EFFECT OF POTASSIUM ON THE YIELD OF ONION

MD. RAKIB HASAN

DEPARTMENT OF SOIL SCIENCE

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

SHER-E-BANGLA NAGAR, DHAKA-1207, BANGLADESH

JUNE, 2021

EFFECT OF POTASSIUM ON THE YIELD OF ONION

BY

MD. RAKIB HASAN

REGISTRATION NO. 14-05992

A Thesis
Submitted to the Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka
In partial fulfillment of the requirements
For the degree of

MASTER OF SCIENCE
IN

SOIL SCIENCE

SEMESTER: JANUARY-JUNE, 2019

Approved by:

(Professor A. T. M. Shamsuddoha)
Supervisor

(Prof. Dr. Alok Kumar Paul)
Co-supervisor

(Prof. A. T. M. Shamsuddoha)
Chairman
Examination Committee

DEPARTMENT OF SOIL SCIENCE
Sher-e-Bangla Agricultural University (SAU)
Sher-e-Bangla Nagar, Dhaka-1207

CERTIFICATE

This is to certify that the thesis entitled,**“EFFECT OF POTASSIUM ON THE YIELD OF ONION”**submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in SOIL SCIENCE,** embodies the result of a piece of bona fide research work carried out by **MD. RAKIB HASAN**, Registration No. **14-05992** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Place: Dhaka, Bangladesh

Prof. A. T. M. Shamsuddoha
Department of Soil Science
Sher-e-Bangla Agricultural University,
Supervisor

DEDICATED

TO MY RESPECTIVE

TEACHER, BELOVED

PARENTS & MY WIFE

ACKNOWLEDGEMENT

At first, the author takes the opportunity to express his deepest sense of gratefulness to Almighty Allah who enables the author to complete his research work for the degree of Master of Science (MS) in Soil Science. The author really does not have adequate words to express his heartfelt sense of gratification, ever indebtedness and sincere appreciation to his benevolent teacher and research supervisor, **Prof. A. T. M. Shamsuddoha,** Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka-1207, for his constant help, scholastic guidance, planning experiment, valuable suggestions, timely and solitary instructive criticism for successful completion of the research work as well as preparation of this thesis. It is a great pleasure for the author to express his sincere appreciation, profound sense, respect and immense indebtedness to his respected co-supervisor, **Prof. Dr. Alok Kumar Paul** and Chairman, **Prof. A. T. M. Shamsuddoha**, Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka-1207, for providing him with all possible help during the period of research work and preparation of the thesis. The author would like to express his deepest respect and boundless gratitude to all the respected teachers of the Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka-1207 for their sympathetic co-operation and inspiration throughout the course of this study and research work. Cordial thanks are also due to all laboratory staff and field workers of SAU farm for their co-operation to complete his research work in the field. The author deeply acknowledges the profound dedication to his beloved Parents and Sisters for their moral support, steadfast encouragement and continuous prayer in all phases of academic pursuit from the beginning to the completion of study successfully. Finally, the author is deeply indebted to his friends and well-wishers especially Ramisha Ibnat Rifa, Md. Azaharul Islam Arif, Sajed Hasan Bappy, Tarik Ahmed, Raju Mir, Sajedul Islam and Sathee Tirkey for their kind help, constant inspiration, co- operation and moral support which can never be forgotten.

The Author

Place: SAU, Dhaka

EFFECT OF POTASSIUM ON THE YIELD OF ONION

BY

MD. RAKIB HASAN

ABSTRACT

A field experiment was conducted at the Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during Rabi season from November 2019 to March, 2020 to evaluate the effect of different levels of potassium on growth and yield of onion (BARI piaj-4). The experiment was laid out in a RCBD with three replications. Eight different levels of potassium were used as treatments viz. 0, 18, 36, 54, 72, 90, 108, and 126 kg ha^{-1}. Results revealed that application of potassium had a significant effect on growth parameters specifically Plant height (cm), Number of leaves per plant, Length of leaves (cm), Fresh weight of leaves (g), Fresh weight of bulb (g), Diameter of bulb (cm), Dry weight of bulb (g), Length of bulb (cm) and Yield (t ha^{-1}). The highest bulb yield (19.83 t ha^{-1}) and maximum bulb diameter (5.05cm), weight of onion bulb(65.67g) were obtained with 90 kg K ha^{-1}.The lowest bulb yield (13.07 t ha^{-1}) was recorded in the plot that received no potassium fertilizer. On overall considerations, 90 kg K ha^{-1} was considered as optimum dose for the yield of onion under the experimental conditions.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	Full meaning
AEZ	Agro-Ecological Zone
Agric.	Agriculture
Agril.	Agricultural
BBS	Bangladesh Bureau of Statistics
BCPC	British Crop Production Council
cm	Centi-meter
CV	Coefficient of variation
^0C	Degree Celsius
df	Degrees of freedom
DAT	Days After Transplanting
et al.	And others
FAO	Food and Agriculture Organization
g	Gram
ha	Hectare
CRSP	Collaborative Research Support Program
J.	Journal
kg	Kilogram
LSD	Least Significant Difference
mg	Milligram
MP	Muriate of Potash
RCBD	Randomized Complete Block Design
SAU	Sher-e-Bangla Agricultural University
TSP	Triple Super Phosphate

CHAPTER I

INTRODUCTION

Onion (*Allium cepa* L.) is by far the most important bulb crop and one of the most popular vegetable crops in the world (FAO, 2016). However, in Bangladesh, it is widely used as a cooking seasoning. The world's largest onion producing countries are China, India, the United States, Japan and Spain (FAO, 1993). A serving of 100 grams of edible onion bulbs contains 1.4 grams of protein, 11.2 grams of carbohydrates, 12 milligrams of ascorbic acid, fiber (0.6 grams), water (86.8 grams) and a variety of vitamins, such as vitamin A (0.012 mg), vitamin C (11 mg), thiamine (0.08 mg), riboflavin (0.01 mg), niacin (0.2 mg) and some minerals, such as phosphorus (39 mg), calcium (32 mg), sodium (1, 0 Milligrams), iron (0.7 milligrams) and potassium (rank 157). Mg) and 49 calories (Encyclopedia, 2017; Suresh, 2007). Recent studies have shown that onions in the diet play an important role in preventing heart disease and other diseases (Encyclopedia, 2017). Among spices grown in Bangladesh, onion production ranks first and planting area ranks second (Ministry of Agriculture, 2016). It is grown in almost all areas of Bangladesh, but it is commercially grown in larger areas such as Faridpur, Rajshahi, Dhaka, Mymensingh, Comilla, Jessore, Rangpur and Pabna (anonymous, 1998). In 2013-2014, Bangladesh's onion production was 13.87,000 tons, covering an area of 3.73,000 acres, with an average yield of 3,718 kg/acre (BBS, 2016). With the increase in population, the demand for and imports of onions are increasing, but due to land restrictions, it is impossible to increase crop production horizontally. The expansion of onion cultivation will hinder the cultivation of other high-yield crops, especially rice, the staple food in Bangladesh. The only way to solve the problem is to increase the yield per hectare. The average yield per hectare is about 6.82 tons, which is much lower than other developed countries with an average yield of more than 17.5 tons hectares (FAO, 2016). The successful cultivation of onion depends largely on the best cultural management practices. This includes careful application of fertilizers and chemical fertilizers, effective use of available soil moisture, planting distance and planting time. Soil fertility is the main factor that increases the yield of any crop. Therefore, soil nutrient management is a very important research field.

There is a significant response of onion to both inorganic and organic fertilizer (Nasreen and Hossain. 2000; Ullah, 2003). The status of nitrogen, phosphorus, potassium and Sulphur, zinc and boron for the growth and yield of vegetable crops is well established. Among the nutrients, potassium acting a significant role on onion production.

The onion is a shallow rooted and potash-loving crop; hence impartially high concentration of nutrients including potassium must be sustained in the upper layer of the soil. Generally, a heavy dose of fertilizer is suggested for onion cultivation

(MacGillibray, 1961). Like other tuber and root crops, onion is very responsive to potash. Among the several nutrients essential to produce high yield of onion, potassium is measured to a very important element due to its effect for translocation of photosynthates, storage quality, bulb size, bulb numbers and yield per plant

(Sangakkara and Piyadasa, 1993). Potassium is one of the three major nutrients taken up by the plant in huge amounts and the suitable level of potassium increases crop resistance to numerous diseases, stalk and stem breakage and at stress situations.

(Razzak *et al.* 1990). Methods of application of potassium fertilizers have great effect on their application by the crop. Time of application of potash throughout the growing period of onion is important in bulb formation.

Satter and Haque (1975) stated that split application of nitrogen and potash gave higher weight of winter onion bulb than single application of same dose. In Bangladesh. very partial works have been carried out to evaluate the effect of different methods of application of potash on onion crop. There are also numerous evidences of fixation and leaching loss of potassium from the soil

(Huq *et al.* 1990). So suitable doses of potassium and their application method of fertilizer might have help increasing the potassium fertilizer use efficiency. Considering the above facts, the present study was under taken with the following objectives:

- ❖ To evaluate the effect of potassium on growth and the yield of onion (BARI piaj-4).
- ❖ To find out appropriate dose of potassium for maximum yield of onion (BARI piaj-4).

CHAPTER II
REVIEW OF LITERATURE

A number of lessons on the split application of potassium and a limited study with several level of potash on the performance of various crops in many areas of the world were done. The results of split application of potassium were showed to be satisfactory in assessment with the results of single application of the same. This may be due to loss of potash in various forms when the full dose is applied at a time. In shallow rooted crop like onion, split application of nitrogen as well as potash could be more useful for better application by the plant. In Bangladesh, some research works have been done on the influence of split application of potash on some vegetable crops while most of the works were concentrated with the source of muriate of potash (KCI). Research reports about application method and different levels of potassium for onion production under varying soil and climatic conditions of Bangladesh are very scanty. However, some of the associated research findings on onion from various sources of home and abroad have been studied in this chapter which may be important and useful for the present study.

The effects of FYM, ammonium sulphate. super phosphate and potassium sulphate were considered by Katyal (1977). He recommended to use 15 to 20 tons. 100 kg ammonium sulphate, 175 kg supper phosphate and 130 kg potassium sulphate per hectare before transplanting and a top dressing of another 150 kg ammonium sulphate in early stage of growth of onion crop while Rashid (1983) recommended 10 tons cow dung, 175 kg urea, 125 kg TSP and 150 kg MP per hectare for effective onion cultivation in Bangladesh.

Green *et al. (*1980) observed that on a nutrient washed-out sandy loam soil, optimal level of N, P and K fertilizer were 206,105 and 119 kg ha^{-1}, individually for spring sown bulb crops and 209 and 138 kg ha^{-1} of P and K. respectively for autumn-sown bulb crops.

Guptta and Gaffar (1981) studied that the effect of different row spacing under different combinations of nitrogen, phosphorus and potassium on the growth and yield of onion. Application of NPK exerted a significant effect on the yield and yield contributing characters of onion. Economic yield was obtained from NPK application @46:36:36 kg ha'. respectively.

Agarwal *et al*. (1981) observed that the plant received N, P_20_5 and or K_20 at 80-160: 40-80: 40-80 kg ha^{-1} respectively gave the highest yield from plots receiving 160:40:40 or 80:40:80 kg ha^{-1}.

Patil *et al* (1983) had a trial of NPK with the onion cv. White local. In their experiment. N, P_20_5 and K_2O were connected at the rate of 75, 150, 75 or 150 and 50 or 100kg ha^{-1} separately. In case of 75 kg N, abdicate was 222.9 q ha^{-1} With the increment of phosphorus the abandon was too expanded but application of K had small effect on the abdicate

Satanarayana and Arora (1984) detailed that onion bulb abandon expanded with direct application of nitrogen up to 60 kg ha^{-1}, Potash at 40 kg as K_20 ha^{-1}, onion did not affect its bulb yields. Deshmukh *et al.* moreover detailed advantageous impact of K on bulb yield of onion up o 40 kg K_2O ha^{-1}

Madan and Sandhu (1985) taken note that successful plant development and most extreme bulb yield and dry matter abdicate were gotten with the application of N: P_2O_5: K_2O at 120: 60: 60 kg ha^{-1}, individually.

Amin (1985) detailed that nitrogen at 60 kg ha^{-1} coupled with potash at l00 kg ha^{-1} gave the leading execution in regard of bulb distance across (5.86 cm), bulb weight (64.70 g) and surrender of onion (27.47 t ha^{-1}).

In a fertilizer experimental on onion showed by Beresniewiez and Nowosiecski (1986). it was stated that 200 kg K_20 along with 200 kg N. 200 kg P_20_5, 20 kg Mg, 5 kg Mn. 5 kg Zn. 10 kg Cu and 1.5 kg Mo per hectare gave the highest yield. Yield was extra improved when organic fertilizer (lignite or peat) at 100 N43/ha was applied at the same time.

