at 30 DAP as a preventive measure for controlling fungal infection. Ridomil (0.25%) was sprayed at 45 DAP to protect the crop from the attack of late blight.

3.5.6.5 Haulm cutting

Haulm cutting was done at February 10, 2014 at 90 DAP, when 40-50% plants showed senescence and the tops started drying. After haulm cutting the tubers were kept under the soil for 10 days for skin hardening. The cut haulm was collected, bagged and tagged separately for further data collection.

3.5.6.6 Harvesting of potatoes

Harvesting of potato was done at March 3, 2014 at 10 days after haulm cutting. The potatoes of each plot were separately harvested, bagged and tagged and brought to the laboratory. The yield of potato plant^{-1} was determined in gram. Harvesting was done manually by hand.

3.5.7 Recording of data

Experimental data were recorded from 20 DAP and continued until harvest. Dry weights of different plant parts were collected after harvesting. The following data were collected during the experimentation.

A. Crop growth characters

i. Days to 1st emergence and days to final emergence
ii. Plant height at 20, 40, 60 and 80 DAP
iii. Number of leaves plant^{-1} at 20, 40, 60 and 80 DAP
iv. Number of stems hill^{-1} at 20, 40, 60 and 80 DAP
v. Leaf area plant^{-1} at 20, 40, 60 and 80 DAP
vi. Total chlorophyll content of leaves at 20, 40, 60 and 80 DAP
vii. Stem diameter at 20, 40, 60 and 80 DAP
viii. Dry matter content plant^{-1} (%) at 20, 40, 60 and 80 DAP

B. Yield and yield components

ix. Dry matter content of tuber at 20, 40, 60, 80 DAP and at harvest
x. Number of tubers hill^{-1}
xi. Average weight of tuber (g)
xii. Yield of tuber (t ha^{-1})

C. Quality characters

xiii. Tuber flesh dry matter content (%)
xiv. Specific gravity
xv. Total soluble solids (% Brix)

3.5.8 Experimental measurements

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

A. Crop growth characters

i. Days to 1st emergence and days to final emergence

After planting the potato tuber keenly observed the emergence twice in a day (morning and afternoon) until final emergence.

ii. Plant height (cm)

Plant height refers to the length of the plant from ground levels to the tip of the tallest stem. It was measured at an interval of 20 days starting from 20 DAP till 80 DAP. The height of each plant of each plot was measured in cm with the help of a meter scale and mean was calculated.

iii. Number of leaves plant^{-1}

Number of leaves plant^{-1} was counted at an interval of 20 days starting from 20 DAP till 80 DAP. Leaves number plant^{-1} were recorded by counting all leaves from each plant of each plot and mean was calculated.

iv. Number of stems hill^{-1}

Number of stems hill^{-1} was counted at an interval of 20 days starting from 20 DAP till 80 DAP. Stem numbers hill^{-1} was recorded by counting all stem from each plot.

v. Leaf area plant^{-1} (cm^2)

Leaf area plant^{-1} was measured an interval of 20 days starting from 20 DAP till 80 DAP by non-destructive method using CL-202 Leaf Area Meter (USA). Mature leaf (from 4th node) were measured all time and expressed in cm^2. Three mature plant of each plot were measured and then average mean value was calculated.

vi. Chlorophyll content of leaves (SPAD value)

Chlorophyll content of leaves was measured at an interval of 20 days starting from 20 DAP till 80 DAP. Mature leaf (fourth leaves from top) were measured all time. Three mature plant of each plot were measured by using portable Chlorophyll Meter (SPAD-502, Minolta, Japan) and then calculated an average SPAD value for each plot at each sampling time. The chlorophyll meter Soil Plant Analysis Development (SPAD-502) is a simple and portable diagnostic tool that measures the greenness or the relative chlorophyll concentration of leaves (Kariya *et al.,* 1982; Torres-netto *et al.,* 2005). It provides instantaneous and non-destructive readings on plants based on the quantification of the intensity of absorbed light by the tissue sample using a red LED (wavelength peak is ~650 nm) as a source. An infrared LED, with a central wavelength emission of approximately 940 nm, acts simultaneously with the red LED to compensate for the leaf thickness (Minolta Camera Co. Ltd., 1989).

vii. Stem diameter (cm)

Stem diameter was measured at an interval of 20 days starting from 20 DAP till 80 DAP. The stem diameter of each plant of each plot was measured in cm by using Slide Calipers and then means value was calculated.

viii. Above ground stem dry matter content (%)

First the fresh weight of haulm was taken. Then the samples of stem were dried in oven at 72^0C for 72 hours. From which the dry matter percentage of above ground harvest was calculated with the following formula (Elfinesh *et al.,* 2011)-

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

B. Yield and yield components

ix. Number of tubers hill^{-1}

Number of tubers hill^{-1} was counted at harvest. Tuber numbers hill^{-1} was recorded by counting all tubers from each plant.

x. Yield of tuber (t ha^{-1})

Tubers of each plot were collected separately from which yield of tuber hill^{-1} was recorded in kilogram and converted to ton hectare^{-1}.

xi. Average weight of tuber (g)

Average weight of tuber was measured by using the following formula-

$$\text{Average weight of tuber} = \frac{\text{Yield of tuber plant}^{-1}}{\text{Number of tubers hill}^{-1}}$$

xii. Grading of tuber (% by number and % by weight)

Tubers harvested from each plot were graded by number and by weight on the basis of diameter into the >55mm, 45-55mm, 28-45mm and <28mm and converted to percentages. A special type of frame (potato riddle) was used for grading of tuber.

C.Quality characters

xiii. Tuber flesh dry matter content (%)

The samples of tuber were collected from each treatment. After peel off the tubers the samples were dried in an oven at 72^{0}C for 72 hours. From which the dry matter content (%) of tuber flesh was recorded.

xiv. Specific Gravity (g cm^{-3})

It was measured by using the following formula -

$$\text{Specific gravity} = \frac{\text{Weight of tuber in air}}{\text{Weight of tuber in fresh water at } 4^0 \text{ C}}$$

xv. Total soluble solids (TSS)

TSS of harvested tubers was determined in a drop of potato juice by using Hand Sugar Refrectometer "ERMA" Japan, Range: 0-32% according to (AOAC, 1990) and expressed as BRIX value.

3.6 Statistical Analysis

The data obtained for different characters were statistically analyzed following the analysis of variance techniques by using MSTAT-C computer package programme. The significant differences among the treatment means were compared by Least Significant Difference (LSD) at 5% levels of probability (Gomez and Gomez, 1984).

Chapter IV

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

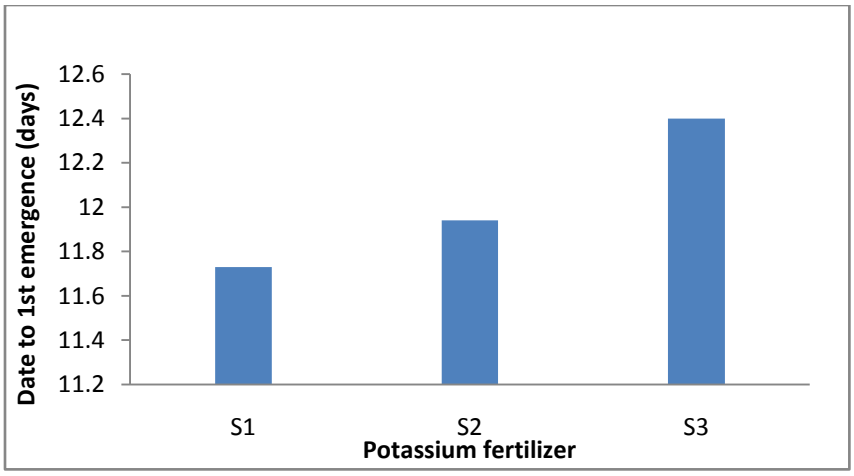
The experiment was conducted to find out the response of variety and different potassium source on the growth, yield and quality of potato. The results obtained from the study have been presented, discussed and compared in this chapter through table(s), figures and appendices. The analysis of variance of data in respect of all the parameters have been shown in Appendix 4-15. The results have been presented and discussed with the help of table and graphs and possible interpretations given under the following headings.

4.1 Crop growth characters

4.1.1 Days to 1st emergence (Visual observation)

4.1.1.1 Effect of Potassium sources

Days to 1st emergence was significantly influenced by different potassium sources, results revealed that, the duration of emergence gradually increasing up to S_3 treatment (Appendix 4 and Figure 1). The K_2SO_4 source (S_3) took the maximum days (12.40 days) for 1st emergence whereas, the minimum days (11.73 days) was taken by S_1 (KCl source) which was statistically similar (11.94 days) with S_2 (KNO_3). This result showed that KCl was the early emergence whereas, K_2SO_4 was the late one. Emergence depends on soil moisture, soil temperature, seed temperature, disease and physiological age of seed. Source affects the plant when plant had root. Roots are being developed 10-15 days after emergence. This trends was supported by the trends of Eugenia (2008).



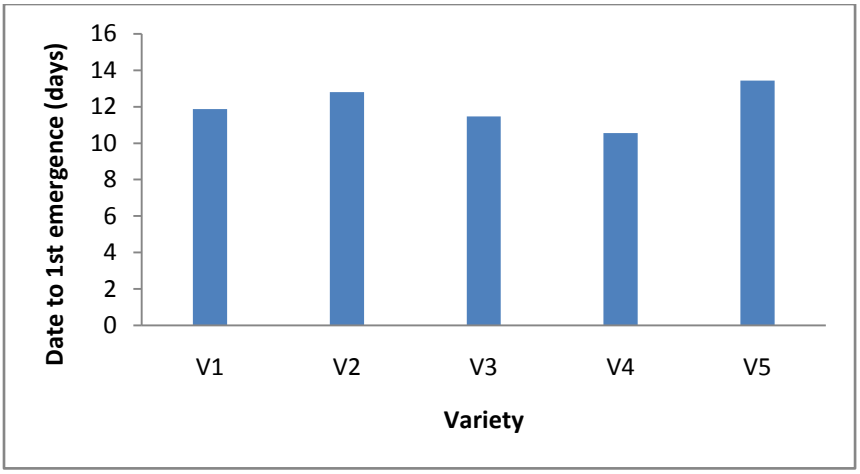
S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

Figure 1: Effect of different potassium sources on date to 1st emergence of potato

LSD value=0.3812

4.1.1.2 Effect of Variety

Days to 1st emergence was significantly influenced by the different potato varieties (Appendix 4 and Figure 2). Results revealed that the variety 'BARI TPS-I' took the maximum days (13.43 days) for emergence whereas, the minimum days (10.56 days) was taken by 'Diamant'. This result showed that 'Diamant' was the early emergence variety whereas, 'BARI TPS-I' was the late one. This might be due to varietal characters.



V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-1.

Figure 2: Effect of variety on date to 1st emergence of potato

LSD value=0.4933

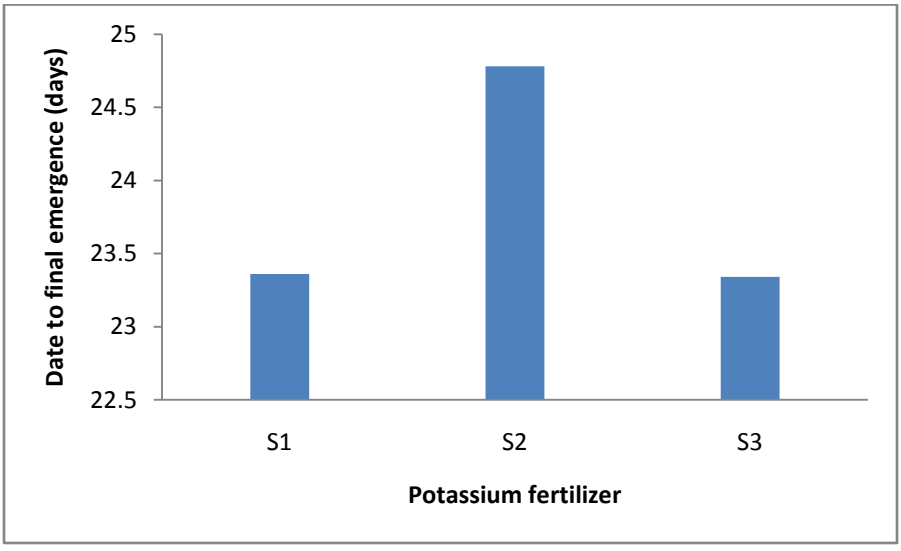
4.1.1.3 Interaction effect of potassium source and variety

Interaction effect of variety and potassium sources significantly influenced by days to 1st emergence of potato tubers (Appendix 4 and Table 1). The minimum duration for 1st emergence (9.67 days) was recorded from the combination of KCl source and Diamant treatment whereas, the maximum duration (15.00 days) was recorded from the combination of KNO_3 source and BARI TPS-I.

1.1.2 Days to final emergence (Visual observation)

4.1.2.1 Effect of potassium sources

Days to final emergence was significantly influenced by different potassium sources (Appendix 4 and Figure 3). The KNO_3 source (S_2) took the maximum days (24.34 days) for final emergence whereas, the minimum days (23.34 days) was taken by S_3 (K_2SO_4 source) which was statistically similar (23.36 days) with S_1 (KCl). This result showed that K_2SO_4 was the early emergence whereas, KNO_3 was the late one.



