

**Response of Potato (*Solanum tuberosum* L.) cv. Kufri Jyoti to
varying levels & time of Potassium application**

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(2010-A-849-M)



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Technology of Kashmir**

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Thesis

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award of the degree of**

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(Vegetable Science)**

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Dedicated to my beloved Father

To my beloved Father, who though, not alive to see the fruits of his prayers and well wishes, he always rendered for my success and prosperous life. I am extremely helpless to inform him the success but can only cordially pray for his soul rest at the highest ranks of paradise.

Sher-e-Kashmir
University of Agricultural Sciences and Technology of Kashmir
Division of Vegetable Science, Shalimar Campus, Srinagar-191121

Certificate – I

This is to certify that the thesis entitled, “**Response of Potato (*Solanum tuberosum* L.) cv. Kufri Jyoti to varying levels & time of Potassium application**” submitted in partial fulfillment of the requirements for the award of the degree of **Master of Science in Horticulture (Vegetable Science)**, to the **Faculty of Post-graduate Studies, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir** is a record of bonafide research work carried out by **Ms. Alima Shabir (Regd. No. 2010-A-849-M)** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

It is further certified that information received during the course of investigation has duly been acknowledged.

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We, the members of the Advisory Committee of **Ms. Alima Shabir (Regd. No. 2010-A-849-M)**, a candidate for the degree of **Master of Science in Horticulture (Vegetable Science)** have gone through the manuscript of the thesis entitled, **“Response of Potato (*Solanum tuberosum* L.) cv. Kufri Jyoti to varying levels & time of Potassium application”** and recommend that it may be submitted by the student in partial fulfillment of the requirements for the award of the degree.

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This is to certify that the thesis entitled, “**Response of Potato (*Solanum tuberosum* L.) cv. Kufri Jyoti to varying levels & time of Potassium application**” submitted by **Ms. Alima Shabir (Regd. No. 2010-A-849-M)** to the **Faculty of Post-graduate Studies, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir** in partial fulfillment of the requirements for the award of the degree of **Master of Science in Horticulture (Vegetable Science)** was examined and approved by the Advisory Committee and External Examiner on

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ABSTRACT

Present investigation entitled “Response of Potato (*Solanum tuberosum* L.)” cv. Kufri Jyoti to varying levels & time of Potassium application’ was carried out at Vegetable Experimental Field, Division of Vegetable science during *Kharif* 2011 to work out the optimum level and best time of potassium application for obtaining high yield and quality of potato.

The experiment was laid in a randomized block design with three replications at the spacing of 60x 20 cm. Three levels of potassium i.e., 50 kg, 100 kg and 150 kg and seven treatments. Full basal, $\frac{3}{4}$ basal + $\frac{1}{4}$ top dressing at 40 Days after planting, $\frac{3}{4}$ basal + $\frac{1}{4}$ top dressing at 60 Days after planting, $\frac{1}{2}$ basal + $\frac{1}{2}$ top dressing at 40 Days after planting $\frac{1}{2}$ basal + $\frac{1}{2}$ top dressing at 60 Days after planting, No basal + $\frac{1}{2}$ top dressing at 40 Days after planting + $\frac{1}{2}$ Top Dressing at 60 Days after planting, Full top dressing at 40 Days after planting were tried in the experiment. The observations were recorded on growth, yield and quality traits from 10 randomly selected plants from each treatment.

Among various treatments 150 Kg potassium applied basally improved the growth of the plant than other treatments. Treatment (T₁₈)150 Kg potassium applied in two splits of $\frac{1}{2}$ basal + $\frac{1}{2}$ top dressing at 40 Days after planting recorded significantly highest yield of 301.28q/ha and proved better in improving yield attributing characters of potato. The tuber quality with respect to Vitamin C, Protein content, Specific gravity also exhibited higher values.

Economics studies indicated treatment combination of 150 Kg potassium applied in two splits of $\frac{1}{2}$ basal + $\frac{1}{2}$ top dressing at 40 Days after planting proved to be most profitable with maximum benefit cost ratio of 2.28. The investigation further revealed that same treatment turned to be remunerative quantitatively and qualitatively as well as for pushing further the Net Returns. The results as such provide guidance for establishment of level and time of potassium application to enhance yield attributes of potato.

