EFFECT OF SPLIT APPLICATION OF N, K AND FYM LEVELS ON THE PRODUCTIVITY OF SEED POTATO DERIVED FROM TRUE POTATO SEED

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CERTIFICATE

This is to certify that thesis entitled, "**EFFECT OF SPLIT APPLICATION OF N, K AND FYM LEVELS ON THE PRODUCTIVITY OF SEED POTATO DERIVED FROM TRUE POTATO SEED**" submitted to the Institute of Seed Technology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in SEED TECHNOLOGY**, embodies the result of a piece of bona fide research work carried out by **AVIK ROY**, Registration No. : 11-04631 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: June, 2017
Place: Dhaka, Bangladesh

(Prof. Dr. Tuhin Suvra Roy)
Supervisor

Dedicated To

My Beloved Parents

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SAU,Dhaka

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ABSTRACT

A field experiment was carried out during the period from November, 2016 to April, 2017 at the farm of Sher-e-Bangla Agricultural University, Dhaka, to investigate the effect of split application of N, K and FYM levels on the productivity of seed potato derived from true potato seed (TPS). Three Nitrogen (N) levels *viz*., N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up and N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 60 DAP, two Potassium (K) levels *viz*., K_1 = 60 kg K ha^{-1} at planting and K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up and two Farm Yard Manure (FYM) levels *viz*., F_1 = 6 t FYM ha^{-1} at planting and F_2 = 10 t FYM ha^{-1} at planting were considered for the experiment. The experiment was laid out in a split split plot design with three replications. The collected data on different growth and yield parameters were analyzed statistically. Results revealed that all the treatment combinations showed promising effect on yield and yield attributes of potato. It was observed that the highest weight of tuber $hill^{-1}$ (0.284 kg), tuber yield (37.87 t ha^{-1}) and ‘A’ graded seed potato yield (10.60 t ha^{-1}) was found from $N_1K_2F_2$ but the highest non-seed potato yield (22.47 t ha^{-1}) was found from $N_3K_1F_1$. But the highest percent of seed potato yield by weight (70.66%), ‘B’ graded seed potato yield (8.98 t ha^{-1}) and percent of non-seed potato yield by weight (65.00%) were found from $N_2K_1F_1$ where the lowest number of stem $hill^{-1}$ (2.00), weight of tuber $hill^{-1}$ (0.173 kg), tuber yield (23.00 t ha^{-1}), seed potato yield (9.93 t ha^{-1}), ‘A’ graded seed potato yield (5.78 t ha^{-1}) and ‘B’ graded seed potato yield (4.15 t ha^{-1}) were also achieved from $N_3K_2F_2$.

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ABBREVIATIONS AND ACRONYMS

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

Chapter 1

Introduction

CHAPTER I

INTRODUCTION

Potato *(Solanum tuberosum)* is the 4th world crop after wheat, rice and maize. Bangladesh is the 7th potato production country in the world (FAOSTAT, 2014). In Bangladesh, it ranks 2nd after rice in production. The national average yield and total production in Bangladesh are 19.03 t ha^{-1} and 9435150.00 metric tons, respectively (FAOSTAT, 2014). Total production is increasing day by day as such consumption also rapidly increasing in Bangladesh. But, the yield of potato is very low in Bangladesh compared to other potato growing countries like New Zealand (47.74 t ha^{-1}), Netherlands (45.66 t ha^{-1}), USA (47.15 t ha^{-1}), Japan (30.65 t ha^{-1}), and even in India (22.92 t ha^{-1}) (FAOSTAT, 2014). This low yield of potato might be due to lack of quality seeds, high cost of quality seed, unavailability and uneven distribution of certified seeds, and use of indigenous cultivars having low yield potential are noticeable (Wiersema, 1984).

To overcome this, an alternative technology of true potato seed (TPS) or use of botanical seed or true seed for commercial potato production has shown great promise for producing both disease-free and cheaper seed and thereby, reducing the cost of cultivation and help farmers to be less dependent on conventional seed sources (Roy *et al.,* 1999). However, the success of potato production using TPS largely depends on the productivity of quality TPS (Upadhya *et al.*, 2003).

Potato tuber contains 70-82% water, 17-29% dry matter, 11-23% carbohydrate, 0.8-3% protein, 0.1% fat and 1.1% minerals. Potato is the rich source of starch, vitamin C and B and minerals. It contains 20.6% carbohydrates, 2.1% protein, 0.3% fat, 1.1% crude fibre and 0.9% ash. It also contains good amount of essential amino acids like leucine, tryptophan and isolucine (Khurana and Naik, 2003). Potato contains high protein-calorie ratio (17 g protein: 1000 Kcal) and yields more edible energy, protein (3 kg/ha/day) and dry matter per unit area and time (47.6 kg/ha/day) compared to cereals (Ezekiel and Pandey, 2008).

Potato demands high level of soil nutrients due to relatively poor developed and shallow root system in relation to yield. Potato produces much more dry matter in a shorter cycle. The high rate of dry matter production results in large amount of nutrients removed per unit time, which generally most of the soils are not able to supply. Hence, nutrients from external sources as fertilizers become essential. Balanced fertilization is a pre-requisite for getting optimum yield potential of potato (Kushwah *et al*., 2005).

Nitrogen fertilizer application is considered as one of the most important factor which limits production of potato (Tran and Giroux, 1991). Nitrogen is important for potato crop as it is a heavy feeder. N deficiency is characterized by yellowing of leaves, stunted growth and lower yield. Application of nitrogen significantly influenced the plant length, foliage coverage, number of main stem per hill, fresh weight of haulm per hill, number of tubers per hill, weight of tubers per hill, yield of tubers and seed tubers per hectare (Zamil *et al*., 2010). Nitrogen application plays a key role in crop growth of potato and development resulting in increased size and number of both processing and non-processing grade tubers ultimately enhancing total yield (Kumar et al., 2007). Potato crop requires high amount of nitrogen for optimum yield (Errebhi *et al*., 1998).

Potassium is essential for carbohydrate synthesis and in the translocation and movement of starch from potato leaves to tubers (Babaji *et al*., 2009). Potassium increases leaf expansion particularly at early stages of growth, extends leaf area duration by delaying leaf shedding near maturity. It increases both the rate and duration of tuber bulking. Its application activates number of enzymes involved in photosynthesis, carbohydrate metabolism and proteins and assists in the translocation of carbohydrates from leaves to tubers. Potato crop is a heavy remover of soil potassium and removes 1.5 times the amount of nitrogen and 4-5 times the amount of phosphate. Potassium application revealed a yield increase between 1.0 t ha^{-1} and 5.2 t ha^{-1} (Bansal and Trehan, 2011).

Being a heavy feeder of nutrients, potato required high amount of nitrogen, phosphorus and potassium. Chemical fertilizer is the main source of nutrients use for potato cropping. However, continuous dependence of chemical fertilizer causes nutritional imbalance and adverse effects on physico-chemicals and biological properties of soil. Integrated nutrient management is a better approach for supplying nutrient or food to the crop by including organic and inorganic source of nutrient (Arora, 2008). Inorganic fertilizers becoming very costly and their imbalanced use deteriorate soil physico-chemical environment. At the same time large quantities of random organic sources of nutrients are not exploited in crop productions. These organic sources of nutrients are cheaper, ecofriendly, improve soil properties and can supplement nutrient requirement of crops partially.

From the above consideration, the present study was under taken with the following objectives

1. To standardize the optimum split application of N, K and FYM for increasing seed potato production from seedling tuber drive from TPS.

Chapter 2

Review of literature

CHAPTER II

REVIEW OF LITERATURE

Potato is one of the important vegetable crop in Bangladesh and as well as many countries of the world. For increasing the growth and yield of potato abundant studies were conducted in the country and abroad. But a very few studies on the related to growth and tuber production due to Effect of split application of N, K and FYM levels on the productivity of seed potato derived from the true potato seed have been carried out in our country as well as many other countries of the world. On the other way, the research work so far been done in Bangladesh and is not adequate and conclusive. Nevertheless, some of the important and informative works and research findings related to the split application of N, K and FYM on growth and tuber production of potato have been reviewed in this chapter under the following headings-

2.1 Effect of N on growth and yield of potato

Georgakis *et al.* (1997) conducted experiments and the results showed that increase in nitrogen rates up to favorite point led to increase in tuber yield per unit area. The highest values of this trait affected by nitrogen were obtained at 80 and 160 kg ha^{-1} nitrogen and the lowest one was belonged to control. With increasing nitrogen application, number of stolons, number of tubers and, consequently, yield were increased. This may attributable to the fact that in such conditions, vegetative growth of the aerial parts can increase and hence, inhibit transferring photosynthetically matters into the storage parts (tubers). Errebhi *et al.* (1998) stated that the potato crop requires high amounts of N for optimum yields as reported.

Peshin (1999) conducted different experiments and reveled that excessive application of N leads to delayed maturity, poor tuber quality and occasional reduction in tuber yield. Belanger *et al.* (2000) found that application of appropriate amounts of nitrogen (80 kg ha^{-1}) in potato resulted in more favorable effects than higher rates.

Patel and Patel (2001) conducted an experiment and concluded that nitrogen is the first limiting nutrient in potato production. It greatly influences crop growth and tuber yield. A mature crop of potato yielding 25 to 30 tons ha^{-1} removed 120 to 140 kg N ha^{-1}. He also reported that higher rate of nitrogen provides better growth, development and translocation of photosynthates from source to sink (tuber) which resulted in higher yield of tubers.

The effects of N (75, 100, 125, 150 and 175 kg N ha^{-1}) and crop duration (75, 90, 105 and 120 days) on the bulking properties of potato cv. Kufri Sutlej were determined in a field experiment conducted by Kumar *et al.* (2002). Plant length, number of stems per hill, leaf fresh weight, number of tubers per hill, dry matter content, yield of different grade tubers, mean total tuber yield and tuber bulking increased with increasing rates of N. except for plant length, number of stems per hill and leaf fresh weight which increased only up to 105 days of crop duration. The rest of the parameters measured increased with crop duration up to 175 days.

Wadas *et al.* (2005) investigated the effects of agro textile covering (from planting to plant length of 15 cm) and N application (0, 30, 60 and 90 kg ha^{-1}) on the yield and tuber quality of early potato cultivars Aster and Drop in Poland. The covering with N application resulted in an increase of the dry matter content in tubers by 1.29% and starch by 0.45%.

Love *et al.* (2005) treated three new cultivars Bannock Russet, Gem Russet, and Summit Russet, along with the standard cultivar, Russet Burbank, were treated with four N rates (0, 100, 200, and 300 kg N ha^{-1}) using two different application timing procedures (“early,” with two-thirds N applied preplant, and “late,” with one-third applied pre plant). Each of the four cultivars showed a unique response to N application treatments. Bannock Russet achieved maximum yield and net returns with relatively small amounts of N fertilizer. Gem Russet also showed no response to application timing and had NO_3-nitrogen sufficiency concentrations similar to or slightly higher than those of Russet Burbank. Summit Russet showed a strong trend for improved N use-efficiency when most of the N was applied early. On the other hand, analysis of net returns revealed a trend for greater profitability for Summit Russet when the majority of N was applied during tuber bulking.

Kanbi and Bhatnagar (2005) conducted field experiments to study the effect of organic-inorganic sources of nitrogen fertilizers on chlorophyll content of leaves (at 65 and 85 days crop), tuber yield, dry matter, chips quality and storage behaviour of potato cv. Kufri Badshah. The application of 25 t ha^{-1} organic manure along with 100% recommended dose of nitrogen in inorganic form or more than 50% of recommended dose of nitrogen in inorganic form and remaining parts of nitrogen in castor cake or poultry manure increased the chlorophyll content, tuber yield, tuber dry matter and minimized storage losses and improved quality of chips. Mahmoodi and Hakimian (2005) found that increase in nitrogen application, leads to increase in potassium content of tuber.

Singh and Gupta (2005) conducted a field experiment to study the effect of bio, organic and inorganic source of nutrients on potato tuber yield. Application of farm yard manure (FYM) @ 15 t ha^{-1} a significantly increased the growth, tuber and net return of potato. Application of 100% N of recommended dose also boosted the growth and yield of potato. Application of FYM recorded the saving of 60 kg N ha^{-1}. *Azotobacter* proved effective in enhancing the growth and tuber yield of potato. Interaction effect of FYM, nitrogen and *Azotobacter* was significant. Highest tuber yield and net return was obtained with application of FYM @15 t ha^{-1} + *Azotobacter* + 100% recommended dose of nitrogen.

Marguerite *et al.* (2006) revealed that tuber yield per unit area was increased with increasing nitrogen fertilizer up to suitable level. Also, increase in density led to significant increase in tuber yield.

Kumar *et al.* (2007) conducted a field experiment to optimize the growth period-specific N requirements of table potato cultivars. Growth, yield and economic parameters of both the genotypes were evaluated for their response to four N levels (0, 90, 180 and 270 kg ha^{-1}) and two growth periods (75 and 110 days). Likewise, it showed steady increase in marketable and total tuber yields. Agronomic N-use efficiency (118.666.0 kg tubers/kg N applied) decreased linearly with increase in N levels. Net income and benefit: cost ratio indicated that both the cultivars should be fertilized with 270 kg N $ha^{-1}$when harvested at 110 days, but 180 kg N ha^{-1} is sufficient when harvested at 75 days.

Mehdi *et al.* (2008) carried out the experiment which consisted of treatments 4 genotypes of potato (Kufri Chandramukhi, K. Jyoti, PP-48 and PP- 2500), 3 levels of N (60, 120 and 180 kg ha^{-1}) and 2 levels of FYM (15 and 30 t ha^{-1}). Genotype PP-2500 recorded highest yield followed by Kufri Chandramukhi, Jyoti and PP-48. The interaction effect of genotypes, levels of N and FYM was significant in both the years with maximum tuber yield recorded with 180 kg N + 30 t FYM ha^{-1}, which was statistically at par with 120 kg ha^{-1} N + 30 t FYM ha^{-1}. It was concluded that potato genotype PP-2500 and Kufri Chandramukhi supplemented with 120 kg N ha^{-1} + 30 t FYM ha^{-1} was the best for commercial cultivation under cold arid conditions of Ladakh.

Das and Barik (2008) conducted an experiment in farmers' field to study the effect of nutrient management in potato through vermicompost and urea each with sole and in different proportions on growth, productivity, nutrient uptake, economics and soil fertility of succeeding wet season rice in potato-sesame-rice cropping system. Integrated use of plant nutrients in potato through vermicompost and urea had significant influence on growth, productivity, nutrient uptake, economics and soil nutrient reserve after rice as evidenced from pooled data. Supplementation of 40-60 % recommended dose (RD) of nitrogen from vermicompost and rest from chemical fertilizers in potato exhibited the highest growth, yield attributes and yield, net return, return per rupee investment and nutrient uptake in rice. These treatments also left higher residual available nitrogen, phosphorus and potassium after rice harvest. Use of

100 % RD of N entirely from chemical fertilizers or farmers' practice in potato had lesser residual effect on succeeding wet season rice compared with integrated use of organic (vermicompost) and chemical sources.

Saeidi *et al.* (2009) reported that application of nitrogen, led to increase in tuber yield than control. Janagrad *et al.* (2009) designed a factorial randomised Block Design on Cultivars "Agria" and "Satina" and N fertilizer levels included control, 80, 160 and 200 kg N ha^{-1}. Results showed that Agria was significantly superior in all traits except stem length. As N level increased, auxiliary branch number and plant length increased. The maximum stem and leaf biomass and leaf number was achieved with 160 kg N ha^{-1} treatment and the highest main stem number was achieved in 80 kg N ha^{-1}treatment.

Sandhu *et al.* (2010) conducted a field study with three processing varieties consisting of one Indian variety Kufri Chipsona-1 and two non-Indian varieties *viz.,* Atlantic and Lady Rosetta along with one Indian table variety Kufri Pukhraj to evaluate total and processing "grade tuber (>45 mm tuber diameter) yield and quality characteristics at four nitrogen levels (0, 100, 200 and 300 kg N ha^{-1}). There was an increase in total and processing grade tuber yield with nitrogen application up to 200 kg N ha^{-1}. Chip colour darkened with the application of nitrogen, while dry matter content and tuber flesh firmness were maximum at 200 kg N ha^{-1}. The contents of reducing sugars, sucrose, free amino acids and total phenols increased with nitrogen application. Based on processing grade tuber yield and quality parameters, 200 kg N $ha^{-1}$was the optimum dose and Atlantic was the most suitable variety followed by Kufri Chipsona-1.

A study conducted by Zamil *et al.* (2010) reveled that application of nitrogen levels significantly influenced plant length, foliage coverage, number of main stem $hill^{-1}$, fresh weight of haulm $hill^{-1}$, number of tubers $hill^{-1}$, weight of tubers $hill^{-1}$, yield of tubers and seed tubers ha^{-1}. He also found that the tuber yield ha^{-1} was significantly and positively correlated with plant length, foliage coverage, and number of stems per hill, fresh weight of haulm $hill^{-1}$, number of tubers hill^{-1} and weight of tubers hill^{-1}. Also reported a linear relationship between yield of tubers ha^{-1} and the different levels of nitrogen, hence reported the increase in tuber yield with the application of higher levels of nitrogen.

A field experiment was set up by Muthoni and Kabira (2011) to investigate the effects of different sources of nitrogen on potato. The treatments consisted of ten fertilizer materials and two potato varieties, namely, 'Tigoni' and 'Asante'. The potato yields were high with variety 'Tigoni' giving an average of 81.0 tons ha^{-1} in the first season and 86.8 tons ha^{-1}in the second season. Variety 'Asante' yielded an average of 59.5 tons ha^{-1} in the first season and 62.1tons ha^{-1} in the second season.

Barghi *et al.* (2012) conducted an experiment in with four levels of nitrogen fertilizer (0, 80,160, and 200 kg of nitrogen per hectare) in main plots and two varieties of potato including Agria (late maturing) and Satina (early maturing) in secondary plots. The experiment was conducted as split plot with randomized complete block design with four replications. A significant increase in tuber yield was recorded with the increase in the dose of nitrogen.

Etemad and Sarajuoghi (2012) studied the effect of Nitrogen fertilizer on yield and yield components and determined the best level of this fertilizer for Agria cultivar of potato. In this research the effects of three levels of nitrogen fertilizer, four different times of application times of the fertilizer and interaction of these treatments were studied. The maximum number of tubers, the maximum weight of tubers and the maximum number of stems were obtained with application of 200 Kg ha^{-1} N fertilizer.

A field trial was conducted by Singh and Lal (2012) to find out suitable dose of potassium for potato cultivar Kufri Pukhraj for optimum yield, quality and nutrient use efficiency under different nitrogen level. Maximum yield of 39.83t ha^{-1} was obtained when N and K was applied @225 M kg N ha^{-1} and 150 K_2O kg ha^{-1} against a tuber yield of only 14.36 t ha^{-1} without N and K application.

2.2 Effect of K on growth and yield of potato

Grewal and Singh (1979) determined that on an average, the potato crop, yielding about 29 t ha^{-1}, removed about 91 kg K_2O ha^{-1}. Satyanarayana and Arora (1985) concluded that although the potato crop requires a heavy input of K for high yields, adequate levels should be established for economic yields and sustainable productivity. It is well documented that K affected potato quality and yield. Insufficient K resulted in reduced potato yield and small sized tubers.

Sahota *et al.* (1988) revealed that potassium allowed the crops to adapt to environmental stress, and promoted plant tolerance to insect infection and resistance to fungal disease. Moreover, K fertilizer reduced frost injury and enzymatic browning. It increased starch, total sugar, sugar, reducing sugar, protein and ascorbic acid content of tubers.

Tandon and Sekhon (1988) stated that potassium was considered as an integral component of the balanced fertilization of potato crop to improve yield as well as quality of the tuber.

Omran *et al.* (1991) reported that an adequate supply of potassium strengthens stems to prevent lodging, increases yield and improves tuber quality .It also allows the crops to adapt to environmental stress. It promotes plant tolerance to insect infection and resistance to fungal disease. He also stated that an adequate supply of potassium strengthens stems to prevent lodging, increases yield and improves tuber quality.

Nandekar *et al.*(1991) found that there was a significant effect of increasing K levels on the yield of medium as well as small grade tubers, but there was a negative effect on the yield of very small grade (<25 g) tubers, though the yield differences were not significant.

Perrenoud (1993) stated that potassium promotes large size of tubers by increasing water accumulation in tubers resulting in higher tuber yield. Trehan and Grewal (1994) revealed that the potato varieties differ widely with regard to K use efficiency. Potato cultivars namely Kufri Bahar and Kufri Badshah responded only upto 50 kg K ha^{-1}. Kufri Jyoti and Kufri Chandramukhi on the other hand responded upto 100 kg K ha^{-1}. According to Govindakrishan *et al.* (1994) the yield of medium grade tubers was increased, but that of the small grade tuber was not affected by progressive application of K fertilizer.

Westermann *et al.* (1994) concluded that dry matter of potatoes decreased with increasing K level. Excess K fertilizer was reported to reduce dry matter or specific gravity.

Lalitha *et al.* (1997) had recorded the enhancement in net return with progressive application of potassium from 0 to 150 and 0 to 90 kg K_2O ha^{-1} respectively. They also noted an increase in tuber yield with increasing K application rates up to the highest rate. Higher B:C ratio at higher dose of potash was due to high gross and net return from the cultivation.

Fageria *et al.* (1997) observed that potato crop feeds heavily on soil potassium and the tuber removed 1 to 5 times the amount of nitrogen and 4 to 5 times the amount of phosphate. Potato also acts as an indicator crop for K availability because of its high K requirement. Oktay *et al.* (1997) concluded that K nutrition increases the average size of the tuber significantly.

Singh *et al.* (1997) revealed that the yield of small grade (<25 g) tubers with an increase in K application rates, while two categories of medium grade tubers, weighing 51-75 g and 25-50 g, showed slightly negative but nonsignificant effect of K rates on tuber yield, respectively. He also found that the yield of small grade tubers had negative trend with increasing rates of K application. Thus, there was recorded a highly positive correlation between tuber yield of aggregate and large grade tubers, followed by a fairly good positive correlation between yield of aggregate and medium grade tubers and a strong negative correlation between yield of aggregate and small grade tubers, indicating the respective contribution of tubers of various grades to the aggregate tuber yield.

Deka and Dutta (1999) stated that there is an increase in tuber bulking rate with the progressive K application rates. Singh and Bansal (2000) have recorded the enhancement in net return with progressive application of potassium from 0 to 150, 0 to 90, and 0 to 120 kg K_2O ha^{-1}, respectively. They also noted an increase in tuber yield with increasing K application rates up to the highest rate.

Trehan *et al.* (2001) found that potassium increased the size of tubers and not the number. So, it increases the yield by increasing the number and yield of large sized tubers.

Tawfik (2001) found that compared to low K rate, the higher K rate application increased the yield of medium (28-60 mm) and over-sized (>60 mm) tubers by approximately 15% and 40%, respectively.

Abdelgadir *et al.* (2003) found that application of 215 kg K_2O ha^{-1} was sufficient to produce an economic yield and high quality of potatoes.

Moinuddin *et al.* (2004) conducted a field experiment with four genotypes of potato were grown with graded levels of potassium (K) (0, 75, 150, and 225 kg K_2O ha^{-1}) with a uniform dose of nitrogen (N) (200 kg ha^{-1}) and phosphorus (P) (100 kg P_2O_5 ha^{-1}) to study their performance with regard to growth, yield, and economic parameters. Growth parameters (above ground plant biomass and tuber bulking rate), tuber yield, and the yield components (tuber population, average tuber weight), as well as economic parameters (net return, return per rupee invested and net production value) were significantly affected by increasing K application rates. Potassium application at 150 kg K_2O ha^{-1} proved to be optimum dose for most parameters studied. Progressive application of K significantly increased the aggregate as well as large and medium grade tuber yields, with concomitant decrease in the yield of small grade tubers. The highest contribution of large grade tubers (>75 g) to the aggregate yield was found to be mainly due to the large size of the tuber; while medium grade tubers contributed it through size as well as number of tubers.

Genotypes differed in optimum and maximum yield. Agronomic efficiency of all the genotypes had maximum value at 75 kg K_2O ha-^{1}, which decreased with increase in K dose. The yield performance of the genotypes was truly reflected in the net economic returns, with 150 kg K_2O ha^{-1} proving the optimum K level. However, return per rupee invested and net production value showed a reverse trend, with 75 kg K_2O ha^{-1} proving as the best K application rate.

Moinuddin *et al.* (2005) concluded that there is increase in plant length and biomass in higher levels of potash. Increase in plant length with increasing rate of potassium applied might be due to proper utilization of nitrogen and phosphorus by plant; hence the overall shoot growth is expected.

Kumar *et* al.(2005) conducted a field study and indicated that process grade (> 45 mm) and total tuber number increased with the application of potash over control, however, stem number and leaf number were not influenced as a result of different K levels. Significant increase in process/total tuber yields and net returns was recorded up to 150 kg K_2O ha^{-1}, hence this dose was recommended for Chipsona cultivars.

Babaji *et al.* (2009) revealed that potassium is important in carbohydrate formation and in the transformation and movement of starch from potato leaves to tubers. Singh *et al.* (2010) conducted a field trial on potato and found that application of 100 kg K_2O ha^{-1} as MOP significantly increased number as well as tuber yield of large (>75g) and medium- large (50-75g) tubers which resulted in increase in overall tuber yield as well as the marketable yield.

Bansal and Trehan (2011) stated that potato crop is a heavy remover of soil potassium and removes 1.5 times the amount of nitrogen and 4-5 times the amount of phosphate. Potassium application revealed a yield increase between 1.0 t ha^{-1} and 5.2 t ha^{-1}. There was less weight loss and rottage of tubers with potassium application. Results indicate that potassium nutrition influences tuber size, dry matter content, susceptibility to black spot bruise, after “cooking darkening, reducing sugar content, fry colour and storage quality. Potassium application is reported to increase the size of tubers, especially, if K supply of the soil is low to medium. Starch content in tubers was positively correlated to potassium application. Generally, K application decreased reducing sugars and lighten chip colour under low K nutrition levels.

Dhakal *et al.* (2011) conducted an experiment with 16 treatments consisting of two mulch levels (mulched and no mulch) as main plot, two varieties (Kufri Chipsona-1 and Kufri Chipsona-2) as sub plot and four levels of potash (0, 50, 100 and 150 kg K_2O ha^{-1}) as sub-sub plot arranged in split-split plot design with four replications to evaluate the effect of these treatments on tuber production and their effect on quality of potato chips. The result showed that increasing levels of potash from 0-150 kg K_2O ha^{-1}increased the dry matter accumulation, LAI, number and weight of tuber per plant. The result also showed that as the level of potash increased there was a decrease level of reducing sugar and browning of chips as well. On the other hand, higher potash levels increased the percent of fat content and recovery of chips. Also increase in potash levels resulted to increase in gross return, net return, and B/C ratio.

2.3 Effect of FYM

The term 'farm yard manure' (FYM) is an expression to signify any manure prepared in the backyard using the farm waste, cattle dung and urine. Conventionally, FYM is prepared by spreading cattle dung, water and crop residues in a specially made pit at the backyard of every Indian household in the village (Mukund and Prabhakarasetty, 2006).