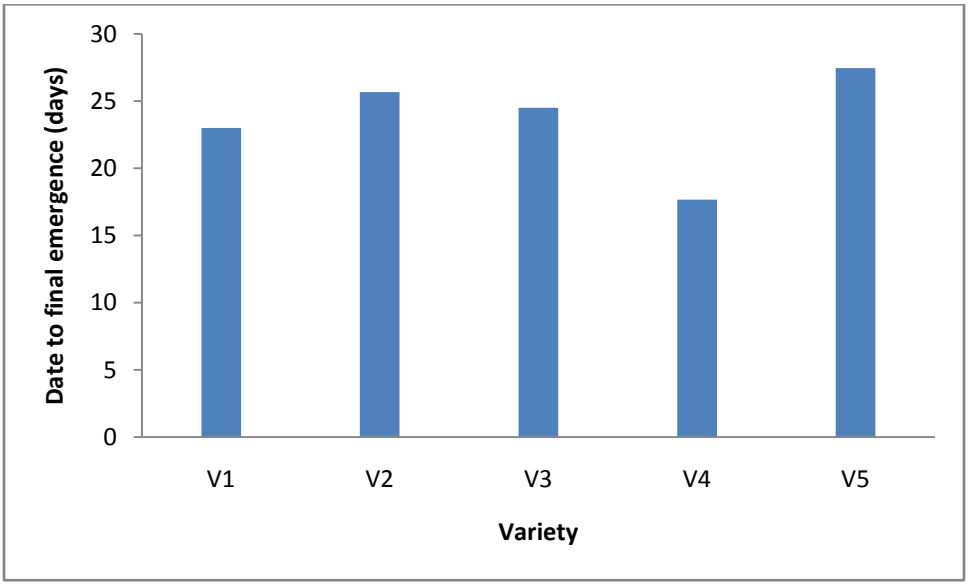
S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

Figure 3: Effect of different potassium sources on date to final emergence of potato

LSD value=0.4469

4.1.2.2 Effect of varieties

Days to emergence was significantly influenced by the different potato varieties (Appendix 4 and Figure 4). Results revealed that the variety 'BARI TPS-I' took the maximum days (27.47 days) for emergence whereas, the minimum days (17.67 days) was taken by 'Diamant'. This result showed that 'Diamant' was the early emergence variety whereas, 'BARI TPS-1' was the late one. This might be due to varietal characters.



V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 – BARI TPS-1.

Figure 4: Effect of variety on date to final emergence of potato

LSD value=0.5770

4.1.2.3 Interaction effect of potassium sources and variety

Interaction effect of variety and potassium source significantly influenced the days taken to final emergence of potato tubers (Appendix 4 and Table 1). The minimum duration for final emergence (17.20 days) was recorded from the combination of KCl source and Diamant treatment (S_1V_4) which was statistically similar (17.60 days) with combination of K_2SO_4 source and Diamant (S_3V_4) treatment. The

maximum duration (28.70 days) was recorded from the combination of KNO_3 source and BARI TPS-I (S_2V_5) treatment.

Table 1. Interaction effect of potassium sources and variety on date of 1st emergence (days) and date of final emergence (days) of potato

Treatments	Date of 1st emergence (days)	Date of final emergence (days)
S_1V_1	12.30 de	19.20 j
S_1V_2	12.00 ef	26.00 d
S_1V_3	11.70 f	27.70 b
S_1V_4	9.67 i	17.20 l
S_1V_5	13.00 c	26.70 c
S_2V_1	11.00 g	25.10 fg
S_2V_2	12.70 cd	25.70 de
S_2V_3	10.70 gh	24.00 h
S_2V_4	10.30 h	18.20 k
S_2V_5	15.00 a	28.70 a
S_3V_1	12.30 de	24.70 g
S_3V_2	13.70 b	25.30 ef
S_3V_3	12.00 ef	22.10 i
S_3V_4	11.70 f	17.60 l
S_3V_5	12.30 de	27.00 c
$LSD_{(0.05)}$	0.49	0.57
CV (%)	2.45	1.02

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

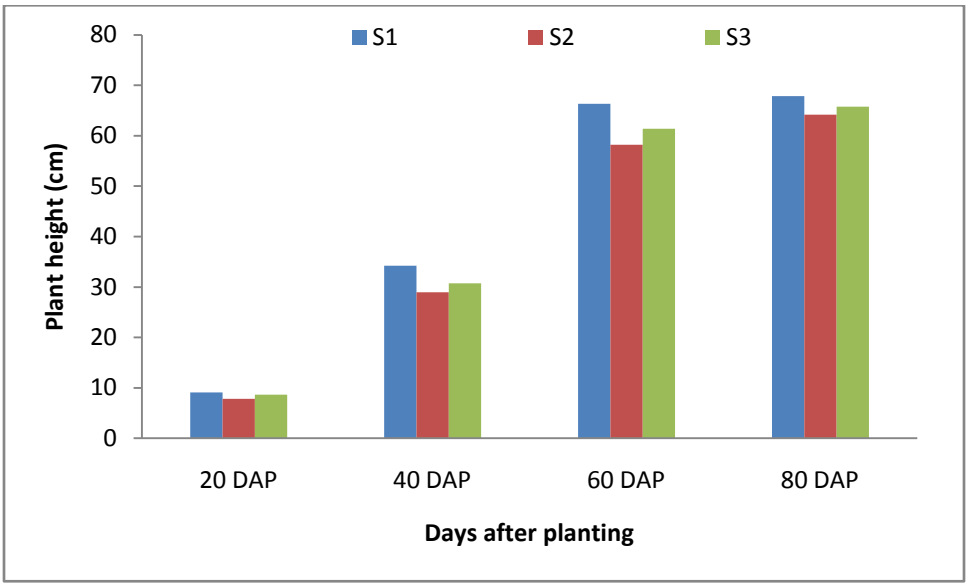
V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.1.3 Plant height

4.1.3.1 Effect of potassium sources

The plant height of potato was measured at 20, 40, 60 and 80 100 DAP. It was evident from Figure 5 and Appendix 5 that the height of plant was significantly influenced by potassium at all the sampling dates. At 40, 60 and 80 100 DAP, KCl source application showed the longest plant (9.09, 34.20, 66.32 and 67.85 cm,

respectively) whereas, the shortest plant (7.76, 28.98, 58.25 and 64.20 cm, respectively) was found from KNO_3 application.



S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

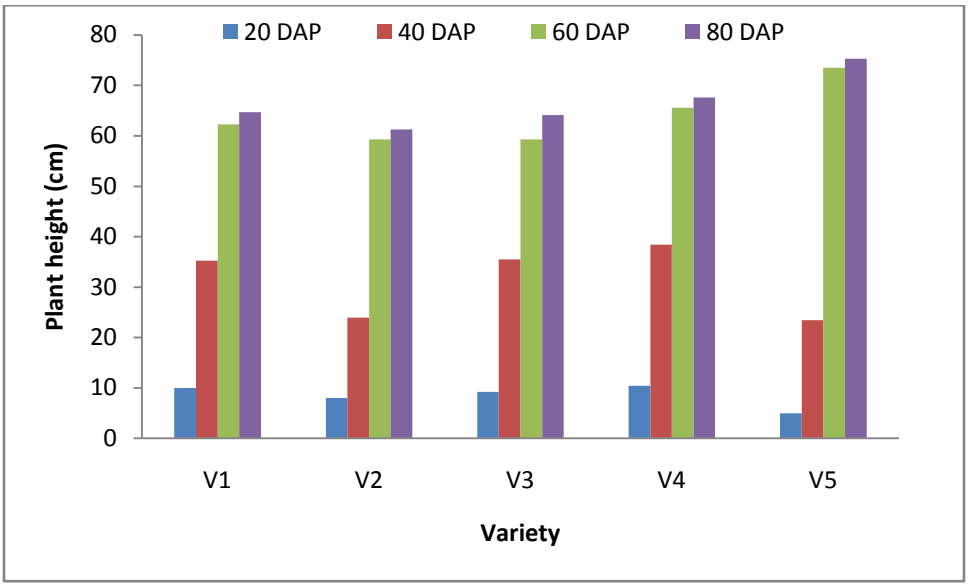
Figure 5: Effect of different potassium sources on plant height of potato

LSD value= 0.3548, 0.4258, 0.6644 and 0.3428 at 20, 40, 60 and 80 DAP, respectively

4.1.3.2 Effect of varieties

The plant height of potato varieties were measured at 20, 40, 60 and 80 DAP. It was evident from Figure 6 and Appendix 5 that the height of plant was significantly influenced by variety at all the sampling dates. Figure 5 showed that plant height increased with advancing growing period irrespective of varieties, the potato height increased rapidly at the early stages of growth and rate of progression in height was slow at the later stages. At 20 and 40 DAP, 'Diamant' showed the longest plant (10.41 and 38.43 cm, respectively) whereas, the shortest plant (4.93 and 23.44 cm, respectively) was found from the variety 'BARI TPS-I' which was statistically similar with 'Asterix' (23.96 cm) at 40 DAP. At 60 and 80

DAP, 'BARI TPS-1' gave the highest plant height (73.54 and 75.30 cm, respectively) whereas, the lowest height was recorded from 'Axterix' (59.59 and 61.30 cm, resperctively) which was statistically similar with 'Carrriage' (59.31 cm) at 60 DAP. Present investigation referred, 'BARI TPS-1' exposed best in terms of plant height. The variations in the plant height among the varieties also recorded by Rabbani (1996) and Bashar (1978) in their experimental results. Plant height of a crop depends on the plant vigor, cultural practices, growing environment and the varietal characters. In the present experiment since all the varieties were grown in the same environment and were given same cultural practices, the variation in the plant height among the varieties might be due to the varietal character.



V_1: Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

Figure 6: Effect of variety on plant height of potato

LSD value= 0.4580, 0.5496, 0.8577 and 0.4425 at 20, 40, 60 and 80 DAP, respectively

4.1.3.3 Interaction effects of potassium sources and variety

Significant Interaction effects of variety and potassium sources on plant height was observed at 20, 40, 60 and 80 DAP (Appendix 5 and Table 2). Plant height increased with advancing growing period irrespective of variety and potassium (Table 2). At 20 and 40 DAP, the tallest plant (11.20 and 45.33 cm, respectively) was obtained from the combination of S_1V_4 treatment which was statistically similar with S_1V_1 (11.00 cm) at 20 DAP and the shortest plant (4.51 and 14.23 cm, respectively) was obtained from S_2V_5 treatment which was statistically similar with S_1V_5 (4.61 cm) at 20 DAP. At 60 and 80 DAP, the highest plant height (79.70 and 80.40 cm, respectively) was observed from S_1V_5 treatment whereas, the shortest plant (51.00 and 58.10 cm, respectively) was obtained from S_2V_2 treatment. The highest plant height (80.40 cm) was recorded from the combination of KCl source and BARI TPS-I application treatment.

Table 2. Interaction effect of potassium sources and variety on plant height of potato

Treatments	Plant height (cm) at			
	20 DAP	40 DAP	60 DAP	80 DAP
S_1V_1	11.00 a	44.51 b	56.26 h	64.30 h
S_1V_2	8.84 fg	17.20 l	59.73 g	65.20 g
S_1V_3	9.80 c	35.83 e	59.13 g	63.53 i
S_1V_4	11.20 a	45.33 a	53.86 i	65.80 f
S_1V_5	4.61 k	31.08 h	79.70 a	80.40 a
S_2V_1	9.04 ef	35.67 e	64.40 f	61.40 j
S_2V_2	7.21 i	37.02 d	51.00 j	58.10 l
S_2V_3	8.50 g	18.83 k	56.76 h	60.80 k
S_2V_4	9.70 cd	36.16 e	71.30 bc	70.50 c
S_2V_5	4.51 k	14.23 m	70.53 cd	70.20 c
S_3V_1	9.78 cd	35.10 f	66.13 e	68.40 d
S_3V_2	7.99 h	20.62 j	59.02 g	60.60 k
S_3V_3	9.33 de	42.33 c	70.17 d	68.10 d
S_3V_4	10.32 b	33.63 g	71.60 b	66.50 e
S_3V_5	5.67 j	22.04 i	70.40 d	75.30 b
$LSD_{(0.05)}$	0.45	0.54	0.85	0.44
CV (%)	3.22	1.05	1.80	2.40

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

S_1: KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

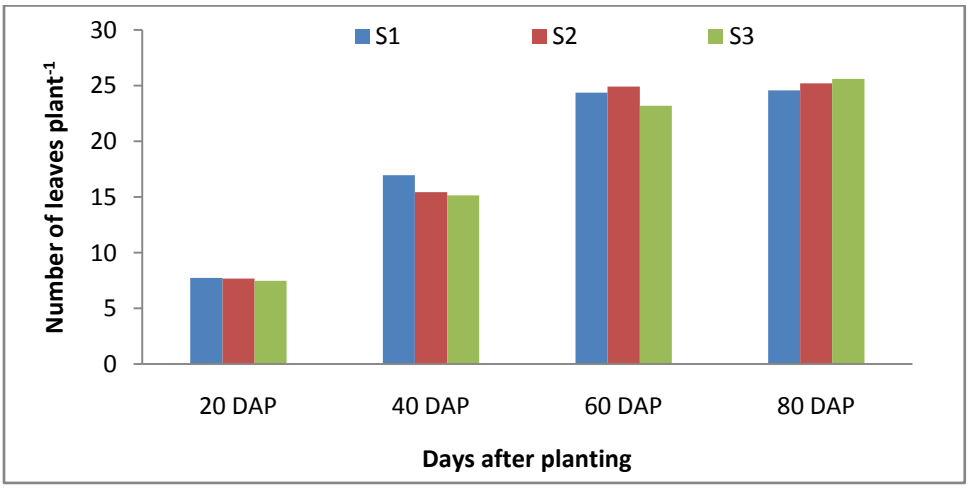
V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.1.4 Number of leaves plant^{-1}

4.1.4.1 Effect of potassium sources

Different potassium sources exhibited significant variation in respect expect 20 DAP at 20, 40, 60 and 80 DAP (Appendix 6 and Figure 7). Number of leaves plant^{-1} increased with advancing growing period up to 80 DAP (Figure 8). At 20 and 40 DAP, the maximum leaves number plant^{-1} (7.72 and 16.94, respectively) was observed from the KCl application (S_1) treatment and the minimum number (7.47 and 15.14, respectively) was observed from K_2SO_4 application treatment which was statistically similar with S_2 (15.42) at 40 DAP. At 60 DAP, the

maximum leaves number plant^{-1} (24.92) was observed from the KNO_3 application (S_2) treatment whereas, the minimum number (23.20) was observed from K_2SO_4 application treatment. At 80 DAP, the maximum leaves number plant^{-1} (25.60) was observed from the K_2SO_4 application (S_3) treatment whereas, the minimum number (24.58) was observed from KCl application treatment. The present study referred that K_2SO_4 source application produced maximum number of leaf.