Rudolph (1986) proposed that for a single edit of' onion a base dressing providing P at 30-40 kg and K at 80-100 kg ha^{-1} is prescribed, where crops are to be grown on a location for up to 3 progressive a long time, the prompted rates are 48-56 kg and 180-222 kg of P and K ha^{-1}, respectively.

Saimbhi *et al* (1987) detailed that applying NPK at the most elevated rate gave most noteworthy bulb measure. most extreme surrender (33.89 t ha^{-1}) and best quality of dried out unions. The highest NPK combination was 100 kg N, 60 kg P_20_5 and 60 kg K_20 per hectare.

A field trial was conducted by. Soto (1988) with basic level for P. K and S and response to N. The rate was 100 kg ha^{-1} for each of P_20_5 and K_2O and 50 kg S ha^{-1}. The applied nitrogen ® 0, 55, 100 and 150 kg ha^{-1} and watched that 50 kg N ha^{-1} was the best for abdicate reaction.

Hedge (1988) supported an experiment with cv. Pusa Red onion and observed that application of N fertilizer increased bulb yield but not quality. He also showed that uptake of N. P. K. Ca and Mg nutrients mostly increased due to higher dry matter production.

Bruckner (1988) specified that where K_2O content of the soil was lowest the onion yield was also lowest. The higher nutrient uptake from the soil was found at the site where, higher yield was gained. There was a positive correlation between the K content of onions and the K content of soil, but this was not the case with P. Nitrogen content of onions was less than K content, later the high demand is for potash by this crop.

Singh and Dhankhar (1988) stated that higher level of N reduced anchoring and improved plant growth, ascorbic acid content and yield. Potassium also reduced anchoring and neck thickness and increased plant growth, yield and ascorbic acid, dry matter, sugar and S content of the bulbs.

Duque *et al.* (1989) studied the growth and nitrogen, phosphorus and potassium uptake of onion. The outcomes showed that the plant demand for N and K was higher during early growth stages, whereas demand for P was continuous throughout the progress. Uptake levels were 38.8, 38.6 and 71.3 kg N. P_20_5 and K_20. respectively, for the yield of 2.5 t ha^{-1}.

Singh *et al.* (1989) watched the impact of green manuring on the abdicate of onion. They set up two sorts of lands, one without already green manuring and another with green manuring by *Sesbania aculata.* A combination of 120 kg N and 50 kg K_20 gave the taller plants and the higher number of takes off per plant, maximum bulb weight and diameter per plant and higher bulb abdicate within the to begin with explore green manuring too greatly upgraded plant development and bulb abdicate.

Goohkin (1989) showed experiment on methods of vegetable seed germination upgrading and stated that seed priming in a solution of mixed potassium salts was an effective as the polyethylene glycol (PEG-6000) treatment. Germination vigor and held emergence of seedlings were increased by 17-22% using aerated solutions of 0.4- 0.5% KNO_3 + K_3PO_4. Yield was increased by 2 1-28%.

Jayabharathi (1989) stated that the higher yield of onion was be gotten by using the highest dose of NPK (75 kg of each nutrient). It was 55-75 % superior than the control. With the application of higher dose of fertilizer, the production of big size bulbs in assessment with medium and small size bulbs were produced significantly greater than the lower dose supplied bulbs.

Pandey *et al.* (1990) considered with four levels of nitrogen (0, 50, 100 and 150 kg ha^{-1}), three levels of phosphorus (0, 40 and 80kg ha^{-1}) and two levels of potash (0 and 50 kg ha^{-1} to determine the yield and quality of kharif onion. They initiate maximum yield and net return with N: P: K @ 150:40:50 kg ha^{-1}, respectively.

Baloch *et al.* (1991) gained maximum bulb yield (22.66 t ha^{-1}) with the application of 125 kg N + 75 kg K_20 ha^{-1}. The highest plant height (38.5 cm). number of leaves $plant^{-1}$ (17.0), single bulb weight (82 g), vertical bulb diameter (4.80 cm) and plane bulb diameter (5.78) were gotten with 125 kg N + 100 kg K_2O ha^{-1}.

Amado and Teixeira (1991) studied in a unused area with or without N and all the treatments received 120 kg P_20_5 ha^{-1} and 66 kg K_2O ha^{-1}. Combined application of NPK gave the highest dry matter and bulb yield of onion. They also stated that growth in bulb yield was related to the amount of dry matter of the Cover crop residues.

Jitendra *et al.* (1991) in their experimental of onion CVs applied N @ 80. 120 and 160 kg ha^{-1}, K_20 @ 100 + $ZnSO_4$ @ 2.5 kg ha^{-1}. Higher N levels improved plant growth and yield. K alone and with Zn also improved plant growth, yield and dry matter contents. The highest yield (27.48-32.68 t ha^{-1}) was obtained with the higher rate of N along with K and Zn.

Mukhopadhyay *et al.* (1992) conducted a field trial to study the effect of potassium doses (25, 50, 75 and 100 kg K_20 ha^{-1} a applied as basal and in two equal splits along with a control) on the growth and yield of sweet potato var. IB440. It was detected that the response of potassium fertilizer was more distinct when applied in splits. The highest LAI. CGR, tuber bulking rate, number of tubers per plant. total tuber yield (18.16 and total vine yield (22.12 t ha^{-1}) were noted at 75 kg K 20 ha^{-1} when applied in two equal splits.

Rahim *et al.* (1992) conducted fertilizer experimental on onion generation. Onion sets were planted on 6th November at a dispersing of 25 x 15 cm and provided with 0-160 kg N and potassium 0-100 kg ha^{-1}. while half fertilizers were related some time recently planting and half 30 days after planting. The combined application of higher rates of N and K gave the maximum yield of 11.11 t ha^{-1} compared with 4.5 t ha^{-1} from control.

Sharma (1992) stated that the application of K as K_20 at the rate of 40 kg ha^{-1} gave significantly higher bulb associated with control. Further increase in K level did not show any useful effect. He also found that the economic optimum doses were 81 kg nitrogen and 59 kg K_20 ha^{-1}. The response of optimum level of N and K was up to 43.3 t ha^{-1}.

Nasiruddin *et al.* (1993) described that the effect of potassium and Sulphur on growth and yield of onion applied also exclusively or combined increased plant height, leaf production ability, bulb diameter and weight as well as the bulb yield. They suggested too kg potash and 30kg Sulphur per hectare for cultivation of onion.

Sangakkara and Piyadasa (1993) observed the effect of eight levels of potassium supplied as KCI, when applied as either basal or split (basal and top dressing) on the growth and yields of multiplier (onion) under a uniform level of nitrogen and phosphorus. These treatments were established under both rainfed and irrigated conditions. Potassium increased bulb size, bulb numbers and yields per plant of multiplier (onion), along with dry weights. When potassium was applied as basal, optimum yield was obtained at 100 kg K_20 per hectare. Split applications reduced the potassium requirement for optimal yields to 75 kg K_20 per hectare. Application of irrigation did not reduce the potassium content required for optimal yield. though the response was significantly greater than tinder rainfed conditions.

Vachltani and Patel (1993) deliberate the effect of different levels of nitrogen (50, 100 and 150 kg N kg ha^{-1}), phosphorus (25, 50 and 75kg P_20_5 ha^{-1}) and potash (50, 100 and 150 kg K_20 ha^{-1}) on the growth and yield of onion. They initiate that plant height, number of leaves $plant^{-1}$, bulb weight and yield were highest with 150 kg N ha^{-1}. though bulb weight and yield with 100 kg N ha^{-1} were not significantly different. Increasing phosphorus application increased the number of leaves per plant and weight. size and yield of bulbs. Tender of K increased only the number of leaves per plants.

Katwale and Saraf (1994) stated that the maximum bulb yield was found with the application of NPK at the rate of 125:60:100 kg ha^{-1} individually. The rate also gave the highest economic return.

Rizk (1997) accepted that an experiment to study the effect of plant density and NPK fertilizers on the productivity of onion. Lower planting density resulted in higher number of leaves per plant, higher fresh and dry weight, higher leaf areas, higher average bulb weights and higher uptake of N. The sum of bulb yield and yield of marketable bulbs were highest with condensed planting. Increasing the NPK rate increased all vegetative growth parameters measured and increased the yield of bulbs. The best application method for NPK was two equal doses applied at 30 and 60 days after transplanting.

Anwar *et al.* (1998) watched that the application of nitrogen, phosphorus, potassium, sulphur and zinc expanded the number of leaves plant alongside higher bulb yield of onion with the expanding rates up to 150 kg N ha^{-1}. 120 kg P_20_5 ha^{-1}. 120 kg K_20 ha^{-1}. 20 kg S ha^{-1} and 5 kg Zn ha^{-1} at Jessore zone.

Nagaich *et al.* (1998) watched in a field test at Gwalior where S was applied @0, 20, 40 and 60 kg S ha^{-1} and K was 0,40, 80 and 120 kg K_20 ha^{-1} to Nasik Red onions, Bulb yields expanded with the expanding of rate and it was greatest at an intermediate K rate (80 kg K_2O ha^{-1}).

Janardan and Singh (1998) showed a field experiment to know the effect of stockosorb and potassium levels on potato and onion. They initiate that the higher biomass, bulb weight, bulb diameter and bulb yield were found with the application of 300 kg K_20 + 150 kg stockosorbthinkg-1 plus an adequate number of irrigations. The maximum response of 11.1 kg bulbthinkg- 1 stockosorb was noted at 150 kg stockosorbthinha-l. Comparatively higher concentrations of N. P and K were detected in the soils treated with stockosorb.

Sing and Mohanty (1998) deliberate the growth and yield of onion in Orissa. India, in 1995-96 and 1996-97. Nitrogen (80. 120 and 160 kg ha^{-1}). K_20 (80, 100 and 120 kg ha^{-1}) and P_20_5 (60 kg ha^{-1}) were applied in a randomized block to give a total of 8 treatments. With the collective N level plant height became increased in both the trial period. Nitrogen and K at 160 and 80 kg ha^{-1} ,respectively (160:80 NK) resulted in the maximum plant height and 120:80 NK produced the minimum plant height. Bulb girth and number of leaves $plant^{-1}$ were greatest with 160:80 NK and least with 80:80 NK. Bulb weight was greatest with 160:80 NK followed by 120:120 NK and 160:100 NK: a significantly lower bulb, weight was achieved with 80:80 NK. The highest yield (295.8 q ha^{-1}) was achieved with 160:80 NK. Based on these results, the recommended rates for marketable onion production in and around bulb answer are 160 kg N. 80 kg K_20 and 60 kg P_2O ha^{-1}.

Harun-or-Rashid (1998) carried out a field trial at the Bangladesh Agricultural University, Mymensingh on the result of NPKS on growth and yield of onion at different plant spacing. He stated that the maximum bulb weight (40.50 g) and bulb yield (20.751 ha^{-1}) were found from the combination of 125-150-150-30 kg N. P_20_5, K_20. S ha^{-1}, respectively, while the minimum bulb yield (16.75 t ha^{-1}) was recorded from the control treatment. Application of NPKS enlarged the plant height, leaf number, length of bulb. bulb diameter, and bulb weight as well as the bulb yield, He suggested 100-150-200-30 kg N. P_20. K_20, S ha^{-1} for the cultivation of BARI piaj-4 at BAU Farm conditions.

Jiang *et al.* (1998) considered in plot trials with onions were with 0, 375, 450 or 525 kg potassium sulfate ha^{-1}. Bulb sizes increased with increasing rate of fertilizer application and bulb weight enlarged from 231 g with no fertilizer to

324 g with the highest fertilizer rate. Minimum bulb yield was found 69.4 t ha^{-1} with no fertilizer and maximum bulb yield was found with the higher rate of potassium sulphate 85.3 t ha^{-1}. Net benefit increased with growing rate of potassium fertilizer application.

Islam (1999) showed a trial to find out the effects of different sources of potassium and diverse application methods on yield, yield qualities of onion, and potassium uptake by plants at Bangladesh Agricultural Research Institute, Gazipur during the winter of 1994-1995. Three sources of potassium (muriate of potash, potassium nitrate, and potassium sulfate) and three application approaches viz, basal, 1/2 basal+1/2 at 20 days after transplanting (DAT) and 1/3 basal +1/3 at 20 DAT +1/3 at 40 DAT were used in the study. Maximum (35 kg ha^{-1} and minimum (26 kg ha^{-1}) K accumulation was noted in two split applications and a single basal application, respectively.