Shankaran and Subbaiah (1997) reported that the content of N, P_2O_5, and K_2O in FYM was 0.05 to 1.50, 0.40 to 0.80 and 0.50 to 1.90 per cent, respectively. Banerjee and Singhamahapatra (1986) noticed high leaf area indices in potato during most of the active growth period and even up to maturity of the crop with delayed leaf senescence due to application of farm yard manure. Further, crop growth rate (CGR) increased as the growth progressed up to 55 days after planting.

Selvaraj *et al.* (1993) observed better vegetative growth of garlic crop when supplied with 25 tonnes of farm yard manure per hectare. Gubbuk *et al.* (1993) obtained highest plant length by applying 225 kg FYM ha^{-1} in Dwarf Cavendish banana and 150 kg per mat for Basrai banana.

Sendur *et al.* (1998) showed the use of biofertilizers and organic like *azospirillum,* FYM and vermicompost, respectively combined with recommended dose of fertilizers showed better performance in terms of growth and fruit yield of tomato.

Naidu *et al.* (1999) reported that application of NPK (80:60:50 kg ha^{-1}) and FYM (20 t ha^{-1}) helps in obtaining higher plant length, number of leaves per plant, internodal length and number of nodes per plant in okra. Goramnagar *et al.* (2000) found maximum leaf area, plant length and plant spread in Nagpur orange plants which were fed with FYM (15 kg) + N (360 g) + P_2O_5 (180 g) per plant.

Sundharaiya *et al.* (2003) also reported that application of FYM (12.5 t ha^{-1}) + wettable sulphur (20 kg ha^{-1}) + urea (60 kg ha^{-1}) resulted in higher plant length, number of leaves and herbage yield over other treatment in sweet basil.

Gopichand *et al.* (2006) reported that interaction of plant spacing and FYM level on *Curcuma aromatica* showed higher crop growth rate value at 50cm x 50cm spacing with FYM level of 22.5 tonnes ha^{-1}, in the second year and from initial to second year.

Sood (2007) reported that significant increase in plant length, number of leaves per plant and leaf area per plant was recorded in potato crop variety Kufri Jyoti with combined application of organic (FYM) and inorganic source of nutrients in the ratio of 1:3, respectively.

Suja (2009) reported that application of farmyard manure @12.5 tonnes ha^{-1} along with wood ash @ 3 tonnes ha^{-1} favoured canopy growth i.e., plant length and leaf production in tannia. Similarly, tannia crop growth was also influenced by the combined application of farmyard manure @12.5 tonnes ha^{-1} and NPK @ 80:50: 100 kg ha^{-1}.

2.4 Effect of NK on growth and yield of potato

Al-Moshileh *et al.* (2005) conducted an experiment with five levels of potassium fertilizer and four levels of nitrogen fertilizer with different splitting methods on vegetative and tuber yields of potato were studied on agronomic performance, tuber quality and total yield of potatoes grown on a sandy soil. Results revealed that increasing potassium sulfate rates resulted in a significant increase ($p>0.05$) in plant length, leaf area, chlorophyll concentration, specific gravity, K concentration and carbohydrate content. Marketable tuber yield was also significantly improved with increasing K rates. Also, the application of 300 kg Nha^{-1} split in three equal doses gave the highest percent of soil coverage and marketable tuber yield. Under the conditions of this experiment, it is concluded that K and N is needed by potatoes for economic yield.

Chadha *et al*. (2006) concluded that the uptake value of potato is higher at high N and K levels .This was due to better absorption of N and K from the fertilizers during the different growth stages of the crop.

Vijaya Lakshmi *et al.* (2012) conducted a field experiment on a sandy loam soil during rabi season to study the effect of levels of nitrogen (0, 60, 120 and 180 kg N ha^{-1}) and potassium (0, 60, 120 and 180 kg K_2O ha^{-1}) on potato tuber yield and soil available nutrient status. The tuber yield of potato was significantly increased with nitrogen, potassium and their interactions. The highest tuber yield (223.9 q ha^{-1}) was recorded by combined application of nitrogen @ 180 kg ha^{-1} + potassium @ 180 kg ha^{-1} (N_3K_3) which was on par with nitrogen @ 180 kg ha^{-1} + potassium @ 120 kg ha^{-1} (N_3K_2). The total uptake of N and K by potato at harvest was highest with N_3K_3 combination and the per cent increase being 139.4 and 142.8, respectively over N_0K_0. With regard to soil available nutrient status, N_3K_3 recorded highest available N and K_2O contents in soil at all the stages of crop growth, the per cent increase being

72.2 (30 DAS), 114.6 (60 DAS) and 122.3 (at harvest) compared to that of at control (N_0K_0). Similarly the available potassium increased by 40.3 (30 DAS), 31.5 (60 DAS) and 41.4 (at harvest) per cent when compared against control (N_0K_0). From the results it was evident that higher levels of N and K had met the requirement of potato crop at different growth stages, which was reflected in terms of yield.

2.5 Effect of FYM with inorganic fertilizers

Application of farm yard manure results in improved crop yields, soil physical properties, nutrient availability, microbial activity and residual benefits to succeeding crops (Mukund and Prabhakarasetty, 2006).

Sharma *et al.* (1979) indicated that, continuous application of farm yard manure produced higher yield in potato than the combined application of P and K as inorganic fertilizers. Sharma *et al.* (1980) observed that there was significant and positive effect of FYM on yield. They also showed that, translocation was improved due to application of FYM in summer crop. According to Grewal and Trehan (1984) application of FYM @ 15 and 30 tonnes ha^{-1} recorded significantly increased tuber yield in potato crop by 39 and 42 per cent, respectively. They opined that higher yield was mainly due to improvement in tuber size.

Asumus and Gorlitz (1986) observed that combined application of FYM and mineral fertilizer increased potato yield. In the same way, Mandal and Mazumdar (1986) indicated application of RDF in combination with FYM (15 t ha^{-1}) resulted in higher potato tuber yield compared to control.

The two trials conducted by Mandal and Mazumdar (1986) recorded maximum potato tuber yield (20.8 and 20.4 t ha^{-1}) with the application of 15 tonnes of farm yard manure per hectare compared to control (17.7 and 16.1 t ha^{-1} during 1983 and 1984, respectively).

Sharma and Arora (1987) reported that the application of farm yard manure decreased the number of tubers in the small grade and increased the medium and large graded tubers in potato. Kropisz (1992) observed that application of FYM (25 t ha^{-1}) and NPK recorded significantly higher yield compared to FYM alone and NPK in cabbage, onion and carrot.

Ilin *et al.* (1992) also observed that application of mineral fertilizers and FYM increased potato tuber yield by 43 - 45.3%. An assessment made over several years showed that each tonnes of FYM is equivalent to 3 Kg fertilizer nutrients in a single crop and 5 Kg in double cropping in terms of yield responses generated (Tandon, 1995).

Selvaraj *et al.* (1993) observed better yield of garlic crop supplied with 25 tonnes of farm yard manure. Increase in yield of garlic was due to direct and indirect effect of farm yard manure (Kumar, 1994).

Veena and Kumari (2000) reported that integrated use of farmyard manure @20 t ha^{-1} along with 40 kg N and 120 kg K_2O ha^{-1} could produce higher arrowroot rhizome yields of 15.36 and 15.35 t ha^{-1} respectively.

James and Mitra (2001) revealed that integrated application of 50% FYM and 50% chemical fertilizer with 10 tonnes ha^{-1} of fly ash and micronutrient in an acid lateritic soil increase the sweet potato tuber yield two times than that of organic material alone. Ram and Nagar (2003) reported higher yield (13.69 kg $plot^{-1}$) in Allahabad safeda variety of guava, when it was nourished with 200 kg FYM + 200 g Azotobacter.

Susan *et al.* (2003) reported that balanced application of NPK at 100:50:100 Kg ha^{-1} along with FYM at 12.5 t ha^{-1} is beneficial in maintaining starch content of cassava tubers. Powon *et al.* (2005) reported that application of 100 kg P + 20 MT FYM ha^{-1} resulted in the highest tuber dry weight, shoot dry weight and total tuber yield. They opined that the combination of organic fertilizers and low rates of inorganic fertilizers is a promising low cost option in the production of high yields of potatoes.

Sood (2007) revealed that combined application of organic (FYM) with in organic fertilizers in the ratio of 1:3 gave the maxiumum yield (269 q ha^{-1}) over control (100 q ha^{-1}), he opined that the higher potato tuber yield under integrated use of organic and inorganic source was mainly due to higher proportion of large and medium size tuber.

Mehadi *et al.* (2008) studied four genotypes of potato *viz.*, Kufri chandramukti, Kufri Jyoti, PP-48 and PP-2500 for their response for three levels of N (60, 120 and 180 kg ha^{-1}) and two levels of FYM (15 and 30 t ha^{-1}) and reported that maximum tuber yield was recorded with 180 kg N+ 30 tonnes ha^{-1}, which was statistically at par with 120 kg N ha^{-1} + 30 tonnes FYM ha^{-1}. They also concluded that the potato genotype PP-2500 and Kufri Chandramukhi supplemented with 120 kg ha^{-1}N + 30 t FYM ha^{-1} were the best genotypes for commercial cultivation under cold arid conditions of Ladakh.

Kumar *et al.* (2008) evaluated the indigenous potato processing cultivars Kufri chipsona-1 and Kufri chipsona-2 under eight nutritional management strategies (related with substitution of inorganic fertilizer with organic manure and supplementation of secondary/micro nutrients like Mg, Zn and Fe) during two seasons in west central plains. They concluded that for chipsona cultivars, the total nutrient requirements can be managed through integrated approach of inorganic fertilizers and organic manure use i.e., 75 percent recommended NPK through inorganic source and 25 percent from FYM (on N basis) without affecting the processing grade and total tuber yield and processing quality.

Baishya *et al.* (2010) reported higher tuber yield and greater net returns in the North eastern hill region of Meghalaya through use of 25% recommended dose of fertilizer + 75% recommended dose of nitrogen through FYM. Among the varieties tried, Kufri Megha recorded significantly higher tuber yield when compared with Kufri Giriraj and Kufri Jyoti.

Chapter 3

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

The field experiment was conducted during the period from November, 2016 to April, 2017 to find out the Effect of split application of N, K and FYM levels on the productivity of seed potato derived from the true potato seed. In this chapter the details of different materials and methodologies used followed during the experimental period have seen presented under the following heads:

3.1 Experimental location

The experiment was conducted at the Agronomy Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the *Rabi* season of November, 2016 to April, 2017.

3.2 Description of the experimental site

The experimental site is geographically situated at 23°41'N latitude and 90°22'E longitude at an altitude of 8.6 meter above sea level. For better understanding about the experimental site has been shown in the Map of AEZ of Bangladesh in Appendix I.

3.3 Climate

The experimental site under the sub-tropical climate that is characterized by cold temperature and minimum rainfall are the main features of the Rabi season. The weather conditions during experimentation such as monthly rainfall (mm), mean temperature (^{0}C), sunshine hours and humidity (%) have seen presented in Appendix II.

3.4 Soil

The soil of the experimental field belongs to the general soil type, Shallow Red Brown Terrace Soils under Brahmaputra Madhupur Tract. The land was above flood level and sufficient sunshine was available during the experimental period. Soil samples from 0-15 cm depth were collected from the experimental field. The soil analyses were done at Soil Resource and Development Institute (SRDI), Dhaka. The physicochemical properties of the soil have been presented in Appendix III.

3.5 Treatments of the experiment

The experiment comprised of three factors:

Factor A: Split application N

1. N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up
2. N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up
3. N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

Factor B: Split application K

1. K_1 = 60 kg K ha^{-1} at planting
2. K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

Factor C: FYM application

1. F_1 = 6 t FYM ha^{-1} at planting
2. F_2 = 10 t FYM ha^{-1} at planting

Here, it can be noted that the first earthing up and second earthing up were done at 40 and 60 DAP, respectively.

3.6 Planting material

The first generation TPS seedling tubers (120g-130) of BARI TPS-1 were collected from the Tuber Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur.

3.7 Preparation of the experimental field

The selected field for growing the TPS seedling tubers was first opened at last week of October with a power tiller and was exposed to the sun for a week. Then the land was prepared to obtain good tilth by several ploughing, cross ploughing and laddering. Subsequent operations were done with harrow, spade and hammer etc. Weeds and stubbles were removed; larger clods were broken into small particles. The land was finally prepared on 05 November 2016 into a desirable tilth to ensure proper germination conditions. The plot was partitioned into the unit plots according to the experimental design. Required manures and fertilizers were used as per treatment. Proper irrigation and drainage channels were also prepared around the plots. Each unit plot was well prepared keeping length of the plot about 15 cm from the drains. The soil was treated with Furadan 5G @ 15 kg ha^{-1} when the plot was finally ploughed to protect the young seedlings from the attack of cutworm. The bed soil was made friable and the surface of the beds was leveled.

3.8 Experimental design and layout

The two factor experiment was laid out in a split split plot design (factorial) with three replications. The size of unit plot was 2 m × 1.5 m. Distances between block to block and plot to plot was 0.70 m. Treatments were randomly distributed within the blocks.

3.9 Manure and fertilizer application

The crop was fertilized as per treatment. N, K and FYM were applied during the experiment. Other fertilizer such as P, Zn, B, gypsum were also applied.

3.10 Seed preparation and sowing

The seedling tubers were taken out of the cold store about three weeks before planting. The tubers were graded according to the size and kept under diffuse light conditions to have healthy and good sprouts. Planting was done on November 10, 2016. The well sprouted seed tubers were planted at a depth of

5-7 cm in furrow made 60 cm apart. Hill to hill distance was maintained for 20 cm in the experiment. After planting, the seed tubers were covered with soil.

3.11 Intercultural operations

The seedlings were always kept under care and observation. After emergence of seedlings, the following intercultural operations were accomplished for their better growth and development:

3.11.1 Irrigation

The crop was irrigated with a watering can as and when needed depending on the moisture status of the soil and requirement of plants.

3.11.2 Weeding

Weeding was necessary to keep the plots free from weeds, ease of aeration and conserve soil moisture. The newly emerged weeds were uprooted carefully after complete emergence of TPS seedlings and afterwards when necessary. Mulching was done by breaking the surface crust as and when needed.

3.11.3 Earthing up

The practice of earthing up were done at 40 and 60 DAP, respectively.

3.11.4 Plant protection measures

Furadan 5G @ 20 kg ha^{-1} was applied during final preparation of the main field to prevent the crops and tubers from the soil insects. Sevin dust was used after sowing the seeds to prevent them from insect attack. Fungicide, Ridomil (0.25%) was sprayed at an interval of 10 days, commencing at 40 DAP as a preventive measure against late blight, Kenalux 0.1% was also sprayed in addition to Ridomil to protect the crop from the attack of virus disseminating aphid.

3.12 General observation

The field was frequently observed to notice any changes in plants, pest and disease attack and necessary action for normal plant growth.

3.13 Harvesting

Harvesting of the crop was done at 100 DAP. The harvested plants were tagged separately plot wise. Ten sample plants were randomly selected from each plot and tagged for recording necessary data and then the whole plot was harvested with the help of spade. The yield of tuber was taken plot wise and converted into ton ha^{-1}. Care was taken to avoid injury of seedling tubers during harvesting.

3.14 Data recording

In order to study the effects of the treatments on yield components and yield of seedling tubers, data in respect of the following parameters were collected during the growth of plants and at harvesting time of the crop. During the plant growth, 10 plants were selected randomly from each unit plot for collection of data. The sampling was done in such a way that the border effects were completely avoided. For this purpose, the outer two lines and the extreme end of the middle rows were excluded.

3.14.1 Days to first and final emergence

Days was counted from planting to firs emergence which was expressed as days to first emergence and days to completion of emergence was expressed as days to final emergence.

3.14.2 Plant length

The length of the sample plants was measured from each plot in centimeter from the ground level to the tip of the longest shoot at 20, 40, 60 and 80 DAP (days after planting).

3.14.3 Number of stem hill^{-1}

The number of stems of the 10 selected plants was counted and the average number of stems hill^{-1} was calculated at 20, 40, 60 and 80 DAP.

3.14.4 Number of tubers hill^{-1}

The number of tubers hill^{-1} was recorded after harvesting of 10 samples plant from each unit plot and the average number of tubers was calculated.

3.14.5 Weight of tubers hill^{-1}

The weight of tubers hill^{-1} was calculated from the average of 10 selected plants from each unit plot at harvest.

3.14.6 Gross yield of tubers plot^{-1} and hectare^{-1}

The yield plot^{-1} was recorded from harvested tubers of all plants including sample plants of a unit plot and expressed as kg and converted into hectare and expressed in ton per hectare.

3.14.7 Seed yield

Seed yield was calculated by adding 45-55 mm and 28-45 mm in diameter size and expressed in percentage.

3.14.8 Non seed yield

Non-seed yield was calculated by adding >55 mm and <28 mm in diameter and expressed in percentage.

3.14.9 Grade of tubers

Tubers harvested from 10 selected sample plants of each plot were graded by number and by weight. The following four grades on the basis of diameter and converted to percentage. >55 mm in diameter 45-55 mm in diameter 28-45 mm in diameter <28 mm in diameter.

3.15 Statistical analysis

The collected data were analyzed statistically following the analysis of variance (ANOVA) technique and the mean differences were adjusted by Duncan's Multiple Range Test (DMRT) using the statistical computer package program, MSTAT-C (Russell, 1986).

Chapter 4

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The results of the study regarding the effect of split application of N, K and FYM levels on growth characters yield and yield related traits of potato derived from the true potato seed have been presented and possible interpretations have been made in this chapter.

4.1 Days to first and final emergence of seedling

4.1.1 Effect of N

Non-significant variation was found on days to first and final emergence of seedling of potato influenced by different split application of N (Fig. 1). But it was observed that the highest days to first emergence of seedling (12.25) was found from N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up) where the highest days to final emergence of seedling (16.58) was found from N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up). Similarly, the lowest days to first and final emergence of seedling of potato (11.42 and 15.84 respectively) was obtained from N_3 (60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP).

4.1.2 Effect of K

Considerable variation was not observed on days to first and final emergence of seedling of potato influenced by different split application of K (Fig. 2). The highest days to first emergence and days to final emergence of seedling (12.34 and 16.50 respectively) was found from K_1 (60 kg K ha^{-1} at planting) where the lowest days to first emergence and days to final emergence of seedling (11.56 and 16.11 respectively) was found from K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up).

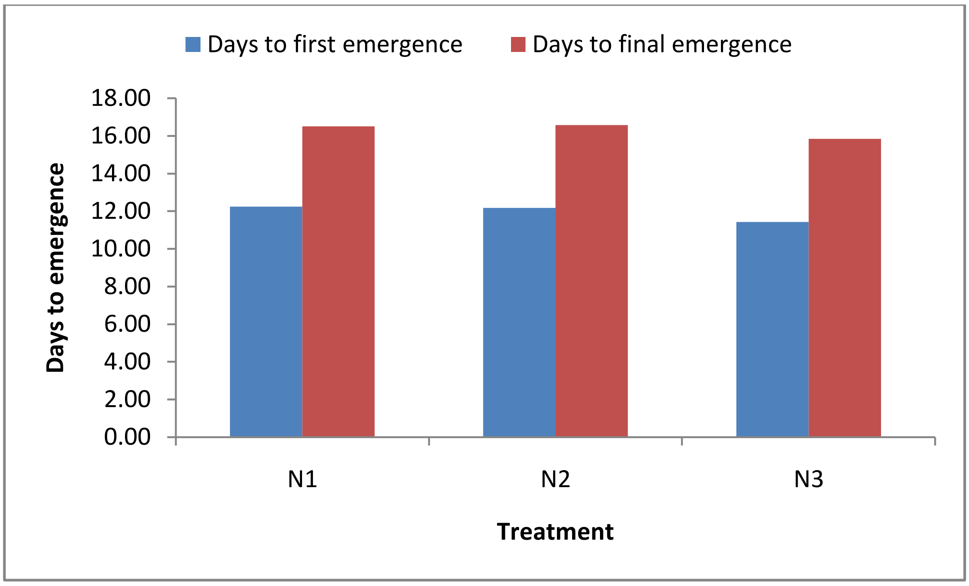

Fig. 1. Effect of N on days to first and final emergence of seedlings. SE (±) = 0.257 and 0.233, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

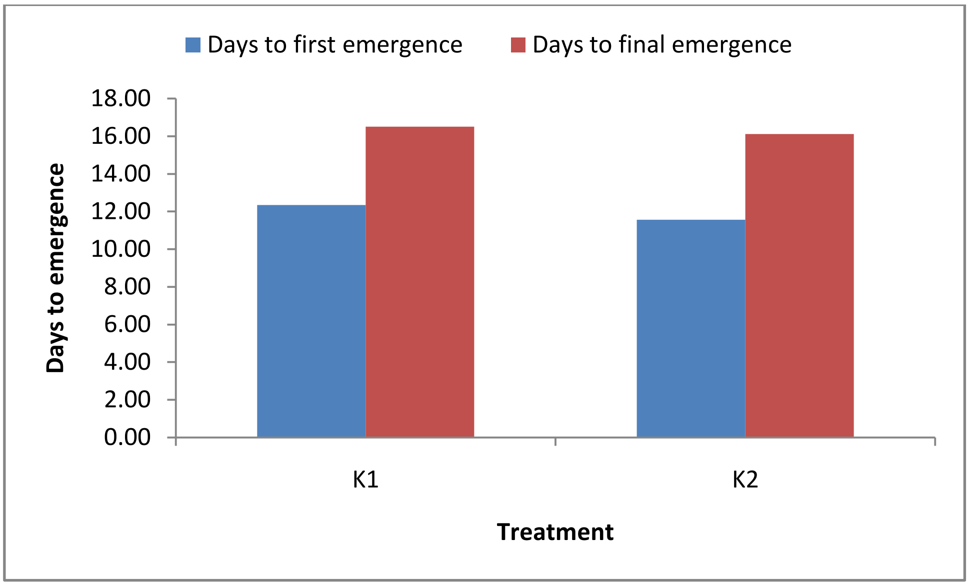

Fig. 2. Effect of K on days to first and final emergence of seedlings. SE (±) = 0.236 and 0.114, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.1.3 Effect of FYM

Considerable variation was not observed on days to first and final emergence of seedling of potato influenced by different rate of FYM application (Fig. 3). Results showed that the highest days to first emergence of seedling (12.11) was found from F_2 (10 t FYM ha^{-1} at planting) whereas the highest days to final emergence of seedling (16.45) was found from F_1 (6 t FYM ha^{-1} at planting). Again, the lowest days to first emergence of seedling (11.78) was found from F_1 (6 t FYM ha^{-1} at planting) while the lowest days to final emergence of seedling (16.17) was found from F_2 (10 t FYM ha^{-1} at planting).

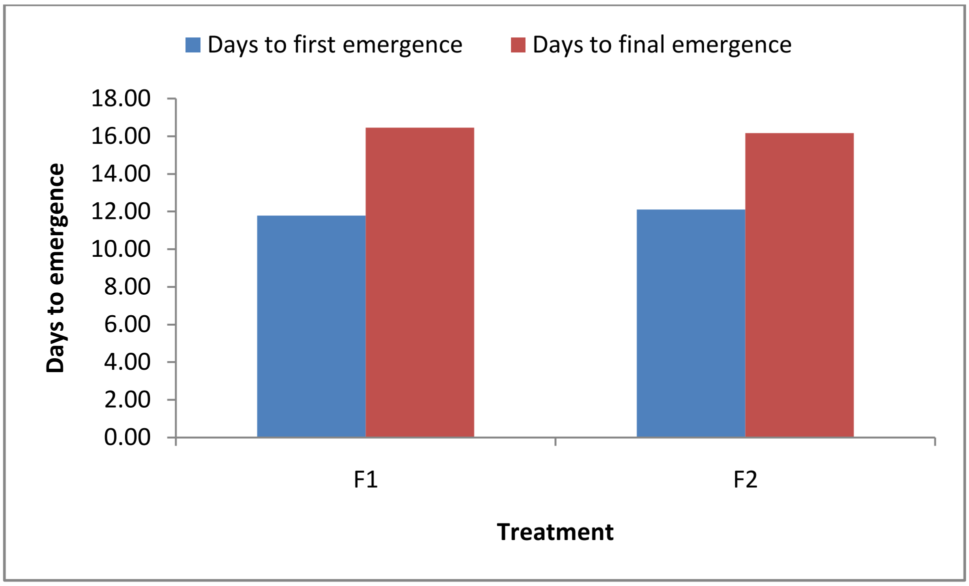

Fig. 3. Effect of FYM on days to first and final emergence of seedlings. SE (±) = 0.388 and 0.341, respectively.

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.1.4 Combined effect of N and K

Significant variation was not found for days to first and final emergence of seedling influenced by combined effect of N and K (Fig. 4). The highest days to first emergence of seedling (12.84) was found from N_3K_1 where the highest days to final emergence of seedling (16.67) was found from N_2K_1. Similarly, the lowest days to first emergence of seedling (10.00) and days to final emergence of seedling (15.34) was achieved from N_3K_2.

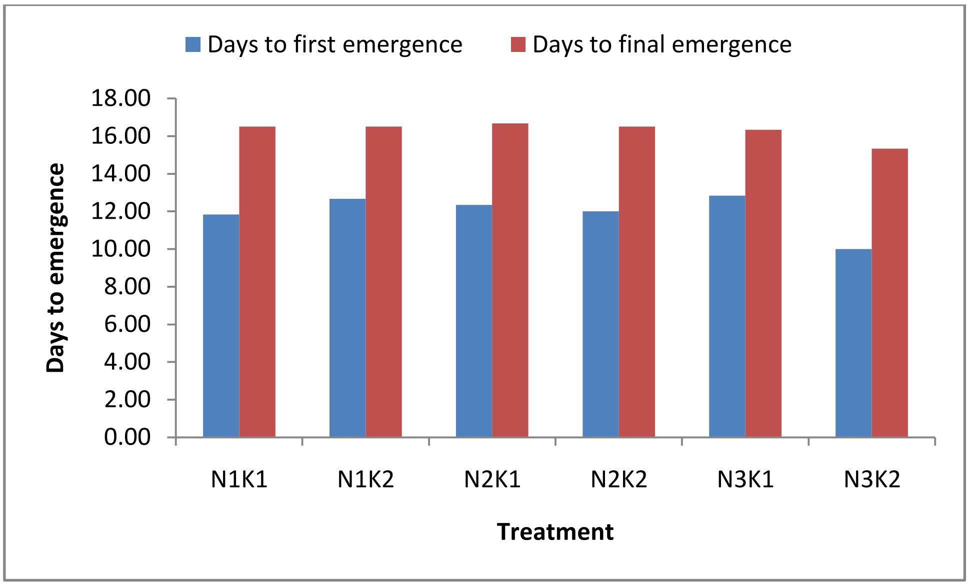

Fig. 4. Effect of N and K on days to first and final emergence of seedlings. SE (±) = 0.236 and 0.114, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 kg K ha^{-1} at first earthing up

4.1.5 Combined effect of N and FYM

There was no significant variation on days to first and final emergence of seedling influenced by combined effect of N and FYM (Fig. 5). The highest days to first emergence of seedling (12.84) and the highest days to final emergence of seedling (17.17) was found from N_2F_2. Similarly, the lowest days to first emergence of seedling (10.84) and lowest days to final emergence of seedling (15.34) was achieved from N_3F_2.