S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

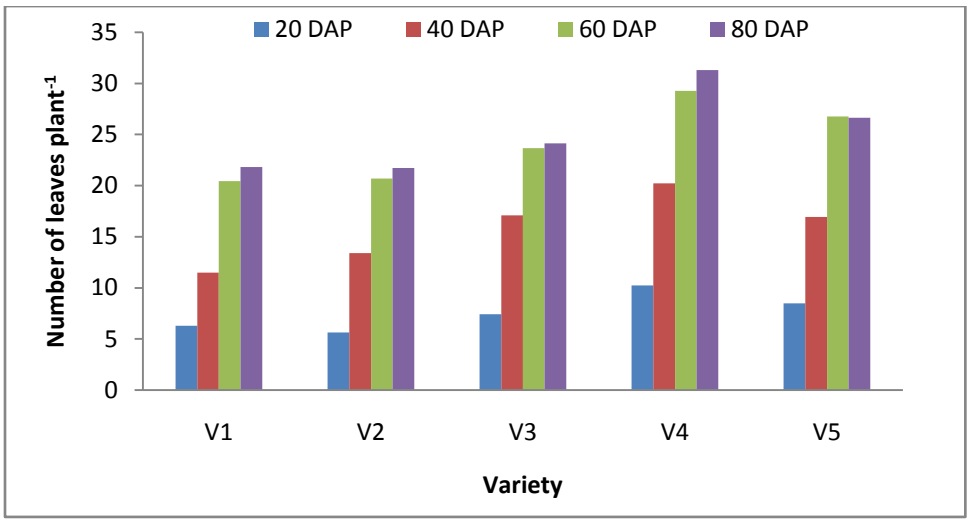
Figure 7: Effect of different potassium sources on number of leaves plant^{-1} of potato

LSD value= NS, 0.8758, 0.2926 and 0.2779 at 20, 40, 60 and 80 DAP, respectively

4.1.4.2 Effect of varieties

Different varieties exhibited significant variation in respect of number of leaves plant^{-1} of potato at 20, 40, 60 and 80 DAP (Appendix 6 and Figure 8). Number of leaves plant^{-1} increased with advancing growing period up to 80 DAP irrespective of varieties (Figure 7). At 20 and 40 DAP, the maximum leaves number plant^{-1} (10.23 and 20.23, respectively) was observed from the variety 'Diamant' and the minimum number (5.63) was observed from 'Asterix' at 20 DAP and (11.50) was observed from 'Cardinal' at 40 DAP. At 60 and 80 DAP, the maximum leaves number plant^{-1} (29.27 and 31.30, respectively) was obtained from the 'Diamant'

whereas, the minimum (20.43 and 21.73, respectively) was from 'Cardinal' which was statistically similar with 'Asterix' (20.70 and 21.83, respectively). The study referred that 'Diamant' variety produced maximum number of leaf.



V_1: Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

Figure 8: Effect of variety on number of leaves plant^{-1} of potato

LSD value= 0.3850, 1.131, 0.3777 and 0.3587 at 20, 40, 60 and 80 DAP, respectively

4.1.4.3 Interaction effect of potassium sources and variety

There was significant variation among the interaction of potassium source and variety on the total numbers of leaves plant^{-1} at 20, 40, 60 and 80 DAP (Appendix 6 and Table 3). Number of leaves plant^{-1} increased with advancing growing period up to 80 DAP irrespective of potassium source and variety (Table 3). At 20 and 40 DAP, the maximum number of leaves plant^{-1} (10.50 and 24.50, respectively) was recorded with the combination of KCl source and Diamant application (S_1V_4) treatment which was statistically similar with S_2V_4 (10.30) at 20 DAP whereas, the minimum (5.13) was recorded from the S_3V_1 treatment at 20 DAP and (10.40) was recorded from the S_2V_1 treatment at 20 DAP which was statistically similar with S_1V_2 (5.40) at 20 DAP, with S_1V_1 (10.90) at 40 DAP. At 60 and 80 DAP, the maximum number of leaves plant^{-1} (30.00 and 32.30, respectively) was recorded with the combination of KCl source and Diamant application (S_1V_4) treatment

whereas, the minimum (19.40 and 20.80, respectively) was recorded from the combination of KNO_3 source and Asterix application (S_2V_2) treatment. Present study showed that KCl application source and Diamant produced maximum number of leaf.

Table 3. Interaction effect of potassium sources and variety on number of leaves plant^{-1} of potato

Treatments	Number of leaves plant^{-1} at			
	20 DAP	40 DAP	60 DAP	80 DAP
S_1V_1	7.20 g	10.90 h	20.60 h	21.80 hi
S_1V_2	5.40 j	14.00 f	22.50 f	21.50 i
S_1V_3	6.10 i	16.80 d	22.60 f	24.30 e
S_1V_4	10.50 a	24.50 a	30.00 a	32.30 a
S_1V_5	9.40 c	18.50 c	26.20 d	23.00 g
S_2V_1	6.50 h	10.40 h	20.40 hi	21.90 h
S_2V_2	4.80 k	12.20 g	19.40 j	20.80 j
S_2V_3	8.60 d	20.30 b	26.30 d	24.50 e
S_2V_4	10.30 a	18.60 c	28.70 c	30.20 c
S_2V_5	8.20 jk	15.60 e	28.80 c	28.60 d
S_3V_1	5.13 jk	13.20 fg	20.30 hi	21.80 hi
S_3V_2	6.70 h	14.00 f	20.20 i	22.90 g
S_3V_3	7.60 f	14.20 f	22.10 g	23.60 f
S_3V_4	9.90 b	17.60 cd	29.10 b	31.40 b
S_3V_5	7.80 f	16.70 de	24.30 e	28.30 d
$LSD_{(0.05)}$	0.38	1.13	0.37	0.35
CV (%)	3.03	4.27	1.93	1.85

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

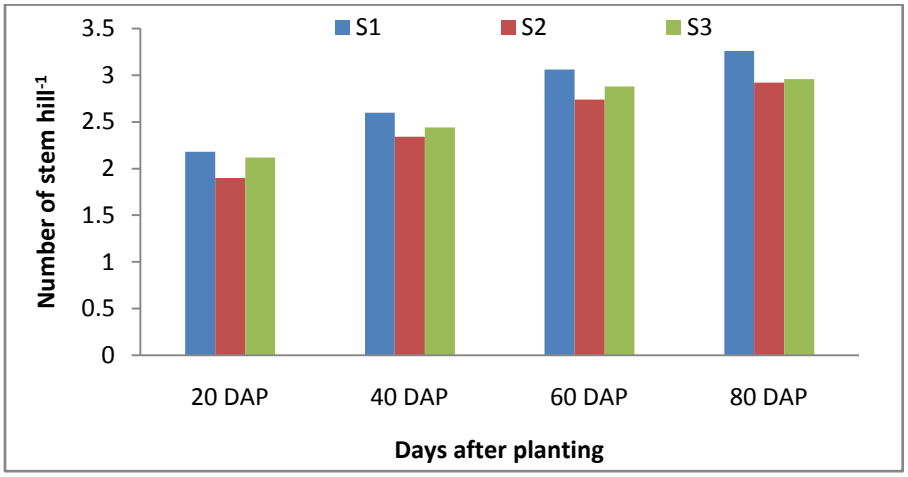
V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.1.5 Number of stems hill^{-1}

4.1.5.1 Effect of potassium sources

The number of stems hill^{-1} was non-significant among different potassium sources at 40, 60 and 80 DAP but 20 DAP was significant (Appendix 7 and Figure 9). Number of stems hill^{-1} increased with advancing growing period up to 80 DAP

irrespective of potassium source (Figure 19). At 20 DAP, the maximum stem numbers hill^{-1} (2.18) was obtained from S_1 treatment which was statistically similar with S_3 (2.12) and the minimum (1.90) was obtained from S_2 treatment. At 40, 60 and 80 DAP, the numerically maximum number of stems hill^{-1} (2.60, 3.06 and 3.26, respectively) was recorded from S_1 treatment whereas, the minimum (2.34, 2.74 and 2.92, respectively) number was from S_2 treatment. This might be due to different potassium fertilization application effect.



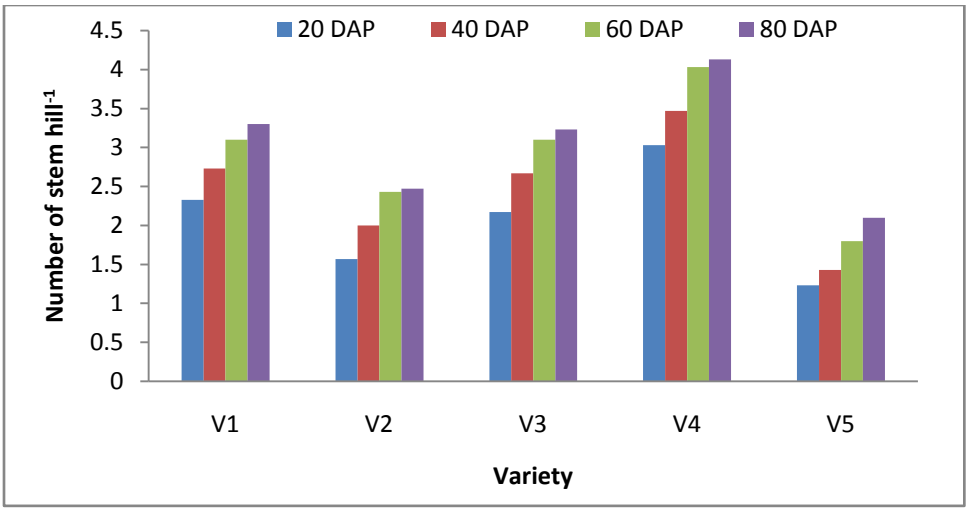
S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

Figure 9: Effect of different potassium sources on number of stem hill^{-1} of potato

LSD value= 0.2623, NS, NS and NS at 20, 40, 60 and 80 DAP, respectively

4.1.5.2 Effect of Varieties

The number of stems hill^{-1} was significantly varied among the varieties at 20, 40, 60 and 80 DAP (Appendix 7 and Figure 10). Number of stems hill^{-1} increased with advancing growing period up to 80 DAP irrespective of varieties and thereafter remained constant (Figure 9). At 20, 40, 60 and 80 DAP, the maximum stem numbers hill^{-1} (3.03, 3.47, 4.03 and 4.13, respectively) was obtained from the variety 'Diamant' and the minimum (1.23, 1.43, 1.80 and 2.10, respectively) was obtained from the 'BARI TPS-I' which was statistically similar with 'Asterix' (1.57, 2.00, 2.43 and 2.47, respectively). The study referred that 'Diamant' variety produced maximum number of stem hill^{-1}. This might be due to varietal characters.



V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

Figure 10: Effect of variety on number of stem hill^{-1} of potato

LSD value = 0.3387, 0.5890, 0.7155 and 0.7096 at 20, 40, 60 and 80 DAP, respectively

4.1.5.3 Interaction effect of potassium sources and variety

Interaction effect of variety and potassium sources significantly influenced the stem numbers hill^{-1} (Appendix 7 and Table 4). At 20 DAP, the maximum number of stems hill^{-1} (3.40) was recorded from the combination of KCl and Diamant (S_1V_4) treatment and the minimum number (1.00) of stems hill^{-1} was recorded from S_2V_2 and S_2V_5 treatment which was statistically identical with S_2V_5 (1.30). At 40 and 60 DAP, the maximum number (4.00 and 4.70) of stems hill^{-1} was counted from the combination of KCl and Diamant (S_1V_4) treatment whereas, the minimum number (1.30 and 1.70) was counted from S_2V_5 and S_3V_5 treatment which was statistically similar with S_2V_2 and S_1V_5 (1.70 and 2.00). At 80 DAP, the maximum number of stems hill^{-1} (4.70) was recorded from the combination of KCl and Diamant (S_1V_4) treatment which was statistically similar with S_2V_4 (4.00) whereas, the minimum number (2.00) of stems hill^{-1} was recorded from S_2V_2, S_2V_5, S_3V_5 treatment which was statistically similar with S_1V_5 (2.30), S_1V_2 (2.70) and S_3V_2 (2.70).

Table 4. Interaction effect of potassium sources and variety on number of stem hill^{-1} of potato

Treatments	Number of stem hill^{-1} at			
	20 DAP	40 DAP	60 DAP	80 DAP
S_1V_1	2.00 cd	2.60 c-e	3.00 bc	3.30 b-d
S_1V_2	2.00 cd	2.10 ef	2.60 cd	2.70 de
S_1V_3	2.10 c	2.60 c-e	3.00 bc	3.30 b-d
S_1V_4	3.40 a	4.00 a	4.70 a	4.70 a
S_1V_5	1.40 ef	1.70 fg	2.00 de	2.30 e
S_2V_1	2.30 c	2.60 c-e	3.00 bc	3.30 b-d
S_2V_2	1.00 g	1.70 fg	2.00 de	2.00 e
S_2V_3	2.20 c	2.70 cd	3.30 bc	3.30 b-d
S_2V_4	3.00 b	3.40 b	3.70 b	4.00 ab
S_2V_5	1.00 g	1.30 g	1.70 e	2.00 e
S_3V_1	2.70 b	3.00 bc	3.30 bc	3.30 b-d
S_3V_2	1.70 de	2.20 d-f	2.70 cd	2.70 de
S_3V_3	2.20 c	2.70 cd	3.00 bc	3.10 cd
S_3V_4	2.70 b	3.00 bc	3.70 b	3.70 bc
S_3V_5	1.30 fg	1.30 g	1.70 e	2.00 e
$LSD_{(0.05)}$	0.33	0.58	0.71	0.70
CV (%)	9.78	14.30	14.78	13.92

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

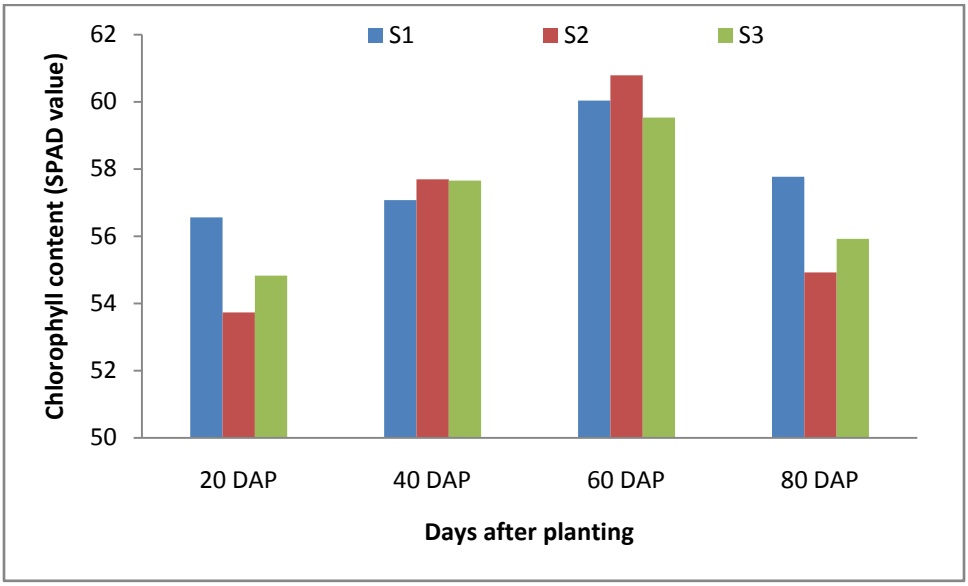
V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.1.6 Chlorophyll content of leaves (SPAD value)

4.1.6.1 Effect of potassium sources

Chlorophyll content of potato leaves were not significantly affected by different potassium sources at 20, 40, 60 except 80 DAP (Appendix 8 and Figure 11). Chlorophyll content (SPAD value) increased with the advancement of plant age i.e., up to 60 DAP irrespective of potassium and thereafter decreased due to yellowing of leaves (Figure 12). At 20, 40 and 60 DAP, the numerically maximum chlorophyll content (SPAD value) (56.56, 57.70 and 60.79, respectively) was recorded from S_1 treatment and the minimum (53.73, 57.08 and 59.53,

respectively) was recorded from S_2 treatment. At 80 DAP, the highest chlorophyll content (SPAD value) (57.77) was recorded from KCl source and the lowest (54.92) was recorded from KNO_3 source which was statistically similar with K_2SO_4 (55.92).