Rodriguez *et al.* (1999) supported research during 1993-94 and 1994-95 on onion to discovery the effect of nitrogen, phosphorus and potassium rates, sources and forms upon onion (*Allium cepa*) bulb yield and quality. Yield, plant height, leaf number, and polar and equatorial diameters were measured in treatments with different rates, sources and forms of N, P and K. Significant contact between of P and K rates (applied up to 98.2 and 200 kg ha^{-1}, respectively) could not he detected, nor significant contact between N and P.

Nagaich *et al.* (1999) showed research with four rates of potassium (0, 40, 80 and 120 kg K_20 ha^{-1} during 1995-96 and 1996-97 on growth characters, yield qualities, yield and quality of onion on a sandy loam soil in Madhya Pradesh, India. Application of 80 kg K_20 ha^{-1} significantly increased bulb weight $plant^{-1}$ and horizontal diameter of the bulb.

Singh *et al.* (2000) conducted a trial at Rajasthan. during rabi season of 1993-95. Onion cv. N-53 was grown under factorial mixtures of 3 levels each of nitrogen (50, 75 and 100 kg N), phosphate (3, 2, 22.0 and 30.8 kg P) and potash (41.5, 62.2 and 83.0 kg K). It was decided that onion productivity could be improved considerably by the application of 100 kg N, 30.8 kg P and 810 kg potassium ha^{-1}.

Mohanty and Das (2001) detected that the application of 90 kg N and 60 kg K_20 ha^{-1} was better for gaining higher yield with larger bulbs, whereas 30 kg ha^{-1} each of N and K_20 was recommended to appreciate medium bulbs with moderate yield and better keeping quality in long term storage.

Yadav *et al.* (2002) showed a trial on onion cultivars puna Red, White Marglobe, Nasik Red and Rasidpura Local which were supplied with 50, 100 and 150 kg N and K ha^{-1} in Jaipur, Rajasthan, India during the rabi seasons of 1998-2000. Yield, fresh weight of bulb, total soluble solids and allyl propyl disulfide content increased, while ascorbic acid content decreased with the increase in N and K rates. Rasidpura Local noted the highest values for the parameters measured except allyl propyl disulfide content which was highest in Nasik Red.

Mandira and Khan (2003) accepted an experiment with diverse levels of nitrogen (at 0, 100, 150 and 200 kg ha^{-1}) and potassium (0, 75 and 150 kg ha^{-1}) assumed as soil application, to study their effect on the growth, yield and yield qualities of onion cv. N-53 in a study conducted in Tripura. India during rabi season of 2001. Nitrogen at 150 kg ha^{-1}, potassium at 75 kg ha^{-1} and their combination recorded the best performance in terms of yield and growth. All other treatments and their combinations were greater than to control.

Sharma *et al.* (2003) steered a field experiment in Leo. Himachal Pradesh, India. to study the effect of mutual use of NPK and farmyard manure (FYM) on yield attributes, yield. nutrient uptake by onion (*Allium cepa*) as well as on build up of available N. P. K during the rabi seasons of 1998 and 1999. The treatments involved 3 levels of FYM (0, 10 and 20 ha^{-1}) and 4 levels of NPK (0, 50, 100 and 150 % of the recommended dose, which is 125 kg N, 33 kg P and 50 kg K ha^{-1}). Application of fertilizers at the rate of 100 (325 kg N, 33 kg P and 50 kg K ha^{-1}) and 150% (187 kg N. 49kg P and 75 kg K ha^{-1}) of recommended dose recorded an increase of 42 and 56 % over 50% NPK level in bulb yield of onion. Correspondingly, application of FYM at 10 and 201 ha^{-1} enlarged bulb yield by 9 and 19% over 100 % NPK alone, correspondingly. Bulb yield recorded in the case of 100 % NPK along with 20 t FYM ha^{-1} (19.87 t ha^{-1}) was at par with 150 % NPK alone (18.82 1 ha^{-1}) thus signifying the savings of chemical fertilizers of 52 kg N. 16 kg P and 25 kg K ha^{-1}. Use of NPK fertilizers along with FYM also caused by a significant enhancement in available N, P, K status of the soil.

Yadav *et al.* (2003) showed an experiment to regulate the optimum rate of potassium to gain maximum and good quality of onion bulb. Four cultivars (Puna Red, White Macglobe, Nasik Red and Rasidpura local) were given three potassium rates (50, 100 and 150 kg ha^{-1}). The highest K rate noted the highest plant height, leaf number per plant, leaf fresh weight, leaf dry weight. neck thickness, bulb equatorial diameter, bulb polar diameter, bulb fresh weight and bulb yield. The lowest K rate noted the lowest neck thickness.

Singh *et al.* (2003) considered the effects of K fertilizer (30, 60, 90 and 120 kg ha^{-1}) applied as split dressings (1/2 as basal + 1/2 as top dressing at 45 days after transplanting or DAT or 1/3 as basal + 1/3 top dressing at 45 DAT + 1/3 top dressing at 90 DAT) on the seed yield of onion cv. N-53 at Dhaulakuan. Himachal Pradesh. India during the rabi season of 1994/95 and 1995/96. The application of K at 60, 90 and 120 kg hal^{-1} in three splits (1/3 as basal, 1/3 as top dressing at 45 DAT + 1/3 as top dressing at 90 DAT) encouraged early bolting, and caused in the greatest height of flower stalks, 1000-seed weight and seed yield. Thus, the application of 60 kg K ha^{-1} in three splits was the most economical rate for onion.

From these evaluations, it is detected that both potassium and its fertilizing method played a dynamic role on the growth and yield for a successful onion cultivation. In most cases. muriate of potash (KCI) was used as source of potash. Consequently, optimum level of potassium laterally with application method might play a significant role to increase onion production. The present study was, therefore, assumed to test the efficiency of different levels of potash with different fertilizing methods.

CHAPTER III

MATERIALS AND METHODS

This chapter organizes the materials and methods used in the experiment, including a brief overview of the experimental location, onion variety, soil, climate, land preparation, experimental design, treatments, and soil and plant sample collection cultural operations, and analytical methods. Here are the specifics of the study technique.

3.1 Experimentation site Description

3.1.1 Location

The research work was conducted in rabi season at the Sher-e-Bangla Agricultural University Farm, Sher-e-Bangla Nagar, Dhaka-1207 during the rabi season of October. 2019 to March 2020. It is located at 90.2^0N and 23.5^0E latitude. The specific location of experimental site is presented in map.

3.1.2 Soil

The soil in the experimental field is from the Tejgaon series of AEZ No. 28, Madhupur Tract, and is classed as Shallow Red Brown Terrace Soils according to Bangladesh soil classification. Before the experiment began, a composite sample was prepared by collecting dirt from numerous locations across the field at a depth of 0-15 cm. The soil was air-dried, crushed, and sieved through a 2 mm sieve before being examined for physical and chemical characteristics. Appendices II details some of the soil's early physical and chemical features.

3.1.3 Climate

The climate of trial site is sub-tropical, characterized by three distinct seasons, the monsoon from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October. The monthly average temperature, humidity and rainfall during the crop growing period were collected from Weather Yard, Bangladesh Meteorological Department, and presented in Appendix III.

3.2 Collection and preparation of initial soil sample

Before initiation of the experiment, initial soil samples at 0-15 cm depth were collected from different plots of experimental field. The composite soil sample was air dried, ground to pass through 2 mm sieve and used for analysis of physical and chemical properties of soil.

3.3 Treatment of the experiment

The experiment consisted of application different levels of potash on BARI piaj-4

The levels of potassium were as Follows:

Eight levels of potassium:

K_1: Control (0 kg K ha^{-1}) K_5: (72 kg K ha^{-1})

K_2: (18 kg K ha^{-1}) K_6: (90 kg K ha^{-1})

K_3: (36 kg K ha^{-1}) K_7: (108 kg K ha^{-1})

K_4: (54 kg K ha^{-1}) K_8: (126 kg K ha^{-1})

3.4 Layout of the experimental plots

Total number of plots	:	24
Individual plot size (2m×2.5m)	:	5 m^2
Space between block to block	:	0.75 m
Block to border (row)	:	0.50 m
Block to border (column)	:	0.50 m
Replication	:	3
Drainage size	:	0.38 m

The layout of the experimental plots shown in figure 1

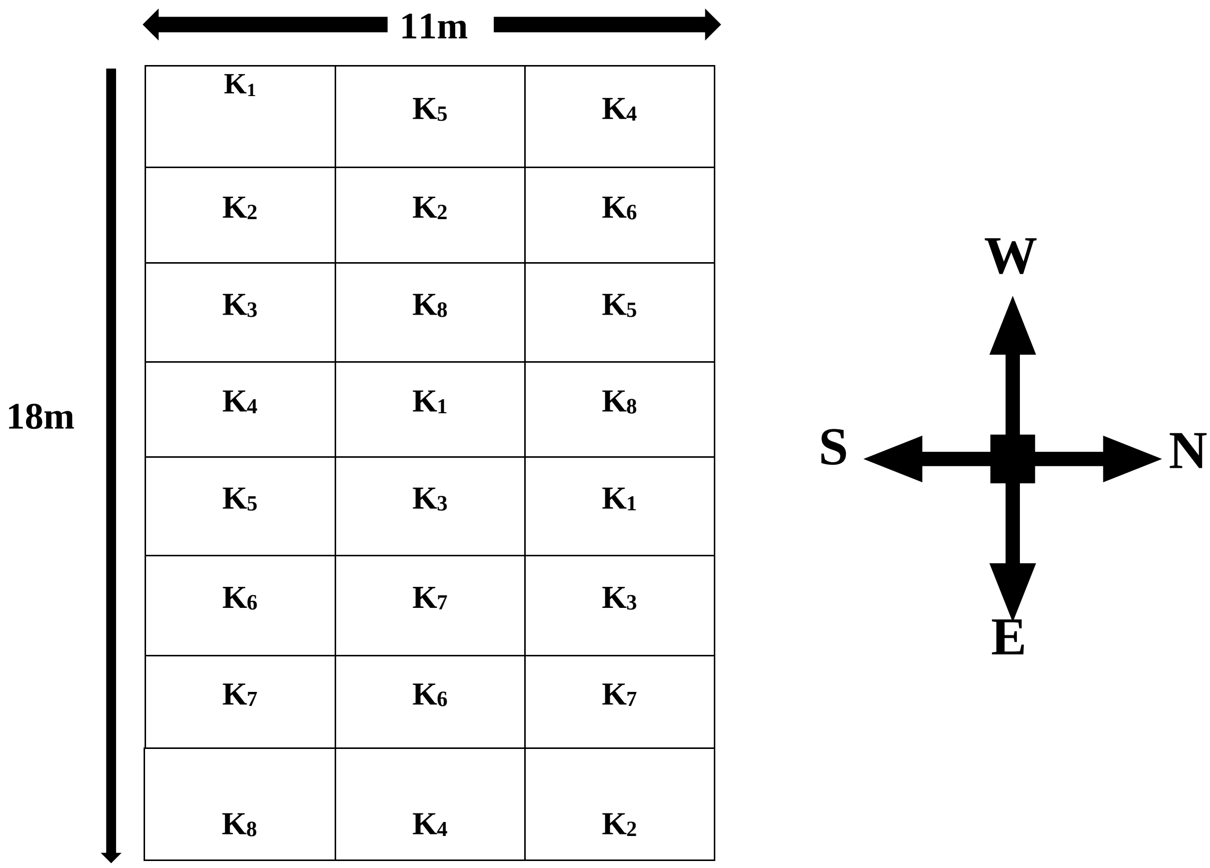


Fig. 1. Field layout of the experimental plot

3.5 Cultivation of Onion

3.5.1 Seed sowing

The first date of seed sowing was 1st November 2019. The sprouted seeds (3-4 in number) were sown directly in the raised seedbed for raising seedlings to be transplanted. The young seedlings were exposed to dew by night and mild sunshine in the morning and evening. Shades were given over the seedbed to retain soil moisture and to save the seedlings from direct sun and rain. When the seedlings of the seedbeds attained a height of about 10 cm, thinning operation was done keeping only one healthy seedling in right place.

3.5.2 Site selection

The land selected for raising seedling was light in texture and well drained. The land was opened and left for drying for 10 days. Bigger clods were broken into pieces and finally the soil was made loose. friable and brought to fine tilth. All weeds and stubbles were removed and the soil was mixed with well-decomposed cow dung applying Furadan 5G 20 kg ha^{1} was covered by polythene for two days. The seedbed was 3m x 1m in size with a height of about 20 cm. Onion seeds were soaked overnight (twelve hours) in water and allowed to sprout in a piece of moist cloth keeping in the sun shade for one day.

3.5.3 Land Preparation

The trial plot was opened in the month on November 2019 with the help of a tractor. Subsequently, the land was prepared by numerous ploughings and cross ploughings with a power tiller followed by laddering. Weeds and stubbles were removed and the large clods were broken into smaller pieces to acquire a desirable tilth of friable soils for transplanting the seedlings.