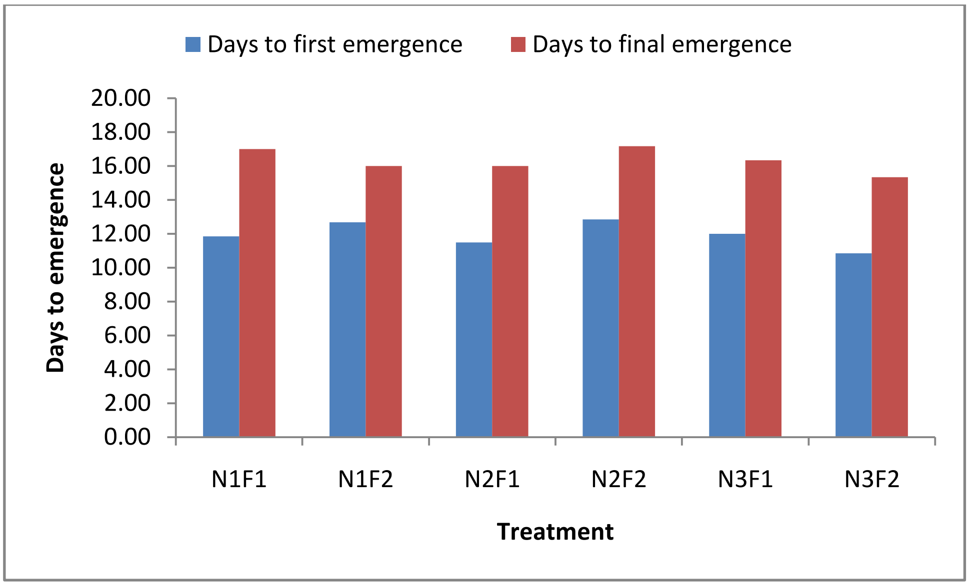

Fig. 5. Effect of N and FYM on days to first and final emergence of seedlings. SE(±) = 0.388 and 0.341, respectively .

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.1.6 Combined effect of K and FYM

Combined effect of K and FYM had no significant difference on days to first and final emergence of seedling of potato (Fig. 6). The highest days to first emergence of seedling (13.00) was found from K_1F_2 where the highest days to final emergence of seedling (16.67) was found from K_1F_1. Similarly, the lowest days to first emergence of seedling (11.22) and lowest days to final emergence of seedling (16.00) was achieved from K_2F_2.

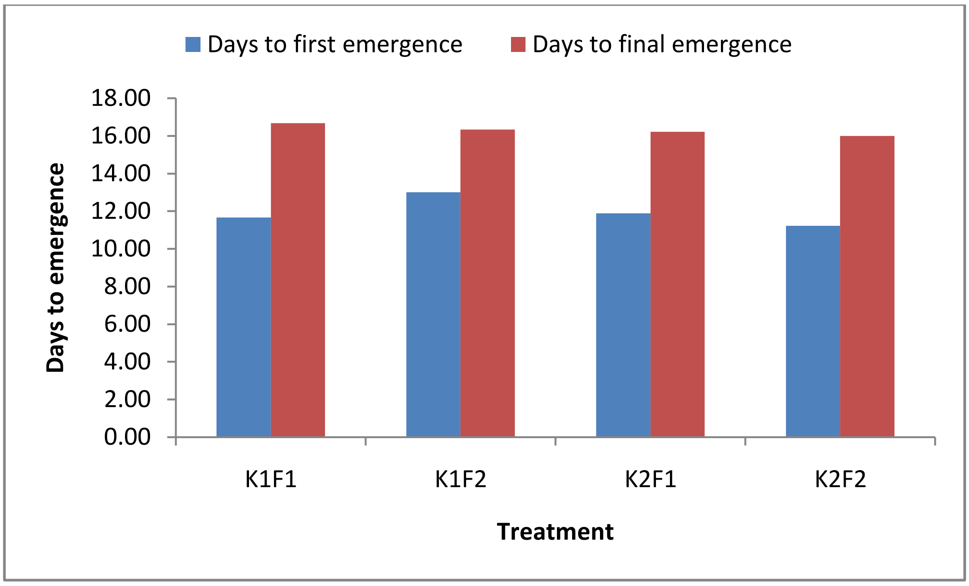

Fig. 6. Effect of K and FYM on days to first and final emergence of seedlings. SE (±) = 0.372 and 0.344, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.1.7 Combined effect of N, K and FYM

Significant variation was found on 80% of emergence of seedling affected by combined effect of N, K and FYM (Table 1). Results signified that the highest days to first emergence of seedling (13.67) was found from $N_2K_1F_2$ which was significantly different from others followed by $N_3K_1F_1$ whereas the lowest days to first emergence of seedling (9.00) was achieved from $N_3K_2F_2$ followed by $N_1K_1F_1$, $N_2K_1F_1$ and $N_3K_2F_1$. In terms of days to final emergence of seedling, the highest (17.33) was obtained from $N_2K_1F_2$ whereas the lowest days to final emergence (15.00) was found from $N_3K_2F_2$.

Table 1. Combined effect of N, K and FYM on days to first and final emergence of seedlings

Treatments	Days to emergence	
	Days to first emergence	Days to final emergence
$N_1K_1F_1$	11.00 e	17.00 b
$N_1K_1F_2$	12.67 c	16.00 c
$N_1K_2F_1$	12.67 c	17.00 b
$N_1K_2F_2$	12.67 c	16.00 c
$N_2K_1F_1$	11.00 e	16.00 c
$N_2K_1F_2$	13.67 a	17.33 a
$N_2K_2F_1$	12.00 d	16.00 c
$N_2K_2F_2$	12.00 d	17.00 b
$N_3K_1F_1$	13.00 b	17.00 b
$N_3K_1F_2$	12.67 c	15.67 d
$N_3K_2F_1$	11.00 e	15.67 d
$N_3K_2F_2$	9.00 f	15.00 e
SE (±)	0.514	0.466
CV (%)	6.517	5.388

Values with common letter (s) within a column do not differ significantly as 5% level of probability

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.2 Plant length

4.2.1 Effect of N

Signification variation was found on plant length of potato at all growth stages except 20 DAP influenced by different split application of N (Fig. 7). Results indicated that the highest plant length (16.67, 42.59, 57.83 and 65.67 cm at 20, 40, 60 and 80 DAP, respectively) was found from N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up) followed by N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up) where the lowest plant length (14.25, 37.92, 51.00 and 60.59 cm at 20, 40, 60 and 80 DAP, respectively) was obtained from N_3 (60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP). Similar results was also observed by Saeidi *et al.* (2009) and Zamil *et al.* (2010) who found that plant length increased with the increasing rate of nitrogen.

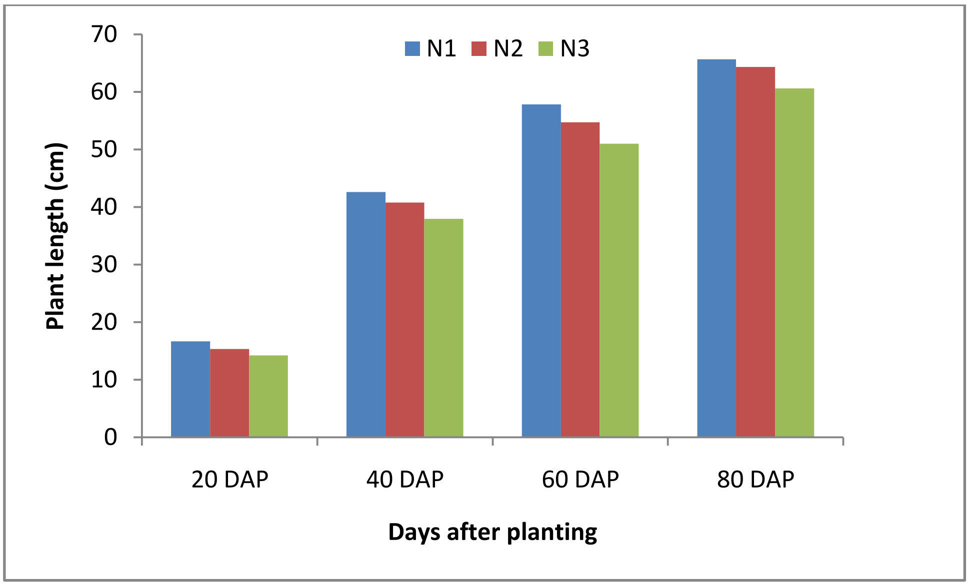

Fig. 7. Effect of N on plant length of potato at all growth stages. SE (±) = 0.686, 0.709, 0.672 and 1.251 at 20, 40, 60 and 80 DAP, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

4.2.2 Effect of K

Considerable variation was not observed on plant length of potato at different growth stages influenced by different split application of K (Fig. 8). The highest plant length (16.56, 41.28, 54.83 and 64.11 cm at 20, 40, 60 and 80 DAP, respectively) was found from K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at earthing up) whereas the lowest plant length (14.28, 39.56, 54.22 and 62.95 at 20, 40, 60 and 80 DAP respectively) was found from K_1 (60 kg K ha^{-1} at planting). Moinuddin *et al.* (2005) also concluded that there is an increase in plant length and biomass in higher levels of potash. Increase in plant length with increasing rate of potassium applied might be due to proper utilization of nitrogen and phosphorus by plant.

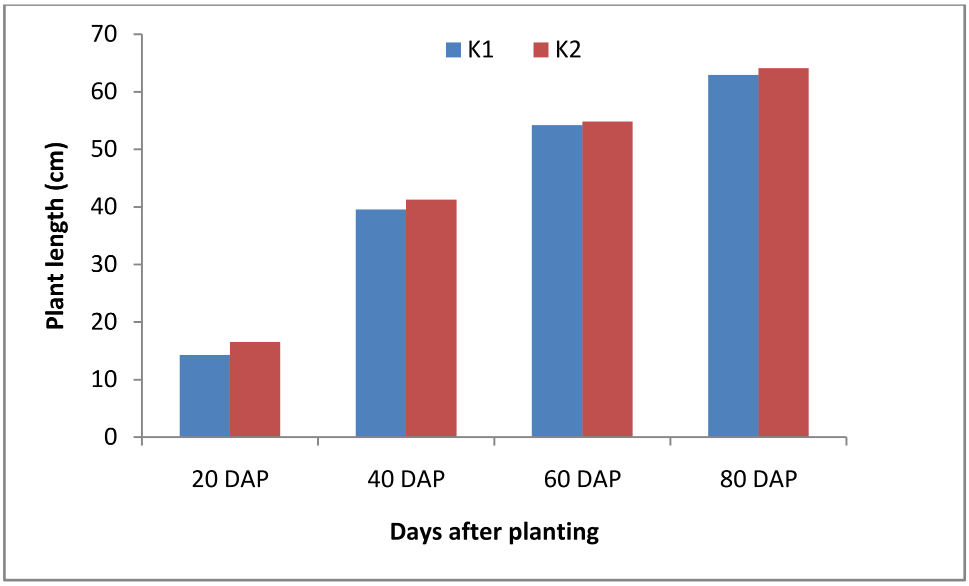

Fig. 8. Effect of K on plant length of potato at all growth stages. SE (±) = 0.284, 0.293, 0.366 and 0.385 at 20, 40, 60 and 80 DAP, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.2.3 Effect of FYM

Considerable variation was not found on plant length of potato at different growth stages influenced by different rate of FYM application (Fig. 9). Results showed that the highest plant length (16.28, 41.34, 56.06 and 65.06 cm at 20, 40, 60 and 80 DAP respectively) was found from F_1 (6 t FYM ha^{-1} at planting) whereas the lowest plant length (14.56, 39.50, 53.00 and 62.00 cm at 20, 40, 60 and 80 DAP, respectively) was found from F_2 (10 t FYM ha^{-1} at planting).

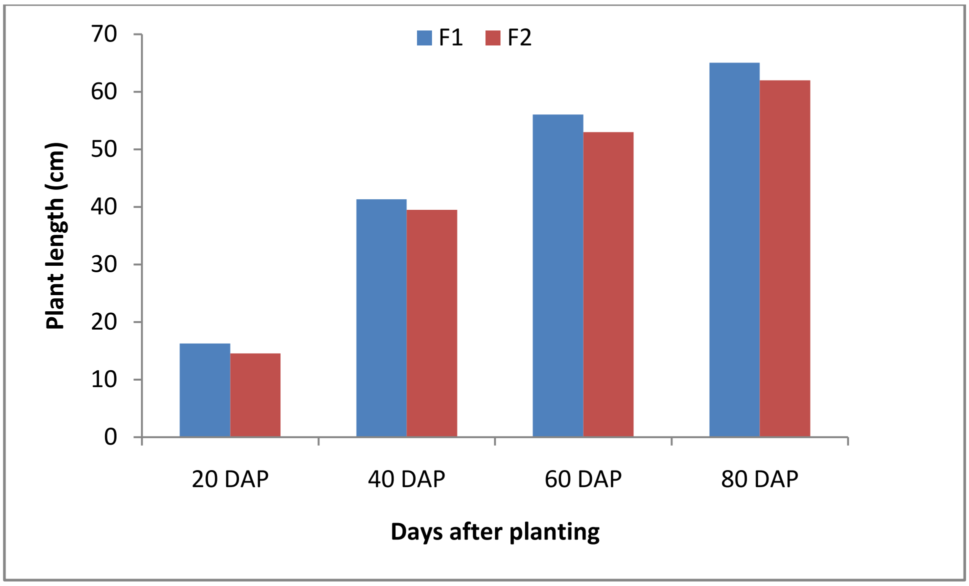

Fig. 9. Effect of FYM on plant length of potato at all growth stages. SE (±) = 0.352, 0.376, 0.417 and 0.506 at 20, 40, 60 and 80 DAP, respectively.

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.2.4 Combined effect of N and K

Significant variation was found for plant length of potato at different growth stages affected by combined effect of N and K (Fig. 10). Results indicated that the highest plant length (17.67, 44.17, 58.00 and 66.33 cm at 20, 40, 60 and 80 DAP, respectively) was found from N_1K_2 which was statistically identical with N_2K_1 at all growth stages. The lowest plant length (11.17, 33.67, 48.00 and 57.67 cm at 20, 40, 60 and 80 DAP, respectively) was found from N_3K_1 which was significantly different from all other combinations. Al-Moshileh *et al.* (2005) also found similar result with the present study.

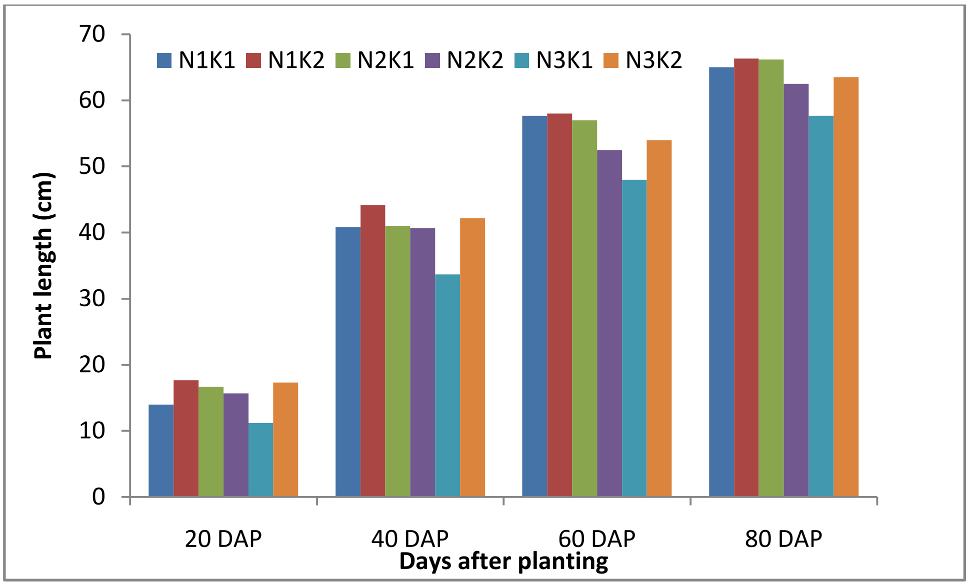

Fig. 10. Effect of N and K on plant length of potato at all growth stages. SE (±) = 0.284, 0.293, 0.366 and 0.385 at 20, 40, 60 and 80 DAP, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.2.5 Combined effect of N and FYM

Significant variation noted on plant length of potato influenced by combined effect of N and FYM (Fig. 11). Results signified that the highest plant length (17.50, 42.67, 58.67 and 66.00 cm at 20, 40, 60 and 80 DAP, respectively) was found from N_1F_2. The plant length from the combination of N_1F_1 at 40, 60 and 80 DAP and from N_1F_2 at 80 DAP was statistically identical with N_1F_2. Similarly, the lowest plant length (11.34, 34.67, 46.67 and 56.34 cm at 20, 40, 60 and 80 DAP, respectively) was found from N_3F_2 which was significantly different from all other treatment combinations at all growth stages.

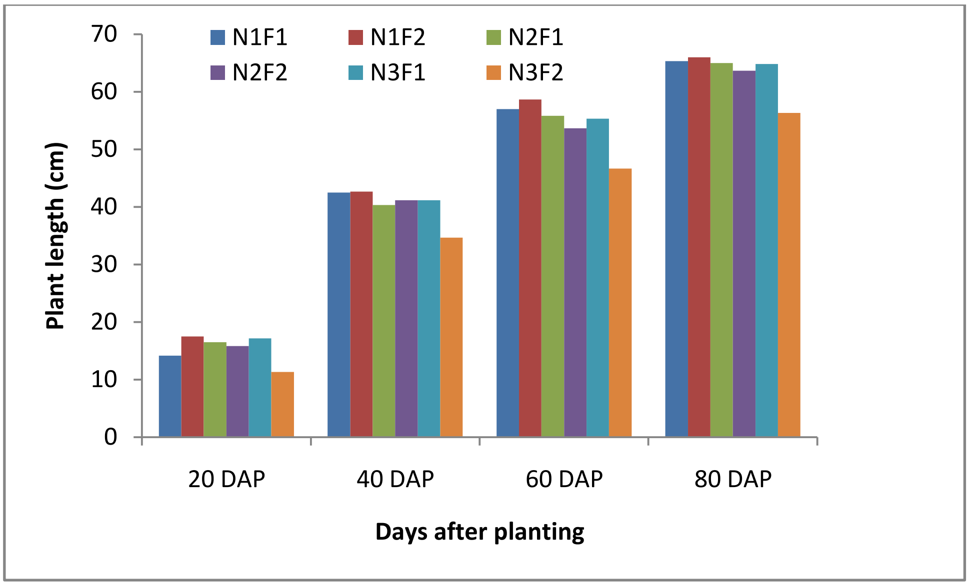

Fig. 11. Effect of N and FYM on plant length of potato at all growth stages. SE (±) = 0.352, 0.376, 0.417 and 0.506 at 20, 40, 60 and 80 DAP, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.2.6 Combined effect of K and FYM

Combined effect of K and FYM had significant difference on plant length of potato (Fig. 12). It was observed that the highest plant length (17.67, 42.89, 56.22 and 65.55 cm at 20, 40, 60 and 80 DAP, respectively) was found from K_2F_1 which was statistically identical with K_1F_1 at 60 and 80 DAP. The highest plant length (13.67, 39.34, 52.56 and 61.34 cm at 20, 40, 60 and 80 DAP, respectively) was found from K_1F_2 which was statistically identical with K_2F_2 at 40, 60 and 80 DAP.

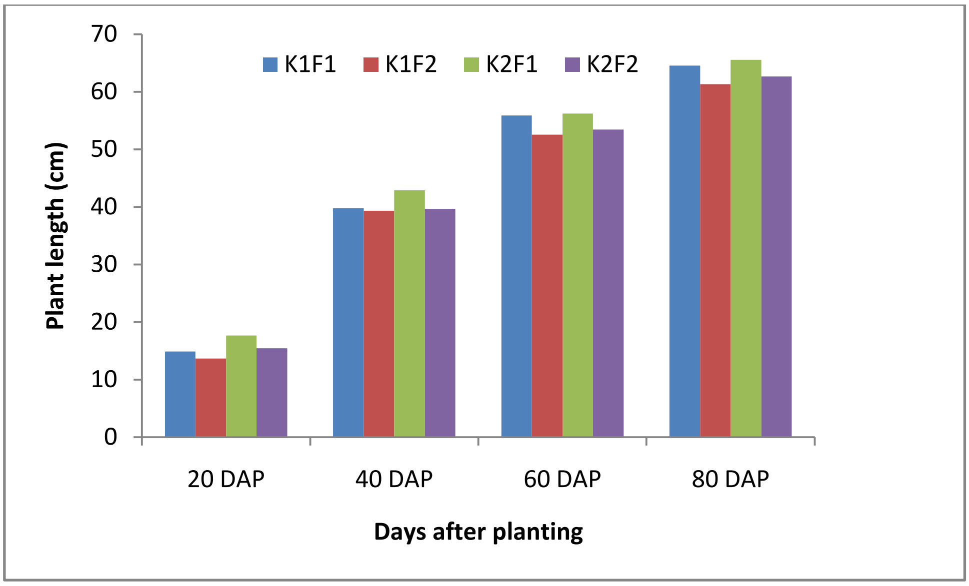

Fig. 12. Effect of K and FYM on plant length of potato at all growth stages. SE (±) = 0.836, 0.757, 0.811 and 0.902 at 20, 40, 60 and 80 DAP, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.2.7 Combined effect of N, K and FYM

Significant variation was found on plant length of potato affected by combined effect of N, K and FYM (Table 2). Results signified that the highest plant length (23.00, 47.67, 60.67 and 70.00 cm at 20, 40, 60 and 80 DAP, respectively) was found from $N_3K_2F_1$ which was statistically identical with $N_1K_2F_2$ and $N_2K_1F_1$ at 60 and 80 DAP. The lowest plant length (11.00, 32.67, 46.00 and 55.67 cm at 20, 40, 60 and 80 DAP, respectively) was achieved from $N_3K_1F_2$ which was statistically identical with $N_3K_2F_2$ and $N_3K_1F_1$ at all crop duration.

Table 2. Combined effect of N, K and FYM on plant length of potato at all growth stages

Treatments	Plant length (cm) at			
	20 DAP	40 DAP	60 DAP	80 DAP
$N_1K_1F_1$	12.00 f	42.67 c	57.33 bc	65.33 b
$N_1K_1F_2$	16.00 d	45.67 b	58.00 b	64.67 bc
$N_1K_2F_1$	16.33 cd	42.33 c	56.67 cd	65.33 b
$N_1K_2F_2$	17.00 c	39.67 d	59.33 a	67.33 a
$N_2K_1F_1$	21.33 b	42.00 cd	60.33 a	68.67 a
$N_2K_1F_2$	14.00 e	39.67 d	53.67 e	63.67 c
$N_2K_2F_1$	13.67 ef	38.67 ef	51.33 f	61.33 de
$N_2K_2F_2$	17.67 c	42.67 c	53.67 e	63.67 c
$N_3K_1F_1$	11.33 g	34.67 h	50.00 fg	59.67 e
$N_3K_1F_2$	11.00 g	32.67 i	46.00 h	55.67 h
$N_3K_2F_1$	23.00 a	47.67 a	60.67 a	70.00 a
$N_3K_2F_2$	11.67 g	36.67 g	47.33h	57.00 h
SE (±)	1.372	1.418	1.344	2.502
CV (%)	8.736	10.316	9.517	11.366

Values with common letter (s) within a column do not differ significantly as 5% level of probability

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.3 Number of stem hill^{-1}

4.3.1 Effect of N

Non-significant variation was found on number of stem hill^{-1} at different growth stages of potato influenced by different split application of N (Fig. 13). But it was observed that the highest number of stem hill^{-1} (1.25, 2.50, 2.92 and 2.92 at 20, 40, 60 and 80 DAP, respectively) was found from N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up) whereas the lowest number of stem hill^{-1} (1.08, 1.75, 2.33 and 2.33 at 20, 40, 60 and 80 DAP, respectively) was obtained from N_3 (60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP). The results obtained from the present study were similar with the findings of Zamil *et al.* (2010) and Etemad and Sarajuoghi (2012).

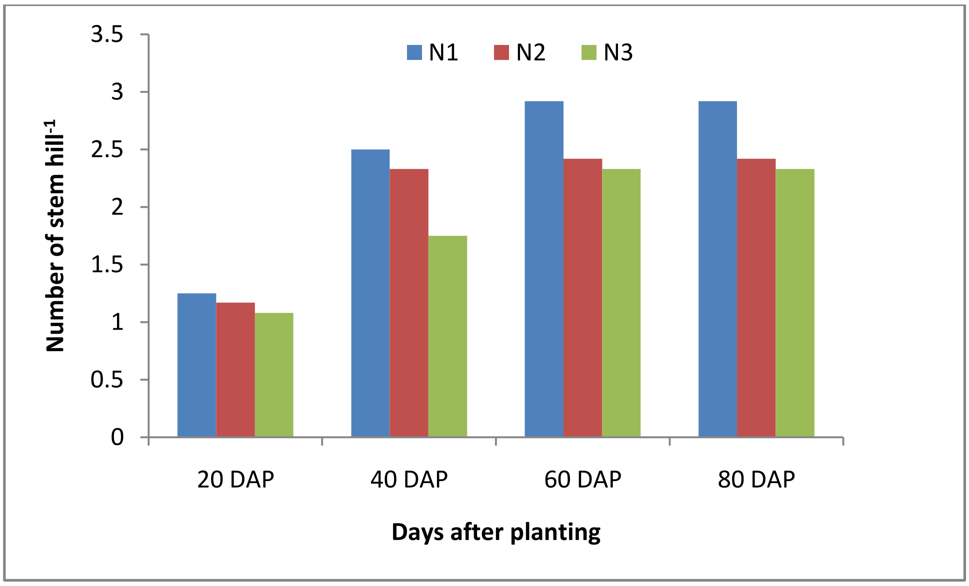

Fig. 13. Effect of N on number of stem hill^{-1} at different growth stages. SE (±) = 0.0585, 0.082, 0.083 and 0.083 at 20, 40, 60 and 80 DAP, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

4.3.2 Effect of K

Considerable variation was not observed on number of stem hill^{-1} at different growth stages of potato influenced by different split application of K (Fig. 14). The highest number of stem hill^{-1} (1.17, 2.22, 2.61 and 2.61 at 20, 40, 60 and 80 DAP, respectively) was found from K_1 (60 kg K ha^{-1} at planting) whereas the lowest number of stem hill^{-1} (1.16, 2.17, 2.50 and 2.50) was found from K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up).