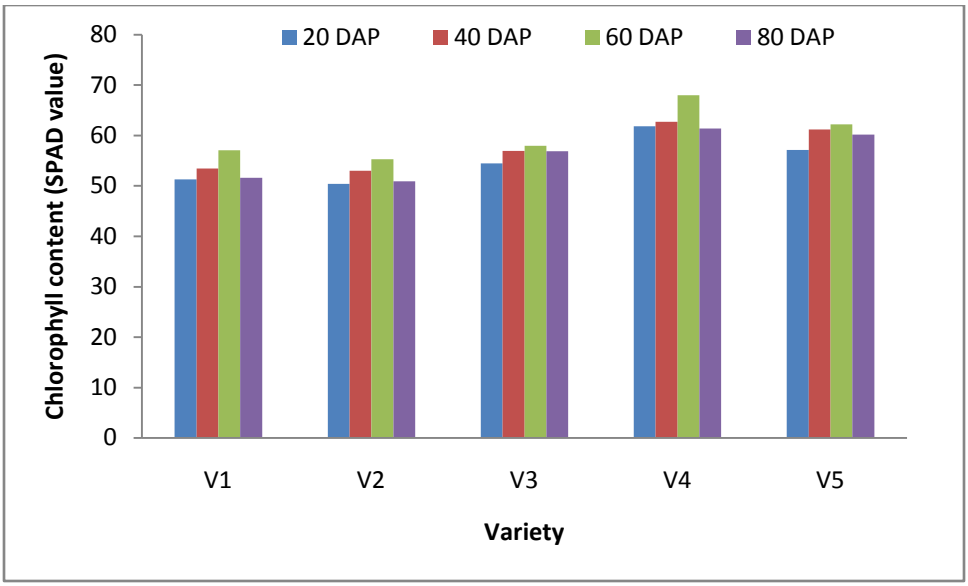
S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

Figure 11: Effect of different potassium sources on chlorophyll content (SPAD value) of potato

LSD value= NS, NS, NS and 1.288 at 20, 40, 60 and 80 DAP, respectively

4.1.6.2 Effect of varieties

Chlorophyll content of potato leaves were significantly affected by the varieties at 20, 40, 60 and 80 DAP (Appendix 8 and Figure 12). Chlorophyll content (SPAD value) increased with the advancement of plant age i.e., up to 60 DAP irrespective of varieties and thereafter decreased due to yellowing of leaves (Figure 11). At 20, 40, 60 and 80 DAP, the maximum chlorophyll content (SPAD value) (61.87, 62.73, 68.00 and 61.37, respectively) was recorded from 'Diamant' (V_4) which was statistically similar with 'BARI TPS-I', (57.13, 61.23, 62.24 and 60.21, respectively) whereas, the minimum (50.40, 53.03, 55.33 and 50.93, respectively) was recorded from the variety 'Asterix' which was statistically similar with 'Cardinal' and 'Carriage'.



V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

Figure 12: Effect of variety on chlorophyll content (SPAD value) of potato
LSD value = 4.753, 2.139, 1.792 and 1.662 at 20, 40, 60 and 80 DAP, respectively

4.1.6.3 Interaction effect of potassium sources and variety

Interaction effect of different variety and potassium source in terms of chlorophyll content also exposed significant variation at 20, 40, 60 and 80 DAP (Appendix 8 and Table 5). Chlorophyll content (SPAD value) increased with advancing growing period up to 60 DAP irrespective of variety and potassium source and thereafter decreased due to yellowing of leaves (Table 5). At 20, 40, 60 and 80 DAP, the maximum chlorophyll content (SPAD value) (69.60, 67.10, 70.00 and 67.10, respectively) was recorded from the combination of KCl source and Diamant (S_1V_4) and the minimum (46.70, 49.80, 50.60 and 48.70, respectively) was recorded from the KNO_3 source and Asterix.

Table 5. Interaction effect of potassium sources and variety on chlorophyll content (SPAD value) of potato

Treatments	Chlorophyll content (SPAD value) at			
	20 DAP	40 DAP	60 DAP	80 DAP
S_1V_1	51.70 cd	54.70 e-g	56.00 g	52.00 h
S_1V_2	52.10 cd	55.70 de	56.30 g	49.10 i
S_1V_3	54.60 b-d	55.00 ef	59.50 ef	57.60 de
S_1V_4	69.60 a	67.10 a	70.00 a	67.10 a
S_1V_5	54.80 b-d	62.20 bc	61.80 d	60.90 b
S_2V_1	50.50 de	53.00 fg	60.60 de	53.80 g
S_2V_2	46.70 e	49.80 h	50.60 h	48.70 i
S_2V_3	55.30 bc	61.50 bc	58.50 f	56.30 ef
S_2V_4	57.90 b	63.30 b	66.60 b	57.00 e
S_2V_5	58.23 b	60.91 c	64.27 c	58.78 cd
S_3V_1	51.70 cd	52.70 g	54.60 g	49.00 i
S_3V_2	52.40 cd	53.60 e-g	59.10 ef	55.00 fg
S_3V_3	53.60 b-d	54.30 e-g	55.90 g	56.80 e
S_3V_4	58.10 b	57.80 d	67.40 b	60.00 bc
S_3V_5	58.34 b	60.58 c	60.66 de	60.95 b
$LSD_{(0.05)}$	4.75	2.13	1.79	1.66
CV (%)	5.16	2.23	1.78	1.77

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.1.7 Total Leaf area plant^{-1}

4.1.7.1 Effect of potassium sources

Potassium significantly influenced total leaf area of potato at 20, 40, 60 and 80 DAP (Appendix 9 and Table 6). Total leaf area increased with advancing growing period up to 80 DAP irrespective of potassium and thereafter decreased due to senescence of plant (Table 7). At 20, 40, 60 and 80 DAP, the highest total leaf area plant^{-1} (3.54, 1022, 3795 and 4245 cm^2, respectively) was found in S_1 treatment and the lowest (3.06, 879, 3627 and 4077 cm^2, respectively) was found in S_3 treatment.

Table 6. Effect of potassium sources on total leaf area (cm^2) of potato

Potassium source	Total leaf area (cm^2) at			
	20 DAP	40 DAP	60 DAP	80 DAP
S_1	3.56 a	1022.20 a	3795.00 a	4245.00 a
S_2	3.20 b	911.60 b	3628.00 b	4178.00 b
S_3	3.06 c	879.00 c	3627.00 c	4077.00 c
$LSD_{(0.05)}$	0.12	34.78	32.12	54.70
CV (%)	5.00	2.90	4.67	5.50

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

4.1.7.2 Effect of varieties

Varietal effect significantly influenced leaf area of potato at 20, 40, 60 and 80 DAP (Appendix 9 and Table 7). Leaf area increased with advancing growing period up to 05 DAP irrespective of varieties and thereafter decreased due to senescence of plant (Table 6). At 20, 40, 60 and 80 DAP, the highest leaf area $plant^{-1}$ (3.97, 1215, 4986 and 5536 cm^2, respectively) was found in the variety 'Diamant' and the lowest (2.97, 645, 3098 and 3648 cm^2, respectively) was found in the 'BARI TPS-I'. Study referred that the potato variety 'Diamant' exposed best result in terms of leaf area $plant^{-1}$.

Table 7. Effect of variety on total leaf area (cm^2) of potato

Variety	Total leaf area (cm^2) at			
	20 DAP	40 DAP	60 DAP	80 DAP
V_1	3.60 b	1073.00 b	3226.00 d	4220.00 b
V_2	3.33 bc	861.70 c	3339.00 c	3889.00 c
V_3	3.27 c	726.70 d	3670.00 b	3776.00 d
V_4	3.97 a	1215.00 a	4986.00 a	5536.00 a
V_5	2.97 d	645.30 e	3098.00 e	3648.00 e
$LSD_{(0.05)}$	0.28	44.90	41.46	70.62
CV (%)	5.00	2.90	4.67	5.50

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.1.7.3 Interaction effect of potassium sources and variety

Total leaf area of potato significantly influenced by the Interaction effect of variety and potassium source at 20, 40, 60 and 80 DAP (Appendix 9 and Table 8). At 20 DAP, the highest total leaf area plant^{-1} (4.20 cm^2) was recorded from S_1V_4 treatment which was statistically similar with S_3V_4 (4.10 cm^2) whereas, the lowest (2.70 cm^2) was recorded from S_2V_5 treatment. At 40, 60 and 80 DAP, the highest (1320, 5577 and 6127 cm^2, respectively) total leaf area was found from the combination of KCl source and Diamant treatment whereas, the lowest (609, 2566 and 3116 cm^2, respectively) was found from the combination of KCl source and BARI TPS-I treatment. The study indicated that KCl source and Diamant showed better performance in terms of leaf area plant^{-1}.

Table 8. Interaction effect of potassium sources and variety on total leaf area (cm^2) of potato

Treatments	Total leaf area (cm^2) at			
	20 DAP	40 DAP	60 DAP	80 DAP
S_1V_1	3.60 b-d	1098.00 d	4023.00 e	4114.00 f
S_1V_2	3.80 b	990.00 e	2746.00 j	3696.00 j
S_1V_3	3.10 gh	673.00 g	3564.00 f	4573.00 e
S_1V_4	4.20 a	1320.00 a	5577.00 a	6127.00 a
S_1V_5	3.10 gh	609.00 hi	2566.00 k	3116.00 k
S_2V_1	3.70 bc	1256.00 b	3531.00 fg	3962.00 h
S_2V_2	3.00 h	594.00 i	2123.00 l	3250.00 i
S_2V_3	3.40 d-f	672.00 g	3412.00 h	4081.00 fg
S_2V_4	3.60 b-d	1305.00 a	5065.00 b	5615.00 b
S_2V_5	2.70 i	652.00 gh	3534.00 fg	4084.00 fg
S_3V_1	3.50 c-e	1165.00 c	3100.00 i	4583.00 e
S_3V_2	3.20 f-h	922.00 f	4170.00 d	4720.00 d
S_3V_3	3.30 e-g	914.00 f	4033.00 e	2673.00 l
S_3V_4	4.10 a	1019.00 e	4316.00 c	4866.00 c
S_3V_5	3.10 gh	675.00 g	3493.00 g	4043.00 g
$LSD_{(0.05)}$	0.28	44.90	41.46	70.62
CV (%)	5.00	2.90	4.67	5.50

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

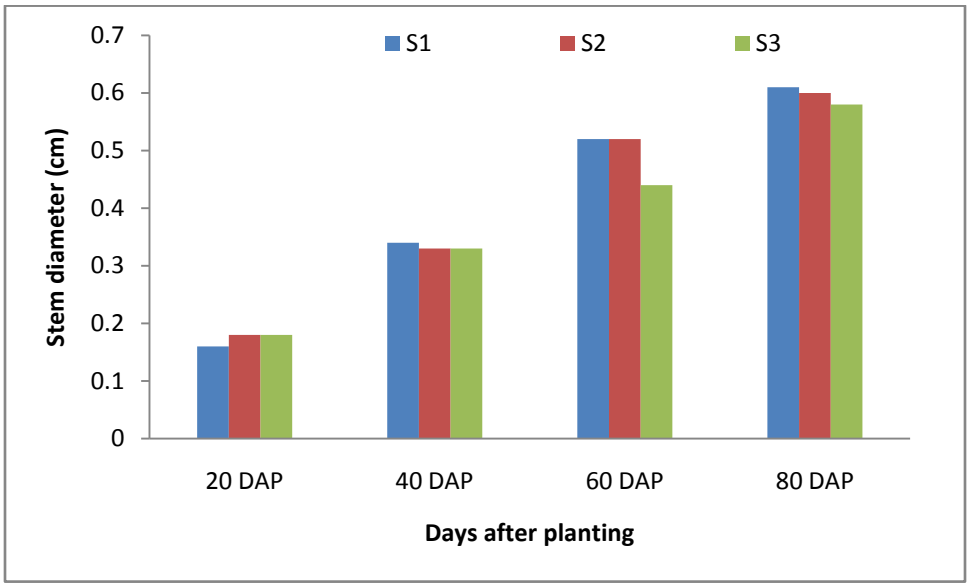
S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

V_1: Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.1.8 Stem diameter

4.1.8.1 Effect of potassium sources

Significant variation was recorded for stem diameter due to different potassium sources of potato at 60 and 80 DAP (Appendix 10 and Figure 13). Stem diameter increased with advancing growing period up to 80 DAP irrespective of potassium (Figure 14). In vegetative stage, potato stems were fleshy and succulent and at later (harvesting) stage, it becomes hard and slender due to senescence of plant. At 60 and 80 DAP, the widest stem diameter (0.58 and 0.63 cm, respectively) was recorded from KCl treatment whereas, the narrowest (0.44 and 0.58 cm, respectively) was recorded from K_2SO_4 treatment.