Key words: potato, potassium, quality, yield, time

Signature of Student
Dated:

Signature of Major Advisor
Dated:

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Chapter-1

INTRODUCTION

One of the major problems facing mankind is the need to feed an increasing population particularly in developing countries. The potato (*Solanum tuberosum* L.) is known for sustaining millions of lives by providing cheap and nutritious food during the times of war and hunger. The crop is of special significance in the developing countries owing to its high production potential per unit area and time, high nutritional value to sustain burgeoning population and ward off malnutrition and hunger. Potato plays a very important role in human diet and this has been realized by FAO and the year 2008 was celebrated as the year of potato with the slogan of the “Hidden Treasure”. It is a herbaceous plant belonging to family solanaceae with its edible part a modified underground stem known as tuber.

The potato is native of high Andean region of Southern American and has disseminated to other continents by Europeans. It was introduced in India towards the beginning of seventeenth century most probably by the Portuguese traders or by British missionaries. Today potato ranks fourth in terms of production after maize; rice and wheat and India is the third largest producer of potato in world. Globally it is cultivated in 150 countries covering an area of 19 million hectares with production of 329 million tones and productivity of 17.3 tonnes per hectare. In India potato ranks first in area among all the vegetable crops. It is being cultivated on an area of 1835 hectares with production of 36577 million tones and productivity of 19.9 million tones per hectare. (Anonymous 2010a) The state of Jammu and Kashmir occupies an area of 6500 hectares under potato cultivation with a production of 99,600 tones and productivity of 15.32 tones per hectare. Potato is one of the leading commercial crop of Kashmir valley and is being cultivated on an area of about 2500 hectares with a production of 32,500 tones and productivity of 13.00 tones per hectare (Anonymous

2009b). Potato has been considered as the king of staple food and it has been recognized as a wholesome food and richest source of energy in most countries of the world. Potato contains significant levels of phenolic compounds and vitamin C as a potent antioxidant (Brown, 2005). It is mostly used as a vegetable either sole or mixed with brinjal, tomato, beans and also processed for preparing chips, french fries, papad, certain sweet dishes like halwa and gulab jamun. Potatoes are also used as feed for livestock and in industry for the manufacture of starch and alcohol.

Potato is one of the important crop of the world and is consumed by over billions people across the globe mainly as a leading vegetable. Potato is a versatile, carbohydrate rich food highly popular worldwide, prepared and served in a variety of ways. Freshly harvested potato contains about 80 percent water and 20 percent dry matter. About 20 to 60 percent of dry matter is starch. On a dry weight basis, the protein content of potato is similar to that of cereals and is very high in comparison with other roots and tubers. In addition, the potato is low in fat. Potatoes are rich in several micronutrients, especially vitamin C when eaten with skin. The Potato is a moderate source of iron, and its high vitamin C content promotes iron absorption. It is a good source of vitamin B₁, B₃ and B₆ and minerals such as potassium, phosphorus and magnesium. It also contains foliate, pantothenic acid and riboflavin. Since potato produces more edible energy and protein per unit of time and covers more area compared to many other food crops, it fits well into multiple cropping system prevalent in tropical and sub tropical agro-climatic conditions and provides profitability and employment generations thereby expanding fast in developing countries.

Manurial and mineral requirements of the potato crop are usually high because of its high yield potential per unit area and time. The application of fertilizer and organic manures in a specific manner is thus essential for obtaining economic yield. At present the average yield of potato in India is much below the crop potential

yield. The results of various fertilizer experiments have revealed that potassium is essential for increasing yield and quality of potato. But the farmers are generally using nitrogen or nitrogen + phosphorus unknowingly making these nutrients as shovels to mine the soil potassium. This is neither advisable nor desirable and definitely not in long term interest of farmers who aim to harvest higher yield year after year. Further, the amounts of potassium used are much smaller than potassium removal, resulting in negative balance even in soils where potassium is applied at traditionally recommended rates.