3.5.4 Rate of manures and fertilizers

Manures and fertilizers were used in the experiment according to the recommendation of BARI as follows:

Fertilizers	Dose ha^{-1}
Urea	140 kg ha^{-1}
Triple super phosphate	40 kg ha^{-1}
Gypsum	20 kg ha^{-1}
Muriate of potash	As per treatments

Table 1: Fertilizers recommendation of BARI

3.5.5 Fertilizer application

During final field preparation, the whole amount of thoroughly decomposed cow dung, as well as all fertilizers except nitrogen and potassium, were put to the soil. Urea was used in this experiment. There are three equal divides. The first divide was applied during final land preparation, while the second split was applied after that. After 20 days of transplanting, the second split was applied occurs, followed by a third split after 40 days. The fertilizer had been extensively incorporated into the soil.

3.5.6 Seedling transplantation

28-days-old seedlings that were healthy and disease-free were plucked from the seedbeds and placed in the main field with a line-to-line spacing of 10 cm. On 28th November 2019 and plant to plant spacing of 10 centimeters. In the afternoon. the seedbed had previously been irrigated. Uprooting the seedlings in order to avoid root damage. The seedlings had been Immediately after transplantation. the plants were watered. A few seedlings were also put next to one other. Gap fills will be done in the experimental area.

3.5.7 Intercultural operation

After transplanting the seedlings, intercultural operations were done whenever required for getting better growth and development of the plants. So, the crop was always kept under careful observation.

3.5.7.1 Gap fillings

Within one week, damaged seedlings were replaced with healthy plants from the surplus plants.

3.5.7.2 Weeding and mulching

To keep the crop free of weeds and pests, weeding was done three times after transplantation. Mulching was accomplished by fracturing the soil crust for easier aeration a soil conservation. When moisture is required, especially after irrigation, it should be provided.

3.5.7.3 Plant protection

Preventive measure was taken against soil borne insects. For the prevention of Cutworm Furadan 5G@20 kg ha^{-1} was applied. No insect pest infestation was found in the field after pesticide application. Few, a days after transplanting some plants were attacked by purple blotch disease caused by *Alternaria puri*. It was controlled by spraying Ruvral 50WP four times at 10 days interval after transplanting.

3.6 Harvesting

The crop was used to harvested according to their maturity, they reached adulthood in 28th March 2020 majority of the leaves have dried out and are collapsing at the neck of the plant bulbs.

3.7 Data collection

Data on different parameters were collected from the sample plants. Five plants were chosen at random from each plot to capture data in order to prevent the border effect and achieve the best level of accuracy. The outside rows, as well as the outer plants in the middle rows, were avoided for this.

3.8 Data were collected on the different parameters:

1. Plant height (cm)

2. Number of leaves

3. Length of leaves (cm)

4. Fresh weight of leaves (g)

5. Fresh weight of bulb (g)

6. Diameter of bulb (cm)

7. Dry weight of bulb (g)

8. Length of bulb (cm)

9. Yield (t ha^{-1})

3.8.1 Plant height (cm)

Following 30, 50, 70, and 90 days after transplanting, the height of the chosen five plants in each plot was measured (DAT). The height was measured in centimeters (cm) from the floor to the ceiling. The length of the bulb's neck to the tip of the longest leaf, as well as the average heights of the chosen five. The plants were taken to see how quickly they grew.

3.8.2 Number of leaves

After 30 days, the number of leaves per plant on chosen plants was counted, and the average of five plants was used to determine the number of leaves per plant. The quantity of leaves at 50, 70, and 90 DAT, plant was also detected.

3.8.3 Length of leaves (cm)

From the pseudo stem to the tip of the leaf, the length of the leaf was measured in centimeters. The average of five chosen plants at 30, 50, 70, and 90 DAT was recorded.

3.8.4 Fresh weight of leaves (g)

The leaves are cutting from onion and the fresh leaves from field collected and weight is taken properly measured.

3.8.5 Fresh weight of bulb (g)

Five plants from each unit plot were plucked at random. By cutting pseudo stem and leaving just 2.5 cm with the bulb, the top was removed. In an electric balance, five bulbs were weighed, and the average was used to determine the individual bulb weight.

3.8.6 Diameter of bulb (cm)

The diameter of the bulb was measured at the center section of the bulb during harvest from five different angles. A slide caliper was used to randomly choose plants, and the average was taken.

3.8.7 Dry weight of bulb (g)

Each unit plot's complete onion bulbs were collected. Each unit plot's after drying the onion dry weight of bulbs was recorded separately.

3.8.8 Length of Bulb (cm)

The length of the bulb was measured with a slide caliper from the neck to the bottom of the bulb from five randomly selected plants during harvest, and the average was calculated.

3.8.9 Yield (t ha^{-1})

The weight of the bulbs was then measured in kilograms (kg) from each unit plot using a simple balance. The bulb yield per plot was calculated to provide a yield in tons per hectare.

3.9 Soil sample analysis

In the laboratory of the Department of Soil Science, Sher-e-Bangla Agricultural University, SRDI, Dhaka, the initially acquired soil samples were tested for both physical and chemical properties texture, p^H, organic matter, total N, available P, exchangeable K and available S were among the parameters investigated. (Table 5). shows the physical and chemical characteristics of the original soil. Standard procedures were used to examine the soil.

3.10 Post harvest soil sampling

The post soil samples were taken at a depth of 0 to 5 cm at harvest. The samples were taken from each plot using an auger to create a plot wise individual composite sample. Plant roots, leaves, and other plant parts were picked up and discarded after soil samples were taken. The samples were then air dried and analyzed for physical and chemical analyses, store in a clean plastic container.

3.11 physico-chemical properties of soil

3.11.1 Soil Physical Properties

3.11.1.1 Particle size analysis

The hydrometer method used to determine the particle size of the soil sample, and the USDA textural triangle was used to determine the textural class.

3.11.1.2 Bulk density

The bulk density was calculated using a core sampler to get a known volume of undisturbed soil cores. It was calculated by dividing the oven dried (at 105°C) mass of the soil core with the inner volume of sampler.

3.11.1.3 Density of particles

The density of soil particles was measured using the Pycnometer technique, as described by black (1965)

3.11.1.4 Porosity

The relationship between bulk density and particle density was used to calculation the porosity of the soil, as shown below:

% Soil Porosity = (1 - (Bulk Density ÷ Particle Density)) x 100

3.11.2 Soil Chemical Properties

3.11.2.1 Soil pH

In soil water suspension, pH was measured using a glass electrode pH meter. Jackson recommended a 1:2.5 soil-to-water ratio (1958).

3.11.2.2 Organic Carbon (%)

The wet oxidation method developed by Walklev and Black was used to measure organic carbon in soil (1935). Following concentrated sulphuric acid digestion and distillation with 40% NaOH, total nitrogen was measured using the micro Kjeldahl method. The resulting ammonia was collected in a boric acid indicator and titrated against 0.02 NH_2 SO_4 (Black. 1965).

3.11.2.3 Available phosphorus

available phosphorus was extracted from soil by shaking with 0.5 M $NaHCO_3$ solution of, pH 8.5 (Olsen et al. 1954). The phosphorus in the extract was then determined by developing blue color using $SnCl_2$ reduction of phosphomolybdate complex. The absorbance of the molybdophosphate blue color was measured at 660 nm wave length by spectrophotometer and available P was calculated with the help of a standard curve.

3.11.2.4 Exchangeable potassium

Exchangeable potassium was determined by 1 N NH_4 OAC (pH 7.0) extract of the soil by using flame photometer (Black, 1965).

3.11.2.5 Available Sulphur

By extracting soil samples using a 0.15 percent CaCl2 solution, the amount of available Sulphur in the soil was measured (Page et al., 1982). The extraction of concentration was calculated turhidinietrically, and the turbidity intensity was quantified with a spectrophotomer at 420 nm wavelength.

3.12 Economic analysis

Based on the cost and benefit of various therapies, the study was conducted in order to determine the most lucrative therapy. By removing the entire input cost from the gross income, the net benefit was computed. The whole market value of an onion bulb was used to determine gross revenue overall market value of fertilizers, as well as other material and non-material costs were used to compute the input cost, which indicated the largest net grain.

3.13 Statistical analysis

All the data were statistically analyzed by using statistix 10 computer package programs for different characters to find out the significance of the difference for different dose of potassium on yield and yield contributing characteristics of onion. The mean values of all the treatments were calculated and analyses of variance for all the characters were performed by the F-test (variance ratio). The significance of the difference among the treatment combinations of means was estimated by least significance difference (LSD) at 5% level of probability.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter comprises the presentation and discussion of the results obtained from the investigation The results of the effects of potassium (K) and their effects on the yield of onion have been presented and discussed in this following chapter. The analysis of variance of data on Plant height (cm) Number of leaves, Length of leaves (cm), Fresh weight of leaves (g), Fresh weight of bulb (g), Diameter of bulb (cm), Dry weight of bulb(g), Length of bulb (cm), Yield (t ha^{-1}) obtained from the present experiment discussed in this chapter. The results and possible interpretations of the results have been given under the following headlines for easy of discussion, comprehension and understanding.

4.1. Effect of K on growth and yield of onion

4.1.2 Effect of K on plant height (cm) of onion

Different of Potassium showed statistically significant variation in respect of the plant height when fertilizers in different doses were applied (Table 2) However among the different doses of fertilizer, K_2 (18 kg ha^{-1}) showed the highest plant height (59.84 cm) namely K_6, K_5, K_4, and K_3 treatments showed the statistically similar plant height. and the different doses of fertilizer. K_1 (0 kg ha^{-1}) showed the lowest plant height (53.13 cm), which was statistically identical with K_8 (126 kg ha^{-1}) and K_7 (108 kg ha^{-1}) potassium. The taller plants at the highest doses received more nutrients which might have encouraged more vegetative growth. Rai (1981) and Pandey and Mundra (1971) reported that the height of plant increased with the increasing levels of nitrogen. A similar result was also found by Vachhani and Patel (1993). This results are in agreement with the findings of Bhuyan (1979) and Yadav *et al.* (2003).

Table 2. Effect of K on plant height (cm)

Treatments	Plant height (cm)
K_1	53.13d
K_2	59.84a
K_3	56.93abc
K_4	58.00ab
K_5	57.67ab
K_6	58.57ab
K_7	53.80cd
K_8	56.04bcd
Significance level	**
SE	1.47
$LSD_{0.05}$	3.15
CV (%)	3.17

****, 1% level of significance   *, 5% level of significance**

Here,

K_1: Control (0 kg K ha^{-1}) K_5: (72 kg K ha^{-1})

K_2: (18 kg K ha^{-1}) K_6: (90 kg K ha^{-1})

K_3: (36 kg K ha^{-1}) K_7: (108 kg K ha^{-1})

K_4: (54 kg K ha^{-1}) K_8: (126 kg K ha^{-1})

4.1.3 Effect of K on the number of leaves of onion per plant

There was a significant variation observed in number of leaves of onion per plant when different doses of potassium were applied (Table 3). Where among the different doses of fertilizers K_4 (54 kg ha^{-1}) treatment, showed the highest number of leaves (6.60) per plant. which was statistically similar with K_3, $K_{2,}$ K_6, K_5 and K_8 treatments with the different fertilizer doses. On the contrary, the lowest number of leaves (5.367) was observed with K_1 (0 kg ha^{-1}), where no fertilizer was applied. The finding of Vachhani and Patel (1993) was in support with these results. The increased number of leaves might be due to favorable effects of nitrogen on the vegetative growth and accumulation of materials that helped proper growth and development of the onion bulb.

Table 3. Effect of K on the number of leaves of onion per plant

Treatments	Number of leaves
K_1	5.367c
K_2	6.20ab
K_3	6.40a
K_4	6.60a
K_5	6.07ab
K_6	6.13ab
K_7	5.73bc
K_8	6.07ab
Significance level	*
SE	0.3
$LSD_{0.05}$	0.65
CV (%)	6.12

****, 1% level of significance   *, 5% level of significance**

Here,

K_1: Control (0 kg K ha^{-1}) K_5: (72 kg K ha^{-1})

K_2: (18 kg K ha^{-1}) K_6: (90 kg K ha^{-1})

K_3: (36 kg K ha^{-1}) K_7: (108 kg K ha^{-1})

K_4: (54 kg K ha^{-1}) K_8: (126 kg K ha^{-1})

4.1.4 Effect of K on the length of leaves of onion

Application of potassium fertilizer at different doses showed a significant variation on the length of leaves of onion (Table 4). Among the different fertilizer doses K_2 (18 kg ha^{-1}) showed the highest leaf' length was (53.67 cm), and second highest was (53.40 cm) statistically similar with the fertilizer dose of K_4 (54 kg ha^{-1}). On the other hand, the lowest leaf length (47.00 cm) was recorded with K_1 (0 kg ha^{-1}) treatment where no potash was applied. Optimum fertilizer doses might be increased the vegetative growth of onion that lead to the highest leaf length. Bulb weight, abdicate of bulb, Yadav *et al* (2003) reported that bulb size increased with increased levels of potassium.