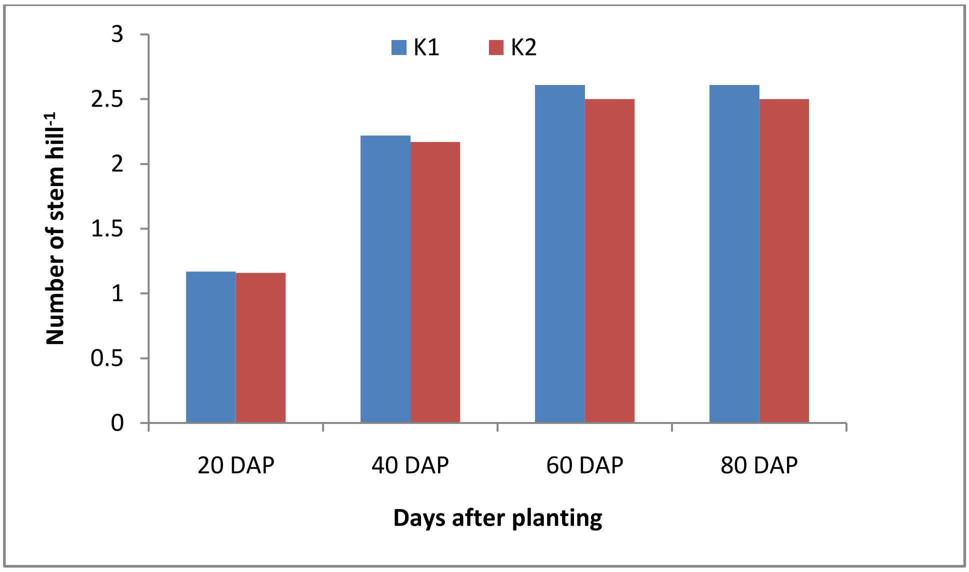

Fig. 14. Effect of K on number of stem hill^{-1} at different growth stages. SE (±) = 0.036, 0.042, 0.044 and 0.044 at 20, 40, 60 and 80 DAP, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.3.3 Effect of FYM

Considerable variation was not found on number of stem hill^{-1} at different growth stages of potato influenced by different rate of FYM application (Fig. 15). Results showed that the highest number of stem hill^{-1} (1.22, 2.22, 2.61 and 2.61 at 20, 40, 60 and 80 DAP, respectively) was found from F_1 (6 t FYM ha^{-1} at planting) whereas the lowest number of stem hill^{-1} (1.11, 2.17, 2.50 and 2.50) was found from F_2 (10 t FYM ha^{-1} at planting).

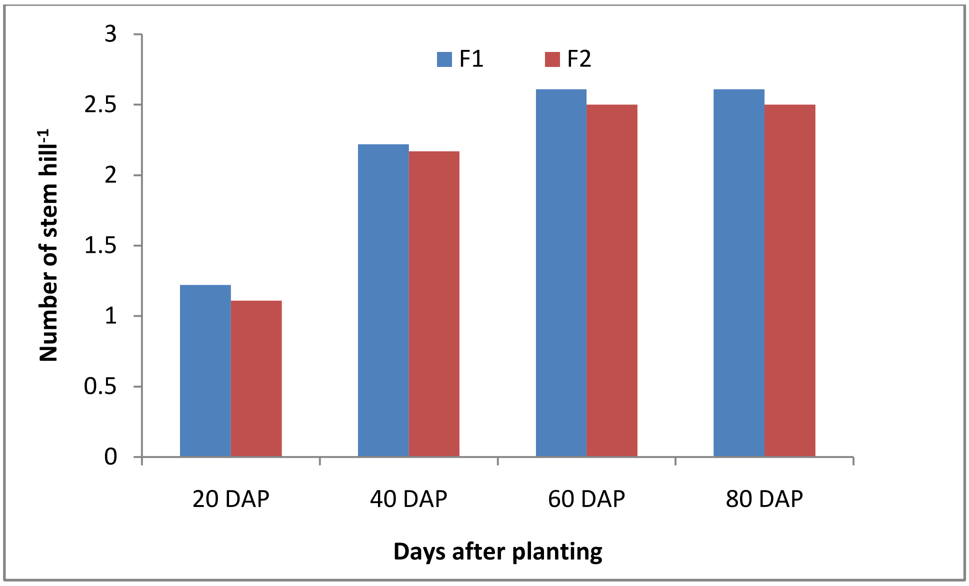

Fig. 15. Effect of FYM on number of stem hill^{-1} at different growth stages. SE (±) = 0.052, 0.058, 0.061and 0.061 at 20, 40, 60 and 80 DAP, respectively.

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.3.4 Combined effect of N and K

Significant variation was recorded on number of stem hill^{-1} at all growth stages of potato influenced by combined effect of N and K (Fig. 16). Results revealed that the highest number of stem hill^{-1} (1.33, 2.67, 3.00 and 3.00 at 20, 40, 60 and 80 DAP, respectively) was found from N_1K_1 which was statistically similar with N_1K_2 at 40, 60 and 80 DAP whereas the lowest number of stem hill^{-1} (1.00, 1.67, 3.17 and 2.17 at 20, 40, 60 and 80 DAP, respectively) was achieved from N_3K_2.

4.3.5 Combined effect of N and FYM

There was also significant variation on number of stem hill^{-1} at different growth stages of potato influenced by combined effect of N and FYM (Fig. 17). The highest number of stem hill^{-1} (1.33, 2.67, 3.00 and 3.00 at 20, 40, 60 and 80 DAP, respectively) was found from N_1F_1 whereas the lowest number of stem hill^{-1} (1.00, 1.67, 3.17 and 2.17 at 20, 40, 60 and 80 DAP, respectively) was achieved from N_3F_2.

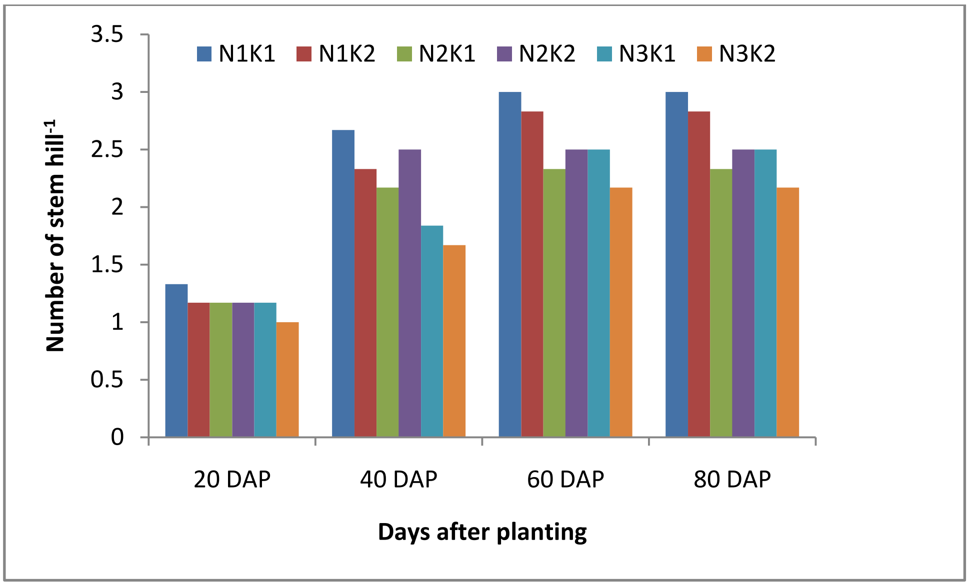

Fig. 16. Effect of N and K on number of stem hill^{-1} at different growth stages. SE (±) = 0.036, 0.042, 0.044 and 0.044 at 20, 40, 60 and 80 DAP, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

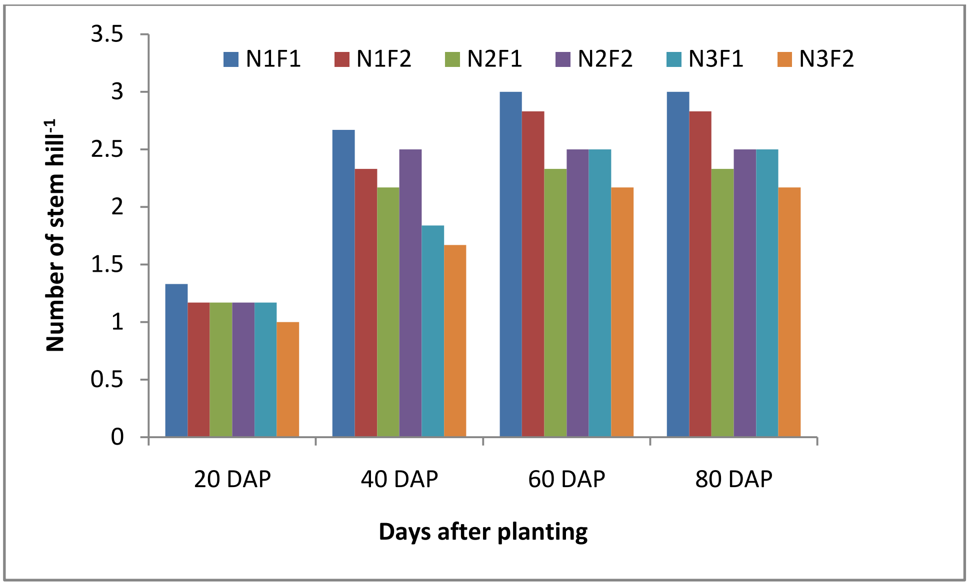

Fig. 17. Effect of N and FYM on number of stem hill^{-1} at different growth stages. SE (±) = 0.052, 0.058, 0.061and 0.061 at 20, 40, 60 and 80 DAP, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.3.6 Combined effect of K and FYM

Combined effect of K and FYM had significant effect on number of stem hill^{-1} of potato (Fig. 18). The highest number of stem hill^{-1} (1.22, 2.22, 2.89 and 2.89 at 20, 40, 60 and 80 DAP, respectively) was found from K_1F_1 whereas the lowest number of stem hill^{-1} (1.11, 2.11, 2.33, 2.33 at 20, 40, 60 and 80 DAP, respectively) was found from K_2F_1 which was statistically identical with K_1F_2.

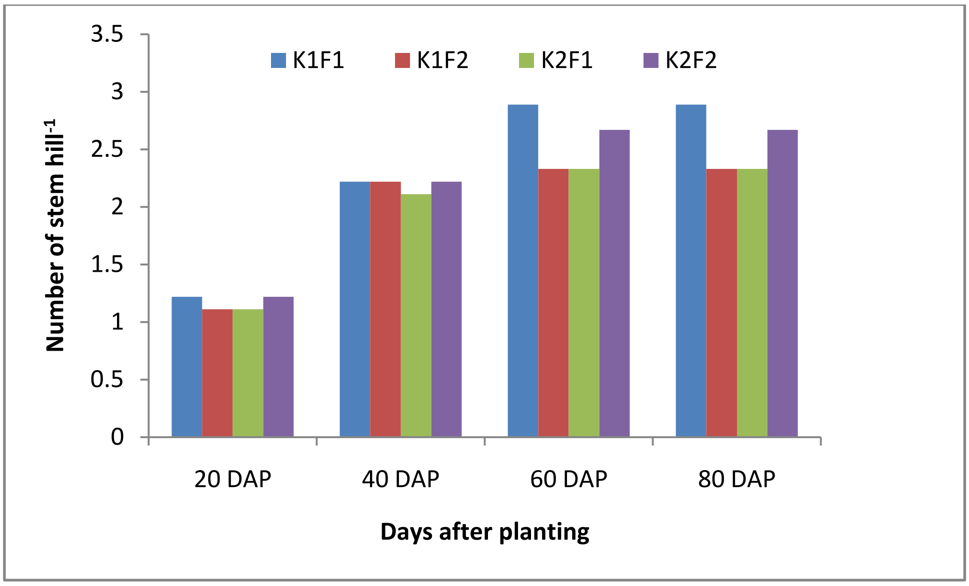

Fig. 18. Effect of K and FYM on number of stem hill^{-1} at different growth stages. SE (±) = 0.073, 0.076, 0.080 and 0.080 at 20, 40, 60 and 80 DAP, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.3.7 Combined effect of N, K and FYM

Significant variation was found on number of stem hill^{-1} at different growth stages affected by combined effect of N, K and FYM (Table 3). Results signified that the highest number of stem hill^{-1} (1.33, 3.00, 3.67 and 3.67 at 20, 40, 60 and 80 DAP, respectively) was found from $N_1K_1F_1$ which was significantly different from all others combinations whereas the lowest number of stem hill^{-1} (1.00, 1.33, 2.00 and 2.00 at 20, 40, 60 and 80 DAP, respectively) was achieved from $N_3K_2F_2$.

Table 3. Combined effect of N, K and FYM on number of stem hill^{-1} at different growth stages

Treatments	Number of stem hill^{-1}			
	20 DAP	40 DAP	60 DAP	80 DAP
$N_1K_1F_1$	1.33 a	3.00 a	3.67 a	3.67 a
$N_1K_1F_2$	1.00 b	2.33 c	2.33 d	2.33 d
$N_1K_2F_1$	1.00 b	2.33 c	2.33 d	2.33 d
$N_1K_2F_2$	1.33 a	2.33 c	3.33 b	3.33 b
$N_2K_1F_1$	1.00 b	2.00 d	2.33 d	2.33 d
$N_2K_1F_2$	1.33 a	2.33 c	2.33 d	2.33 d
$N_2K_2F_1$	1.33 a	2.33 c	2.33 d	2.33 d
$N_2K_2F_2$	1.33 a	2.67 b	2.67 c	2.67 c
$N_3K_1F_1$	1.00 b	1.67 b	2.67 c	2.67 c
$N_3K_1F_2$	1.33 a	2.00 d	2.33 d	2.33 d
$N_3K_2F_1$	1.00 b	2.00 d	2.33 d	2.33 d
$N_3K_2F_2$	1.00 b	1.33 e	2.00 e	2.00 e
SE (±)	0.117	0.184	0.166	0.166
CV (%)	3.214	4.266	4.317	5.211

Values with common letter (s) within a column do not differ significantly as 5% level of probability

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.4 Number of tuber hill^{-1}

4.4.1 Effect of N

Signification variation was found on number of tuber hill^{-1} of potato influenced by different split application of N (Fig. 19). Results indicated that the highest number of tuber hill^{-1} (6.69) was found from N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up) which was statistically identical with N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up) while the lowest number of tuber hill^{-1} (5.47) was obtained from N_3 (60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP). Similar result was also observed by Georgakis *et al.* (1997) and Kumar *et al.* (2002).

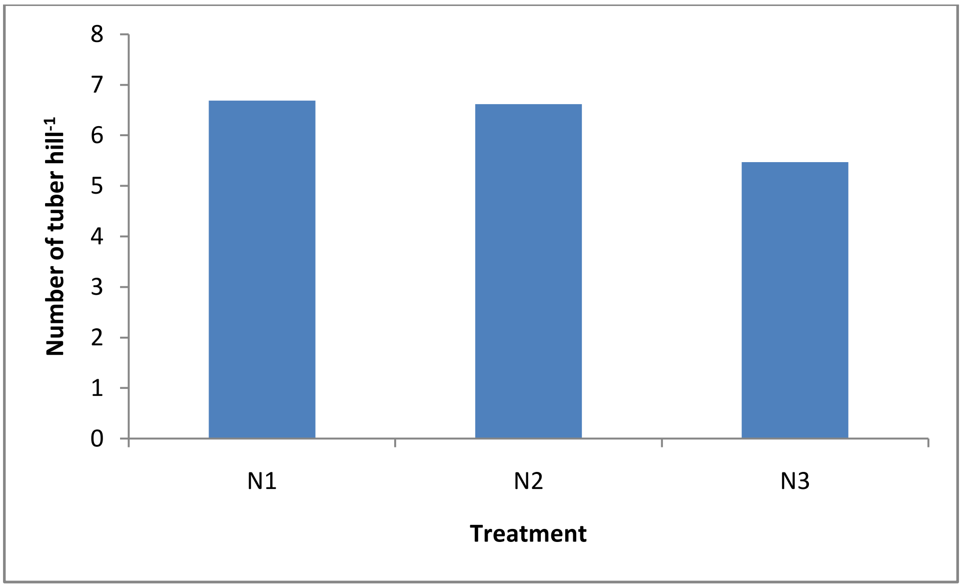

Fig. 19. Effect of N on number of tuber hill^{-1} of potato. SE (±) = 0.761.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

4.4.2 Effect of K

Considerable variation was observed on number of tuber hill^{-1} of potato influenced by different split application of K (Fig. 20). The highest number of tuber hill^{-1} (6.49) was found from K_1 (60 kg K ha^{-1} at planting) whereas the lowest number of tuber hill^{-1} (6.03) was found from K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up).

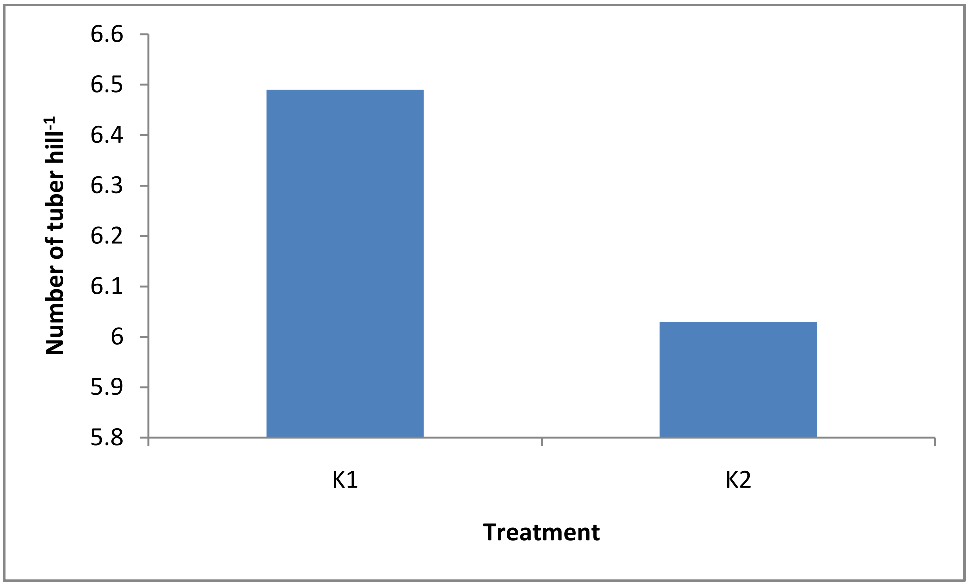

Fig. 20. Effect of K on number of tuber hill^{-1} of potato. SE (±) =0.436.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.4.3 Effect of FYM

Considerable variation was not found on number of tuber hill^{-1} of potato influenced by different rate of FYM application (Fig. 21). Results showed that the highest number of tuber hill^{-1} (6.30) was found from F_2 (10 t FYM ha^{-1} at planting) where the lowest number of tuber hill^{-1} (6.23) was found from F_1 (6 t FYM ha^{-1} at planting).

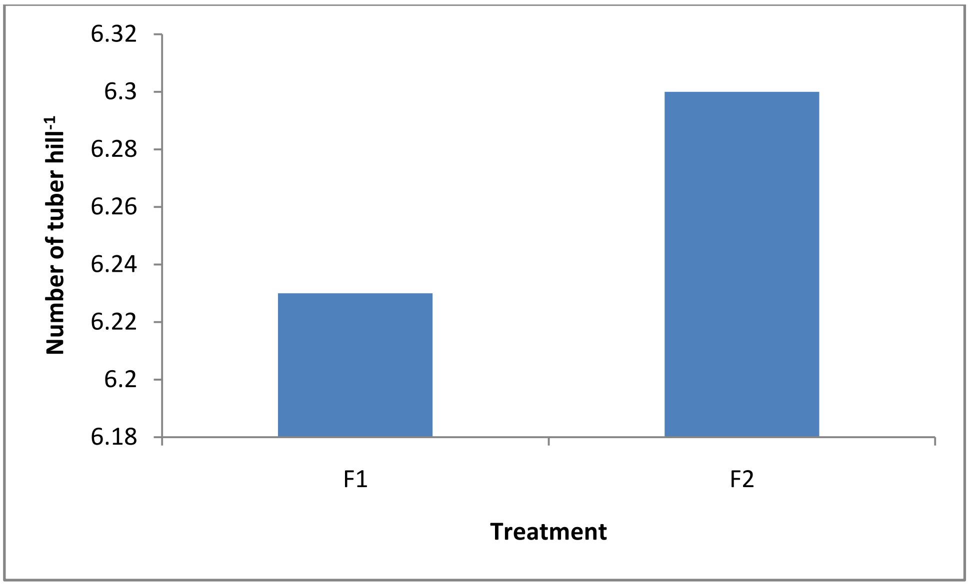

Fig. 21. Effect of FYM on number of tuber hill^{-1} of potato. SE (±) =0.536.

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.4.4 Combined effect of N and K

Significant variation was found for number of tuber hill^{-1} of potato affected by combined effect of N and K (Fig. 22). Results indicated that the highest number of tuber hill^{-1} (6.94) was found from N_2K_1 which was statistically identical with N_1K_2 followed by N_1K_1 and N_2K_2. The lowest number of tuber hill^{-1} (4.82) was found from N_3K_2 which was significantly different from all other combinations.

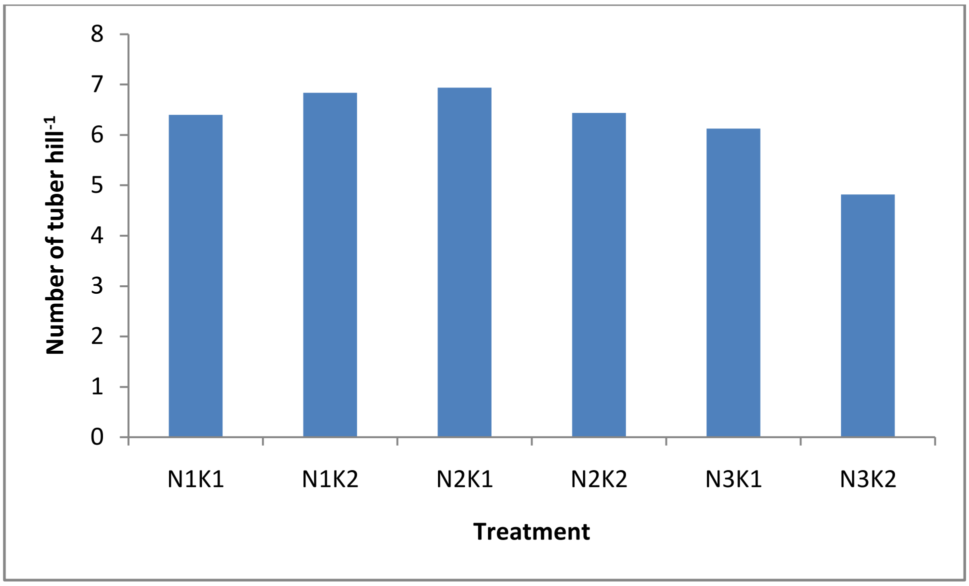

Fig. 22. Effect of N and K on number of tuber hill^{-1} of potato. SE (±) =0.436.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.4.5 Combined effect of N and FYM

Significant variation was noted on number of tuber hill^{-1} of potato influenced by combined effect of N and FYM (Fig. 23). Results signified that the highest number of tuber hill^{-1} (6.82) was found from N_2F_2 which was statistically identical with N_1F_1 and closely followed by N_1F_2 and N_2F_1. Contrarily, the lowest number of tuber hill^{-1} (5.38) was found from N_3F_1 which was statistically identical with N_3F_2.

4.4.6 Combined effect of K and FYM

Combined effect of K and FYM had significant on number of tuber hill^{-1} of potato (Fig. 24). It was observed that the highest number of tuber hill^{-1} (6.50) was found from K_1F_1 which was statistically identical with K_1F_2 whereas the lowest number of tuber hill^{-1} (5.95) was found from K_2F_1 which was statistically identical with K_2F_2.

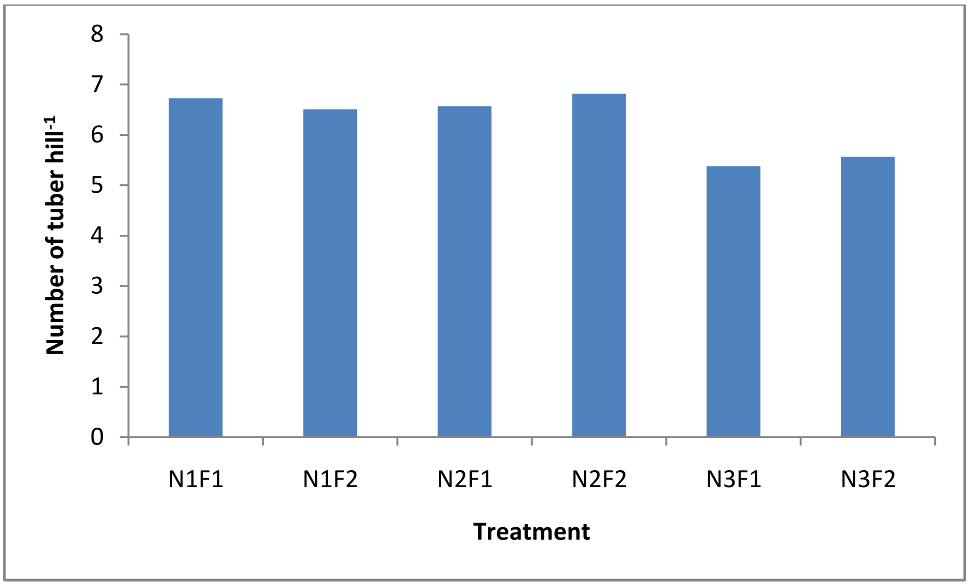

Fig. 23. Effect of N and FYM on number of tuber hill^{-1} of potato. SE (±) =0.536.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

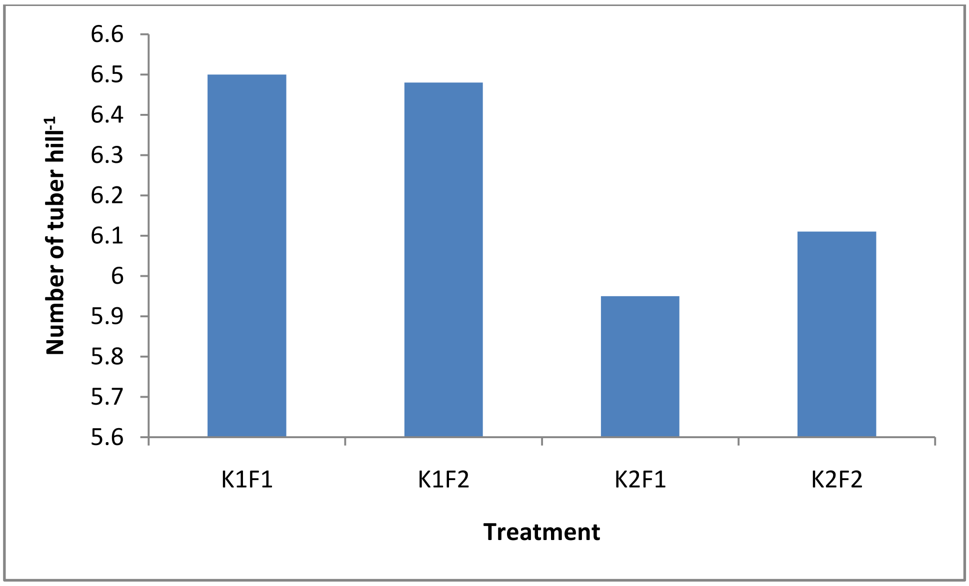

Fig. 24. Effect of K and FYM on number of tuber hill^{-1} of potato. SE (±) =1.036.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.4.7 Combined effect of N, K and FYM

Significant variation was found on number of tuber hill^{-1} of potato affected by combined effect of N, K and FYM (Table 4). Results signified that the highest number of tuber hill^{-1} (7.38) was found from $N_1K_2F_2$ which was statistically identical with $N_1K_1F_1$ and $N_2K_1F_2$. The lowest number of tuber hill^{-1} (4.50) was achieved from $N_3K_2F_2$ which was statistically similar with $N_3K_2F_1$.