S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

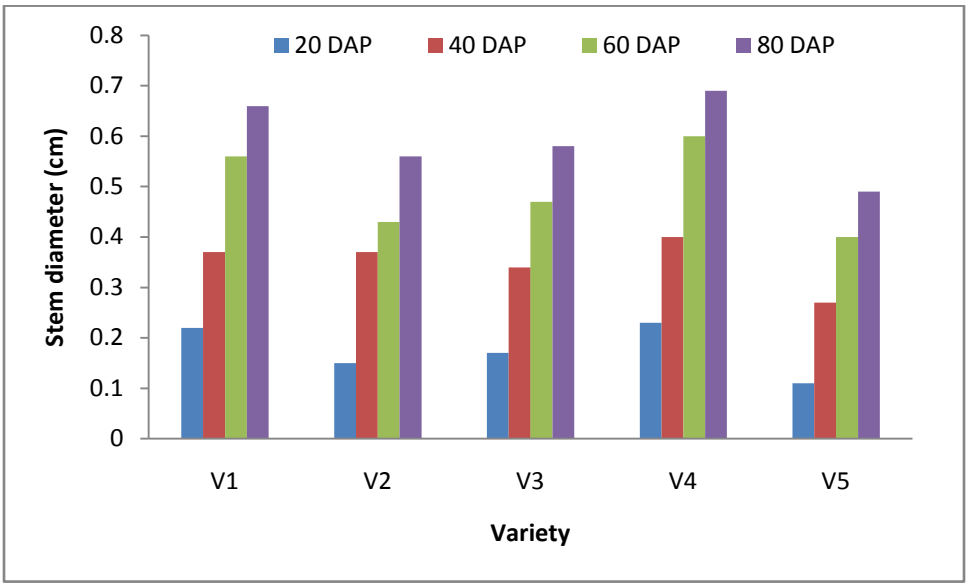
Figure 13: Effect of different potassium sources on stem diameter of potato

LSD value= NS, NS, 0.04095 and 0.01067 at 20, 40, 60 and 80 DAP, respectively

4.1.8.2 Effect of varieties

Significant variation was recorded for stem diameter due to different varieties of potato at 20, 40, 60 and 80 DAP (Appendix 10 and Figure 14). At 20, 40, 60 and 80 DAP, the widest stem diameter (0.23, 0.40, 0.60 and 0.69 cm, respectively) was

recorded from 'Diamant' whereas, the narrowest (0.11, 0.27, 0.40 and 0.49 cm, respectively) was recorded from 'BARI TPS-I'.



V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

Figure 14: Effect of variety on stem diameter of potato

LSD value = NS, 0.05289, 0.05288 and 0.05289 at 20, 40, 60 and 80 DAP, respectively

4.1.8.3 Interaction effect of potassium sources and variety

Interaction effect of variety and potassium sources was significant in respect of stem diameter at 20, 40, 60 and 80 DAP (Appendix 10 and Table 9). At 20, 40, 60 and 80 DAP, the widest stem diameter (0.25, 0.41, 0.72 and 0.70 cm, respectively) was recorded from the combination of S_1V_4 treatment and the narrowest (0.10, 0.22, 0.32 and 0.40 cm, respectively) was recorded from the combination of KNO_3 and Asterix treatment.

Table 9. Interaction effect of potassium sources and variety on stem diameter (cm) of potato

Treatments	Stem diameter (cm) at			
	20 DAP	40 DAP	60 DAP	80 DAP
S_1V_1	0.18	0.36 a-d	0.51 cd	0.68 ab
S_1V_2	0.15	0.32 d-f	0.42 f	0.60 cd
S_1V_3	0.17	0.34 c-e	0.39 f	0.54 e-g
S_1V_4	0.25	0.41 a	0.72 a	0.70 a
S_1V_5	0.12	0.29 ef	0.40 f	0.53 fg
S_2V_1	0.22	0.36 a-d	0.61 b	0.73 a
S_2V_2	0.10	0.22 g	0.32 g	0.40 i
S_2V_3	0.17	0.35 b-d	0.52 cd	0.59 c-e
S_2V_4	0.24	0.40 ab	0.60 b	0.69 a
S_2V_5	0.14	0.28 f	0.38 f	0.47 h
S_3V_1	0.23	0.35 b-d	0.56 bc	0.57 d-f
S_3V_2	0.16	0.32 d-f	0.40 f	0.53 fg
S_3V_3	0.17	0.33 d-f	0.51 cd	0.63 bc
S_3V_4	0.24	0.39 a-c	0.48 de	0.68 ab
S_3V_5	0.13	0.32 d-f	0.43 ef	0.50 gh
$LSD_{(0.05)}$	NS	0.05	0.05	0.05
CV (%)	12.38	8.56	7.64	4.31

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability. NS: Non significant

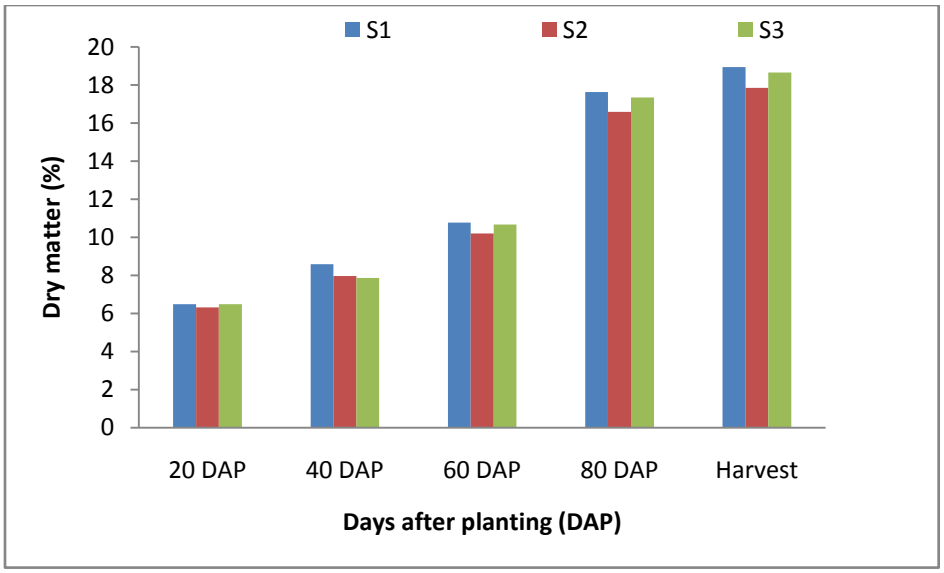
S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.1.9 Above ground stem dry matter content (%)

4.1.9.1 Effect of potassium sources

Above ground stem dry matter content (%) significantly influenced by potassium at 20, 40, 60 and 80 DAP (Appendix 11 and Figure 15). At 20, 40, 60 and 80 DAP, KCl source application produced higher stem dry matter content (6.48, 8.58, 10.78 and 14.63 %, respectively) whereas, the minimum (6.32, 7.96, 10.20 and 13.27 %, respectively) was recorded from KNO_3 source application treatment.

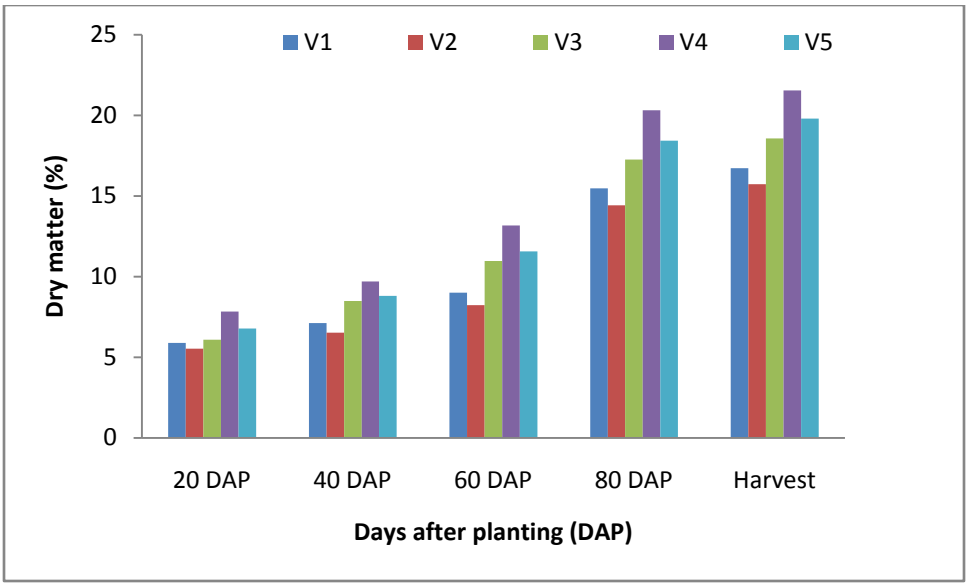


S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

Figure 15: Effect of different potassium sources on dry matter (%) of stem
LSD value= NS, 0.2718, 0.2926 and 0.3710 at 20, 40, 60 and 80 DAP, respectively

4.1.9.2 Effect of varieties

Above ground stem dry matter content (%) significantly influenced by the varieties at 20, 40, 60 and 80 DAP (Appendix 11 and Figure 16). At 20, 40, 60 and 80 DAP 'Diamant' produced higher stem dry matter content (7.83, 9.70, 13.17 and 17.32 %, respectively) whereas, the minimum (5.53, 6.53, 8.23 and 10.91 %, respectively) was recorded from the variety 'Asterix'.



V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 - Diamant and V_5 : BARI TPS-I.

Figure 16: Effect of variety on dry matter (%) of stem

LSD value = 0.4393, 0.3508, 0.3777 and 0.4789 at 20, 40, 60 and 80 DAP respectively

4.1.9.3 Interaction effect of potassium sources and variety

Interaction effect of variety and potassium sources influenced the above ground stem dry matter content at 20, 40, 60 and 80 DAP (Appendix 11 and Table 10). At 20, 40, 60 and 80 DAP, it was observed that the maximum dry matter content of above ground stem (8.20, 10.20, 14.00 and 18.00 %, respectively) was obtained from the combination of KCl source and Diamant treatment whereas, the minimum (5.00, 6.00, 7.50 and 8.20 %, respectively) was recorded from S_2V_2.

Table 10. Interaction effect of potassium sources variety on dry matter (%) of potato

Treatments	Dry matter (%) at				
	20 DAP	40 DAP	60 DAP	80 DAP	Harvest
S_1V_1	6.20 ef	6.60 h	9.60 f	16.09 ef	17.26 g
S_1V_2	5.80 fg	6.60 h	8.40 h	14.93 g	16.27 h
S_1V_3	6.10 ef	9.20 c	9.40 f	17.74 d	19.14 de
S_1V_4	8.20 a	10.2 a	14.00 a	21.67 a	21.94 a
S_1V_5	7.00 bc	8.20 e	11.40 de	18.70 c	20.10 bc
S_2V_1	5.90 fg	7.10 g	9.30 f	16.11 ef	17.38 fg
S_2V_2	5.00 h	6.00 i	7.50 i	12.70 i	13.90 j
S_2V_3	6.20 ef	7.70 f	12.20 c	16.50 e	17.87 f
S_2V_4	7.70 b	9.80 b	13.30 b	19.27 b	20.40 b
S_2V_5	6.53 de	9.20 c	11.60 de	18.31 c	19.71 c
S_3V_1	5.60 g	8.10 e	8.10 h	14.20 h	15.57 i
S_3V_2	5.80 fg	7.00 g	8.80 g	15.61 f	17.05 g
S_3V_3	6.00 fg	8.60 d	11.30 e	17.58 d	18.75 e
S_3V_4	7.30 b	9.10 c	12.20 c	20.00 a	22.30 a
S_3V_5	6.80 cd	9.00 c	11.70 d	18.31 c	19.61 cd
$LSD_{(0.05)}$	0.43	0.35	0.37	0.52	0.59
CV (%)	4.09	2.59	2.14	1.79	1.80

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.2 Yield and yield components

4.2.1 Number of tubers hill^{-1}

4.2.1.1 Effect of potassium sources

Number of tubers hill^{-1} significantly influenced by different potassium source (Appendix 12 and Table 11). The maximum number of tubers hill^{-1} (8.42) was recorded from S_3 treatment which was statistically similar with S_2 (8.22) and the minimum (8.04) was found from S_1 treatment.

4.2.1.2 Effect of varieties

Number of tubers hill^{-1} significantly influenced by the potato varieties (Appendix 12 and Table 12). The maximum number of tubers hill^{-1} (9.60) was recorded from the 'Diamant' and the minimum (7.17) was found from the 'BARI TPS-I' which was statistically similar with 'Asterix' (7.60).

4.2.1.3 Interaction effect of potassium sources and variety

Interaction effect of variety and potassium sources showed significant variation in respect of number of tubers hill^{-1} (Appendix 12 and Table 13). The maximum number of tubers hill^{-1} (10.50) was recorded from the combination of K_2SO_4 and Diamant (S_3V_4) treatment whereas, the minimum (6.80) was recorded from the combination of KNO_3 and BARI TPS-I (S_2V_5) treatment.

4.2.2 Average tuber weight (g)

4.2.2.1 Effect of potassium sources

The average tuber weight varied significantly due to different potassium sources (Appendix 12 and Table 11). The maximum average tuber weight (47.80 g) was recorded from K_2SO_4 treatment whereas, the minimum (46.18 g) was obtained from KCl treatment which was satistically similar with S_2 (46.31).

Table 11. Effect of potassium source on yield parameter of potato

Potassium source	Number of tuber hill^{-1}	Average tuber weight (g)	Yield (t ha^{-1})
S_1	8.04 b	46.18 b	22.57 b
S_2	8.22 ab	46.31 b	21.50 c
S_3	8.42 a	47.80 a	23.54 a
$LSD_{(0.05)}$	0.35	0.52	0.32
CV (%)	3.28	2.86	1.10

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

4.2.2.2 Effect of varieties

The average tuber weight varied significantly due to different varieties (Appendix 12 and Table 12). The maximum average tuber weight (54.83 g) was recorded from the 'Diamant' whereas, the minimum (40.06 g) was obtained from the 'BARI TPS-I' variety.

Table 12. Effect of variety on yield parameter of potato

Variety	Number of tuber hill^{-1}	Average tuber weight (g)	Yield (t ha^{-1})
V_1	8.80 b	50.27 b	24.41 b
V_2	7.60 cd	42.83 d	21.81 c
V_3	7.97 c	45.83 c	19.58 d
V_4	9.60 a	54.83 a	28.10 a
V_5	7.17 d	40.06 e	18.78 e
$LSD_{(0.05)}$	0.45	0.67	0.41
CV (%)	3.28	2.86	1.10

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.
V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.2.2.3 Interaction effect of potassium sources and variety

Interaction of variety and potassium sources had significant effect on average tuber weight (Appendix 12 and Table 13). The maximum average tuber weight (59.40 g) was recorded from S_3V_4 treatment whereas, the minimum (37.67 g) was recorded from S_2V_5 treatment.