Table 4. Effect of K on the length of leaves of onion

Treatments	Length of leaves (cm)
K_1	47.00b
K_2	53.67a
K_3	50.40ab
K_4	53.40a
K_5	49.60ab
K_6	51.13ab
K_7	47.40b
K_8	50.00ab
Significance level	*
SE	2.05
$LSD_{0.05}$	4.4
CV (%)	4.99

, 1% level of significance   *, 5% level of significance

Here,

K_1: Control (0 kg K ha^{-1}) K_5: (72 kg K ha^{-1})

K_2: (18 kg K ha^{-1}) K_6: (90 kg K ha^{-1})

K_3: (36 kg K ha^{-1}) K_7: (108 kg K ha^{-1})

K_4: (54 kg K ha^{-1}) K_8: (126 kg K ha^{-1})

4.1.5 Effect of K on the fresh weight of leaves (g) of onion

The fresh weight of leaves as influenced by diverse measurements of K application appeared (Figure 2). The maximum fresh weight of leaves was (26.47 g) with K_2 (18 kg ha^{-1}) and lowest fresh weight of leaves was found from (18.17 g) with K_5 (72 kg ha^{-1}) treatments. The discoveries of this tests are in near similarity with Kumar *et al.* (2006) and they showed that fresh weight of leaves was essentially higher with the application of Ideal level of potassium might have expanded the accessibility of leaves growth and development.

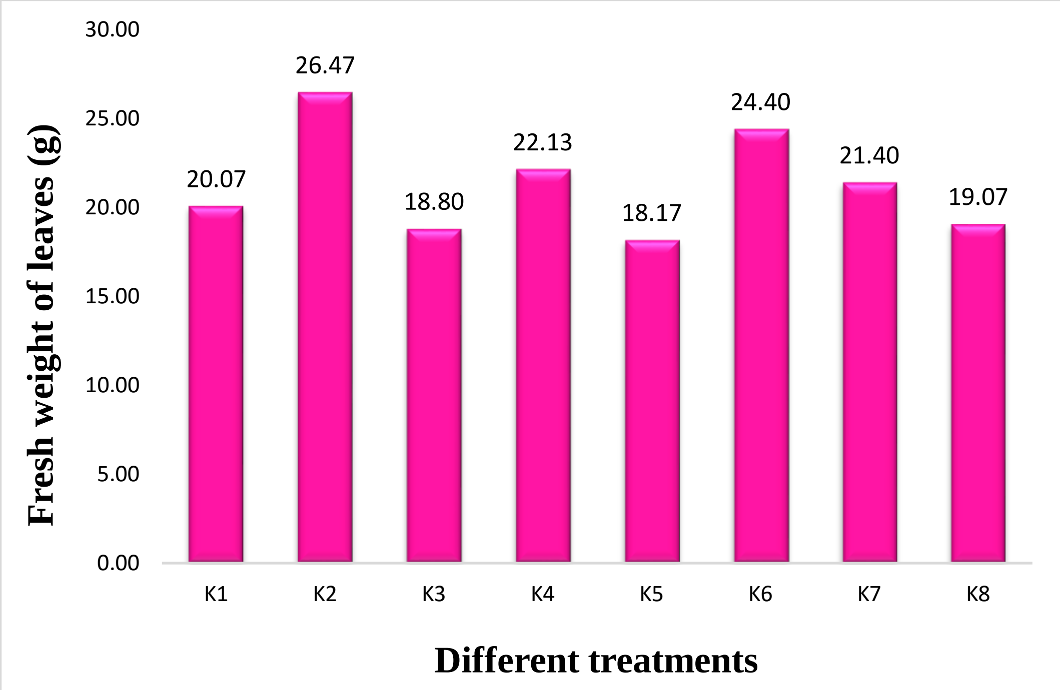


Figure 2. Effect of K on fresh weight of leaves (g) of onion

Here,

K_1: Control (0 kg K ha^{-1}) K_5: (72 kg K ha^{-1})

K_2: (18 kg K ha^{-1}) K_6: (90 kg K ha^{-1})

K_3: (36 kg K ha^{-1}) K_7: (108 kg K ha^{-1})

K_4: (54 kg K ha^{-1}) K_8: (126 kg K ha^{-1})

4.1.6 Effect of K on the fresh weight of bulb (g) of onion

The fresh weight of bulb (g) of onion was influenced by diverse doses of K application appeared (Figure 3). The highest fresh weight of bulb $plant^{-1}$ was (70.73 g) gotten with K_4 (54 kg ha^{-1}) treatment and the lowest fresh weight of bulb $plant^{-1}$ was (60.03 g) gotten with K_7 (108 kg ha^{-1}) treatment. Significant improvement in bulb weight of onion in response to split application of potassium was also reported from a number of investigators at home and abroad (Islam,l999; Nagaich *et al*, 1999; Sangakkara and I'iyadas, 1993; Bhuyan, 1979: Salter and Haque. 1975).

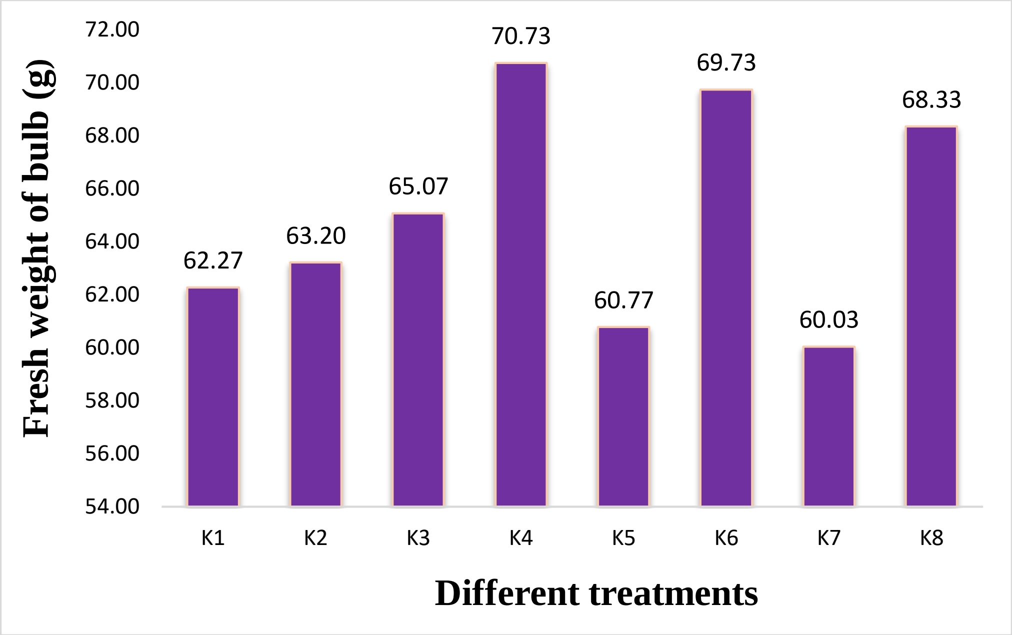


Figure 3. Effect of K on the fresh weight of bulb (g) of onion

Here,

K_1: Control (0 kg K ha^{-1}) K_5: (72 kg K ha^{-1})

K_2: (18 kg K ha^{-1}) K_6: (90 kg K ha^{-1})

K_3: (36 kg K ha^{-1}) K_7: (108 kg K ha^{-1})

K_4: (54 kg K ha^{-1}) K_8: (126 kg K ha^{-1})

4.1.7 Effect of K on diameter of bulb (cm) of onion

Diameter of bulb per plant showed a significant variation due to the effects of different levels of potassium (Figure 4). The highest bulb diameter (5.05 cm) which was obtained from the grown with the dose of K_6 (90 kg ha^{-1}) and the lowest diameter (4.30 cm) as found when the plants were raised from the grown with the dose of K_5 (72 kg ha^{-1}). Similar result was reported by Baloch *et al* (1991). It was revealed that the treatment with the increased gradually higher dose of potassium gave the maximum diameter of bulb. Sufficient potassium nutrient supplied from treatment possibly favored plant growth along with higher bulb. Nasiruddin *et al* (1993) found that the highest bulb yield diameter from 100 kg potash and 30kg Sulphur ha^{-1}.

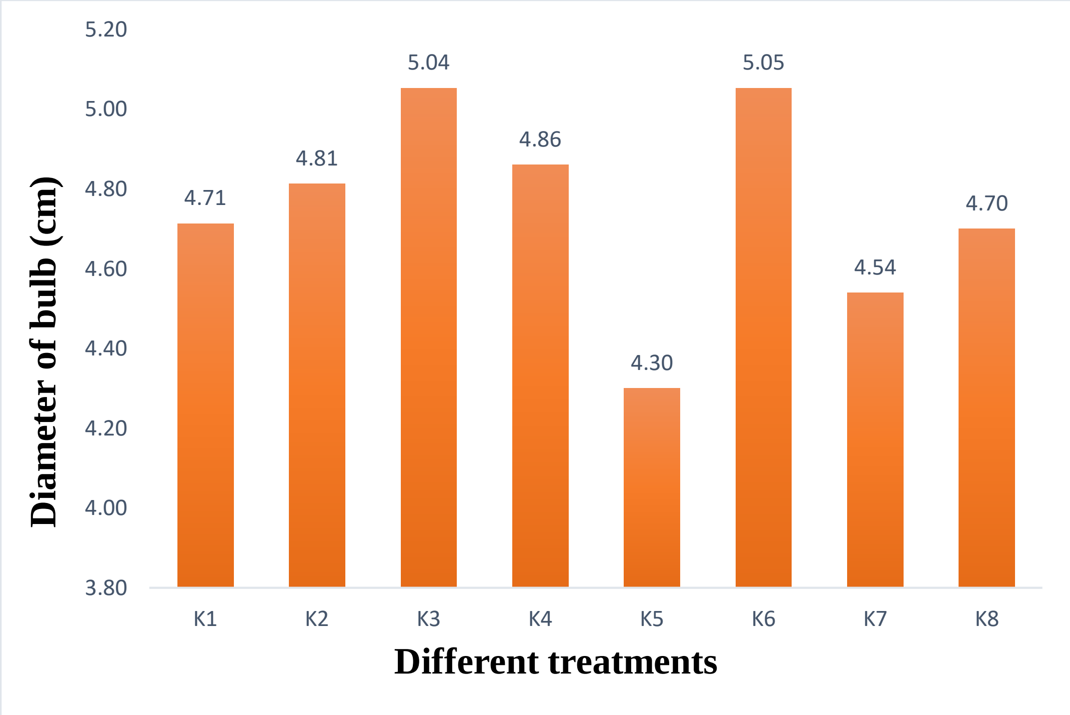


Figure 4. Effect of K on diameter of bulb (cm) of onion

Here,

K_1: Control (0 kg K ha^{-1}) K_5: (72 kg K ha^{-1})

K_2: (18 kg K ha^{-1}) K_6: (90 kg K ha^{-1})

K_3: (36 kg K ha^{-1}) K_7: (108 kg K ha^{-1})

K_4: (54 kg K ha^{-1}) K_8: (126 kg K ha^{-1})

4.1.8 Effect of K on dry weight of bulb (g) of onion

The effect of different doses of potassium fertilizer on the dry weight of bulb of onion was significant (Figure 5). However, the highest dry weight of bulb of onion was (65.67 g) recorded with the treatment of K_6 (90 kg ha^{-1}). On the other hand, the lowest dry weight of bulb of onion (52.87 g) was found in K_7 (108 kg ha^{-1}) treatment. The findings of Jitendra *et al* (1989) were in agreement with the present results, where they stated that 90 kg ha^{-1} K produced better bulb quality.