In India the use of potassium fertilizers is almost negligible. This results not in stagnation of crop yield but also affects the quality of produce. Soil quality is being degraded because of continual removal of potassium along with other nutrients from soil by cropping. Imbalance fertilizer use has led to potassium mining from the soils. The skewed and the excessive use of nitrogen and phosphorus fertilizers might aggravate the situation in different cropping system because of nominal potassium use in the country and continuous use of Nitrogen and Phosphorus would accelerate drainage of soil native potassium reserves. It will not only impoverish soil potassium but also adversely effect crop yields (Akthar *et al.*, 2003). The yield of Potato can be enhanced significantly with balanced fertilization and quality of crop produce can be improved to a great extend with potassium use.

Potato has a shallow root system compared to other crops. On the other hand, uptake of fertilizer nutrients viz. Nitrogen, Phosphorus, Potassium by potato per unit area and time is quite high due to its fast early growth and tuber bulking (Singh *et al.*, 1996). A healthy crop of potato removes about 170-230 kg potassium per hectare indicating that potassium needs of potato are much high than that of cereal crops being a shallow rooted crop, the fertilizer use efficiency of potassium ranges between 50-60 percent. As such potato invariably responds to potassium application in various kinds of soil and agro-climatic conditions in which it is grown. Application

of potassium increases plant height, crop vigour and impart resistance against drought, frost and diseases. 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 carbohydrate from leaves to tubers. Potassium increases the size and the number of tubers. So, it increases the yield by increasing the number and yield of large and medium sized tubers which resulted in increase of overall tuber yield as well as the marketable yield.

Potassium is known as a quality nutrient. It affects tuber size, percentage of dry matter, starch content, internal blackening, storability and resistance to mechanical damage. It has also been reported to provide resistance against pest and disease, drought and frost stresses. Potato is regarded as an indicator crop for potassium because of its high potassium requirement. The need and importance of potash application for harvesting high yield with superior quality produce is greater now than ever before. There has been a significant depletion of the soil potassium reserves due to negligible use of potash over the years. Potash application is important in the emerging deficiencies of nutrients in vegetable crops. Potash need to be put into practice by using at least the recommended rates of potash along with other needed nutrients. At the same time, steps must be initiated to take a fresh look at the current approach and scheduling methodology of potassium application. These should primarily address the need for using soil and crop specific limits of available soil potassium while making potash recommendations and also provide recommendations for progressive farmers who are not satisfied with moderate yield levels.

Since no such study has been carried out on application of potassium in Kashmir valley. Hence present study has been carried out under Kashmir conditions with the following objectives.

1. To study the effect of potassium on growth and yield of potato
2. To identify suitable time and level of potassium application for harnessing maximum yield.
3. To study the effect of potassium on tuber quality, and
4. To work out the relative economics.

Chapter-2

REVIEW OF LITERATURE

Potato demands high levels of soil nutrients due to relative poorly developed and shallow root system in relation to yield (Perrenoud, 1983). Compared with cereal crops, potato produces much more dry matter in a shorter life cycle (Singh and Trehan, 1998). This high rate of dry matter production results in large amounts of nutrients removed per unit time, which generally most of the soils are not able to supply. Thus potato crop has strict requirement for a balanced fertilization management, without which growth and development of the crop are poor and both yield and quality of tubers are diminished. Among the major nutrients, potassium not only improves yield but also benefits various aspects of quality. The tuber quality parameters affected by potassium nutrition are tuber size, percentage of dry matter, starch content, internal blackening, storability and resistance to mechanical damage. Potassium also provides resistance against pest, diseases, frost and drought stresses. The crucial importance of potassium is quality formation stems from its role in promoting synthesis of photosynthates and their transport to the tubers and to enhance their conversion into starch, protein and vitamins (Mengel and Kirkby, 1987). Potassium promotes larger size of potato tubers by increasing water accumulation in tubers resulting in lowering of dry matter and specific gravity (Perrenoud, 1993)

Potato plant needs potassium from early stage of plant growth because of its positive effect on root growth, therefore potassium application at the time of planting is needed. It is a common practice to surface broadcast potassium fertilizers before planting with incorporation into the soil during seed bed preparation (Roberts and Mc Dole, 1978) Deficiency symptoms of potassium usually manifest at tuber initiation, when potassium uptake is maximum (Roberts and Mc Dole, 1985). Potassium may be

lost by leaching, it is thus recommended to apply potassium in two splits. This practice may give better results than the entire dose applied at planting (Grewal *et al.*, 1991). The available literature pertaining to different aspects of the present study has been reviewed in the present chapter as under:

Anand and Krishnappa (1988) conducted an experiment to study the effect of different levels of nitrogen and potassium on the growth, yield and quality of potato. Nitrogen and potassium was applied @ 0, 60, 120, 180 kg and 0, 50, 100, 150 kg respectively. It was observed that 180 kg nitrogen and 150 kg potassium gave the highest yield of 26.08 tonnes. Average tuber yields were 14.13, 18.98, 18.75 and 20.36 tonnes per hectare with the four nitrogen rates respectively and 14.79, 18.83, 19.44 and 19.98 tonnes with the four potassium rates respectively. Tuber starch content decreased with increasing nitrogen rates and increased with increasing potassium rates. Similarly Sharma and Arora (1989) conducted an experiment to study the effect of potassium on yield, nitrogen and phosphorus concentration in potato plant. Potassium was applied @ 0, 50, 100 and 150 kg per hectare. It was observed that total tuber yield increased from 15 tonnes per hectare to 30.8 tonnes per hectare with 100 kg potassium. The yield of ware tubers was greatest with 100 kg potassium.

Furunes (1990) studied the effect of potassium fertilization in relation to nitrogen on the yield and quality of potatoes. Nitrogen and potassium was applied @ 40, 80, 120, 160, 200 kg and 100, 150, 200 kg per hectare respectively. It was reported that by increasing the level of potassium from 0 to 100 kg per hectare the tuber yield increased by 2000 kg and the yield of dry matter by 420 kg/ha. A corresponding significant reduction in enzymatic browning was also found. Similarly Mazur *et al.* (1991) studied the effect of different rates of potassium on yield and yield parameters of potato. Potassium was applied @ 0, 80, 160 and 240 kg per hectare. It was observed that tuber number and yield increased with potassium

application to maximum of 16.27 and 293 t/ha respectively when 240 kg potassium per hectare was applied.

Trehan and Grewal (1991) conducted an experiment to study the effect of time and level of potassium application on the yield and tuber quality of Kufri Jyoti. Potassium was applied @ 0, 33, 66 & 99 kg per hectare at planting and earthing. It was observed that the tuber yield of Kufri Jyoti was increased with application of 66 kg potassium at planting. Kufri Jyoti gave higher, medium (25-75g) and large (>75g) grade tuber yield. The study indicated that Potassium application increased tuber size and tuber potassium concentration but decreased tuber percentage dry matter. Similarly Sud and Grewal (1991) conducted an experiment to study the effect of time of potassium application and different levels of potassium on potato nutrition. Potassium was applied @ 0, 75, 100 kg per hectare at planting or split application of 75 kg Potassium was given @ 0, 25, 50 kg at planting and the remainder at earthing up. It was observed that application of 75 kg potassium at earthing produced a tuber yield of 17.8 tonnes per hectare compared with 15 tonnes from applying 75 kg potassium at planting. In another experiment 0, 30, 60 and 90 kg potassium was applied at planting and at earthing up. Highest tuber yield was reported with application of 90 kg potassium (60 kg at planting and 30 kg at earthing).

Mazur and Krefft (1991) studied the effect of different rates of nitrogen, potassium and magnesium fertilizers on yield, tuber starch and protein content of two potato cultivars. Nitrogen, potassium and magnesium were applied @ 50,100, 150 kg, 41.5, 83, 124.5 kg and 0, 12, 24 kg per hectare respectively. It was observed that tuber yield was not affected by nitrogen rates and was increased by higher rates of potassium and magnesium. Starch content decreased and protein content increased with increasing nitrogen, potassium and magnesium rates in both cultivars. Similarly Sharma (1991) studied the effect of levels of nitrogen, phosphorus, potassium, their interaction on yield and nutrient uptake of potato. Nitrogen, phosphorus and

potassium were applied @ 0-180 kg, 0-78 kg and 0-150 kg per hectare respectively. It was observed that tuber yield increased significantly by 120 kg nitrogen, 78 kg phosphorus and 50 kg potassium per hectare.