4.5 Weight of tuber hill^{-1}

4.5.1 Effect of N

Significant influence was found on weight of tuber hill^{-1} of potato influenced by different split application of N (Fig. 25). The highest weight of tuber hill^{-1} (0.25 kg) was found from N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up) where the lowest weight of tuber hill^{-1} (0.21 kg) was obtained from N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up). Peshin (1999), Kumar *et al.* (2002) and Kanbi and Bhatnagar (2005) also found similar results with the present study.

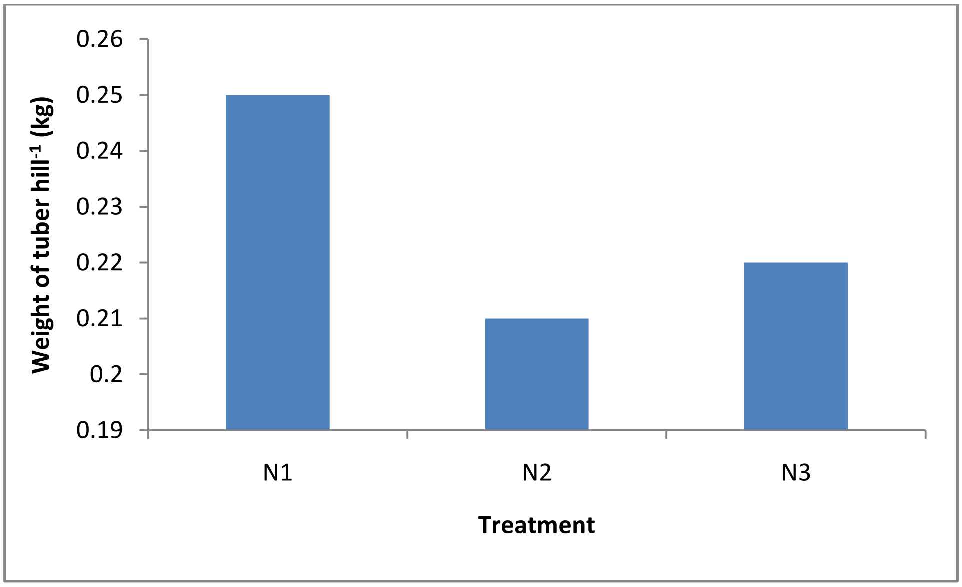

Fig. 25. Effect of N on weight of tuber hill^{-1} of potato. SE (±) = 0.317.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

4.5.2 Effect of K

Considerable variation was not observed on weight of tuber $hill^{-1}$ of potato influenced by different split application of K (Fig. 26). The highest weight of tuber $hill^{-1}$ (0.23 kg) was found from K_1 (60 kg K ha^{-1} at planting) where the lowest weight of tuber $hill^{-1}$ (0.22 kg) was found from K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up).

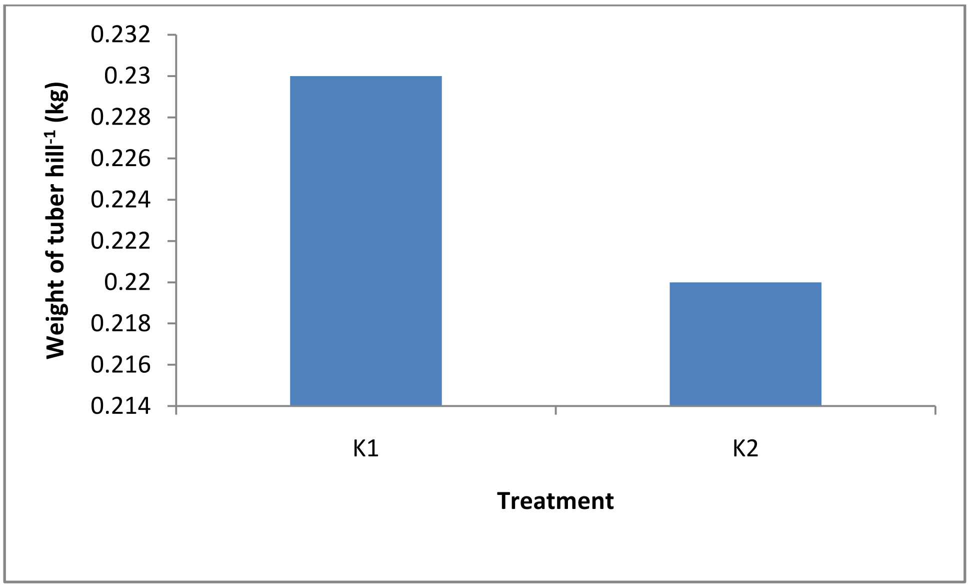

Fig. 26. Effect of K on weight of tuber $hill^{-1}$ of potato. SE (±) =0.352.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.5.3 Effect of FYM

Considerable variation was not found on weight of tuber $hill^{-1}$ of potato influenced by different rate of FYM application (Fig. 27). Results showed that the highest weight of tuber $hill^{-1}$ (0.23 kg) was found from F_2 (10 t FYM ha^{-1} at planting) where the lowest weight of tuber $hill^{-1}$ (0.22 kg) was found from F_1 (6 t FYM ha^{-1} at planting).

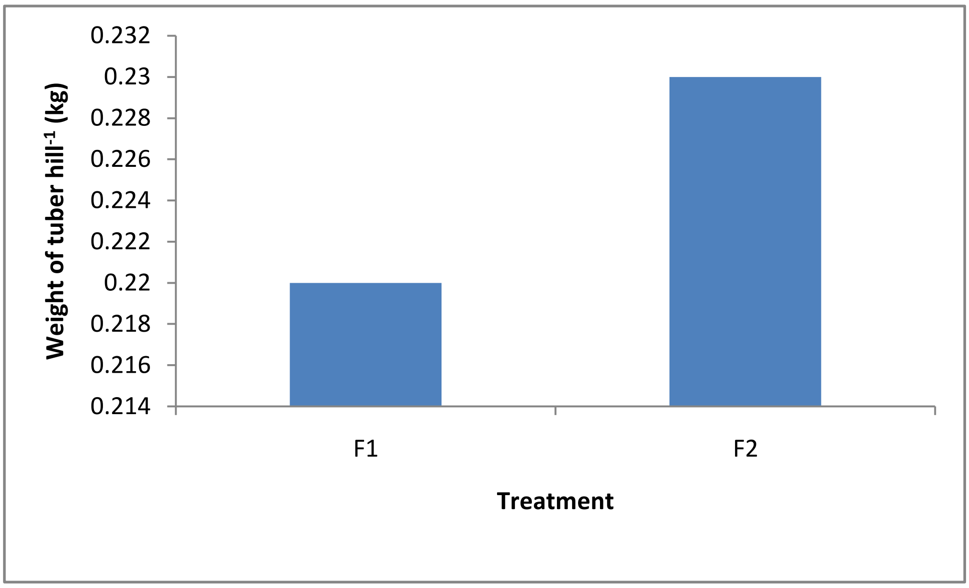

Fig. 27. Effect of FYM on weight of tuber hill^{-1} of potato. SE (±) =0.372.

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.5.4 Combined effect of N and K

Significant variation was found for weight of tuber hill^{-1} of potato affected by combined effect of N and K (Fig. 28). Results indicated that the highest weight of tuber hill^{-1} (0.26 kg) was found from N_1K_1 which was statistically identical with N_1K_2, N_3K_1 and N_2K_2. The lowest weight of tuber hill^{-1} (0.19 kg) was found from N_2K_1 which was statistically identical with N_3K_2.

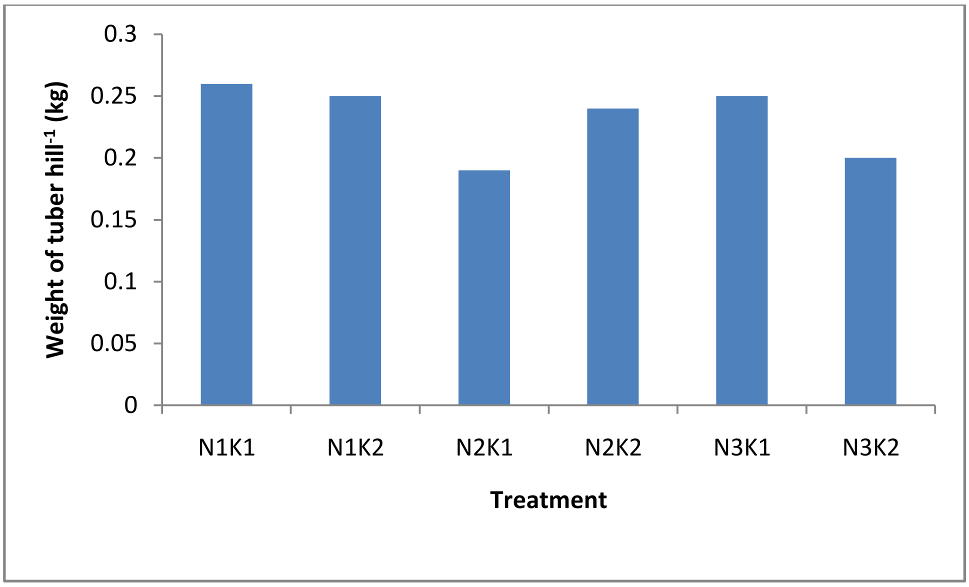

Fig. 28. Effect of N and K on weight of tuber hill^{-1} of potato. SE (±) =0.352.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.5.5 Combined effect of N and FYM

Significant variation was noted on weight of tuber hill^{-1} of potato influenced by combined effect of N and FYM (Fig. 29). Results signified that the highest weight of tuber hill^{-1} (0.27 kg) was found from N_1F_2 followed by N_3F_1 and N_1F_1. Similarly, the lowest weight of tuber hill^{-1} (0.20 kg) was found from N_3F_2 which was statistically identical with N_2F_1.

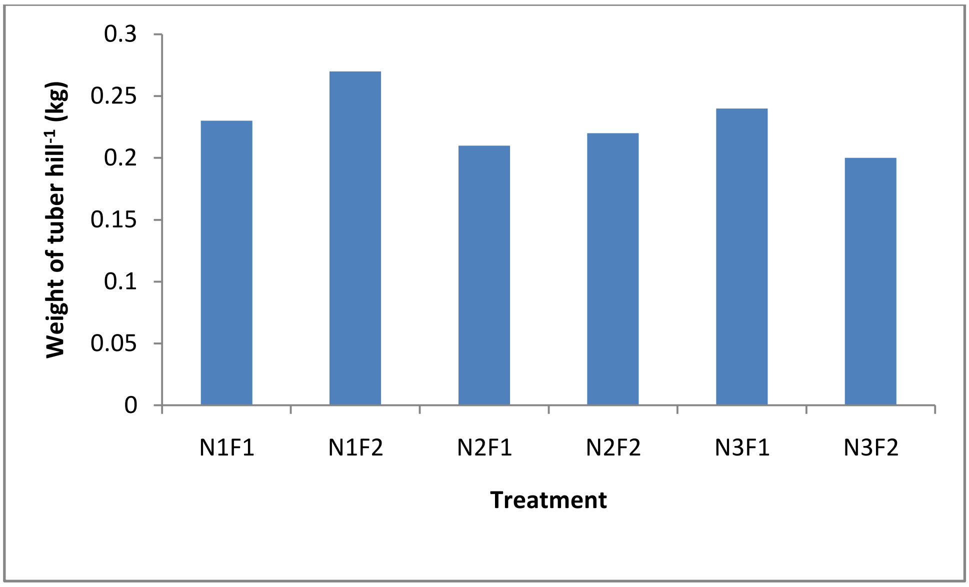

Fig. 29. Effect of N and FYM on weight of tuber hill^{-1} of potato. SE (±) =0.372.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.5.6 Combined effect of K and FYM

Combined effect of K and FYM had non-significant effect on weight of tuber hill^{-1} of potato (Fig. 30). It was observed that the highest weight of tuber hill^{-1} (0.24 kg) was found from K_1F_1 whereas the lowest weight of tuber hill^{-1} (0.22 kg) was found from K_2F_1.

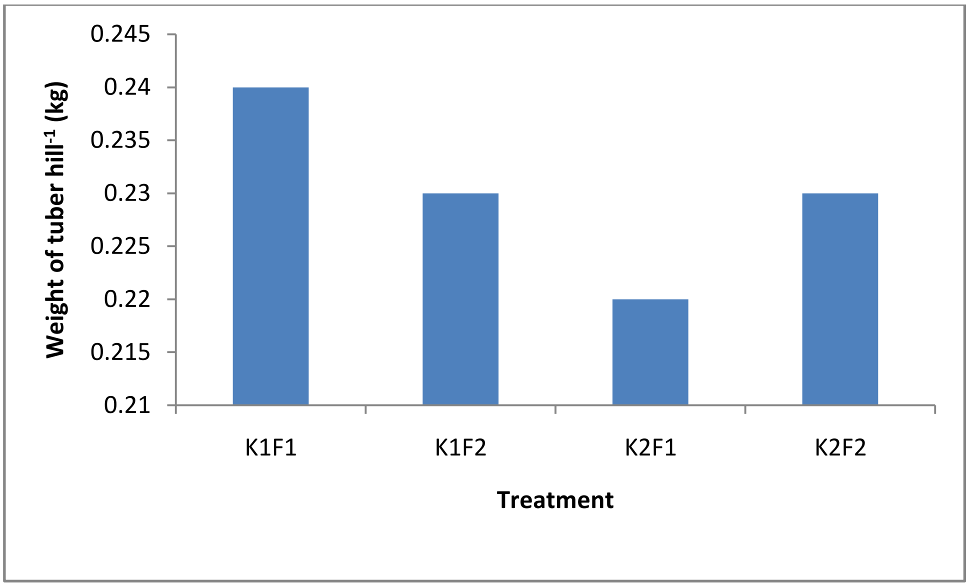

Fig. 30. Effect of K and FYM on weight of tuber hill^{-1} of potato. SE (±) =0.763.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.5.7 Combined effect of N, K and FYM

Significant variation was found on weight of tuber hill^{-1} of potato affected by combined effect of N, K and FYM (Table 4). Results signified that the highest weight of tuber hill^{-1} (0.284 kg) was found from $N_1K_2F_2$ which was statistically identical with $N_1K_1F_1$ and $N_3K_1F_1$. The lowest weight of tuber hill^{-1} (0.173 kg) was achieved from $N_3K_2F_2$ which was statistically similar with $N_2K_1F_1$ and $N_2K_1F_2$.

Table 4. Combined effect of N, K and FYM on number and weight of tuber hill^{-1} of potato

Treatments	Tuber number and weight hill^{-1} (kg)	
	Number of tuber hill^{-1}	Weight of tuber hill^{-1} (kg)
$N_1K_1F_1$	7.17 a	0.260 a
$N_1K_1F_2$	5.63 d	0.250 ab
$N_1K_2F_1$	6.29 c	0.207 cd
$N_1K_2F_2$	7.38 a	0.284 a
$N_2K_1F_1$	6.71 b	0.186 ef
$N_2K_1F_2$	7.17 a	0.189 ef
$N_2K_2F_1$	6.42 bc	0.228 c
$N_2K_2F_2$	6.46 bc	0.242 bc
$N_3K_1F_1$	5.63 d	0.259 a
$N_3K_1F_2$	6.63 b	0.236 bc
$N_3K_2F_1$	5.13 ef	0.217 c
$N_3K_2F_2$	4.50 f	0.173 f
SE (±)	1.522	0.634
CV (%)	5.289	3.266

Values with common letter (s) within a column do not differ significantly as 5% level of probability

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.6 Tuber yield plot^{-1} and tuber yield ha^{-1}

4.6.1 Effect of N

Remarkable influence was observed on tuber yield of potato influenced by different split application of N (Fig. 31). It was noted that the highest tuber yield (0.25 kg plot^{-1} and 33.36 t ha^{-1}) was found from N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up) where the lowest tuber yield (8.45 kg plot^{-1} and 28.15 t ha^{-1}) was obtained from N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up). Similar observation was also found by Georgakis *et al.* (1997), Kanbi and Bhatnagar (2005), Saeidi *et al.* (2009) and Sandhu *et al.* (2010).

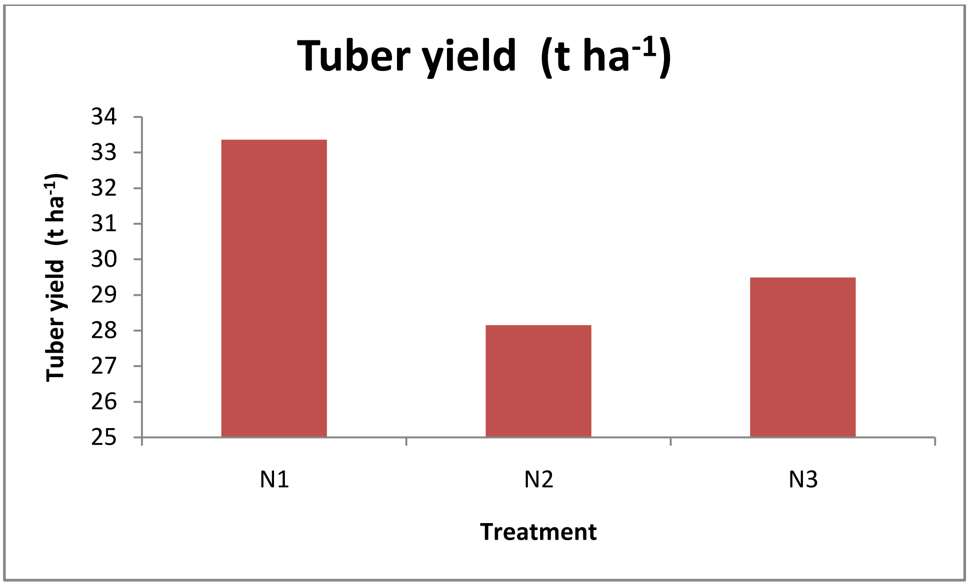

Fig. 31. Effect of N on tuber yield of potato. SE (±) = 1.026 and 1.03, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

4.6.2 Effect of K

Considerable variation was not observed on tuber yield of potato influenced by different split application of K (Fig. 32). The highest tuber yield (9.20kg plot^{-1} and 30.67 t ha^{-1}) was found from K_1 (60 kg K ha^{-1} at planting) where the lowest tuber yield (9.00kg plot^{-1} and 30.01 t ha^{-1}) was found from K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up). Perrenoud (1993), Singh *et al.* (1997) and Kumar *et al.*(2005)also found similar results with the present study.

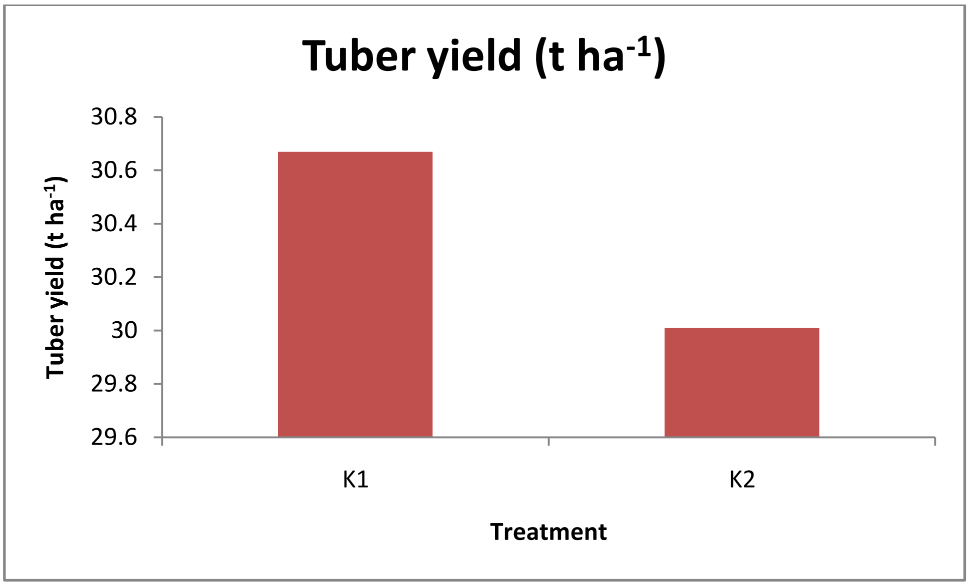

Fig. 32. Effect of K on tuber yield of potato. SE (±) = 0.672 and 0.674, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.6.3 Effect of FYM

Considerable variation was not found on tuber yield of potato influenced by different rate of FYM application (Fig. 33). Results showed that the highest tuber yield (9.16kg plot^{-1} and 30.51 t ha^{-1}) was found from F_2 (10 t FYM ha^{-1} at planting) where the lowest tuber yield (9.05 kg plot^{-1} and 30.16 t ha^{-1}) was found from F_1 (6 t FYM ha^{-1} at planting). Gopichand *et al.* (2006) also observed similar result with the present findings.

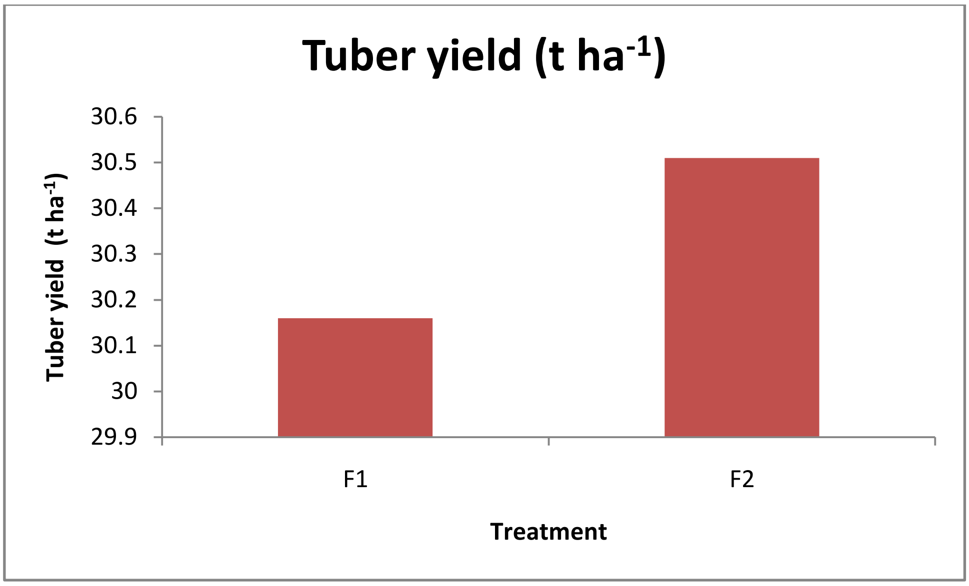

Fig. 33. Effect of FYM on tuber yield of potato. SE (±) = 0.814 and 0.814, respectively.

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.6.4 Combined effect of N and K

Significant variation was found for tuber yield of potato affected by combined effect of N and K (Fig. 34). Results indicated that the highest tuber yield (20.21 kg $plot^{-1}$ and 34.01 t ha^{-1}) was found from N_1K_1 which was statistically similar with N_3K_1. The lowest tuber yield (7.49 kg $plot^{-1}$ and 24.95 t ha^{-1}) was found from N_2K_1 which was statistically similar with N_3K_2. The results found form the present study was similar with the findings of Al-Moshileh *et al.* (2005) and Vijaya Lakshmi *et al.* (2012).

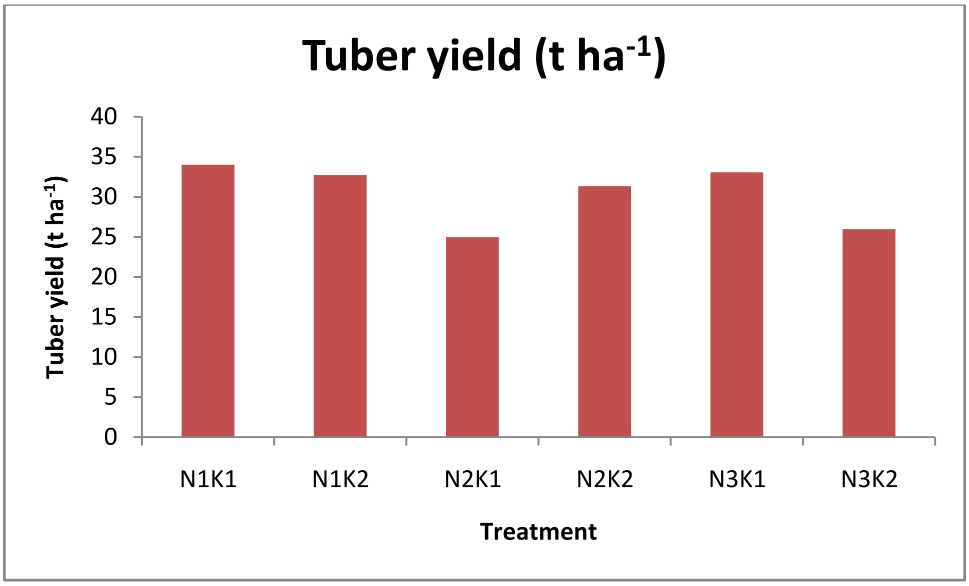

Fig. 34. Effect of N and K on tuber yield of potato. SE (±) = 0.672 and 0.674, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.6.5 Combined effect of N and FYM

Significant variation was noted on tuber yield of potato influenced by combined effect of N and FYM (Fig. 35). Results signified that the highest tuber yield (10.68 kg $plot^{-1}$ and 35.58 t ha^{-1}) was found from N_1F_2 followed by N_3F_1 and N_1F_1. Similarly, the lowest tuber yield (8.18 kg $plot^{-1}$ and 27.25 t ha^{-1}) was found from N_3F_2 which was statistically identical with N_2F_1. Mehadi *et al.* (2008) also found similar results with the present study.