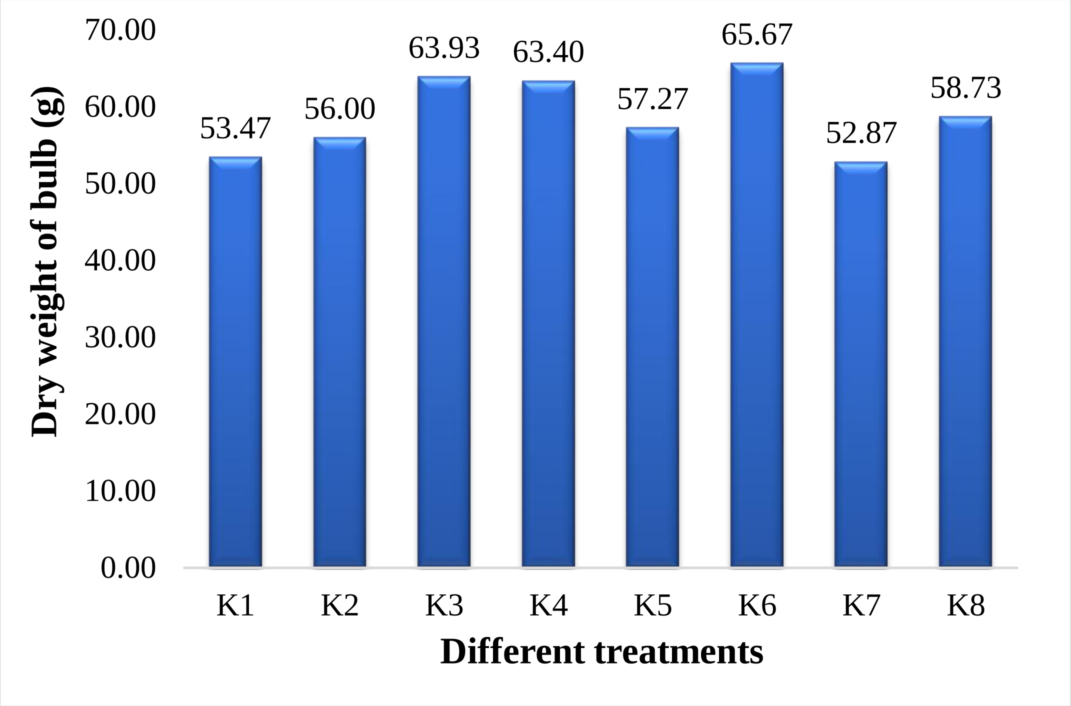


Figure 5. Effect of K on dry weight of bulb (g) of onion

Here,

K_1: Control (0 kg K ha^{-1}) K_5: (72 kg K ha^{-1})

K_2: (18 kg K ha^{-1}) K_6: (90 kg K ha^{-1})

K_3: (36 kg K ha^{-1}) K_7: (108 kg K ha^{-1})

K_4: (54 kg K ha^{-1}) K_8: (126 kg K ha^{-1})

4.1.9 Effect of K on length of bulb (g) of onion

Application of different potassium fertilizer doses showed a significant difference on length of bulb (Figure 6). Along with the different fertilizer doses of K treatment, K_3 treatment showed the highest length of bulb (5.63 cm) and the lowest length of bulb was (4.57 cm) was recorded with K_7 treatment where optimum fertilizer applied doses might be increased the vegetative growth and development of onion that lead to the highest length of bulb. The highest level of potash did not show any more increase in bulb length.

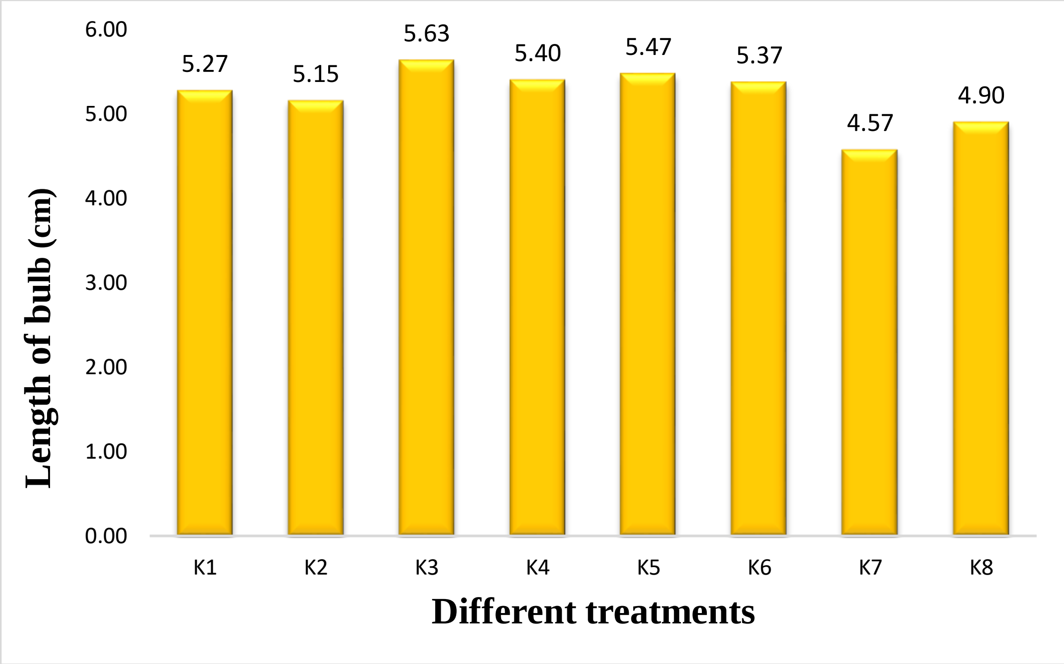


Figure 6. Effect of K on length of bulb (cm) of onion

Here,

K_1: Control (0 kg K ha^{-1}) K_5: (72 kg K ha^{-1})

K_2: (18 kg K ha^{-1}) K_6: (90 kg K ha^{-1})

K_3: (36 kg K ha^{-1}) K_7: (108 kg K ha^{-1})

K_4: (54 kg K ha^{-1}) K_8: (126 kg K ha^{-1})

4.1.10 Effect of K on yield (t ha^{-1}) of onion

The results of the yield effects from different levels of potassium have been shown in (Figure 7). This figure shows apparent that K_6 (90 kg ha^{-1}) treatment gave the highest yield (19.83 t ha^{-1}). On the contrary, the lowest yield of bulb (13.07 t ha^{-1}) was observed with K_1 (0 kg ha^{-1}) where no potash was applied. This result was in agreement with the findings of Rizk (1997) who reported that increased NPKS increased bulb yield. Pandev *et al* (1990) and Bereniewiez and Nowosiceski (1986) also found similar results.

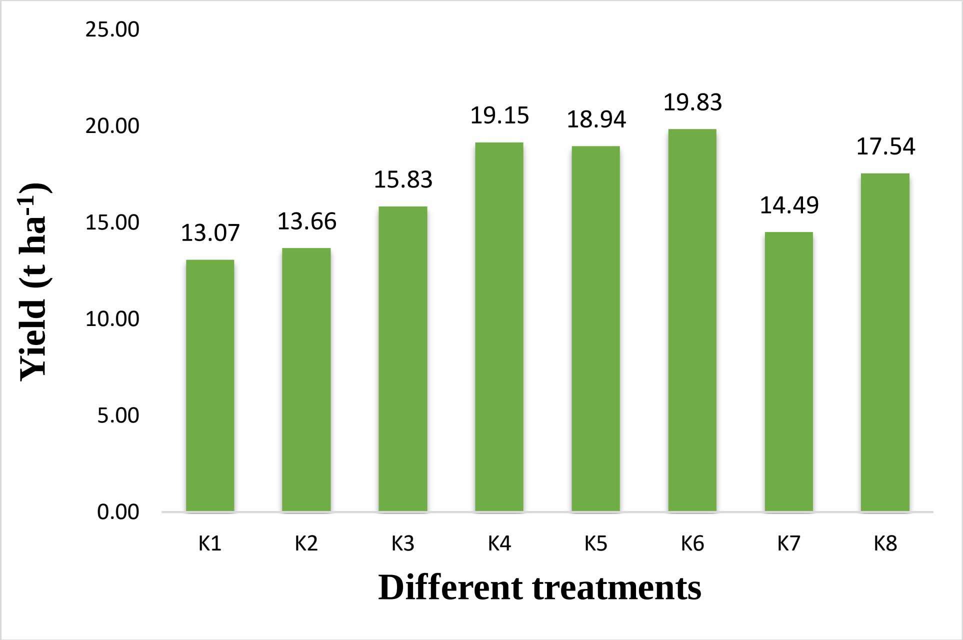


Figure 7. Effect of K on yield (t ha^{-1}) of onion

Table 5. Effect of different doses of potassium (K) fertilizer on post-harvest soil properties

Treatments	pH	Organic carbon (%)	Total N (%)	Available P (ppm)	Exchangeable K (meq/100g)	Available S (µg/g)
K_1	6.53	0.49	0.025e	12.26e	0.13abcd	17.50ab
K_2	6.40	0.47	0.026e	13.46cd	0.11cd	17.33ab
K_3	6.26	0.51	0.029d	13.61bcd	0.09d	18.11ab
K_4	6.20	0.49	0.032d	14.98a	0.12bcd	18.04ab
K_5	6.20	0.48	0.042bc	12.77de	0.14abc	18.48ab
K_6	6.16	0.50	0.053a	14.17abc	0.17a	17.12ab
K_7	6.16	0.49	0.040c	14.65ab	0.14abc	18.94a
K_8	6.13	0.50	0.043b	13.90abcd	0.15ab	15.61b
Significance level	NS	NS	**	**	**	**
LSD	0.1675	0.9957	0.003	0.0028	0.04	0.4773
CV (%)	2.87	11.37	4.34	4.80	17.43	10.06

****, 1% level of significance   *, 5% level of significance**

4.2 Chemical properties of the collected soil after harvesting

After collecting of soil, the Chemical Properties of soil, a composite soil test from 30 cm profundity was collected applying estimate from eight diverse focuses of the test range and a few of its chemical properties some time recently and after collect were decided as displayed in table 5.

4.2.1 Soil pH

There was a non-significant variation recorded for pH in post-harvest soil due to different doses of K fertilizer (Reference section VI B). The maximum pH (6.53) was observed from K_1 treatment though the least pH (6.13) was observed from K_8 treatment (Table 5)

4.2.2 Organic Carbon (%)

Different doses of K fertilizer influenced the organic carbon of soil. From the data the highest value of organic carbon was recorded (0.51%) from K_3 treatment and the lowest organic carbon value was (0.47%) from K_2 treatment. So, there was a non-significant variation between two of them.

4.2.3 Total N (%)

The total N present in the post-harvest soil should be varied significantly because of different doses of K applied (Table 5) and nitrogen content of the post-harvest soil was higher than the initial soil. The total nitrogen content of the post-harvest soil ranged between 0.025 % and 0.053 %. The highest nitrogen (0.053 %) was found in K_6 treatment. The lowest soil N (0.025 %) content was found in K_1 treatment. Sreelatha *et al.* (2006) reported that organic manures had a positive influence on total and available N content of soil.

4.2.4 Available P (ppm)

The available phosphorus content of the post-harvest soil was non-significant due to different doses of K applied in all treatments (Table 5). Available phosphorus content in soil varied from 12.26 to 14.98 ppm due to applied similar phosphorus application. The highest phosphorus content 14.98 ppm was observed in the treatment K_4 which was (14.65 ppm) followed by K_7. The lowest phosphorus content (12.26 ppm) was observed in K_1.

4.2.5 Exchangeable K (meq/100 g soil)

The exchangeable potassium (K) content of the post-harvest soil significantly varied due to different treatments (Table 5). The exchangeable K content of initial soil was 0.10 meq/100 g soil and the values of post-harvest soil ranged from 0.09 to 0.17 meq/100 g soil. The highest exchangeable K 0.17 meq/100 g soil was found in the treatments of K_6. The lowest value 0.09 meq/100 g soil was found in the treatments K_3. The transferrable K enlarged in soils due to the source of nutrients from cow dung throughout the growing period. A similar observation was made by Horuchi *et al*. (2008) who reported that using compost of pea rests enhanced soil NPK and other nutrients in soil.

4.2.6 Available S (ppm)

The existing Sulphur content of the post-harvest soil significantly varied due to similar amount of S applied in all treatments (Table 5). Available Sulphur content in soil varied from 15.61 to 18.94 (µg/g) due to applied different sources of K fertilizer. The maximum sulphur content 18.94 (µg/g) was observed in the treatment $K_{6,}$ which was statistically identical with K_5 treatment. The lowest phosphorus content 15.61 (µg/g) was observed in K_8 treatment.

CHAPTER V

SUMMARY AND CONCLUTION

The experiment was carried out at the Sher-e-Bangla Agricultural University Farm, Dhaka-1207 during 1st November 2019 to 28th March 2020.To estimate the effect of different levels potassium and their interaction on the yield of onion. The soil was silty clay loam in texture having pH 5.80, and organic matter content 1.34 %. The experiment contained of eight different levels of potash viz; 0, 18, 36, 54, 72, 90, 108, and 126 kg ha^{-1}. The experiment was arranged in randomized complete block design with three replications. The size of each unit plot was 2m in 2.5m and 240 plants were accommodated in each plot with spacing 10cm x 10 cm Bulb yield per hectare was estimated on the basis of yield per plot.