Sud and Grewal (1992) conducted an experiment to study the levels and methods of potassium application in potato. Potassium was applied @ 87, 42, 63 and 84 kg per hectare at 3 positions (2-3 cm below tubers, with the tubers and 2-3 cm above tubers). It was observed that tuber yield, nutrient uptake and potassium recovery were significantly increased by 42 kg potassium. Potassium application near to the seed tubers in furrows at the time of planting was preferable as applied potassium was utilized more effectively. Similarly Sharma and Arodra (1992) studied the effects of level of potassium application on dry matter production and Zn, Mn, Fe and Cu uptake by potatoes. Potassium was applied @ 0, 50, 100, 150, 200 kg with 0, 30 tonnes of farm yard manure. It was reported that tuber dry matter increased significantly by 150 kg potassium without FYM and 100 kg potassium with farm yard manure. Application of potassium and farm yard manure increased zinc, manganese, iron and copper uptake.

Sharma (1992) studied the effect of levels of potassium application in potato. Potassium was applied @ 0, 50, 100, 150, 200 kg per hectare and it was reported that tuber yield of 16.7, 22.1, 22.8, 22.0 and 21.9 tonnes per hectare were obtained respectively. Total potassium uptake increased with application of 50 kg potassium per hectare. Similarly Grewal and Kolar (1993) conducted an experiment to study the response of potato to potassium in relation with farm yard manure. Potassium was applied @ 0-125 kg and 0, 10 tonnes farm yard manure. It was observed that tuber yield increased upto 32.0 tonnes per hectare and number of tubers per plant by 9.9 were with a combination of 125 kg potassium and 10 tonnes of farm yard manure.

Chadachan *et al.* (1993) studied the nutrition of nitrogen and potassium on rainfed potatoes cv. Kufri Chandramukhi and Kufri Jyoti. Nitrogen and potassium were applied @ 100, 200, 300 kg per hectare and 100, 150, 200 kg per hectare respectively. It was reported that tuber yield of Kufri Chandramukhi was highest with 200 kg nitrogen and 150 kg potassium and Kufri Jyoti was highest with 200 kg nitrogen and 200 kg potassium. Similarly Jagroop *et al.* (1993) conducted an experiment to study the growth and yield of potato cultivars as affected by plant density and potassium levels. Cultivars were planted at 60 x 15 cm, 60 x 20 cm interrow spacings and 30-150 kg potassium per hectare was given. It was observed that tuber yields were highest at the narrowest spacing (20.9 t/ha) and lowest at the widest spacing (16.1 t). There was a significant yield increase with 120 kg potassium per hectare.

Khan (1993) studied the effect of different levels of nitrogen, phosphorus and potassium fertilizers on potato tuber yield. Potatoes were given 0, 100, 150, 200 and 250 kg nitrogen as urea, 0, 75, 100 and 125 kg phosphorus as single superphosphate and 0, 50, 75 and 100 kg potassium as sulphate of potash and 20 tonnes farm yard manure per hectare. Data is presented for total tuber, seed tuber and graded potato yields across all locations and treatments. It was observed that total tuber yield ranged from 8.66 tonnes per hectare without fertilizers to 64.59 tonnes with 250 kg nitrogen, 125 kg phosphorus, 100 kg potassium and 20 tonnes farmyard manure per hectare. Seed potato yield was highest (45.31 t/ha) with 200 kg nitrogen, 125 kg phosphorus, 75 kg potassium and 20 tonnes farm yard manure per hectare while graded ware potato yield was highest (26.81 t) with 200 kg nitrogen, 125 kg phosphorus, 75 kg potassium and 20 tonnes farm yard manure per hectare. Similarly Govindakrishnan *et al.* (1994) studied the influence of potassium nutrition on aggregate and grade wise yield of four potato varieties. Potassium was applied @ 0-180 kg /ha. It was reported that tuber yields was highest with 180 kg potassium in

Kufri Chandramukhi and Kufri Bahar and increased significantly with up to 60 kg potassium in Kufri Badshah and Kufri Lalima. Medium sized potatoes (25-75 g) constituted the largest fraction of the aggregate yield in all the cultivars. Medium sized tuber yield increased significantly with up to 60 kg potassium in Kufri Chandramukhi and Kufri Lalima, with 120 kg potassium in Kufri Badshah and up to 180 kg potassium in Kufri Bahar. The large sized tubers (>75 g) constituted the second largest fraction in Kufri Lalima and Kufri Badshah while in Kufri Chandramukhi the small sized tubers (>25 g) were the second largest fraction and in Kufri Bahar both small and medium sized yield fractions were almost equal with 60 and 120 kg potassium.