4.2.3 Yield (t ha^{-1})

4.2.3.1 Effect of potassium sources

Different potassium source had significant effect on the yield of tuber ha^{-1} (Appendix 12 and Table 11). The highest tuber yield ha^{-1} (23.54 t ha^{-1}) was obtained from K_2SO_4treatemnt while, the minimum (21.50 t ha^{-1}) was found from KNO_3 treatment.

4.2.3.2 Effect of varieties

Variety had significant effect on the yield of tuber ha^{-1} (Appendix 12 and Table 12). The highest tuber yield $plant^{-1}$ (28.10 t ha^{-1}) was obtained from the variety 'Diamant' while the minimum (18.78 t ha^{-1}) was found from the 'BARI TPS-1'. The yields of different cultivars of potato were significantly different from each other reported by Kundu *et al.* (2012). Similar trend of yield performance was also reported by Hossain (2011) and Das (2006). The probable reason for variation in yield due to the heredity of the variety, difference in agro-ecological condition and soils of the experimental site.

4.2.3.3 Interaction effect of potassium sources and variety

Interaction between potassium and variety played an important role for promoting the yield. Yield of tuber ha^{-1} was significantly influenced by the Interaction effects of potassium and variety (Appendix 12 and Table 13). Among the treatments, the highest yield of tuber ha^{-1} was observed in K_2SO_4 and Daimant (S_3V_4) treatment (31.47 t ha^{-1}) whereas, the minimum (17.30 t ha^{-1}) was found from KNO_3 and BARI TPS-I (S_2V_5) treatment.

Table 13. Interaction effect of potassium sources and variety on yield parameter of potato

Treatments	Number of tuber hill^{-1}	Average tuber weight (g)	Yield (t ha^{-1})
S_1V_1	8.60 de	50.30 cd	24.24 e
S_1V_2	7.60 g-i	43.60 g	21.50 g
S_1V_3	7.80 f-h	45.40 f	20.81 h
S_1V_4	8.90 cd	50.10 cd	27.23 b
S_1V_5	7.30 i	41.50 h	19.06 j
S_2V_1	9.30 bc	50.70 c	24.77 d
S_2V_2	7.40 hi	41.30 h	21.50 g
S_2V_3	8.20 ef	46.90 e	18.34 k
S_2V_4	9.40 b	55.00 b	25.59 c
S_2V_5	6.80 j	37.67 i	17.30 k
S_3V_1	8.50 de	49.80 d	24.22 e
S_3V_2	7.80 f-h	43.60 g	22.42 f
S_3V_3	7.90 fg	45.20 f	19.60 i
S_3V_4	10.50 a	59.40 a	31.47 a
S_3V_5	7.40 hi	41.00 h	19.97 i
$LSD_{(0.05)}$	0.45	0.67	0.41
CV (%)	3.28	2.86	1.10

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

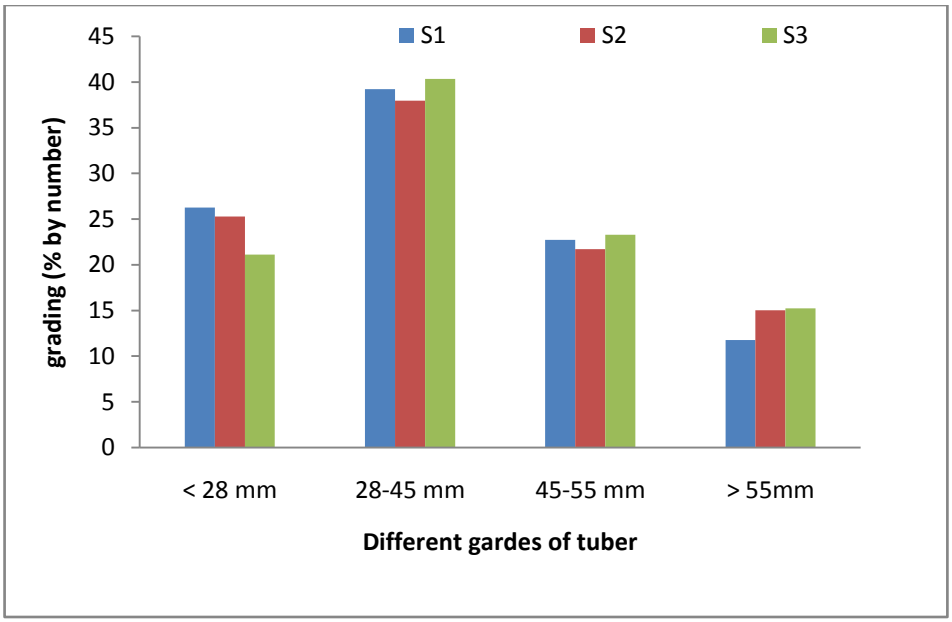
S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.2.4 Grading of tuber (% by number)

4.2.4.1 Effect of potassium sources

There was no significant variation in grading of tuber except >55 mm in diameter tuber but numerical maximum diameter required (Figure 17). S_2 treatment produced the highest percentage (16.11) of large tubers (>55 mm) which was statistically similar with S_3 (15.25 %) whereas, the lowest (12.72 %) was produced by S_1 treatment. In case of 45-55 mm, S_2 produced the maximum tuber number (23.46 %) which was statistically similar with S_1 (22.62 %) and S_3 (22.56 %). In case of 28-45 mm, the numerically highest grade of tuber number (39.61 %) was produced by S_1 treatment.



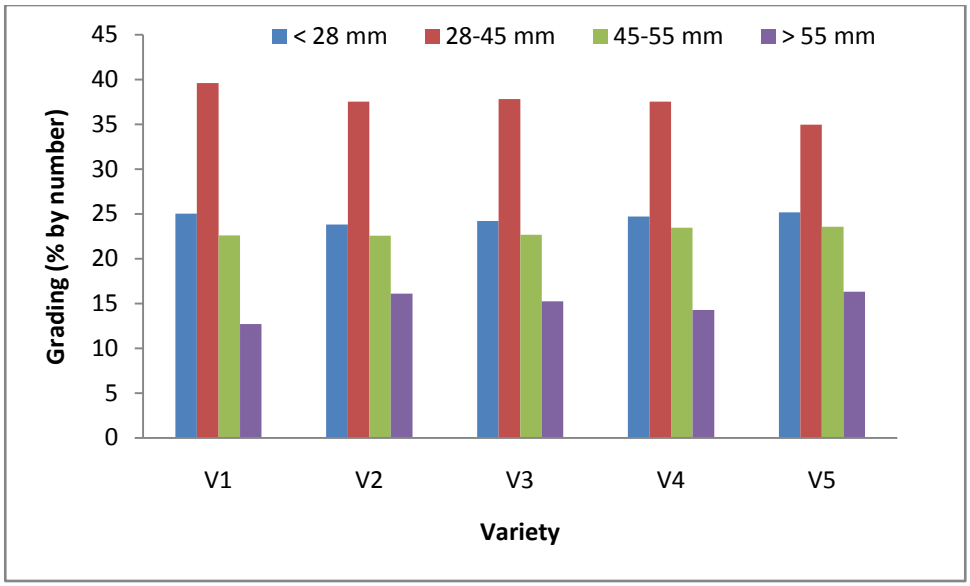
S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

Figure 17. Effect of different potassium sources on grading (% by number of potato)

LSD value= NS, 0.2718, 0.2926 and 0.3710, respectively

4.2.4.2 Effect of variety

There was no significant variation in grading of tuber except <55 mm in diameter tuber but numerical maximum diameter required (Figure18). V_5 treatment produced the highest percentage (16.32) of large tubers (>55 mm) whereas, the lowest (12.72 %) was produced by V_1 treatment. In case of 45-55 mm, V_5 treatment produced the highest tuber number (23.57 %) and lowest was V_2 treatment (22.54 %). In case of 28-45 mm, the highest grade of tuber number (39.61 %) was produced by V_1 treatment. In case of under sized tubers (<28 mm), V_5 treatment produced the highest grade of tuber number (25.26 %) and all treatment was not give significant result.



V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

Figure 18. Effect of variety on grading (% by number) of potato

LSD value = 0.4393, NS, NS and 0.4789, respectively

4.2.4.3 Interaction effect of potassium sources and variety

Interaction effects of variety and potassium sources not significantly influenced the grading of tuber (% by number) except <28 mm and >55 mm in diameter tuber. 28-45 mm and 45-55 mm in diameter tuber numerical maximum diameter required (Table 14). In case of large tuber (>55 mm), the highest grade of tuber number (17.38 %) was produced by S_2V_5 treatment which was statistically similar with S_2V_1, S_3V_1, S_2V_2, S_3V_2, S_1V_3, S_2V_3, S_3V_3, S_1V_4, S_2V_4, S_3V_4, S_1V_5, S_3V_5 and the lowest (8.26 %) from the combination of S_1V_1 treatment. In case of 45-55 mm, the numerically highest grade of tuber number (23.43 %) was produced by V_1S_3 treatment and numerically lowest grade of tuber number (21.22 %) was produced by S_3V_2 treatment. In case of 28-45 mm, the numerically highest grade of tuber number (41.33 %) was produced by combinations of S_1V_1 treatment and numerically lowest grade of tuber number (35.22 %) was produced by S_3V_5 treatment. In case of under sized tubers (<28 mm), the highest percentage of tuber number (28.53) was found from the combinations of S_1V_1 treatment which was

statistically similar with all treatments combinations except S_3V_3, which produced the minimum number of small size (< 28 mm) tuber (20.82 %).

Table 14. Interaction effect of potassium sources and variety on grading of tuber (% by number) of potato

Treatments	Grading of tuber (% by number)			
	<28 mm	**28-45 mm**	**45-55 mm**	**>55 mm**
S_1V_1	28.53 a	41.33	21.87	8.26 c
S_1V_2	26.06 ab	39.58	23.18	11.18 bc
S_1V_3	25.69 ab	37.55	21.45	15.31 ab
S_1V_4	21.05 ab	39.47	23.62	15.87 ab
S_1V_5	26.10 ab	36.09	22.84	14.97 ab
S_2V_1	25.25 ab	37.58	22.46	14.71 ab
S_2V_2	24.76 ab	39.75	22.15	13.35 a-c
S_2V_3	26.80 ab	36.15	22.05	15.00 ab
S_2V_4	21.28 ab	40.12	22.77	15.84 ab
S_2V_5	25.10 ab	34.59	22.94	17.38 a
S_3V_1	25.19 ab	38.45	23.43	12.93 a-c
S_3V_2	23.84 ab	38.45	21.22	16.49 ab
S_3V_3	20.82 b	41.25	23.63	14.31 ab
S_3V_4	21.29 ab	40.56	23.20	14.95 ab
S_3V_5	24.77 ab	35.22	23.09	16.92 a
$LSD_{(0.05)}$	7.60	NS	NS	5.33
CV (%)	18.47	18.34	19.79	21.68

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 levels of probability. NS: Non Significant

S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4

V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

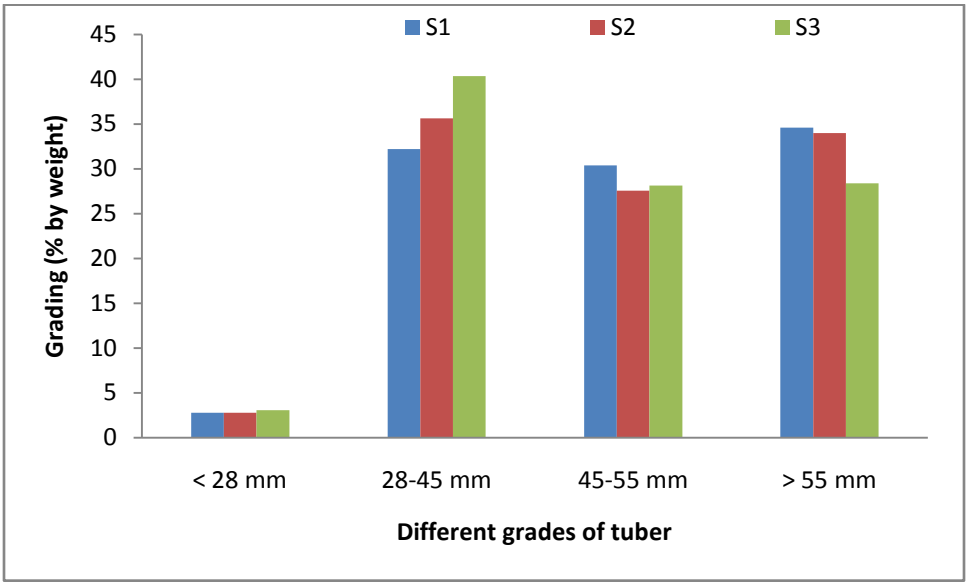
.

4.2.5 Grading of tuber (% by weight)

4.2.5.1 Effect of potassium sources

Grading of tuber (% by weight) was influenced by different potassium source (Figure 19). In case of >55 mm, the maximum grade of tuber weight (34.67 %) was found from the S_3 treatment and the minimum (32.11 %) was found from the S_1 treatment. In case of 45-55 mm, the highest percentage of tuber weight (28.49) was produced by S_1 treatment and the lowest (27.35 %) was produced by S_2

treatment. In case of 28-45 mm, the highest percentage of tuber weight (37.06) was produced by S_2 treatment and the lowest (34.80 %) was produced by S_3 treatment. In case of under sized tubers (<28 mm), the highest percentage of tuber weight (3.22) was produced by S_2 treatment and the lowest (2.34 %) was produced by S_1 treatment.