Data were noted specifically Plant height (cm), Number of leaves, Length of leaves (cm), Fresh weight of leaves (g), Fresh weight of bulb (g), Diameter of bulb (cm), Dry weight of bulb (g), Length of bulb (cm) and Yield (t ha^{-1}). The collected data were evaluated and the differences between the means were evaluated by Duncan's Multiple Range Test. The experimental results are summarized as follows.

The result of the experiment exposed that the application of potassium had statistically significant effect on plant height. Potassium showed statistically a significant variation in respect of the plant height when fertilizers in different doses were applied. Though among the different doses of fertilizer K_2 (18 kg ha^{-1}) presented the highest plant height (59.84 cm) and K_1 (0 kg ha^{-1}) presented the lowest plant height (53.13 cm) where there was no potassium applied.

The leaf production capability was greatly influenced by the application of Potassium. There was a significant difference observed in leaf $plant^{-1}$ of onion when different doses of potassium were applied. Where amongst the different doses of fertilizers K_4 (54 kg ha^{-1}) treatment showing the highest leaf $plant^{-1}$ (6.60). On the other hand, the lowest leaf $plant^{-1}$ (5.367) was observed with K_1(0 kg ha^{-1}) treatment, where no fertilizer was applied.

The leaf length as affected by different doses of potassium showed a statistically significant variation among the different doses of potassium K_2 (18 kg ha^{-1}) showed the highest leaf length (53.67 cm), which was statistically similar with K_4 (53.40 cm),

K_6 (51.13 cm), K_3 (50.40cm), K_8 (50.00 cm) and K_5 (49.60 cm). On the other hand, the lowest leaf length (47.00 cm) was recorded with K_1 (0 kg ha^{-1}) treatment where no potash was applied.

There was a significant difference detected the fresh weight of leaves $plant^{-1}$ as influenced by different quantities of K application appeared. The maximum fresh weight of leaves $plant^{-1}$ was (26.47 g) with K_2 (18 kg ha^{-1}) and lowest fresh weight of leaves $plant^{-1}$ was found from (18.17 g) with K_5 (72 kg ha^{-1}).

The fresh weight of bulb (g) of onion was influenced by diverse doses of K application appeared. The highest fresh weight of bulb $plant^{-1}$ was (70.73 g) gotten with K_4 (54 kg ha^{-1}) treatment and the lowest fresh weight of bulb $plant^{-1}$ was (60.03 g) gotten with K_7 (108 kg ha^{-1}) treatment, so there was a significant variation among the different doses of potassium.

The diameter of bulb per plant displayed a significant variation because of the effects of different levels of potassium. The highest bulb diameter (5.05 cm) which was gotten from the grown with the dose of K_6 (90 kg ha^{-1}) and the lowest diameter (4.30 cm) as found when the plants were raised from the grown with the dose of K_5 (72 kg ha^{-1}).

The result of different doses of potassium fertilizer on the dry weight of bulb of onion was a significant variation. Though, the highest dry weight of bulb of onion was (65.67 g) noted with the treatment of K_6 (90 kg ha^{-1}). On the other hand, the lowest dry weight of bulb of onion (52.87 g) was gotten from in K_7 (108 kg ha^{-1}) treatment.

Application of different potassium fertilizer doses influenced a significant variation on the length of bulb along with the different doses of K treatment, showed the highest length of bulb (5.63 cm) with K_3 (36 kg ha^{-1}) treatment and the lowest length of was bulb (4.57 cm) was recorded with K_7 (108 kg ha^{-1}) treatment.

The effect of different levels of potassium on the yield of onion have been shown a significant variation. From the data shows apparent that K_6 (90 kg ha^{-1}) treatment gave the highest yield (19.83 t ha^{-1}). On the contrary, the lowest yield of bulb (13.07 t ha^{-1}) was observed with K_1 (0 kg ha^{-1}) where no potash was applied, so there was a significant variation among the different doses of potassium.

From the overhead discussion it can be decided that application of K at the rate of 90 kg ha^{-1} was favorable for maximum yield of onion. However, the results are required to substantiate further with different varieties and soil management practices. Since the present study was conducted in only one agro-ecological zone, further investigations are needed to be carried out in other AEZ of Bangladesh.

REFERENCES

Agarwal, M.L., K.Z. Kinra and H.N. Sing. 1981. Manurial requirement of onion in genetic alluvium of Uttar Pradesh. *Indian J. Ag/It L's., 15(1): 5-10.*

Amado, 'I'.J. and L.A.I. Teixeira. 1991. Cover crop effects on nitrogen supply and onion yield. Onion News letter for the Tropics, No 3: 13-15.

Amin, M.R. 1985. Effect of potash and nitrogen on the growth and yield of onion *(Allium cepa L.).M.Sc (Ag) Thesis. Dept. of 'Hort. B.AU. Pp.15-16.*

Anonymous (1998). Monthly Statistical Bulletin of Bangladesh. Bangladesh Bureau of Statistics. Ministry, Govt. of the People"s Republic of Bangladesh, Dhaka.P.54.

Anonymous. 2000. Production technology of onion BARI Peaj-2 and 3 (in Bengali) leaflet. Spices Research Centre, BARI Bogra. pp. 1-4.

Anwer, M.N. N4.S. Huq, M.J.U. Sarker, A.K.M.S. Hoque and M.S. Islam. 1998. Influence of nitrogen. phosphorus, potassium, sulphur and zinc on onion. *Bangladesh J. Agril Res.* 16(2): 181-186.

Balasa. M. and I. Valentin. 1971. The influence of chemical fertilizers on onion yields. Rev, lion. Vitic. 20(3): 21-26. [Cited from lion. Abst. 4l (4):1088.1971.]

Baloch, M.A.. A.F. Baloch, G. Baloch, A.H. Ansari and S.M. Qayyum. 1991. Growth and yield response of onion to different nitrogen and potassium fertilizer *combination levels. Sarhad J. of Agil., 7(2): 63-66.*

BBS (2016).Year Book of Agricultural Statistics -2014. 26th Series. Bangladesh Bureau of Statistics, Statistics and Informatics Division. Ministry of Planning. Govt. of the People"s Republic of Bangladesh, Dhaka.p.8.

Bereniewiez. A. and 0. Nowosiecksi.1986. Effect of increasing rate of mineral fertilizer with simultaneous application of organic fertilizers and liming on vegetable yield and soil salinity. Biuletyn Warzywniczy, 26(2):41-62. [Cited from 1-tort. Abstr.. 57(4) :262. 19871.

Bhuyan. M.A.J 1979. Effect of split application of nitrogen and potash on the growth and yield of onion *(Allium cepa L.). M. Sc.* (Ag) Thesis. Dept. of Hort. BARI, Mymensingh. pp. *13-21.*

Black, C.A. 1965. Methods of Soil Analysis, Part I and pan II, Am. Soc. Agron. Inc. Madison, Wisconsin, USA. pp. 1149-I 178.

Bruckner, U 1988. Nutrient content of summer onions. Gemuse. German Federal Republic, 24(4): 180-I81.

Duque, M. C. *Ni.*, Perdomo.G.C. E. and Jaramillo, V J. (1989). Studies on the growth and nitrogen, phosphorus and potassium uptake in onion. *Allium cepa L.,* cultivar Ocanera. Acta Agronomica, Universidad Nacional de Colombia. *39(3-4):45-53.*

Encyclopedia (2017), http://www.encyclopedia.com/ plantsand-animals/plants/onions.

FAO. 1993. FAO Quarterly Bulletin of Statistics. Food and Agricultural Organization of the United Nations, Rome, Italy. **10**(3):91-94.

FAO (2016), Production Year Book, Food and Agriculture Organization (FAO), Rome, Italy. www.fao.org/statistics/en

Goobkin. V.N. 1989. Methods of vegetable seed germination improvement. Act-Horticulture. No. 253:213-216.

Green, D.J.,T.J. Cleaver, M.K. Turner, K.13. Niendorf and S. M. H. 1980. Comparison of the effect of potassium on content and quality of 22 different vegetables and Argil. Crops. *Agril Sci,19: 441.*

Guptta, G.S.S. and M.A. Gaffar. 1981. Effect of row spacing and different combinations of NPK fertilizer on the yield of onion. Bangladesh Hort., 8(2): 8-12.

Harun-or-Rashid, A.R.M. 1998. Effect of NPKS on the growth and yield of onion at different plant spacing. MS thesis, Dept. Hort., Bangladesh Agril. Univ., Mymensingh. 72p.

Hedge, D. M. 1988. Effect of irrigation and nitrogen fertilization on yield, quality, nutrient uptake and water use of onion (*Allium cepa* L.). *Singapore I. Primary Ind.,* 16(2): 111-123.

Horiuchi, T and Matsui, T. (2008). Effects of compost and green manure of pea and their combinations with chicken manure and rapeseed oil residue on soil fertility and nutrient uptake in wheat-rice cropping system. African Journal of Agricultural Research Vol. **3** (9), pp. 633-639.

Huq, S.M.I., H. Khatun and H. Ahmed. 1990. Effect of polymer on potassium fixation in soils. *Bangladesh J. Soil Sci. 21(1):1-7.*

Islam, M.A. 1999. Growth and yield response of onion to different sources of potassium and application methods. II. Yield attributes and potassium uptake. *Thai J. of Agril. Sci. 32(4):* 443-452.

Janardan Singh and Singh, J. 1998. Effect of stockosorb polymers and potassium levels on potato and onion. J. *of Potassium Research.* 14(1-4): 78-82.

Jayabharathi, M. 1989. Influence *of* different doses of N, P and K on the yield and quality of aggregatum onion cv. Co.4. *Madras Agril. J.* 76(3): 150-I 55.

Jiang, Q. Zhang. H. Ai, G. Jiang. Q.S. and Zhang. H.L. 1998. Application of potassium fertilizer in onion production. China-Vegetables. Liangshan Agricultural Bureau, Liangshan, Shandong 272600, China. 1998, *No.4.38.*

Jitendra, S.,B.S. Dhankhar and J. Sing. 1991. Effect of nitrogen, potash and zinc on storage Loss of onion bulbs *(Allium cepa* L.). Vegetable Science, 18(I):16-23.

Katwale, T.R. and R. K. Saraf. 1994. Studies on response of onion to varying level of fertilizer doses during Monsoon season in Satpura Plateau. *Orissa J. Hort.,22(1-2):* 13-18.

Katyal, S.L. 1977. Vegetable Growing in India. Oxford & IBH Publishing Co. Calcutta, P. 120.

MacGillibray, J.H. 1961. Vegetable production. Mc Graw Hill Book Co. Inc. New York, pp. 169-273.

Madan. S.P.S and J.S. Sandhu. 1985. Influence of nitrogen, phosphorus and potash levels on the growth, bulb yield and dry matter production of white onion variety Punjab-48. Punjab Vegetable Growers, 20: 17-24.

Mandira C. and Khan, A.H. 2003. Effect of nitrogen and potassium on growth, yield and yield attributes of onion. New- Agriculturist. ICAR Research Complex for NEH Region. Tripura Centre. Lembucherra, West Tripura -799210, India. 14(1/2): 9-11.

Mohanty, U.K and Das J.N. 2001. Response of rabi onion cv. Nasik Red to nitrogen and Potassium fertilization. Vegetable- Science. University of Agriculture and Technology, Regional Research Station, Bhawanipatna - 766 001. Orissa, India. 2001, 28: 1.40-42: 5 ref.

Mukhopadhyav, S.K., H. Sen and P.K. Jana. 1992. Effect of potassium on growth and yield of sweet potato. *J. Root Crops.* 18(1): 10-14.

Nagaich, K.N. Trivedi, S.K. Rajesh, L. and Lekhi, It 1998. Effect of Sulphur and potassium fertilization in onion *(Allium cepa* L.). South-Indian-Horliculture. 46(3-*6)*:266-271.

Nagaich, K.N. Trivedi, S.K. Rajesh, L. and Lekhi R. 1999. Effect of Sulphur and potassium fertilization in onion *(Alliutn cepa L.). Horticultural. J. 12(l): 25-31.*

Nasiruddin, K. M., M. F. Mondal, A. *M.* Farooque and M. A. Baten. 1993. Effect of potassium and Sulphur on growth and yield of onion. *Bangladesh J. Agril. Sci..* 20(1):35-40.

Nasreen. S. and A.K.M. Hossain. 2000. Influence of chemical fertilizers and organic manure on the growth and yield of onion. *Bangladesh. J. Agril Rex.25(2):221-231*.

Olsen, S.R.: Cole, C.V.; Watanabe. F.S. and Dean, L.A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Dept. Agric. Circ. p. 929.