Lal and Arora (1994) conducted an experiment to study the effect of phosphorus and potassium on bulking behaviour of potato cultivars at different growth stages. Phosphorus and potassium was applied @ 0, 45 and 90 kg per hectare and 0, 60 and 120 kg per hectare respectively. It was observed that tuber yield was highest at 50 and 65 days after planting and was not significantly different between cultivars at 80, 95 and 110 days after planting. Tuber bulking rate was highest at 65-95 days after planting in all cultivars. Potassium application also increased tuber yield and bulking rate except at 50 days after planting. Similarly Nakashgir *et al.* (1994) applied four doses of potassium (40, 60, 80, 100 kg/ha) and four doses of nitrogen (80, 100, 120 and 140 kg per hectare) to the potato crop and studied their residual effects on yield of turnip. The studies have indicated that nitrogen and potassium applied to potato showed prominent residual effect of 75% on succeeding turnip crop with available water requirement. The application of 120 kg nitrogen and 100 kg potassium per hectare gave highest yield of turnip. They also reported that increasing levels of potassium from 40 to 100 kg per hectare in combination of 100kg per hectare linearly increased the tuber yield of turnip.

Westermann *et al.* (1994) conducted an experiment to study nitrogen and potassium fertilization of potatoes. Nitrogen was applied @ 0, 112, 224 and 336 kg per hectare with selected potassium rates of 0, 112, 224 and 448 kg per hectare. It was observed that both nitrogen and potassium applications increased yields independent of potassium source. Potassium increased yield up to 448 kg potassium per hectare. Similarly Mishra *et al.* (1994) conducted an experiment to study the effect of method, source and rate of potassium application on Kufri Chandramukhi of potato. Potassium was applied @ 120 kg basally and in three split doses half at the time of planting and a quarter at 1st and 2nd earthing and it was observed that tuber yield increased upto 120 kg and more large size tubers (greater than 5 cm) were obtained .

Singh and Singh (1995) conducted an experiment to study the effect of level and method of potassium application on vegetative growth and yield of potato. Potassium was applied @ 200 kg per hectare basally and in three split application (basal + 30 days after planting + 50 days after planting) and reported that application of potassium in splits gave higher tuber yield than applying all the potassium basally. Similarly Singh and Singh (1996) studied the influence of split application of potassium on the quality attributes of potato viz. total soluble solids, starch. Potassium was applied @ 50,100,150 and 200 kg with different proportion of each rate as basal and top dressing. It was reported that tuber total solids decreased but the tuber starch content increased as potassium rates increased.

Singh *et al.* (1996) studied the effect of sources and levels of potassium on potato yield, quality and storage behaviour. Potassium was applied @ 0-180 kg per hectare as sulphate of potash or murate of potash. It was reported that mean tuber yield was highest with 180 kg potassium (34.8 t/ha) and was not affected by potassium source. In tubers stored for 14 weeks, storage losses and sprouting percentage were the lowest where 180 kg potassium was applied. Similarly Panique

et al. (1997) conducted an experiment to study the effect of levels and source of potassium application on potato yield, quality, and disease interaction. Potassium was applied @ 0, 93, 187, 280 and 373 kg per hectare. It was observed that tuber yield increased with an increase in tuber size (170 to 370 g) and above. A significant decrease in hollow heart with increasing rate of potassium fertilizer application was also observed.