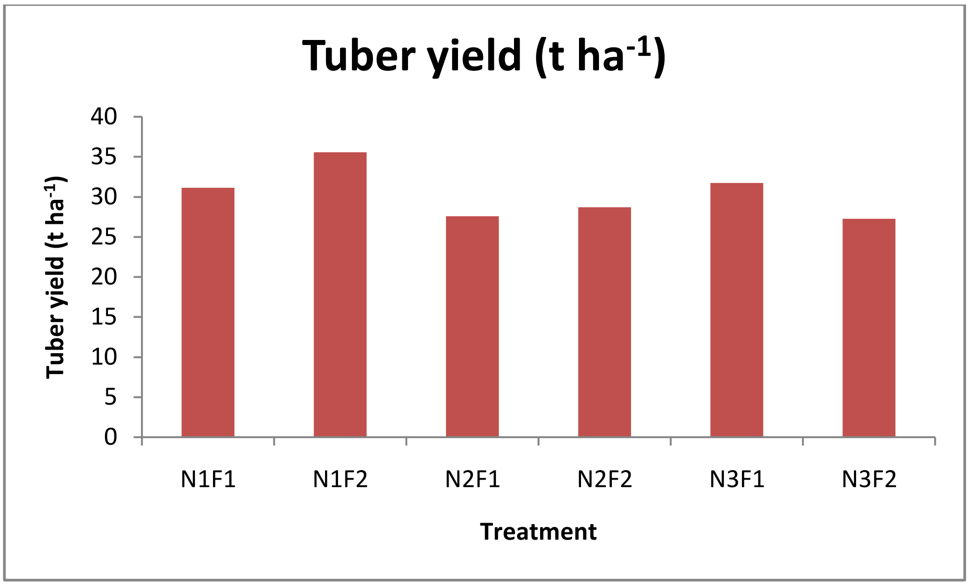

Fig. 35. Effect of N and FYM on tuber yield of potato. SE (±) = 0.814 and 0.814, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.6.6 Combined effect of K and FYM

Combined effect of K and FYM had significant effect on tuber yield of potato (Fig. 36). It was observed that the highest tuber yield (9.41 kg plot^{-1} and 31.36 t ha^{-1}) was found from K_1F_1 which was statistically similar with K_2F_2 while the lowest tuber yield (8.69 kg plot^{-1} and 28.96 t ha^{-1}) was found from K_2F_1 which was statistically identical with K_1F_2. Powon *et al.* (2005) also found similar results on tuber yield with P and FYM association which supported the present study.

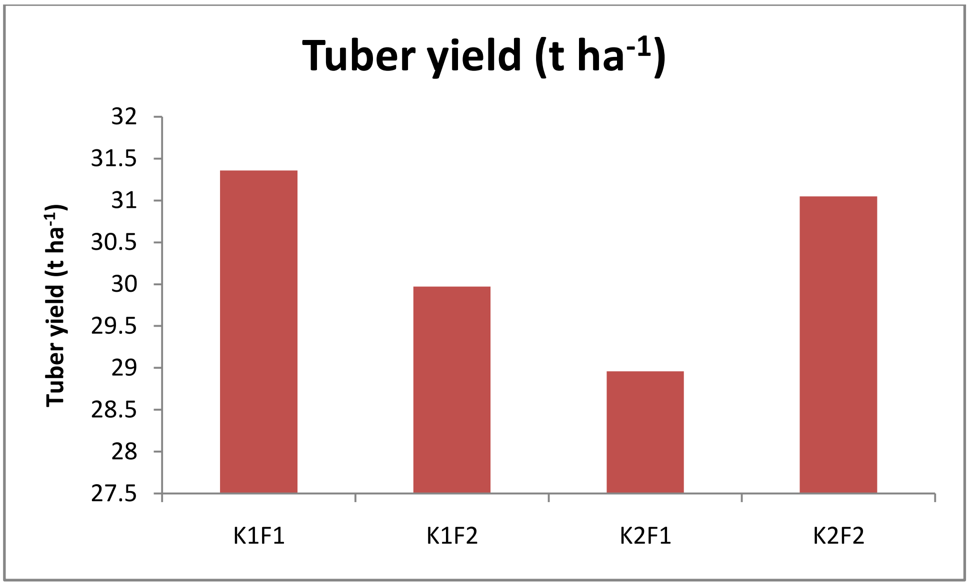

Fig. 36. Effect of K and FYM on tuber yield of potato. SE (±) = 1.002 and 1.003, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.6.7 Combined effect of N, K and FYM

Significant variation was found on tuber yield of potato affected by combined effect of N, K and FYM (Table 5). Results denoted that the highest tuber yield (11.36 kg plot^{-1} and 37.87 t ha^{-1}) was found from $N_1K_2F_2$ followed by $N_1K_1F_1$ and $N_3K_1F_1$. The lowest tuber yield (6.90kg plot^{-1} and 23.00 t ha^{-1}) was achieved from $N_3K_2F_2$ which was closely followed by $N_2K_1F_1$ and $N_2K_1F_2$.

Table 5. Combined effect of N, K and FYM on tuber yield of potato

Treatments	Tuber yield	
	Tuber yield (kg plot^{-1})	Tuber yield (t ha^{-1})
$N_1K_1F_1$	10.42 b	34.72 b
$N_1K_1F_2$	9.99 c	33.29 c
$N_1K_2F_1$	8.27 ef	27.57 h
$N_1K_2F_2$	11.36 a	37.87 a
$N_2K_1F_1$	7.43 g	24.77 i
$N_2K_1F_2$	7.54 g	25.13 j
$N_2K_2F_1$	9.12 d	30.41 f
$N_2K_2F_2$	9.69 cd	32.29 d
$N_3K_1F_1$	10.37 b	34.58 b
$N_3K_1F_2$	9.45 cd	31.50 e
$N_3K_2F_1$	8.67 e	28.89 g
$N_3K_2F_2$	6.90 h	23.00 k
SE (±)	2.052	2.053
CV (%)	7.286	10.513

Values with common letter (s) within a column do not differ significantly as 5% level of probability

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.7 Seed potato yield ha^{-1}

4.7.1 Effect of N

Signification influence was observed on seed potato yield due to different split application of N (Fig. 37). It was noted that the highest seed potato yield (16.18 t ha^{-1}) was found from N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at earthing up + 30 kg N ha^{-1} at second earthing up) followed by N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up) while the lowest seed potato yield (12.90 t ha^{-1}) was obtained from N_3 (60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP).

4.7.2 Effect of K

Considerable variation was not observed on seed potato yield influenced by different split application of K (Fig. 38). But the highest seed potato yield (14.76 t ha^{-1}) was found from K_1 (60 kg K ha^{-1} at planting) whereas the lowest seed potato yield (14.75 t ha^{-1}) was found from K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up).

4.7.3 Effect of FYM

Considerable variation was found on seed potato yield influenced by different rate of FYM application (Fig. 39). Results showed that the highest seed potato yield (15.39 t ha^{-1}) was found from F_1 (6 t FYM ha^{-1} at planting) whereas the lowest seed potato yield (14.12 t ha^{-1}) was found from F_2 (10 t FYM ha^{-1} at planting).

4.7.4 Combined effect of N and K

Significant variation was found for seed potato yield affected by combined effect of N and K (Fig. 40). Results indicated that the highest seed potato yield (16.60 t ha^{-1}) was found from N_2K_1 which was statistically similar with N_1K_2 and N_2K_2. The lowest seed potato yield (12.87 t ha^{-1}) was found from N_3K_2 which was statistically identical with N_3K_1.

4.7.5 Combined effect of N and FYM

Significant variation was noted on seed potato yield influenced by combined effect of N and FYM (Fig. 41). Results signified that the highest seed potato yield (16.24 t ha^{-1}) was found from N_2F_2 which was statistically identical with N_1F_1 and N_2F_1. Similarly, the lowest seed potato yield (11.85 t ha^{-1}) was found from N_3F_2 followed by N_3F_1.

4.7.6 Combined effect of K and FYM

Combined effect of K and FYM had significant effect on seed potato yield (Fig. 42). It was observed that the highest seed potato yield (15.78 t ha^{-1}) was found from K_1F_1 followed by K_2F_1 whereas the lowest seed potato yield (13.75 t ha^{-1}) was found from K_1F_2 followed by K_2F_2.

4.7.7 Combined effect of N, K and FYM

Significant variation was found on seed potato yield affected by combined effect of N, K and FYM (Table 6). Results denoted that the highest seed potato yield (17.73 t ha^{-1}) was found from $N_1K_1F_1$ which was statistically identical with $N_2K_1F_1$ followed by $N_1K_2F_2$ and $N_2K_2F_2$. The lowest seed potato yield (9.93 t ha^{-1}) was achieved from $N_3K_2F_2$ followed by $N_2K_1F_2$.

4.8 Non-seed potato yield ha^{-1}

4.8.1 Effect of N

Significant influence was observed on non-seed potato yield due to different split application of N (Fig. 37). It was noted that the highest non-seed potato yield (18.18 t ha^{-1}) was found from N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up) followed by N_3 (60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP) whereas the lowest non-seed potato yield (12.90 t ha^{-1}) was obtained N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up).

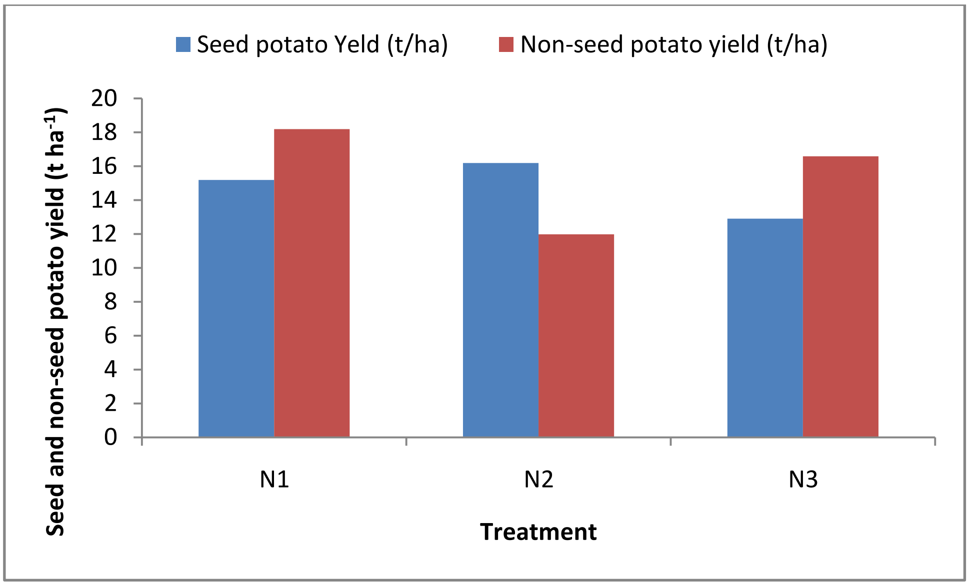

Fig. 37. Effect of N on seed and non-seed potato yield. SE (±) = 1.268 and 1.307, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

4.8.2 Effect of K

Remarkable variation was not observed on non-seed potato yield influenced by different split application of K (Fig. 38). But the highest non-seed potato yield (15.91 t ha^{-1}) was found from K_1 (60 kg K ha^{-1} at planting) whereas the lowest non-seed potato yield (15.26 t ha^{-1}) was found from K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up).

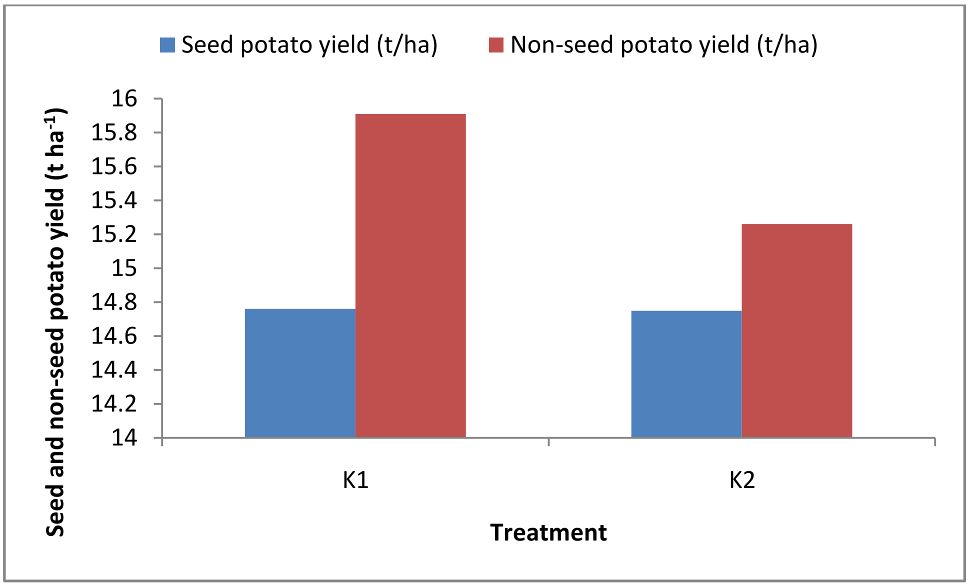

Fig. 38. Effect of K on seed and non-seed potato yield. SE (±) = 0.866 and 0.814, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.8.3 Effect of FYM

Considerable variation was found on non-seed potato yield influenced by different rate of FYM application (Fig. 39). Results showed that the highest non-seed potato yield (16.40 t ha^{-1}) was found from F_2 (10 t FYM ha^{-1} at planting) where the lowest non-seed potato yield (14.77 t ha^{-1}) was found from F_1 (6 t FYM ha^{-1} at planting).

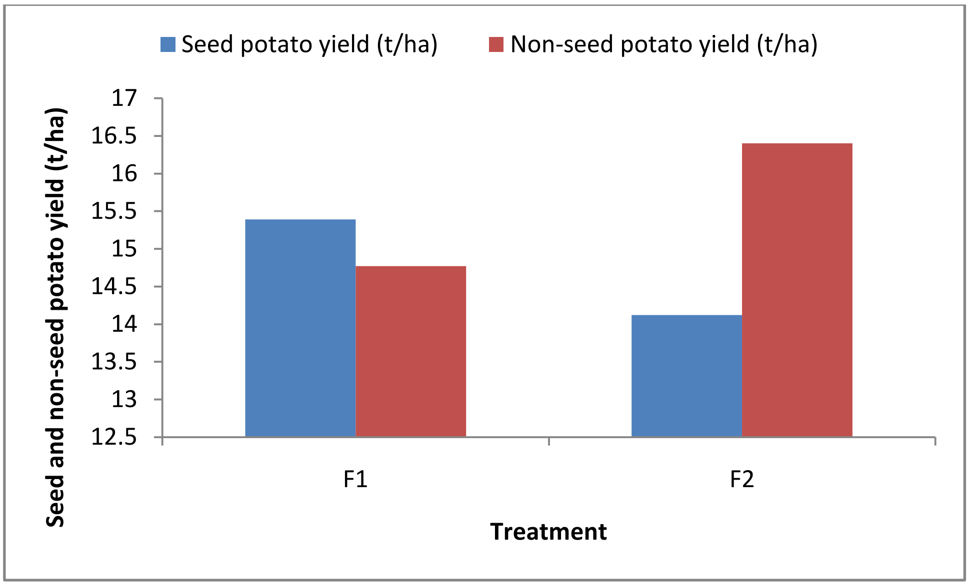

Fig. 39. Effect of FYM on seed and non-seed potato yield. SE (±) = 1.014 and 1.109, respectively.

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.8.4 Combined effect of N and K

Significant variation was found for non-seed potato yield affected by combined effect of N and K (Fig. 40). Results indicated that the highest non-seed potato yield (20.10 t ha^{-1}) was found from N_3K_1 which was statistically similar with N_1K_1. The lowest non-seed potato yield (8.35 t ha^{-1}) was found from N_2K_1 which was significantly different from all other combinations.

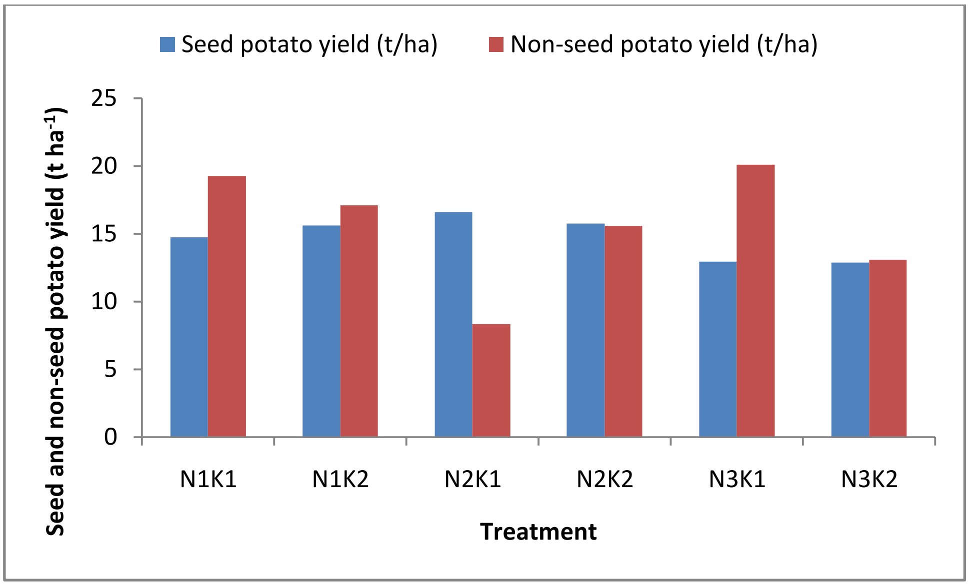

Fig. 40. Effect of N and K on seed and non-seed potato yield. SE (±) = 0.866 and 0.814, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.8.5 Combined effect of N and FYM

Significant variation was noted on non-seed potato yield influenced by combined effect of N and FYM (Fig. 41). Results signified that the highest non-seed potato yield (21.32 t ha^{-1}) was found from N_1F_2 which w which was significantly different from others. Similarly, the lowest non-seed potato yield (11.47 t ha^{-1}) was found from N_2F_1 followed by N_2F_2.

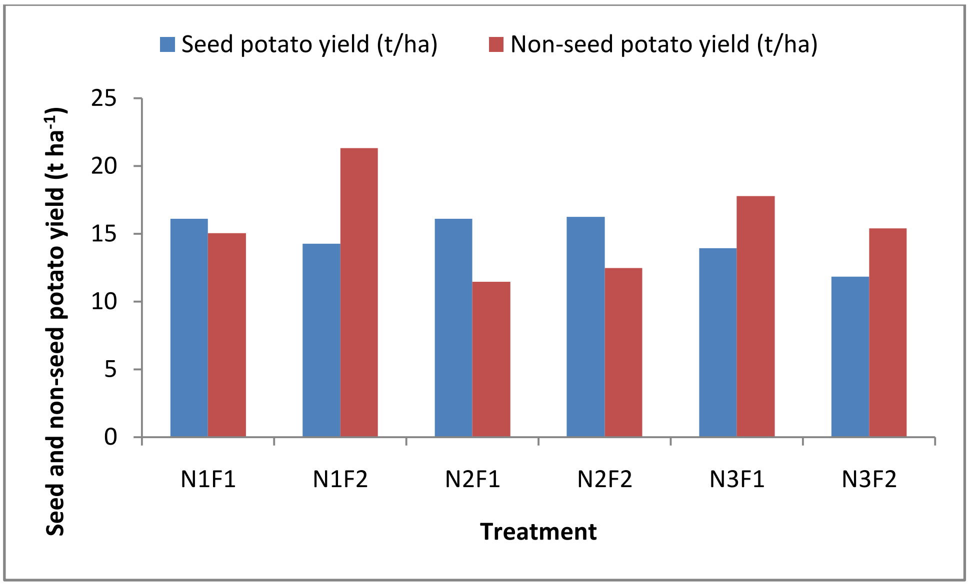

Fig. 41. Effect of N and FYM on seed and non-seed potato yield. SE (±) = 1.014 and 1.109, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.8.6 Combined effect of K and FYM

Combined effect of K and FYM had significant effect on non-seed potato yield (Fig. 42). It was observed that the highest non-seed potato yield (16.57 t ha^{-1}) was found from K_2F_2 followed by K_1F_2 and K_1F_1 where the lowest seed potato yield (13.96 t ha^{-1}) was found from K_2F_1.

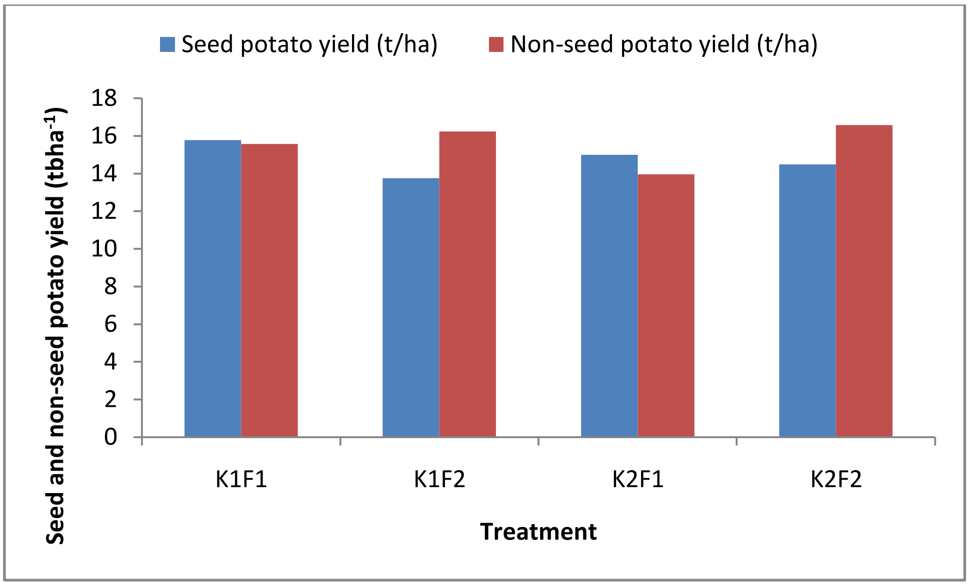

Fig. 42. Effect of K and FYM on seed and non-seed potato yield. SE (±) = 1.206 and 1.307, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.8.7 Combined effect of N, K and FYM

Significant variation was found on non-seed potato yield affected by combined effect of N, K and FYM (Table 6). Results denoted that the highest non-seed potato yield (22.47 t ha^{-1}) was found from $N_3K_1F_1$ which was statistically similar with $N_1K_1F_2$ and $N_1K_2F_2$. The lowest non-seed potato yield (7.27 t ha^{-1}) was achieved from $N_2K_1F_1$ followed by $N_2K_1F_2$.

Table 6. Combined effect of N, K and FYM on seed and non-seed potato yield

Treatments	Seed and non-seed potato yield	
	Seed potato(t ha^{-1})	Non-seed potato(t ha^{-1})
$N_1K_1F_1$	17.73 a	17.00 c
$N_1K_1F_2$	11.77 gh	21.53 b
$N_1K_2F_1$	14.47 de	13.10 e
$N_1K_2F_2$	16.77 b	21.10 b
$N_2K_1F_1$	17.50 a	7.27 g
$N_2K_1F_2$	15.70 c	9.43 f
$N_2K_2F_1$	14.73 d	15.67 d
$N_2K_2F_2$	16.77 b	15.53 d
$N_3K_1F_1$	12.10 g	22.47 a
$N_3K_1F_2$	13.77 f	17.73 c
$N_3K_2F_1$	15.80 c	13.10 e
$N_3K_2F_2$	9.93 i	13.07 e
SE (±)	2.537	2.614
CV (%)	6.374	8.638

Values with common letter (s) within a column do not differ significantly as 5% level of probability

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.9 Percent (%) of seed potato yield by weight

4.9.1 Effect of N

Significant influence was observed on percent of seed potato yield by weight due to different split application of N (Fig. 43). It was noted that the highest percent of seed potato yield by weight (58.38%) was found from N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up) where the lowest percent of seed potato yield by weight (44.14%) was obtained from N_3 (60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP) which was statistically identical with N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up).

4.9.2 Effect of K

Considerable variation was not observed on percent of seed potato yield by weight influenced by different split application of K (Fig. 44). But the highest percent of seed potato yield by weight (49.71%) was found from K_1 (60 kg K ha^{-1} at planting) whereas the lowest percent of seed potato yield by weight (49.17%) was found from K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up).

4.9.3 Effect of FYM

Considerable variation was found on percent of seed potato yield by weight influenced by different rate of FYM application (Fig. 45). Results showed that the highest percent of seed potato yield by weight (52.06%) was found from F_1 (6 t FYM ha^{-1} at planting) while the lowest percent of seed potato yield by weight (46.82%) was found from F_2 (10 t FYM ha^{-1} at planting).

4.9.4 Combined effect of N and K

Significant variation was found for percent of seed potato yield by weight affected by combined effect of N and K (Fig. 46). Results indicated that the highest percent of seed potato yield by weight (66.57%) was found from N_2K_1 which was significantly different from all other combinations followed by N_2K_2. The lowest percent of seed potato yield by weight (39.35%) was found from N_3K_1 followed by N_1K_1.

4.9.5 Combined effect of N and FYM

Significant variation was noted on percent of seed potato yield by weight influenced by combined effect of N and FYM (Fig. 47). Results signified that the highest percent of seed potato yield by weight (59.56%) was found from N_2F_1which was statistically identical with N_2F_2. Similarly, the lowest percent of seed potato yield by weight (39.81%) was found from N_1F_2 which was statistically similar with N_1F_2.

4.9.6 Combined effect of K and FYM

Combined effect of K and FYM had significant effect on percent of seed potato yield by weight (Fig. 48). It was observed that the highest percent of seed potato yield by weight (52.24%) was found from K_1F_1 which was statistically identical with K_2F_1 while the lowest percent of seed potato yield by weight (46.46%) was found from K_2F_2 which was statistically identical with K_1F_2.

4.9.7 Combined effect of N, K and FYM

Significant variation was found on percent of seed potato yield by weight affected by combined effect of N, K and FYM (Table 7). Results exposed that the highest percent of seed potato yield by weight (70.66%) was found from $N_2K_1F_1$ followed by $N_2K_1F_2$. The lowest percent of seed potato yield by weight (35.00%) was achieved from $N_3K_1F_1$ which was statistically identical with $N_1K_1F_2$.

4.10 Percent (%) of non-seed potato yield by weight

4.10.1 Effect of N

Significant influence was observed on percent of non-seed potato yield by weight due to different split application of N (Fig. 43). It was noted that the highest percent of non-seed potato yield by weight (55.86%) was found from N_3 (60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP) which was statistically identical with N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up) whereas the lowest percent of non-seed potato yield by weight (41.63%) was obtained from N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up).