S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

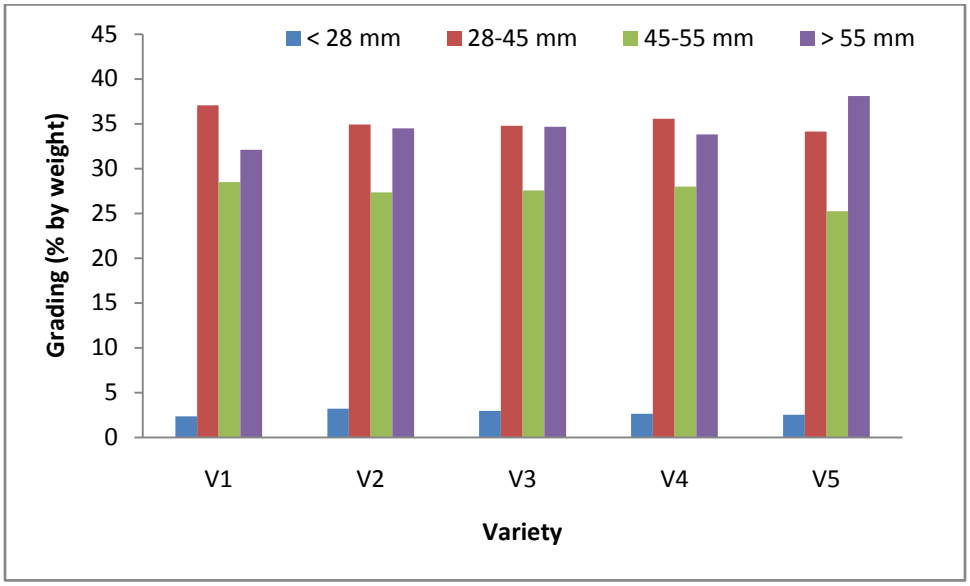
Figure 19. Effect of different potassium sources on grading (% by weight) of potato

LSD value= NS, 0.2718, 0.2926 and 0.3710, respectively

4.2.5.2 Effect of variety

There was no significant variation in grading of tuber (% by weight) on <28 mm and 45-55 mm in diameter. But other two grading of tuber diameter (28-45 mm and >55 mm) was significantly influenced by variety (Figure 20). The <28 mm and 45-55 mm in diameter tuber was not significant so, numerical maximum diameter required. V_4 treatment produced the highest (38.10 %) of large tubers (>55 mm) whereas, the lowest (28.40 %) was produced by V_2 treatment. In case of 45-55 mm, the numerically highest grade of tuber weight (30.41 %) was produced by control treatment and numerically lowest grade of tuber weight (25.25 %) was produced by combinations of V_3 treatment. In case of 28-45 mm, the highest grade

of tuber weight (40.36 %) was produced by V_3 treatment and the lowest (32.20 %) was the control treatment which was statistically similar with V_4 treatment (34.13 %).



V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

Figure 20. Effect of variety on grading (% by weight) of potato

LSD value = 0.4393, NS, NS and 0.4789, respectively

4.2.5.3 Interaction effect of potassium sources and variety

Interaction effect of variety and potassium source significantly influenced the grading of tuber (% by weight) (Table 15). In case of large tuber (>55 mm), the highest grade of tuber weight (38.20 %) was produced by S_1V_5 treatment which was statistically similar with S_3V_5 (38.03 %), V_5S_2 (37.94 %) and the lowest (25.99 %) from S_3V_3treatment. In case of 45-55 mm, the highest grade of tuber weight (34.13 %) was produced by combinations of S_1V_1 treatment while, S_1V_5 treatment showed the lowest grade (24.37 %) of tuber weight which was statistically similar with S_3V_5 (25.55 %). In case of 28-45 mm, the significant highest (42.94 %) of tuber weight was produced by S_3V_3 treatment while, S_1V_2 treatment show the lowest weight of tuber (31.42 %) which was statistically similar with S_1V_1 (32.08 %) and S_3V_1 (32.28 %). In case of small sized tubers (<28 mm), the highest percentage of tuber weight (3.70) was found from S_2V_1treatment which was statistically similar with S_3V_1, S_2V_2, S_3V_2, S_1V_3, S_2V_3,

S_3V_3, S_4V_3, S_2V_4, S_3V_4 whereas, the lowest (1.73 %) was found from the combinations of S_1V_1 treatment followed by with $S_1V_2$and S_2V_2 treatment.

Table 15. Interaction effect of potassium sources and variety on grading of tuber (% by weight) of potato

Treatments	Grading of tuber (% by weight)			
	<28 mm	**28-45 mm**	**45-55 mm**	**>55 mm**
S_1V_1	1.73 d	32.08 i	34.13 a	32.08 e
S_1V_2	2.50 b-d	31.42 i	30.73 b	35.35 bc
S_1V_3	2.98 a-c	33.91 fg	27.89 cd	35.22 bc
S_1V_4	3.38 ab	38.16 d	28.12 cd	30.34 f
S_1V_5	2.09 cd	35.34 e	24.37 g	38.20 a
S_2V_1	3.70 a	33.02 gh	28.19 cd	35.09 bc
S_2V_2	2.57 b-d	37.90 d	27.37 cd	32.17 e
S_2V_3	2.66 b-d	35.59 e	27.86 cd	33.90 d
S_2V_4	2.94 a-c	39.32 c	28.27 cd	29.47 f
S_2V_5	2.87 a-c	33.28 fg	25.90 ef	37.94 a
S_3V_1	3.17 ab	32.28 hi	28.58 c	35.96 b
S_3V_2	2.93 a-c	35.22 e	27.18 de	34.68 cd
S_3V_3	2.99 a-c	42.94 a	28.08 cd	25.99 h
S_3V_4	3.01 a-c	41.02 b	28.18 cd	27.79 g
S_3V_5	2.73 a-d	33.69 fg	25.55 fg	38.03 a
$LSD_{(0.05)}$	1.01	0.93	1.28	1.05
CV (%)	21.66	1.56	2.75	1.86

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 levels of probability
S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.
V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.3 Quality parameter

4.3.1 Tuber flesh dry matter (%)

4.3.1.1 Effect of potassium sources

Tuber flesh dry matter content showed significant variations among the different potassium sources (Appendix 15 and Table 16). The maximum dry matter content of tuber flesh (19.28 %) was recorded from S_3 treatment which was statistically identical with S_1 (19.10 %). The minimum tuber flesh dry matter content (18.65 %) was recorded from S_2 treatment.

Table 16. Effect of potassium sources quality parameter of potato

Potassium source	Flesh dry matter (%)	Specific gravity (g cm^{-3})	Total soluble solids
S_1	19.10 a	1.05	3.50
S_2	18.65 b	1.06	3.40
S_3	19.28 a	1.07	3.56
$LSD_{(0.05)}$	0.35	NS	NS
CV (%)	2.50	4.12	9.95

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability. NS: Non Significant

S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

4.3.1.2 Effect of varieties

Tuber flesh dry matter content showed significant variations among the potato varieties (Appendix 15 and Table 17). The maximum dry matter content of tuber flesh (20.07 %) was recorded from the variety 'Diamant' which was statistically similar was 'Cardonal' (19.92 %), 'Carriage' (19.84). The minimum tuber flesh dry matter content (17.00 %) was recorded from 'BARI TPS-I'. The variation in dry matter content among the potato varieties were also observed by Suyre *et al.* (1975), Lana *et al.* (1970) and Capezio (1987). Variation in tuber dry matter content may be attributed to cultivars inherent difference in the production of total

solids. Burton (1966) reported that genetic differences among varieties play a role in their ability to produce high solids when grown on the same test plot. Dry matter content is subjected to the influence of both the environment and genotypes (Miller *et al.,* 1975; Tai and Coleman, 1999).

Table 17. Effect of variety on quality parameter of potato

Variety	Flesh dry matter (%)	Specific gravity (g cm^{-3})	Total soluble solids
V_1	19.92 a	1.08 ab	3.63 a
V_2	18.24 b	1.04 ab	3.43 ab
V_3	19.84 a	1.06 ab	3.50 ab
V_4	20.07 a	1.11 a	3.93 a
V_5	17.00 c	1.03 b	2.93 b
$LSD_{(0.05)}$	0.46	0.07	0.57
CV (%)	2.50	4.12	9.95

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.3.1.3 Interaction effect of potassium sources and variety

Interaction effect of different variety and potassium source significantly influenced the dry matter content (%) of tuber flesh (Appendix 15 and Table 16). The maximum dry matter content of tuber flesh (20.81 %) was obtained from the combination of KNO_3 and Cardinal (S_2V_1) treatment which was statistically similar S_3V_4 (20.43 %) whereas, the minimum (16.50 %) was obtained from the combination of KNO_3 and BARI TPS-I (S_2V_5) treatment.

4.3.2 Specific gravity

4.3.2.1 Effect of potassium sources

In present study potassium had not significant effect on specific gravity (Appendix 15 and Table 16). Numerically, the highest specific gravity (1.07 g cm^{-3}) was obtained from K_2SO_4 (S_3) whereas, the lowest (1.06 g cm^{-3}) specific gravity was found from KCl (S_1).

4.3.2.2 Effect of varieties

In present study varieties had insignificant effect on specific gravity (Appendix 15 and Table 17). The highest specific gravity (1.11 g cm^{-3}) was obtained from the 'Diamant' which was statically similar was 'Cardinal' (`1.08 g cm^{-3}), 'Asterix' (1.04 g cm^{-3}) and 'Carriage' (1.06 g cm^{-3}) whereas, the lowest (1.03 g cm^{-3}) specific gravity was found from the 'BARI TPS-I' variety. Asmamaw *et al.* (2010) and Elfnesh *et al.* (2011) reported a specific gravity ranging them 1.06 to 1.09 and 1.08 to 1.10, respectively in two separate experiments with nine potato varieties during evaluated their processing quality. Ekin (2011) also reported specific gravity values ranging from 1.07 to 1.08 from a study of eight potato varieties over two consecutive years.

4.3.2.3 Interaction effect of potassium sources and variety

Specific gravity differed significantly due to Interaction effect of variety and potassium (Appendix 15 and Table 18). K_2SO_4 and Diamant (S_3V_4) treatment combinations showed the maximum specific gravity (1.12 g cm^{-3}) which was statistically similar with S_2V_4 (1.11 g cm^{-3}), S_1V_4 (1.10 g cm^{-3}), S_1V_1 (1.09 g cm^{-3}), S_3V_1 (1.08 g cm^{-3}), S_1V_3 (1.07 g cm^{-3}), S_2V_1 (1.06 g cm^{-3}), S_2V_3 (1.06 g cm^{-3}) S_3V_3 (1.06 g cm^{-3}), S_3V_2 (1.05 g cm^{-3}) while, the minimum (1.02 g cm^{-3}) was recorded from the combination of S_2V_5.

Table 18. Interaction effect of potassium sources and variety on quality parameter of potato

Treatments	Flesh dry matter (%)	Specific gravity (g cm^{-3})	Total soluble solids
S_1V_1	20.11 b	1.09 a-d	3.80 a-c
S_1V_2	18.10 e	1.04 b-d	3.20 de
S_1V_3	20.08 b	1.07 a-d	3.60 b-d
S_1V_4	20.23 b	1.10 a-c	3.60 b-d
S_1V_5	17.00 g	1.03 cd	3.30 c-e
S_2V_1	20.81 a	1.06 a-d	3.70 b-d
S_2V_2	17.19 fg	1.04 b-d	3.50 b-e
S_2V_3	19.22 cd	1.06 a-d	3.40 b-e
S_2V_4	19.55 c	1.11 ab	3.90 ab
S_2V_5	16.50 h	1.02 d	2.50 f
S_3V_1	18.83 d	1.08 a-d	3.40 b-e
S_3V_2	19.42 c	1.05 a-d	3.60 b-d
S_3V_3	20.23 b	1.06 a-d	3.50 b-e
S_3V_4	20.43 ab	1.12 a	4.30 a
S_3V_5	17.50 f	1.04 b-d	3.00 ef
$LSD_{(0.05)}$	0.46	0.07	0.57
CV (%)	2.50	4.12	9.95

In a column means having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability.

S_1 : KCl, S_2 : KNO_3 and S_3 : K_2SO_4.

V_1 : Cardinal, V_2 : Asterix, V_3 : Carriage, V_4 : Diamant and V_5 : BARI TPS-I.

4.3.3 Total soluble solids (TSS) (% Brix)

4.3.3.1 Effect of potassium sources

Different potassium sources had not significantly between themselves regarding TSS (Appendix 15 and Table 16). Numerically, the maximum TSS (3.50 %) was recorded from S_1 treatment whereas, the minimum (3.40 %) was obtained from the S_2 treatment.

4.3.3.2 Effect of varieties

Varieties differed significantly between themselves regarding TSS (Appendix 15 and Table 17). The maximum TSS (3.93) was recorded from the variety 'Diamant' (V_4) which was statistically similar (3.63, 3.43 and 3.50, respectively) with

‘Cardinal’, ‘Asterix’ and ‘Carriage’ whereas, the minimum (2.93) was obtained from the variety ‘BARI TPS-1’. Study referred that the variety ‘Damond’ expressed best result in terms of TSS.

4.3.3.3 Interaction effect of variety and potassium sources

It was found that TSS was affected significantly due to the interaction of variety and potassium source (Appendix 15 and Table 18). The highest TSS (4.30 %) was recorded from the combination of K_2SO_4 and Diamant (S_3V_4) which was statistically similar S_2V_4 (3.90 %) whereas, the minimum (2.50 %) was found from the combination of KNO_3 and BARI TPS-I (S_2V_5) which was statistically similar S_3V_5 (3.00 %).

Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the research field, SAU, Dhaka, in the Robi season during the period from November 2013 to March 2014 to study the response of variety and different potassium source on the growth, yield and quality of potato. The experiment consists of three different potassium source viz. S_1 - KCl, S_2 – KNO_3 and S_3 – K_2SO_4 and five potato varieties viz. V_1 - Cardinal, V_2 - Asterix, V_3 - Carriage, V_4 - Diamant and V_5 – BARI TPS-I and The experiment was laid out in Split-Plot design with three replications.

Results showed that days to 1st emergence, days to final emergence, plant height, number of leaves plant^{-1}, number of stem hill^{-1}, leaves area plant^{-1}, total chlorophyll content, stem diameter, dry matter content, yield parameter and quality parameter was significantly influenced by potato varieties. At days to 1st emergence and final emergence, the minimum days (10.56 and 27.67 days, respectively) was taken by 'Diamant'. The tallest plant height (75.30 cm), highest number of leaves plant^{-1} (31.30), number of stem hill^{-1} (4.13), maximum chlorophyll content (SPAD value) (61.37 %), total leaf area (5536 cm^2), stem diameter (0.69 cm), stem dry matter (17.32 %), number of tubers hill^{-1} (9.60), average tuber weight (54.83 g), tuber yield plant^{-1} (28.10 t ha^{-1}), dry matter content of tuber flesh (12.07 %), specific gravity (1.11 g cm^{-3}) and total soluble solids (3.93) was recorded from 'Diamant' potato variety.