Savita and Khalik (1998) conducted an experiment to study the effect of levels and time of potassium application on tuber bulking rate, tuber size and total tuber yield of potato. Potassium was applied @ 60,120,180 kg per hectare as basal and in splits (basal + 30 days after planting) and it was reported that the tuber specific gravity and yield of potato was highest when the potassium was applied in split dressing. Similarly Singh *et al.* (1998) studied the level and method of potassium application on growth yield and quality of potato. Potassium was applied @ 50,100,150 and 200 kg per hectare and in splits ($\frac{1}{2}$ basal + $\frac{1}{2}$ top dressing at 30 days after planting) and it was reported that the split application gave highest dry weight of stem per hill, yield of tubers, dry matter, ascorbic acid, starch and protein content. The number and weight of tubers, their yield was reported highest with 200 kg potassium applied as $\frac{1}{2}$ basal and $\frac{1}{2}$ top dressing at 30 days after planting. The highest benefit : cost ratio was obtained with 200 kg potassium applied as $\frac{1}{2}$ basal and $\frac{1}{2}$ top dressing at 30 days after planting.

Savita *et al.* (2000) studied the effects of potassium rates (60, 120, and 180 kg per hectare) and application dates (100% basal, 50% basal + 50% at 30 days after planting, and 50% basal + 25% at 30 days after planting + 25% at 50 days after planting) on the yield and quality of the potato hybrid. It was reported that application of 180 kg potassium per hectare increased tuber yield by 25.90% over 60 kg potassium per hectare. The two-split application of potassium recorded 5.4% and 15.6% higher tuber yield than 100% basal and three-split application respectively.

Potassium at 180 kg per hectare applied in two splits resulted in the production of high-quality tubers. The application of the recommended potassium rate (120 kg per ha) in two splits increased yield, tuber quality and potassium uptake up to 73.40 kg per hectare. Similarly Qin-Fang (2003) studied the effects of potassium fertilizer application on yield of potato. Seven treatments were used with N:P₂O₅:K₂O ratios of 0:0:0 (control 1), 90:90:0 (control 2), 90:90:30, 90:90:45, 90:90:60, 90:90:75 and 90:90:90 kg/ha. It was observed that the tuber yields in the treatments with potassium fertilizer were significantly higher than those in the control treatments. The highest tuber yield was recorded at 90 kg, followed by 75 and 60 kg potassium per hectare, and the lowest in the control. The optimum potassium application rate was 60-90 kg per hectare.

Kumar *et al.* (2004) studied the effect of potassium fertilization on processing grade, tuber yield and quality parameters in potato. Potassium was applied @ 0, 41.5, 83.0, 124.5 and 166 kg per hectare. It was observed that highest yield of tubers i.e., 32.8 and 29.5 tonnes per hectare was observed in Kufri Chipsona 1 and Kufri Chipsona 2 respectively, with the application of 124.5 kg potassium per hectare. Similarly Moinuddin and Umar (2004) conducted an experiment to study the effects of factorial application of four levels each of potassium (2, 4, 8, and 12 meq L⁻¹) and sulphur (1, 2, 4, and 6 meq L⁻¹), on yield, quality and storage behaviour of tubers. It was observed that increasing potassium and sulphur levels in the nutrient medium increased tuber yield as well as dry matter content. The highest tuber yield and percent dry matter content was recorded at 8 meq L⁻¹ potassium. Similarly Nikardi (2009) conducted an experiment to determine the response of potato to different source of potassium (potassium chloride and potassium sulphate) at different rates of application 150 and 250 kg per hectare and application method as single, split, and split combined with foliar application. In the single application, potassium was applied at planting, while in the split application, potassium was applied half at

planting and the rest at 6 weeks after planting. In the split combined with foliar application treatment, potassium fertilizer was applied half at planting, a quarter at six weeks after planting and another quarter by foliar spraying at seven, eight and nine weeks after planting and reported that potassium sulphate applied in split or split combined with foliar application produced significantly higher tuber yield, and tuber dry weight than those supplied with potassium fertilizer in single application.

Chapter-3

MATERIALS AND METHODS

The present investigation entitled, “**Response of Potato (*Solanum tuberosum* L.) cv. Kufri Jyoti to varying levels and time of potassium application**” was conducted at the experimental fields of the Division of vegetable science, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir during *Kharief* 2011. The details of methods adopted and materials used for experiment are presented as under :

3.1 Location

The experimental field is located at the main campus, Shalimar, Srinagar which is 15 km away from Srinagar city on the foot hills of Mahadev. The altitude of the location is 1606 meter above mean sea level and situated 34°. 05' North of latitude and 74°.89' East of longitude.