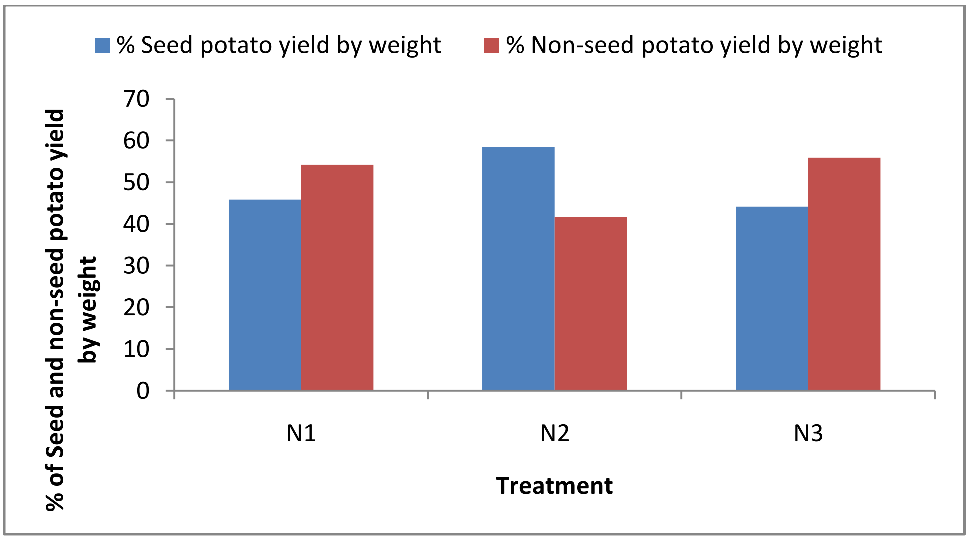

Fig. 43. Effect of N on % of seed and non-seed potato yield by weight. SE (±) = 0.919 and 0.817, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

4.10.2 Effect of K

Considerable variation was not observed on percent of non-seed potato yield by weight influenced by different split application of K (Fig. 44). But the highest percent of non-seed potato yield by weight (50.84%) was found from K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up) where the lowest percent of non-seed potato yield by weight (50.30%) was found from K_1 (60 kg K ha^{-1} at planting).

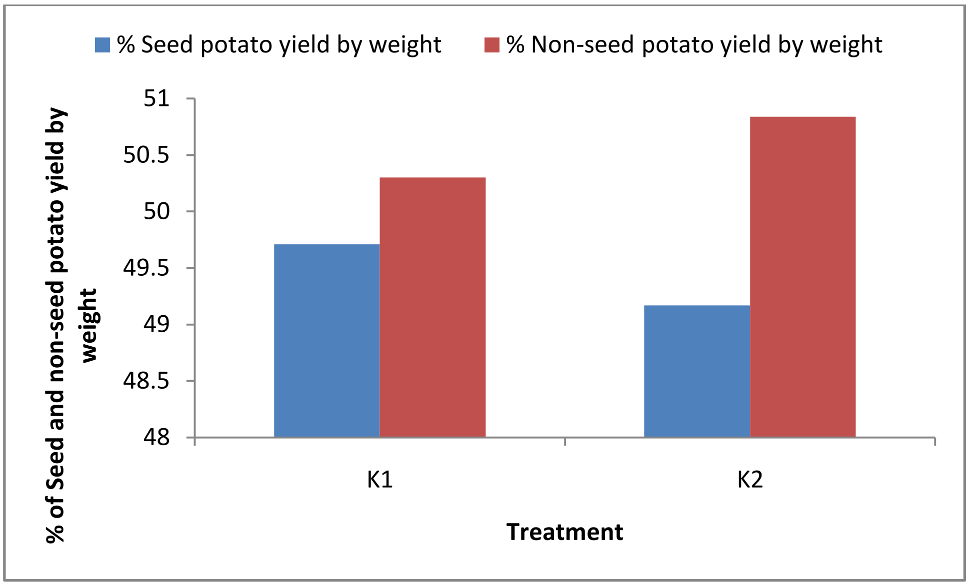

Fig. 44. Effect of K on % of seed and non-seed potato yield by weight. SE (±) = 0.874 and 0.786, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.10.3 Effect of FYM

Considerable variation was found on percent of non-seed potato yield by weight influenced by different rate of FYM application (Fig. 45). Results showed that the highest percent of non-seed potato yield by weight (53.19%) was found from F_2 (10 t FYM ha^{-1} at planting) where the lowest percent of non-seed potato yield by weight (47.95%) was found from F_1 (6 t FYM ha^{-1} at planting).

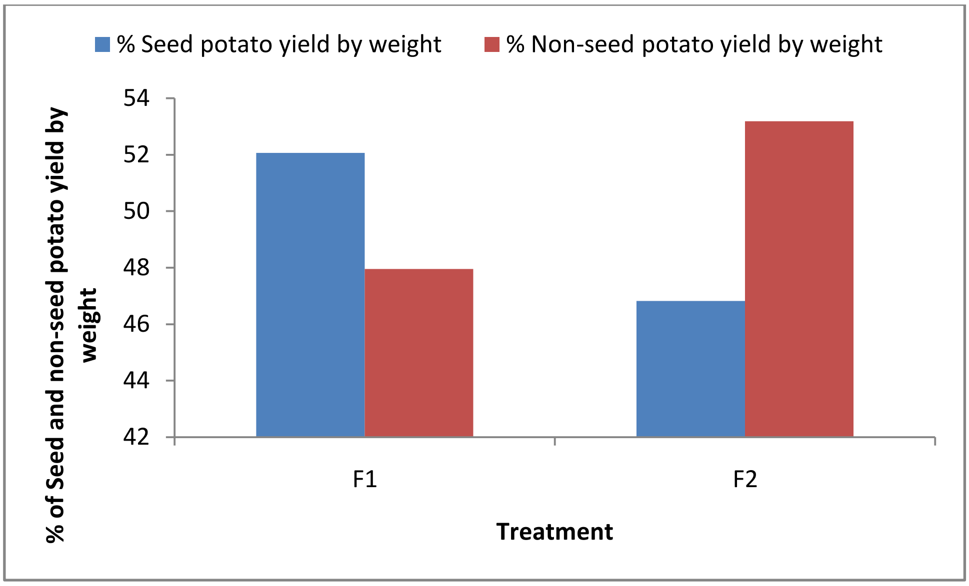

Fig. 45. Effect of FYM on % of seed and non-seed potato yield by weight. SE (±) = 0.933 and 0.852, respectively.

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.10.4 Combined effect of N and K

Significant variation was found for percent of non-seed potato yield by weight affected by combined effect of N and K (Fig. 46). Results indicated that the highest percent of non-seed potato yield by weight (60.65%) was found from N_3K_1 which was significantly different from all other combinations followed by N_1K_1. The lowest percent of non-seed potato yield by weight (33.44%) was found from N_2K_1 which was significantly different from all other combinations.

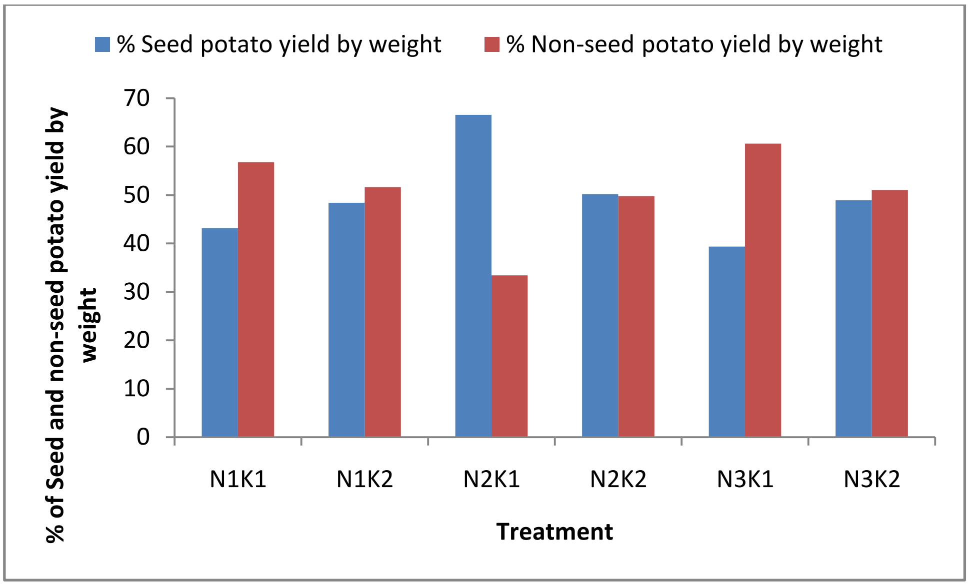

Fig. 46. Effect of N and K on % of seed and non-seed potato yield by weight. SE (±) = 0.874 and 0.786, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.10.5 Combined effect of N and FYM

Significant variation was noted on percent of non-seed potato yield by weight influenced by combined effect of N and FYM (Table 47). Results signified that the highest percent of non-seed potato yield by weight (60.19%) was found from N_1F_2 which was significantly different from all other combinations followed by N_3F_2. Similarly, the lowest percent of non-seed potato yield by weight (40.44%) was found from N_2F_1 which was statistically identical with N_2F_2.

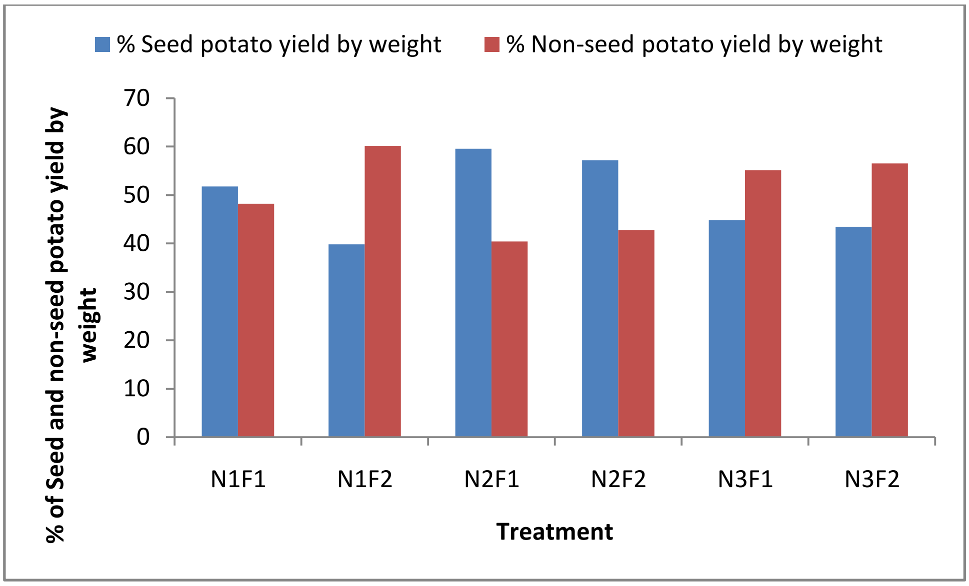

Fig. 47. Effect of N and FYM on % of seed and non-seed potato yield by weight. SE (±) = 0.933 and 0.852, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.10.6 Combined effect of K and FYM

Combined effect of K and FYM had significant effect on percent of non-seed potato yield by weight (Fig. 48). It was observed that the highest percent of non-seed potato yield by weight (53.54%) was found from K_2F_2 which was statistically identical with K_1F_2 where the lowest percent of non-seed potato yield by weight (47.76%) was found from K_1F_1 which was statistically identical with K_2F_1.

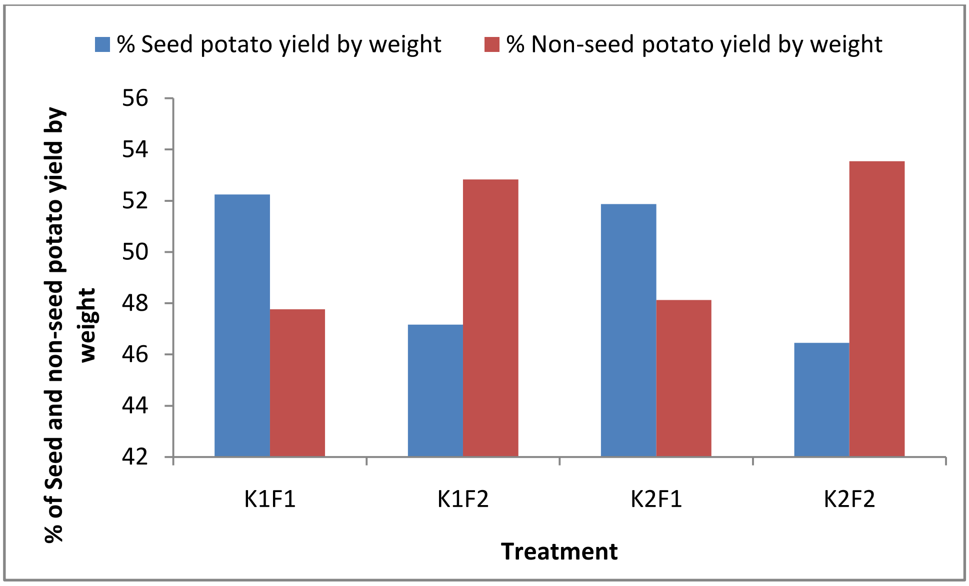

Fig. 48. Effect of K and FYM on % of seed and non-seed potato yield by weight. SE (±) = 1.036 and 0.988, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.10.7 Combined effect of N, K and FYM

Significant variation was found on percent of non-seed potato yield by weight affected by combined effect of N, K and FYM (Table 7). Results exposed that the highest percent of non-seed potato yield by weight (65.00%) was found from $N_2K_1F_1$ which was statistically identical with $N_1K_1F_2$ followed by $N_1K_2F_2$ and $N_3K_1F_2$. The lowest percent of non-seed potato yield by weight (29.34%) was achieved from $N_2K_1F_1$ which was significantly different from others followed by $N_2K_1F_2$.

Table 7. Combined effect of N, K and FYM on % of seed and non-seed potato yield by weight

Treatments	% of Seed potato yield by weight	% of Non-seed potato yield by weight
$N_1K_1F_1$	51.06 d	48.94 d
$N_1K_1F_2$	35.34 g	64.66 a
$N_1K_2F_1$	52.48 d	47.52 d
$N_1K_2F_2$	44.28 f	55.72 b
$N_2K_1F_1$	70.66 a	29.34 g
$N_2K_1F_2$	62.47 b	37.53 f
$N_2K_2F_1$	48.46 e	51.54 c
$N_2K_2F_2$	51.91 d	48.09 d
$N_3K_1F_1$	35.00 g	65.00 a
$N_3K_1F_2$	43.70 f	56.30 b
$N_3K_2F_1$	54.67 c	45.33 e
$N_3K_2F_2$	43.19 f	56.81 b
SE (±)	1.837	1.633
CV (%)	8.322	6.512

Values with common letter (s) within a column do not differ significantly as 5% level of probability

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.11 Grading of seed potato

4.11.1 Effect of N

Significant influence was observed on different graded seed potato yield due to different split application of N (Fig. 49). It was noted that the highest 'A' graded seed potato yield (8.84 t ha^{-1}) was found from N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up) which was statistically identical with N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up) where the lowest 'A' graded seed potato yield (7.65 t ha^{-1}) was obtained from N_3 (60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP). Similarly, the highest 'b' graded seed potato yield (7.74 t ha^{-1}) was found from N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up) followed by N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up) where the lowest 'B' graded seed potato yield (5.26 t ha^{-1}) was obtained from N_3 (60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP).

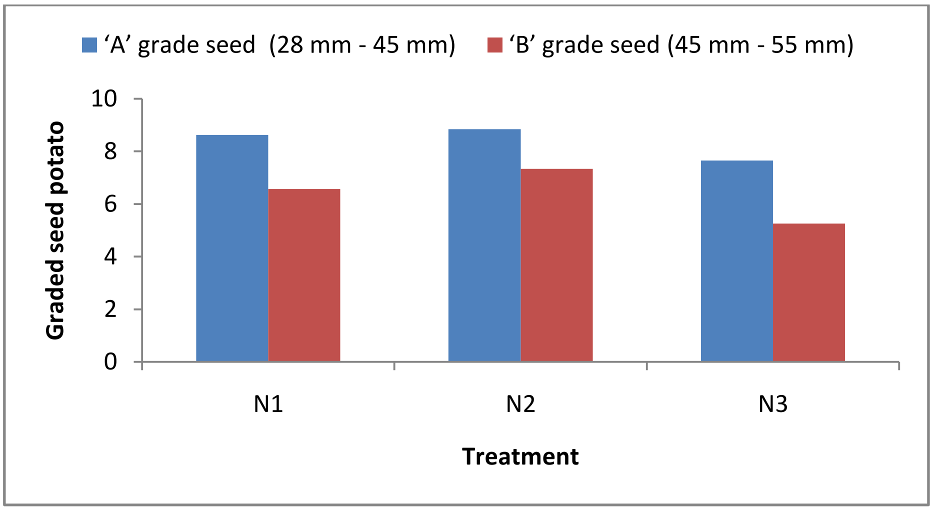

Fig. 49. Effect of N on different graded seed potato yield. SE (±) = 1.038 and 0.769, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

4.11.2 Effect of K

Considerable variation was not observed on different graded seed potato yield influenced by different split application of K (Fig. 50). But the highest 'A' graded seed potato yield (8.40 t ha^{-1}) was found from K_1 (60 kg K ha^{-1} at planting) where the lowest 'A' graded seed potato yield (8.34 t ha^{-1}) was found from K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up). Again, the highest 'B' graded seed potato yield (6.41 t ha^{-1}) was found from K_1 (60 kg K ha^{-1} at planting) where the lowest 'B' graded seed potato yield (6.37 t ha^{-1}) was found from K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up).

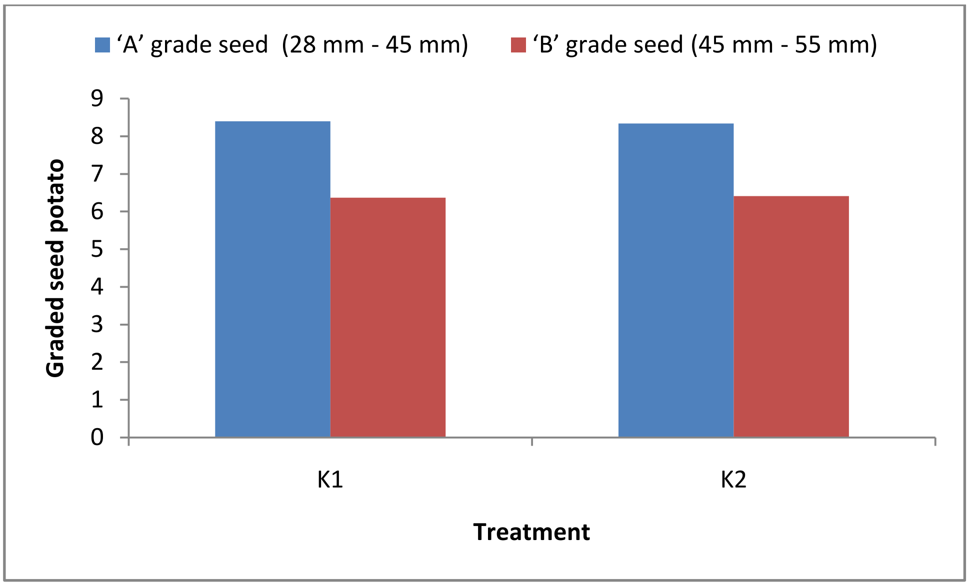

Fig. 50. Effect of K on different graded seed potato yield. SE (±) = 0.687 and 0.592, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.11.3 Effect of FYM

Considerable variation was found on different graded seed potato yield influenced by different rate of FYM application (Fig. 51). Results showed that the highest ‘A’ graded seed potato yield (8.40 t ha^{-1}) was found from F_1 (6 t FYM ha^{-1} at planting) where the lowest ‘A’ graded seed potato yield (8.33 t ha^{-1}) was found from F_2 (10 t FYM ha^{-1} at planting). Again, the highest ‘B’ graded seed potato yield (6.99 t ha^{-1}) was found from F_1 (6 t FYM ha^{-1} at planting) where the lowest ‘B’ graded seed potato yield (5.79 t ha^{-1}) was found from F_2 (10 t FYM ha^{-1} at planting).

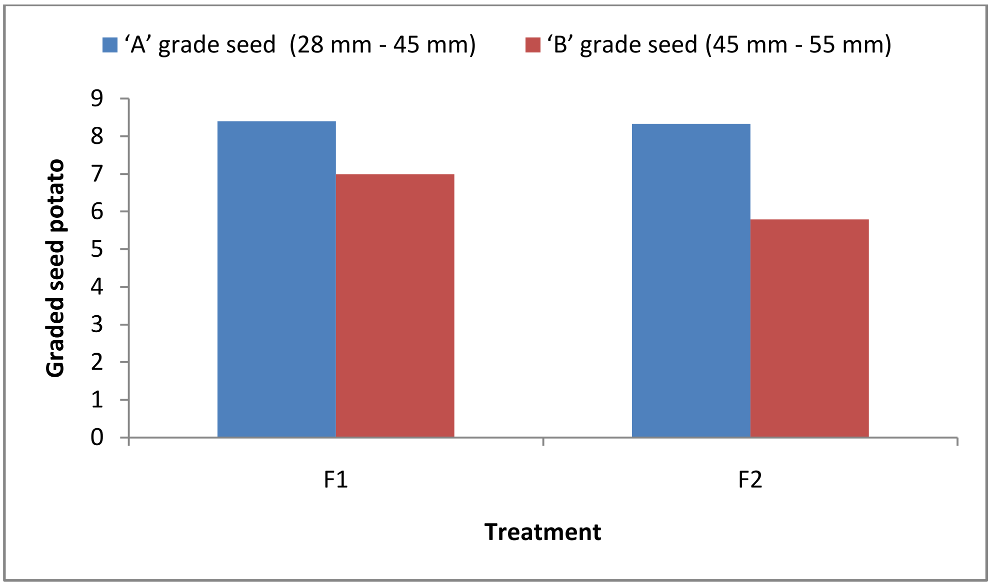

Fig. 51. Effect of FYM on different graded seed potato yield. SE (±) = 1.006 and 0.867, respectively.

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.11.4 Combined effect of N and K

Significant variation was found for different graded seed potato yield affected by combined effect of N and K (Fig. 52). Results indicated that the highest ‘A’ graded seed potato yield (9.01 t ha^{-1}) was found from N_2K_2 which was significantly different from others followed by N_1K_1 and N_2K_1. The lowest ‘A’ graded seed potato yield (7.44 t ha^{-1}) was found from N_3K_2 which was statistically similar with N_3K_1. Similarly, the highest ‘B’ graded seed potato yield (7.94 t ha^{-1}) was found from N_2K_1 which was significantly different from others followed by N_1K_2 where the lowest 'B' graded seed potato yield (5.09 t ha^{-1}) was found from N_3K_1 which was statistically similar with N_3K_2.

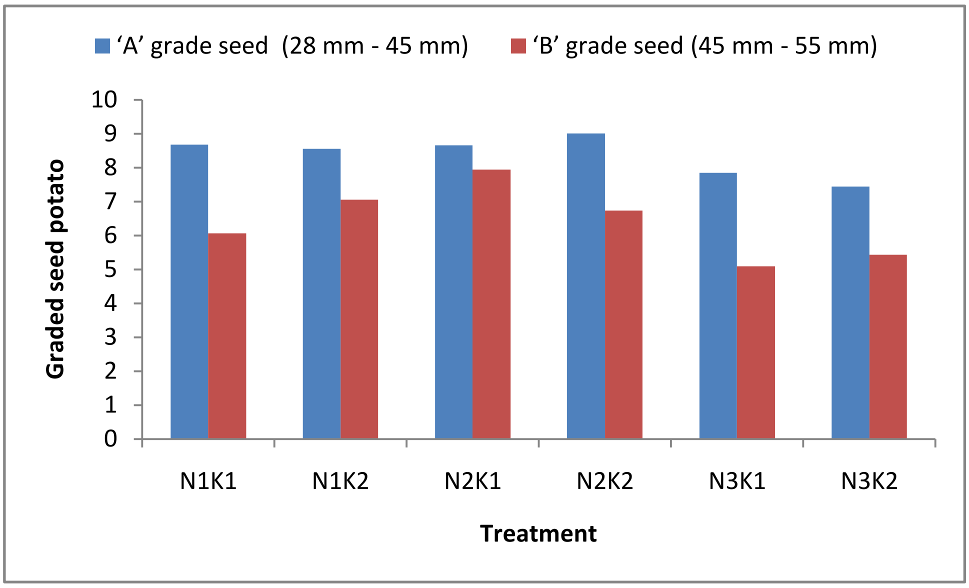

Fig. 52. Effect of N and K on different graded seed potato yield. SE (±) = 0.867 and 0.592, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

4.11.5 Combined effect of N and FYM

Significant variation was noted on different graded seed potato yield influenced by combined effect of N and FYM (Fig. 53). Results signified that the highest 'A' graded seed potato yield (9.03 t ha^{-1}) was found from N_2F_2 which was statistically similar with N_1F_2 where the lowest 'A' graded seed potato yield (7.11 t ha^{-1}) was found from N_3F_2 followed by N_3F_1. Accordingly, the highest 'B' graded seed potato yield (7.72 t ha^{-1}) was found from N_1F_1 which was statistically similar with N_2F_1 where the lowest 'B' graded seed potato yield (4.74 t ha^{-1}) was found from N_3F_2 followed by N_1F_2.

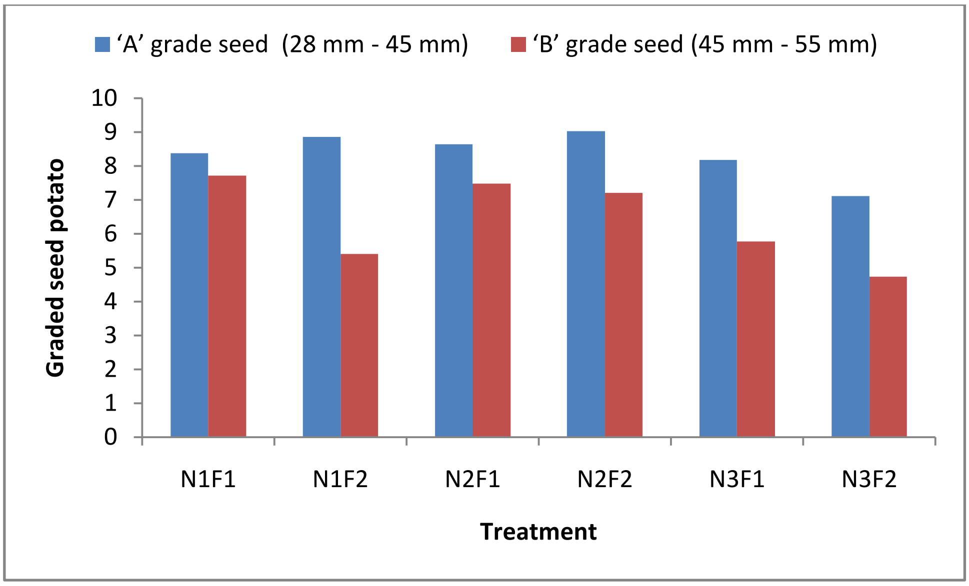

Fig. 53. Effect of N and FYM on different graded seed potato yield. SE (±) = 1.006 and 0.867, respectively.

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.11.6 Combined effect of K and FYM

Combined effect of K and FYM had significant effect on different graded seed potato yield (Fig. 54). It was observed that the highest 'A' graded seed potato yield (8.67 t ha^{-1}) was found from K_1F_1 which was statistically similar with K_2F_2 where the lowest 'A' graded seed potato yield (8.12 t ha^{-1}) was found from K_1F_2 which was statistically identical with K_2F_1. Again, the highest 'B' graded seed potato yield (7.10 t ha^{-1}) was found from K_1F_1 which was statistically similar with K_2F_1 where the lowest 'B' graded seed potato yield (5.63 t ha^{-1}) was found from K_1F_2 which was statistically identical with K_2F_2.