Significant variation of days to 1st emergence, days to final emergence, plant height, number of leaves plant^{-1}, number of stem hill^{-1}, leaves area plant^{-1}, total chlorophyll content, stem diameter, dry matter content, yield parameter and quality parameter was found due to different potassium source. The minimum days to 1st emergence (11.72 days) and days to final emergence (34.34 days) was required in S_1 (KCl source application) treatment. The tallest plant height (67.85

cm), highest number of leaves plant^{-1} (24.58), number of stem hill^{-1} (3.26), maximum chlorophyll content (SPAD value) (60.97 %), total leaf area (4245 cm^2), stem diameter (0.63 cm), stem dry matter (14.63 %), number of tubers hill^{-1} (8.42), average tuber weight (46.18 g), tuber yield plant^{-1} (23.44 t ha^{-1}), dry matter content of tuber flesh (11.28 %), specific gravity (1.07 g cm^{-3}) and total soluble solids (3.50) was observed from K_2SO_4 source application.

Significant Interaction effects of variety and potassium source on days to 1st emergence, days to final emergence, plant height, number of leaves plant^{-1}, number of stem hill^{-1}, leaves area plant^{-1}, total chlorophyll content, stem diameter, dry matter content, yield parameter and quality parameter was observed vegetative and reproductive stage. The minimum duration for 1st emergence (9.67 days) and days to final emergence (27.32 days) was recorded from the combination of 'Diamant' variety and KCl source application (S_1V_4) treatment. The tallest plant height (80.40 cm), highest number of leaves plant^{-1} (23.30), number of stem hill^{-1} (4.70), maximum chlorophyll content (SPAD value) (67.10 %), total leaf area (6127 cm^2), stem diameter (0.70 cm), stem dry matter (18.00 %), number of tubers hill^{-1} (10.50), average tuber weight (59.40 g), tuber yield plant^{-1} (31.47 t ha^{-1}), dry matter content of tuber flesh (12.81%), specific gravity (1.12 g cm^{-3}) and total soluble solids (4.30) was found in 'Diamant' variety and K_2SO_4 source application (S_3V_4) treatment.

Based on the experimental results, it may be concluded that-

- The sources of potassium have positive effect on morphological and growth characters, yield attributes in five potato varieties.
- Application of K_2SO_4 with planting 'Diamant' variety seemed to be more suitable for getting higher yield in potato cultivation.

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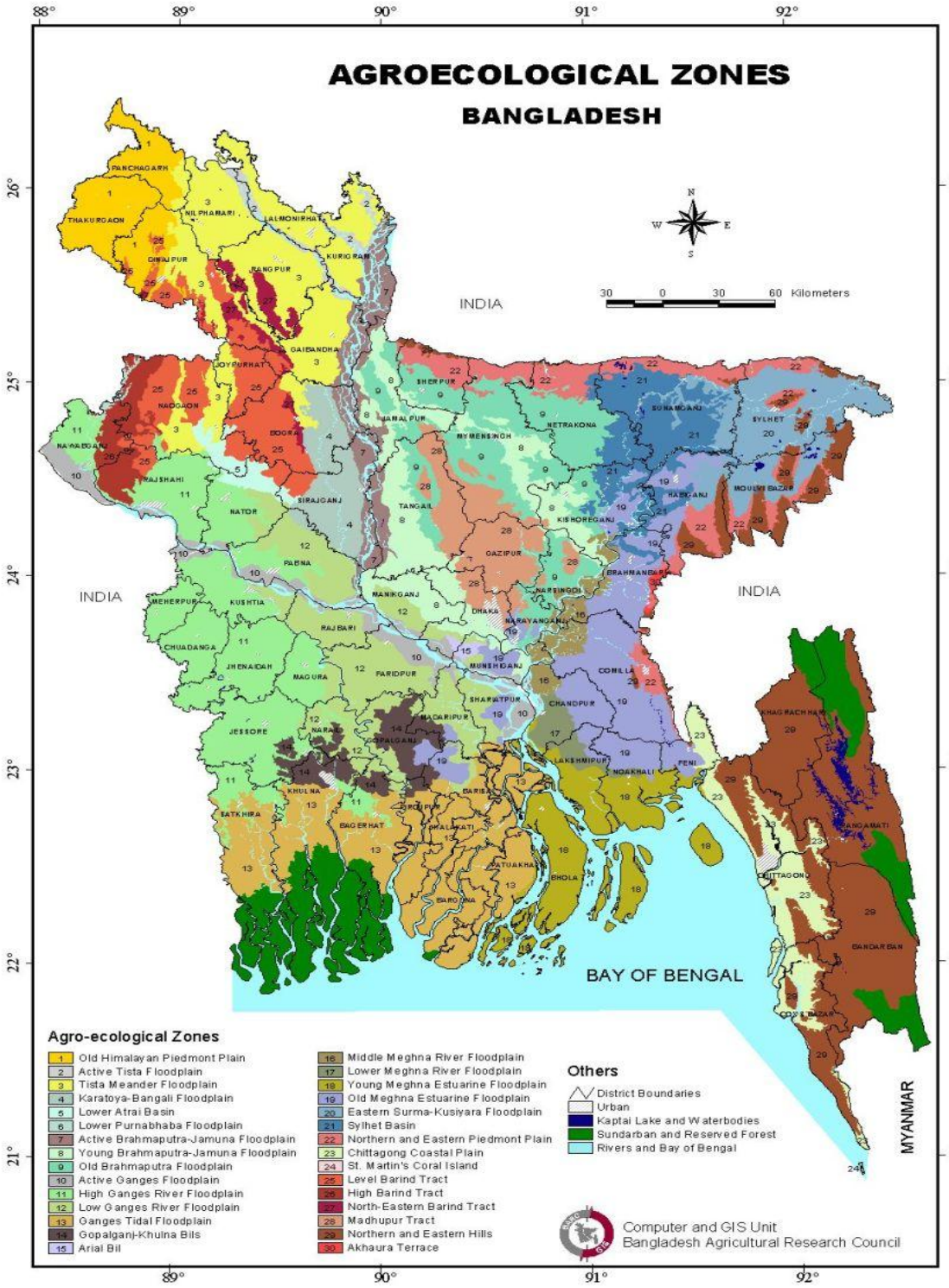
Appendices

APPENDICES

Appendix 1. Agro-Ecological Zone of Bangladesh



Appendix 2. Characteristics of Horticulture Farm soil is analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Experimental field, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping Pattern	Amon rice- Potato

B. Physical and chemical properties of the initial soil

Characteristics	Value
%Sand	27
%Silt	43
%clay	30
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.077
Available P (ppm)	20.00
Exchangeable K (mel 1 00 g soil)	0.10
Available S (ppm)	45

Source : SRDI, 2013

Appendix 3. Monthly record of air temperature, rainfall, relative humidity, soil temperature and Sunshine of the experimental site during the period from November 2013 to March 2014

Month	Average air temperature (°C)			Average relative humidity (%)	Total rainfall (mm)	Total Sunshine per day (hrs)
	Maximum	Minimum	Mean			
November, 2013	29.7	20.1	24.9	65	5	6.4
December, 2013	26.9	15.8	21.35	68	0	7.0
January, 2014	24.6	12.5	18.7	66	0	5.5
February, 2014	36.0	24.6	30.3	83	37	4.1
March, 2014	36.0	23.6	29.8	81	45	3.9

Source: Bangladesh Meteorological Department (Climate & weather division), Agargoan. Dhaka – 1212

Appendix 4. Analysis of variance (mean square) of 1st Days to emergence and final days to emergence

Source of variation	Degrees of freedom	1st Days to emergence	Final days to emergence
Replication	2	10.021	12.250
Potassium (A)	2	23.028**	52.306*
Error	4	1.771	58.194
Variety (B)	4	10.583*	146.764*
A×B	8	3.824*	11.713*
Error	20	2.417	14.903

* and ** indicates significant at 5% and 1% level of probability, respectively.

Appendix 5. Analysis of variance (mean square) of plant height at different DAP

Source of variation	Degrees of freedom	Plant height			
		20 DAP	40 DAP	60 DAP	80 DAP
Replication	2	5.852	80.983	156.225	51.114
Potassium (A)	2	6.051*	49.026*	110.420*	251.181*
Error	4	2.916	4.894	43.111	109.411
Variety (B)	4	10.897*	49.245*	170.324*	250.475*
A×B	8	0.549**	3.452**	9.923**	13.757**
Error	20	1.305	8.520	29.517	62.111

* and ** indicate significant at 5% and 1% level of probability, respectively.

Appendix 6. Analysis of variance (mean square) of number of leaves plant^{-1} at different DAP

Source of variation	Degrees of freedom	Number of leaves plant^{-1}			
		20 DAP	40 DAP	60 DAP	80 DAP
Replication	2	1.970	41.200	149.040	22.600
Potassium (A)	2	9.672*	26.023*	79.191*	204.436**
Error	4	2.805	15.578	11.556	7.721
Variety (B)	4	50.408*	119.856*	205.300*	238.898**
A×B	8	0.577*	6.475*	3.825*	27.453*
Error	20	2.327	13.856	25.211	11.441

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix 7. Analysis of variance (mean square) of number of stems hill^{-1} at different DAP

Source of variation	Degrees of freedom	Number of stems hill^{-1}			
		20 DAP	40 DAP	60 DAP	80 DAP
Replication	2	0.030	0.043	0.007	0.030
Potassium (A)	2	0.040*	0.213*	0.971**	1.924**
Error	4	0.033	0.029	0.029	0.064
Variety (B)	4	0.362*	0.533*	0.645*	1.423*
A×B	8	0.007*	0.070*	0.051*	0.328**
Error	20	0.017	0.039	0.045	0.062

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix 8. Analysis of variance (mean square) of chlorophyll content at different DAP

Source of variation	Degrees of freedom	Chlorophyll content			
		20 DAP	40 DAP	60 DAP	80 DAP
Replication	2	29.303	7.068	10.423	73.426
Potassium (A)	2	764.271**	901.727**	751.181**	290.585**
Error	4	5.004	12.507	6.986	39.192
Variety (B)	4	295.013**	334.201**	339.464**	411.886*
A×B	8	3.332**	5.313**	29.688*	25.105*
Error	20	5.092	10.383	18.235	26.726

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix 9. Analysis of variance (mean square) of total leaf area plant^{-1} at different DAP

Source of variation	Degrees of freedom	Total leaf area plant^{-1}			
		20 DAP	40 DAP	60 DAP	80 DAP
Replication	2	4.596	1381.356	7342.477	10471.583
Potassium (A)	2	858.401**	2061350.604**	11322008.251**	11837209.337**
Error	4	40.209	180.914	1371.893	348.417
Variety (B)	4	1649.548*	772717.850**	18447024.473**	18436485.217**
A×B	8	36.429*	183150.522**	783990.010**	611690.261**
Error	20	30.629	404.774	1514.655	2879.208

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix 10. Analysis of variance (mean square) of stem diameter at different DAP

Source of variation	Degrees of freedom	Stem diameter			
		20 DAP	40 DAP	60 DAP	80 DAP
Replication	2	0.001	0.001	0.003	0.014
Potassium (A)	2	0.038**	0.018**	0.074**	0.099**
Error	4	0.001	0.001	0.029	0.016
Variety (B)	4	0.016**	0.027**	0.097**	0.075**
A×B	8	0.014**	0.002**	0.003**	0.001**
Error	20	0.001	0.000	0.014	0.008

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix 11. Analysis of variance (mean square) of dry matter plant^{-1} at different DAP

Source of variation	Degrees of freedom	Dry matter (%)				
		20 DAP	40 DAP	60 DAP	80 DAP	Harvest
Replication	2	0.014	1.567	16.115	8.038	10.423
Potassium (A)	2	11.431**	21.646**	65.472**	43.932**	751.181**
Error	4	0.007	6.905	5.405	3.504	6.986
Variety (B)	4	11.172**	15.230*	39.874*	82.572*	339.464**
A×B	8	0.617**	0.625**	0.450**	0.806**	29.688*
Error	20	0.024	2.261	1.503	3.561	18.235

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix 12. Analysis of variance (mean square) of yield and yield components

Source of variation	Degrees of freedom	No. of tuber hill^{-1}	Tuber average weight	Yield
Replication	2	0.239	7.238	1.646
Potassium (A)	2	16.141**	546.668**	167.304**
Error	4	1.677	2.702	8.452
Variety (B)	4	13.411*	571.676*	207.136*
A×B	8	0.396*	8.145**	0.001**
Error	20	0.283	0.825	6.063

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix 13. Analysis of variance (mean square) of Grading (% by number) of tuber plot^{-1}

Source of variation	Degrees of freedom	Grading (% by number)			
		>28 mm	28-45 mm	45-55 mm	<55 mm
Replication	2	156.208	80.330	31.342	28.073
Potassium (A)	2	3.558^{NS}	11.910^{NS}	2.122^{NS}	25.339*
Error	4	103.905	102.527	37.694	10.777
Variety (B)	4	62.519^{NS}	65.135^{NS}	8.090^{NS}	46.212*
A×B	8	3.345*	2.393^{NS}	1.673^{NS}	2.480*
Error	20	20.387	48.889	20.423	10.007

* and ** indicate significant at 5% and 1% level of probability, respectively

NS = non-significant

Appendix 14. Analysis of variance (mean square) of Grading (% by weight) of tuber plot^{-1}

Source of variation	Degrees of freedom	Grading (% by weight)			
		>28 mm	28-45 mm	45-55 mm	<55 mm
Replication	2	2.765	7.313	6.516	3.072
Potassium (A)	2	1.753*	12.964**	3.034*	16.488**
Error	4	2.426	9.943	30.744	20.283
Variety (B)	4	0.633^{NS}	145.606*	53.933^{NS}	193.680*
A×B	8	0.355*	3.995**	6.954**	2.997**
Error	20	0.365	0.310	0.585	0.395

* and ** indicate significant at 5% and 1% level of probability, respectively
NS = Non-significant

Appendix 15. Analysis of variance (mean square) of quality parameter at different DAS

Source of variation	Degrees of freedom	Specific gravity	Tuber flesh dry matter	Total soluble solids
Replication	2	0.035	0.014	0.422
Potassium (A)	2	6.877**	10.162**	16.237**
Error	4	0.022	0.014	0.422
Variety (B)	4	4.297**	23.808**	30.884**
A×B	8	0.230*	0.499**	0.777*
Error	20	0.040	0.015	0.422

* and ** indicate significant at 5% and 1% level of probability, respectively