Page, A.L.: Miller. 1(11. and Keency, D.R. 1982. Methods of soil analysis. Part II 2nd ed.). Amer. Soc. Agron. Inc. Madison, Winsconsin, USA.

Pandey,U.13.. Singh. R.Kumar and S.P. Raychaudhury.1990. Response of different levels of N.P.K on the yield and quality of onion. Recent Advances in Medicinal. Aromatic and spice Crops, *1:231-34.*

Patil, P. Y.. V.K. Mahopkar and V.K. Patil. *1983.* Effect of nitrogen. phosphorus and potash on growth and yield of onion. J. Maharashtra Agric. Univ. 8 (I): 41-43. [Cited from Hort. Abstr.. 53(11) :753, 1983].

Rahim, M.A., A. Husain and M.A. Siddique.1992. Production of bulb and storage ability of three cultivars of onion. Punjab Veg. Grower, 17-18:13-20.

Razzaque, A.H.M., M.I. Ali and A.K.M. Habibullah. 1990. Response of Boro rice to potassium application in two soils of Bangladesh. *Bangladesh.J. Soil Sci. 21(1):26-29.*

Rizk, F. A. 1997. Productivity of onin plant *(Allium cepa L.)* as affected by method of planting and NPK application. *Egyptian J. Hort.. 24(2): 2 19-238.*

Rodriguez, S. N. Belmar, N. C and Valenzuela. P. A. (1999). Effect of nitrogen, phosphorus and potassium rates, sources and forms upon onion *(Allium cepa)* bulb yield and quality. Agricultura-Tecnica-Santiago.59(2): 122-132.

Rudolph. M. 1986. Effect of mineral fertilization on seed yield and quality in onions *(Allium cepa L.).* Archiv-fur-Gartenbau, 34(5): 263-271.

Saimbhi, M. S., Gill B. S. and Sandhu. K. S. (1987). Fertilizer requirement of processing onion *(Alliuim cepa* L.) cv. Punjab48. J. of Res., Punjab Agric. Univ., 24(3): 407-410.

Sangakkara, U.R. and E.R. Piyadasa. 1993. Influence of potassium on bulb characteristics of shallot. International Symp. on Alliums for the tropics. *Bangkok. 15-19 Feb. 1993- p 54.*

Satter, M. A and Haque. M. A. (1975). Effect of different levels of nitrogen and potash on the yield of onion, Satter, M.A. and M. A. Haque. 1975. Effect of different levels of nitrogen and potash on the yield of onion, *Bangladesh Hort. 3(2): 33-36,6.*

Satyanarayana. V. and P.N. Arora 1984. Effect of fertilizer on potato and their residual effect on succeeding onion. *Indian J. Agon.,29 (3): 309-311.*

Sharma, R.P. 1992. Effect of planting materials, nitrogen and potash on bulb yield of rainy season onion *(Allium cepa L.). Indian. j. Agon.,37 (4):868-869.*

Sharma. R.P. Dali, N. and Sharma, P.K. 2003. Combined application of nitrogen, phosphorus, potassium and farmyard manure in onion *(Allium cepa L)* under high hills, dry temperate conditions of north-western Himalayas. *Indian. J. of Agril. Sci.* 73(4): 225-227.

Soto, J.A. 1988. Nutritional requirements of onion *(Allium cepa L.)* in the soil of Northern Cartago ii. Critical levels for PK and S and response to N. Agron. Cosrtarricense,12(I) :53-57.

Sreelatha, T., Raju, A S. and Raju, A.P. (2006). Effect of different doses of farm yard manure and poultry manure and their interaction with fertilizer potassium on yield and nutrient uptake in mesta-rice cropping system. J. Res. Crop. **34**: 42-47.

Sing S.P. and C.R. Mohanty. 1998. A note on the effect of nitrogen and potassium on the growth and yield of onion. *Qrissa. J. Hort.* 26(20): 70-71.

Singh, A.K.. Akhilesh. S and Singh, A .2003. Seed production of onion as influenced by potassium and its method of application. *Indian J. of Horticulture.* 60(3: 287-29.

Singh, J. and B. S. Dhankhar. 1988. Effect of nitrogen, potash and zinc on growth. yield and quality of onion. *Indian Agric.,* 32(3): 163-170.

Singh, R.P..N.K.Jain and B. L. Poonia.2000. Response of rabi onion to nitrogen. phosphorous and potash in eastern plains of Rajasthan. *Indian J. Agril. Sci.,* 70 (12): 871-872.

UIIah, M. M. 2003. Nutrient management in rabi onion. Ph.D. Thesis. Dept. of Soil Science. BSMRAU. pp.) SO.

Vachhani, M.U. and Z.G. Patel. 1993. Growth and yield of onion *(Allium cepa L.)* as influenced by nitrogen, potash and phosphorus under South Gujrat Condition. Prog. Hort., 25(3-4): 166-167.

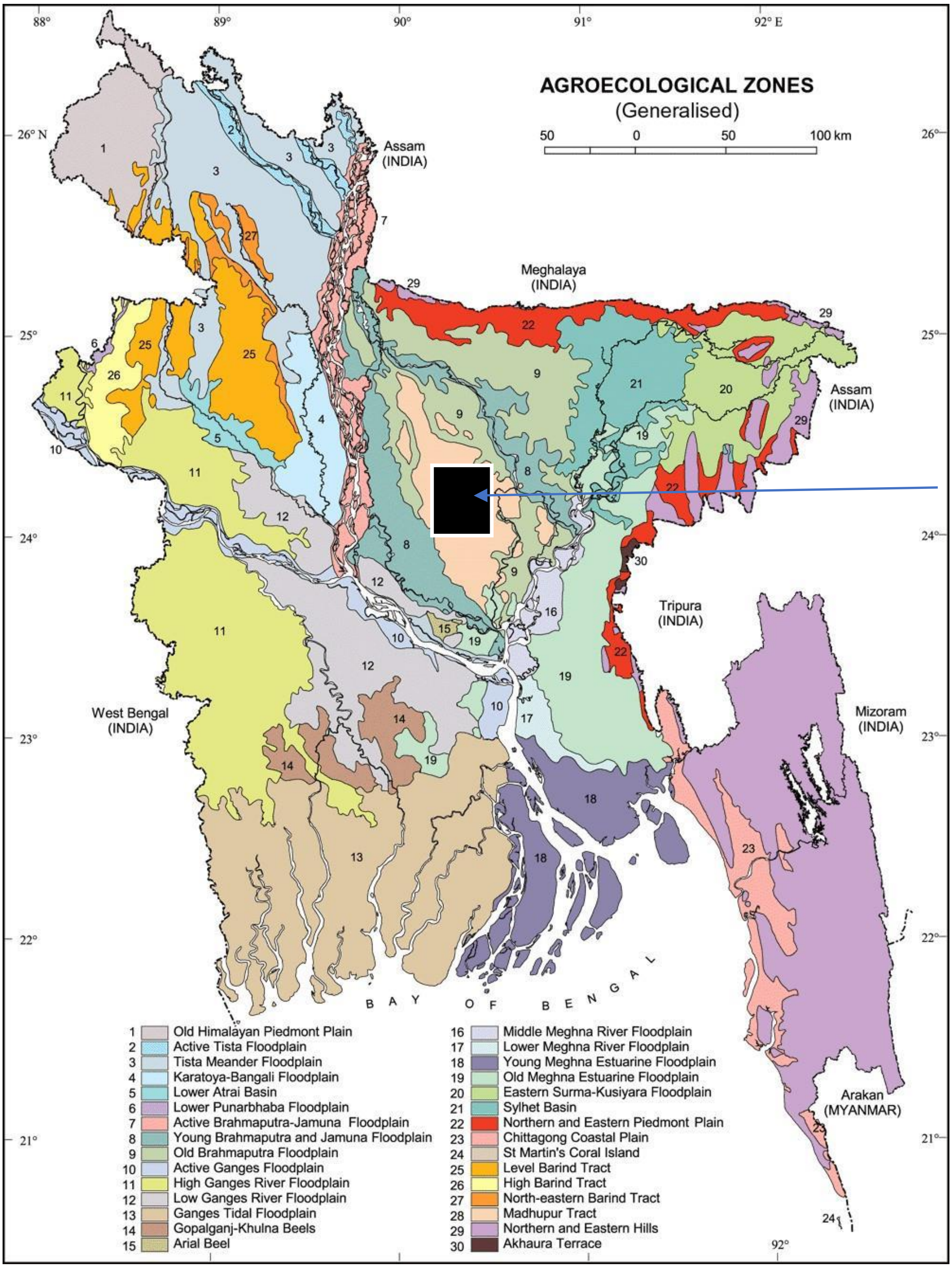
Yadav, R.L, Sen, N. L. and Yadav. B. L. 2003. Response of onion to nitrogen and potassium fertilization under semi-arid condition of Rajasthan. *Indian J. of Horticulture.* 60(2): 176-178.

Yadav, R.L., Sen N.L., Fageria M.S. and Dhaka R.S. 2002. Effect of nitrogen and potassium fertilization on quality bulb production of onion. *Haryana J. of Horticulture. Sci. 31: 3-4, 297-298; 3 ref.*

CHAPTER VI

APPENDICES

Appendix I: Map showing the experimental site under study



Appendix II: Characteristics of soil of experimental field

A. Morphological characteristics of experimental field

Morphological features	Characteristics
Location	Agronomy field , SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow Red Brown Terrace Soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled

B. Physiological properties of the initial soil

Characteristics	Value
Particle size analysis	
Sand%	25
Silt%	45
Clay%	30
Textural Classes	Silty -Clay
pH	6.00
Particle density (g/cc)	2.68
Organic carbon (%)	0.47
Organic matter (%)	0.80
Total N (%)	0.04
Available P (ppm)	22.00
Exchangeable K (meq/100g soil)	0.121

Appendix III. Monthly average of relative humidity, air temperature and total rainfall of experimental site during the period from November 2019 to March 2020

Month	Average RH%	Average temperature (C^0)		Total Average Rainfall(mm)
		Min.	Max.	
November, 2019	50.45	8.56	24.87	00
December, 2019	52.41	6.04	23.35	00
January, 2020	59.13	12.45	21.32	00
February, 2020	53.66	16.34	24.12	4.34
March, 2020	46.37	19.41	28.54	1.22

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

Appendix IV: Schedule of cultural operation in the experiment

Serial No.	Cultural preparation	Date
01	Seedbed preparation	29.10.2019
02	Sowing of seed on seedbed	01.11.2019
03	Opening of the main land	20.11.2019
04	Ploughing and cross ploughing	21.11.2019
05	Breaking of clods, laddering and weeding	22.11.2019
06	Layout of the experimental pit and plot	27.11.2019
07	Applications of 2/3rd different sources of nitrogen and entire of other fertilizer	27.11.2019
08	Transplanting of seedlings to main field	28,11.2019
09	Gap fillings	30.11.2019
10	1st Irrigation	01.12.2019
11	Tagging	03.12.2019
12	1st Weeding with mulching	08.12.2019
13	2nd Irrigation	8.12.2019
14	Ring and watering	12.12.2019
16	2nd Weeding	26.12.2019
17	Fencing with bamboo stick	27.12.2019
18	Data collection with different parameters	26.01.2020
22	Final Harvesting	28.03.2020
23	Collection post-harvest soil	30.03.2020
24	Analysis of soil sample	20.04.2020

Appendix V: Analysis of variance of some parameters with different doses of potassium (K) fertilizer application

Source of variance	DF	Mean sum of square								
		Plant height (cm)	Number of leaves	Length of leaves (cm)	Fresh weight of leaves (g)	Fresh weight of bulb (g)	Diameter of bulb (cm)	Dry weight of bulb (g)	Length of bulb	Yield (t ha^{-1})
Replication	2	6.46	0.37	27.20	22.64	9.45	0.07	9.03	0.04	0.45
Potassium	7	16.11**	0.44*	17.80*	25.54*	51.30*	0.19*	72.17*	0.35*	21.20**
Error	14	3.24	0.14	6.31	7.69	17.69	0.06	22.56	0.10	0.77

Appendix VI: Analysis of variance of different doses of potassium (K) fertilizer on post-harvest soil properties

Source of variance	DF	Mean sum of square						
		P^H	Organic matter (%)	Organic carbon (%)	Total N (%)	Available P (ppm)	Exchangeable K (meq/100g)	Available S (µg/g)
Replication	2	0.00042	0.017	0.016	0.00001	0.803	0.001	0.024
Potassium	7	0.578	0.057	0.00037	0.00029**	2.478**	0.002**	3.113**
Error	14	0.032	0.074	0.00314	0.000003	0.433	0.001	3.148

Appendix VII: Some photos document during experiment