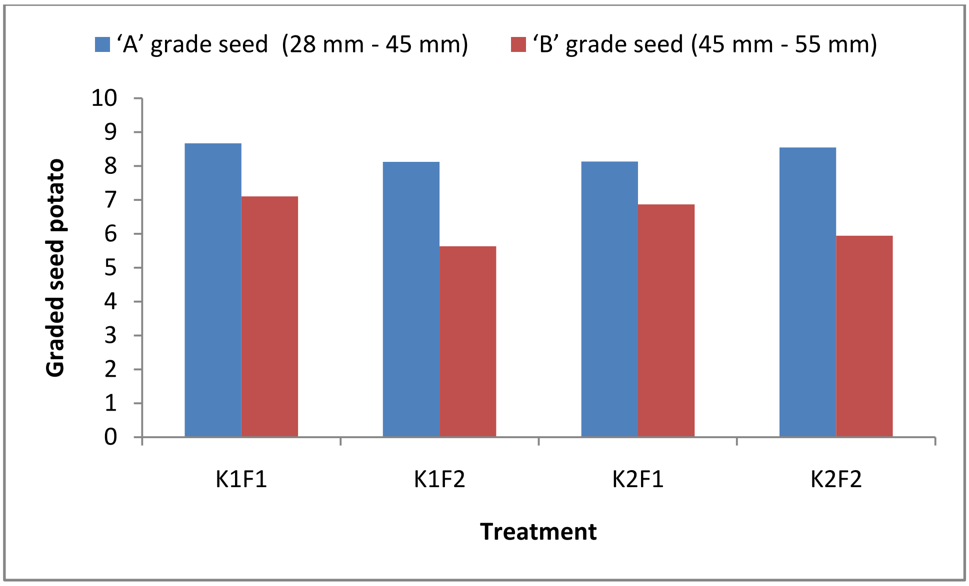

Fig. 54. Effect of K and FYM on different graded seed potato yield. SE (±) = 0.804 and 0.736, respectively.

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

4.11.7 Combined effect of N, K and FYM

Significant variation was found on different graded seed potato yield affected by combined effect of N, K and FYM (Table 8). Results represented that the highest 'A' graded seed potato yield (10.60 t ha^{-1}) was found from $N_1K_2F_2$ which was statistically similar with $N_1K_1F_1$ followed by $N_2K_2F_2$ and $N_3K_2F_1$. The lowest 'A' graded seed potato yield (5.78 t ha^{-1}) was achieved from $N_3K_2F_2$ followed by $N_1K_2F_1$. Similarly, the highest 'B' graded seed potato yield (8.98 t ha^{-1}) was found from $N_2K_1F_1$ which was significantly different from other treatment combinations followed by $N_1K_2F_1$. The lowest 'B' graded seed potato yield (4.15 t ha^{-1}) was achieved from $N_3K_2F_2$ followed by $N_1K_1F_2$.

Table 8. Combined effect of N, K and FYM on different graded seed potato yield

Treatments	Graded tuber (t ha^{-1})	
	'A' grade seed (28 mm - 45 mm)	'B' grade seed (45 mm - 55 mm)
$N_1K_1F_1$	10.24 ab	7.49 c
$N_1K_1F_2$	7.12 f	4.65 i
$N_1K_2F_1$	6.52 g	7.95 b
$N_1K_2F_2$	10.60 a	6.17 fg
$N_2K_1F_1$	8.52 de	8.98 a
$N_2K_1F_2$	8.80 d	6.90 d
$N_2K_2F_1$	8.76 d	5.97 g
$N_2K_2F_2$	9.26 c	7.51 c
$N_3K_1F_1$	7.26 f	4.84 i
$N_3K_1F_2$	8.44 e	5.33 h
$N_3K_2F_1$	9.10 c	6.70 de
$N_3K_2F_2$	5.78 h	4.15 j
SE (±)	2.076	1.539
CV (%)	5.183	5.204

Values with common letter (s) within a column do not differ significantly as 5% level of probability

N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up, N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP

K_1 = 60 kg K ha^{-1} at planting, K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up

F_1 = 6 t FYM ha^{-1} at planting, F_2 = 10 t FYM ha^{-1} at planting

Chapter 5

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

A field experiment was conducted at the field of Sher-e-Bangla Agricultural University, Dhaka, during the period from November, 2016 to April, 2017 to investigate the effect of split application of N, K and FYM levels on the productivity of seed potato derived from true potato seed (TPS). The experiment comprised of three factors *viz*., (i) Nitrogen (N) - 3 levels as N_1 = 60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up, N_2 = 60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up and N_3 = 60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP; (ii) Potassium (K) 2 levels - as K_1 = 60 kg K ha^{-1} at planting and K_2 = 30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up and (iii) FYM - 2 levels as F_1 = 6 t FYM ha^{-1} at planting and F_2 = 10 t FYM ha^{-1} at planting. The experiment was laid out in split split plot design (factorial) with three replications. The collected data were analyzed statistically and the means were separated by DMRT at 5% level of probability.

Considering the effect of N, days to first and final emergence of seedling and number of stem $hill^{-1}$ was not significantly influenced but plant length, number of tuber $hill^{-1}$, weight of tuber $hill^{-1}$, tuber yield $plot^{-1}$ and tuber yield ha^{-1}, seed potato yield ha^{-1}, non-seed potato yield ha^{-1}, percent (%) of seed potato yield by weight, percent (%) of non-seed potato yield by weight and grading of seed potato were significantly influenced by N. The highest plant length (65.67 cm), number of tuber $hill^{-1}$ (6.69), weight of tuber $hill^{-1}$ (0.25 kg), tuber yield (0.25 kg $plot^{-1}$ and 33.36 t ha^{-1}) and non-seed potato yield (18.18 t ha^{-1}) was found from N_1 (60 kg N ha^{-1} at planting + 60 kg N ha^{-1} at first earthing up) while the highest seed potato yield (16.18 t ha^{-1}), % seed potato yield by weight (58.38%), 'A' graded seed potato yield (8.84 t ha^{-1}) and 'B' graded seed potato yield (7.74 t ha^{-1}) were found from N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up) but the highest % non-seed potato yield by weight (55.86%) was found from N_3 (60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP). Accordingly, the lowest plant length (60.59 cm), number of stem hill^{-1} (2.33), number of tuber hill^{-1} (5.47), seed potato yield (12.90 t ha^{-1}), % seed potato yield by weight (44.14%), 'A' graded seed potato yield (7.65 t ha^{-1}), 'B' graded seed potato yield (5.26 t ha^{-1}) were obtained from N_3 (60 kg N ha^{-1} at planting + 20 kg N ha^{-1} at first earthing up + 20 kg N ha^{-1} at second earthing up + 20 kg N ha^{-1} at 75 DAP) but the lowest weight of tuber hill^{-1} (0.21 kg), tuber yield (8.45 kg plot^{-1} and 28.15 t ha^{-1}), non-seed potato yield (812.90 t ha^{-1}) and % non-seed potato yield by weight (41.63%) were obtained from N_2 (60 kg N ha^{-1} at planting + 30 kg N ha^{-1} at first earthing up + 30 kg N ha^{-1} at second earthing up).

Considering the effect of K, most of the parameters did not differ considerably by K but the treatment K_1 (60 kg K ha^{-1} at planting) showed better performance on most of the parameters including tuber yield and seed potato yield compared to K_2 (30 kg K ha^{-1} at planting + 30 K ha^{-1} at first earthing up).

In terms of FYM application, between the two treatments, F_1 (6 t FYM ha^{-1} at planting) and F_2 (10 t FYM ha^{-1} at planting) showed non considerable variation on total tuber yield. The highest tuber yield (30.51 t ha^{-1}) was found from F_2 (10 t FYM ha^{-1} at planting) where the lowest tuber yield (30.16 t ha^{-1}) was found from F_1 (6 t FYM ha^{-1} at planting) but the highest seed potato yield (15.39 t ha^{-1}), 'A' graded seed potato yield (8.40 t ha^{-1}) and 'B' graded seed potato yield (6.99 t ha^{-1}) were found from F_1 (6 t FYM ha^{-1} at planting). The highest non-seed potato yield (16.40 t ha^{-1}) was found from F_2 (10 t FYM ha^{-1} at planting). The lowest seed potato yield (14.12 t ha^{-1}), 'A' graded seed potato yield (8.33 t ha^{-1}) and 'B' graded seed potato yield (5.79 t ha^{-1}) were found from F_2 (10 t FYM ha^{-1} at planting) but the lowest non-seed potato yield (14.77 t ha^{-1}) was found from F_1 (6 t FYM ha^{-1} at planting).

In case of combined effect of N and K, days to first and final emergence of seedling was not significant but the highest plant length (66.33 cm) was found from N_1K_2 whereas the highest number of stem hill^{-1} (1. 3.00) was found from

N_1K_1 but the highest number of tuber hill^{-1} (6.94) was found from N_2K_1. The lowest plant length (57.67 cm) was found from N_3K_1 whereas the lowest number of stem hill^{-1} (1. 2.17) and number of tuber hill^{-1} (4.82) was found from N_3K_2. The highest tuber yield (34.01 t ha^{-1}) was found from N_1K_1 where the highest seed potato yield (16.60 t ha^{-1}) and 'B' graded seed potato yield (7.94 t ha^{-1}) was found from N_2K_1 but the highest 'A' graded seed potato yield (9.01 t ha^{-1}) was found from N_2K_2. The lowest tuber yield (24.95 t ha^{-1}) was found from N_2K_1 where the lowest seed potato yield (12.87 t ha^{-1}) and 'A' graded seed potato yield (7.44 t ha^{-1}) was found from N_3K_2 but the lowest 'B' graded seed potato yield (5.09 t ha^{-1}) was found from N_3K_1.

Considering the combined effect of N and FYM, the highest tuber yield (35.58 t ha^{-1}) and non-seed potato yield (21.32 t ha^{-1}) was found from N_1F_2 whereas the highest seed potato yield (16.24 t ha^{-1}) and 'A' graded seed potato yield (9.03 t ha^{-1}) was found from N_2F_2 but the highest 'B' graded seed potato yield (7.72 t ha^{-1}) was found from N_1F_1. Similarly, the lowest tuber yield (27.25 t ha^{-1}), seed potato yield (11.85 t ha^{-1}), 'A' graded seed potato yield (7.11 t ha^{-1}) and 'B' graded seed potato yield (4.74 t ha^{-1}) was found from N_3F_2 but the lowest non-seed potato yield (11.47 t ha^{-1}) was found from N_2F_1.

Regarding the combined effect of K and FYM, the highest tuber yield (31.36 t ha^{-1}), seed potato yield (15.78 t ha^{-1}), 'A' graded seed potato yield (8.67 t ha^{-1}) and 'B' graded seed potato yield (7.10 t ha^{-1}) were found from K_1F_1 whereas the highest non-seed potato yield (16.57 t ha^{-1}) was found from K_2F_2. Again, the lowest tuber yield (28.96 t ha^{-1}) and seed potato yield (13.96 t ha^{-1}) was found from K_2F_1 whereas the lowest seed potato yield (13.75 t ha^{-1}), 'A' graded seed potato yield (8.12 t ha^{-1}) and 'B' graded seed potato yield (5.63 t ha^{-1}) was found from K_1F_2.

In terms of combined effect of N, K and FYM, all the studied parameters were significantly influenced. The highest days to first emergence of seedling (13.67) and days to final emergence of seedling (17.33) were obtained from $N_2K_1F_2$. The highest plant length (70.00 cm) was found from $N_3K_2F_1$ where the highest number of stem hill^{-1} (3.67) and highest seed potato yield (17.73 t ha^{-1}) was found from $N_1K_1F_1$. Similarly, the highest weight of tuber hill^{-1} (0.284 kg), tuber yield (37.87 t ha^{-1}) and 'A' graded seed potato yield (10.60 t ha^{-1}) was found from $N_1K_2F_2$ but the highest non-seed potato yield (22.47 t ha^{-1}) was found from $N_3K_1F_1$. The highest % seed potato yield by weight (70.66%), 'B' graded seed potato yield (8.98 t ha^{-1}) and % non-seed potato yield by weight (65.00%) were found from $N_2K_1F_1$. The lowest plant length (55.67 cm) was achieved from $N_3K_1F_2$. But the lowest days to first emergence of seedling (9.00) and lowest days to final emergence of seedling (15.00) was obtained from $N_3K_2F_2$. The lowest number of stem hill^{-1} (2.00), weight of tuber hill^{-1} (0.173 kg), tuber yield (23.00 t ha^{-1}), seed potato yield (9.93 t ha^{-1}), 'A' graded seed potato yield (5.78 t ha^{-1}) and 'B' graded seed potato yield (4.15 t ha^{-1}) were also achieved from $N_3K_2F_2$. The lowest non-seed potato yield (7.27 t ha^{-1}) and percent of non-seed potato yield by weight (29.34%) were achieved from $N_2K_1F_1$ but the lowest percent of seed potato yield by weight (35.00%) was achieved from $N_3K_1F_1$.

From the above findings it can be concluded that the treatment combinations of $N_1K_2F_2$ gave highest tuber yield (seed potato + non-seed potato). The highest 'A' grade seed (28 mm - 45 mm) was also obtained from the treatment combinations of $N_1K_2F_2$. But the highest seed potato yield (t) was achieved from $N_1K_1F_1$ whereas the highest 'B' grade seed potato (45 mm - 55 mm) was found from $N_2K_1F_1$. From the above consideration, treatment combinations of $N_1K_2F_2$ is observed as the best treatment combination compared to others.

Chapter 6

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CHAPTER VI

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Appendices

APPENDICES

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

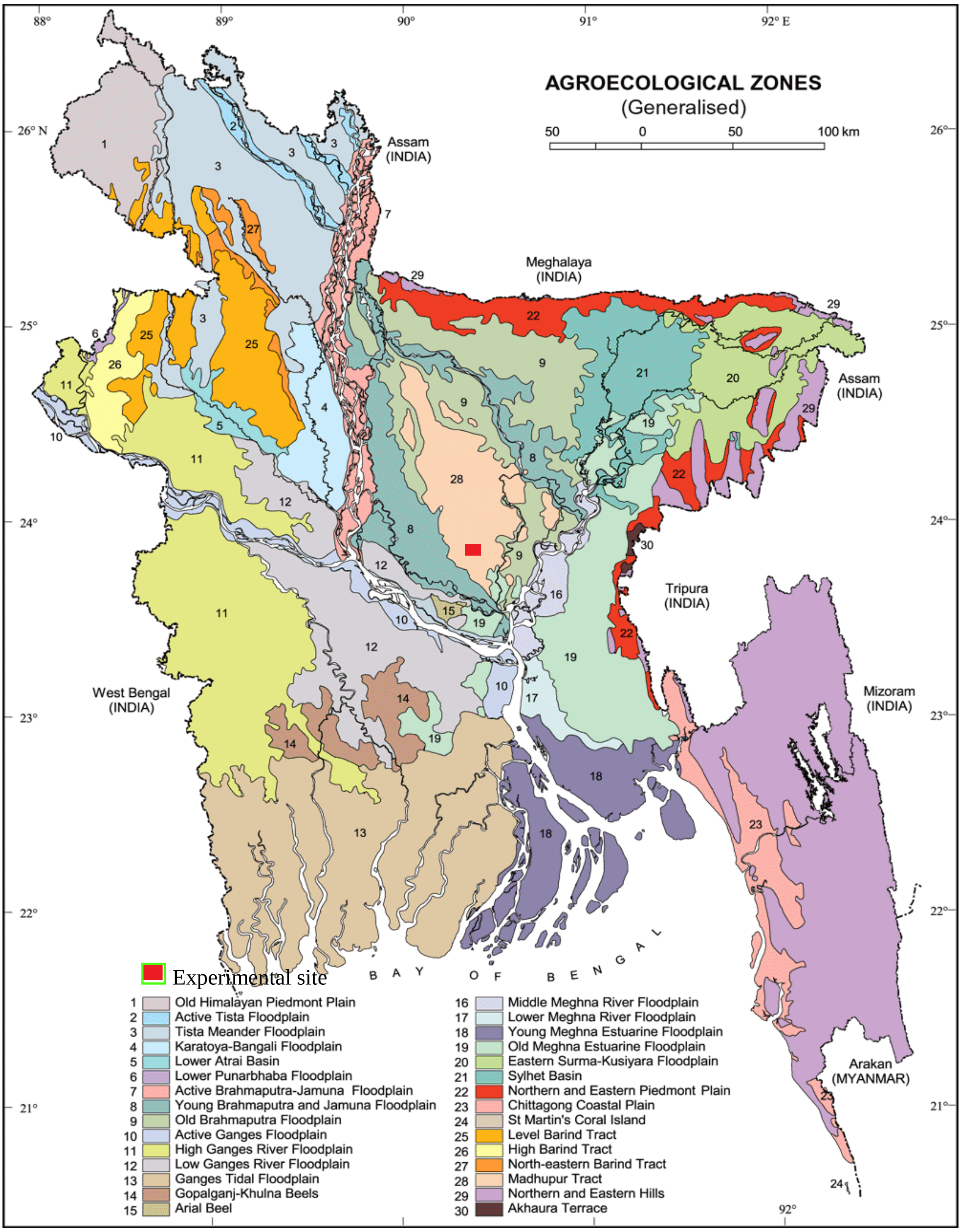

Fig. Experimental site

Appendix II. Monthly records of air temperature, relative humidity, rainfall and sunshine hours during the period from March to June, 2017

Month	RH (%)	Air temperature (C)			Rainfall (mm)
		Max.	*Min.*	*Mean*	
Novembe	56.75	28.60	8.52	18.56	14.40
Decembe	54.80	25.50	6.70	16.10	0.0
January	46.20	23.80	11.70	17.75	0.0
February	37.90	22.75	14.26	18.51	0.0
March	52.44	35.20	21.00	28.10	20.4
April	65.40	34.70	24.60	29.65	165.0
January	46.20	23.80	11.70	17.75	0.0

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

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

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Not Applicable

Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

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

Source: Soil Resource Development Institute (SRDI)

Appendix IV. Layout of the experiment field

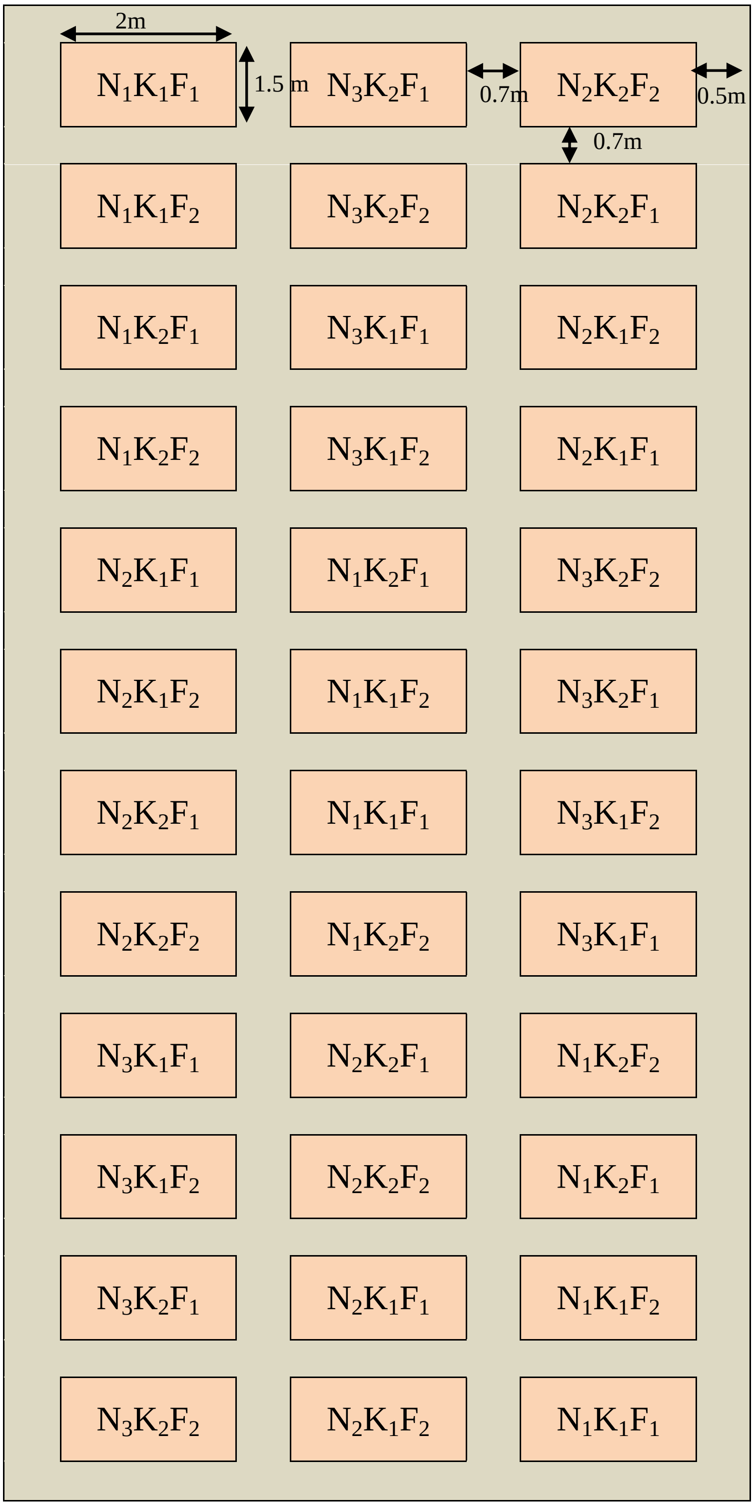

Fig. Layout of the experimental plot

Appendix V. Effect of N, K and FYM on days to first and final emergence of seedlings

Source of variation	Degrees of freedom	Days to emergence	
		Days to first emergence	Days to final emergence
Replication	2	0.132	0.244
Factor A	2	22.16*	26.13*
Factor B	1	0.511	1.712
AB	2	52.05*	44.36*
Factor C	1	2.778	3.511
AC	2	15.72**	16.47**
BC	1	58.77**	51.38*
ABC	2	7.389*	8.524*
Error	22	0.163	0.172

**, indicates significant at 1% level of probability, *, indicates significant at 5% level of probability

Appendix VI. Combined effect of N, K and FYM on plant length of potato at all growth stages

Source of variation	Degrees of freedom	Plant length			
		20 DAP	40 DAP	60 DAP	80 DAP
Replication	2	1.042	3.080	2.362	1.244
Factor A	2	12.16*	22.35*	28.52*	32.36*
Factor B	1	1.111	0.214	2.327	1.327
AB	2	25.05*	52.32**	48.58*	56.28*
Factor C	1	2.778	2.072	1.667	3.324
AC	2	15.72*	15.16*	17.85**	14.38*
BC	1	13.77	18.38	20.52	16.41
ABC	2	27.38*	7.249*	31.147*	27.36**
Error	22	2.017	2.062	2.086	2.122

**, indicates significant at 1% level of probability, *, indicates significant at 5% level of probability

Appendix VII. Combined effect of N, K and FYM on number of stem hill^{-1} at different growth stages

Source of variation	Degrees of freedom	Number of stem hill^{-1}			
		20 DAP	40 DAP	60 DAP	80 DAP
Replication	2	0.001	0.002	0.005	0.005
Factor A	2	1.036**	1.042*	1.106*	1.106**
Factor B	1	0.014	0.016	0.022	0.022
AB	2	2.312*	2.504*	2.478*	2.478*
Factor C	1	0.112	0.119	0.132	0.132
AC	2	2.154*	2.166**	2.148*	2.148*
BC	1	3.362	3.412	3.371	3.371
ABC	2	4.154**	5.103*	4.188*	4.188**
Error	22	0.012	0.014	0.018	0.018

**, indicates significant at 1% level of probability, *, indicates significant at 5% level of probability

Appendix VIII. Combined effect of N, K and FYM on number and weight of tuber hill^{-1} of potato

Source of variation	Degrees of freedom	Tuber hill^{-1}	
		Number of tuber hill^{-1}	Weight of tuber hill^{-1}
Replication	2	0.012	0.007
Factor A	2	4.574*	2.032**
Factor B	1	1.312	0.144
AB	2	3.206**	1.055**
Factor C	1	1.152	0.206
AC	2	4.274*	1.075**
BC	1	6.314	2.136
ABC	2	4.266*	3.104**
Error	22	0.118	0.016

**, indicates significant at 1% level of probability, *, indicates significant at 5% level of probability

Appendix IX. Combined effect of N, K and FYM on tuber yield of potato

Source of variation	Degrees of freedom	Tuber yield	
		Tuber yield plot^{-1}	Tuber yield ha^{-1}
Replication	2	0.124	0.163
Factor A	2	6.314**	7.287*
Factor B	1	1.254	1.366
AB	2	12.20*	13.70*
Factor C	1	1.529	2.622
AC	2	7.312*	8.414*
BC	1	6.614	7.378
ABC	2	14.08**	14.26**
Error	22	1.137	1.117

**, indicates significant at 1% level of probability, *, indicates significant at 5% level of probability

Appendix X. Combined effect of N, K and FYM on seed and non-seed potato yield

Source of variation	Degrees of freedom	Seed and non-seed potato yield ha^{-1}	
		Seed potato	Non-seed potato
Replication	2	0.144	0.148
Factor A	2	5.217**	4.879**
Factor B	1	1.279	1.433
AB	2	10.54*	9.824*
Factor C	1	1.573	2.897
AC	2	6.904**	8.194*
BC	1	8.631*	6.644*
ABC	2	11.86*	10.27*
Error	22	0.201	1.188

**, indicates significant at 1% level of probability, *, indicates significant at 5% level of probability

Appendix XI. Combined effect of N, K and FYM on % seed and non-seed potato yield by weight

Source of variation	Degrees of freedom	Mean square of	
		% Seed potato yield by weight	% Non-seed potato yield by weight
Replication	2	1.036	1.143
Factor A	2	8.514*	6.833*
Factor B	1	3.384	2.462
AB	2	14.96*	10.53*
Factor C	1	2.852	3.878
AC	2	12.68**	11.64**
BC	1	14.37*	13.66**
ABC	2	18.45**	16.29*
Error	22	2.207	2.187

**, indicates significant at 1% level of probability, *, indicates significant at 5% level of probability

Appendix XII. Combined effect of N, K and FYM on different graded seed potato yield

Source of variation	Degrees of freedom	Mean square of	
		'A' grade seed (28 mm - 45 mm)	'B' grade seed (45 mm - 55 mm)
Replication	2	0.336	0.423
Factor A	2	6.529**	5.914**
Factor B	1	2.936	3.833
AB	2	12.63*	10.17*
Factor C	1	2.218	1.724
AC	2	10.88**	11.81**
BC	1	12.72*	8.376*
ABC	2	16.59*	15.57*
Error	22	0.414	0.384

**, indicates significant at 1% level of probability, *, indicates significant at 5% level of probability

Plate 1: Experimental Field Preparation

Plate 2: Seed Showing

Plate 3: Data Collection

Plate 4: Harvesting of potatoes