3.2 Climate

The climate is temperate, characterized by mild summers. June and July are the hottest months while January and February are the coldest. The maximum rainfall is received during March to April.

3.3 Experimental material

Potato (*Solanum tuberosum* L.) cv. Kufri Jyoti maintained by Division of Vegetable science were evaluated for various yield and yield attributing traits at the Experimental fields of the Division of Vegetable science, SKUAST-K Shalimar Srinagar, during *Kharief* 2011. The various treatment application are given in the Table-3.5.1. The experimental material was planted in a Randomized Block Design with three replications. The plot size was kept 2.4x1.8m (4.32 m²). Each plot

consisted of 5 rows in each replication at a spacing of 60 x 20 cm. The experimental field was well prepared and standard cultural, manurial and plant protection practices were followed to ensure a healthy crop growth.

3.4 Physico-chemical characteristics of soil

In order to assess the physico-chemical characteristics of soil of the experimental field, composite soil samples were collected from a depth of 0-15cm prior to application of fertilizers and manures during the growing season of crop. These soil samples were dried under shade, crushed and sieved through 2mm sieve. These samples were subjected to chemical analysis to know the initial fertility status and other properties of soil. The result of the composite sample drawn at the beginning of the experiment during 2011 revealed that the soil was medium in available nitrogen, phosphorus and potassium with neutral pH (Table-A)

Table-A: Chemical properties of soil of experimental field

i) Chemical analysis

S. No.	Year	Result	Method of Analysis Adopted
pH(1:2.5) soil water suspension	2011	6.93	Systronic glass electrode pH(Jackson,1973)
Electrical conductivity(dsm)	2011	0.46	Solubridge conductivity meter (Jackson,1973)
Organic Carbon (%)	2011	1.21	Wet digestion method (Walkley and Black,1934)
Available Nitrogen (kg/ha ⁻¹)	2011	243.30	Alkaline potassium per magnate method (Subbiah & Asija,1956)
Available phosphorus (kg/ha)	2011	21.39	Olsen's method of extraction with 0.5M NaHCO ₃ (Olsen <i>et al</i> 1954) using systronics spectrophotometer
Available Potassium (kg/ha)	2011	161.2	Ammonium acetate extracted (Jackson,1973)

3.5 Experimental Details:

The experiment comprising of two factors (Method of application and three nutritional levels) was laid in random block design with three replications. The details are as under:-

Table 3.5.1: Potato (*Solanum tuberosum* L.) levels and time of potassium application used in the present study

	Particulars	Symbol
1. Potassium level	1. 50 kg K ₂ O/ha	k ₁
	2. 100 kg K ₂ O/ha	k ₂
	3. 150 kg K ₂ O /ha	k ₃
2. Time of potassium application	1. Full basal	t ₁
	2. $\frac{3}{4}$ basal + $\frac{1}{4}$ top dressing at 40 Days after Planting	t ₂
	3. $\frac{3}{4}$ basal + $\frac{1}{4}$ top dressing at 60 Days after Planting	t ₃
	4. $\frac{1}{2}$ basal + $\frac{1}{2}$ top dressing at 40 Days After Planting	t ₄
	5. $\frac{1}{2}$ basal + $\frac{1}{2}$ top dressing at 60 Days After Planting	t ₅
	6. No basal + $\frac{1}{2}$ top dressing at 40 Days After Planting + $\frac{1}{2}$ Top Dressing at 60 Days After Planting	t ₆
	7. Full top dressing at 40 Days after planting	t ₇

Note: N&P will be applied as per package of practice.

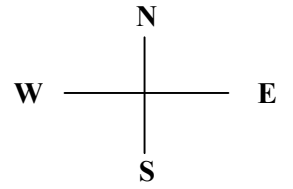
3.5.2 Details of treatment combinations

In all three treatment combinations were tested in the experiment and the details are given below which include the combination of methods and three nutritional levels.

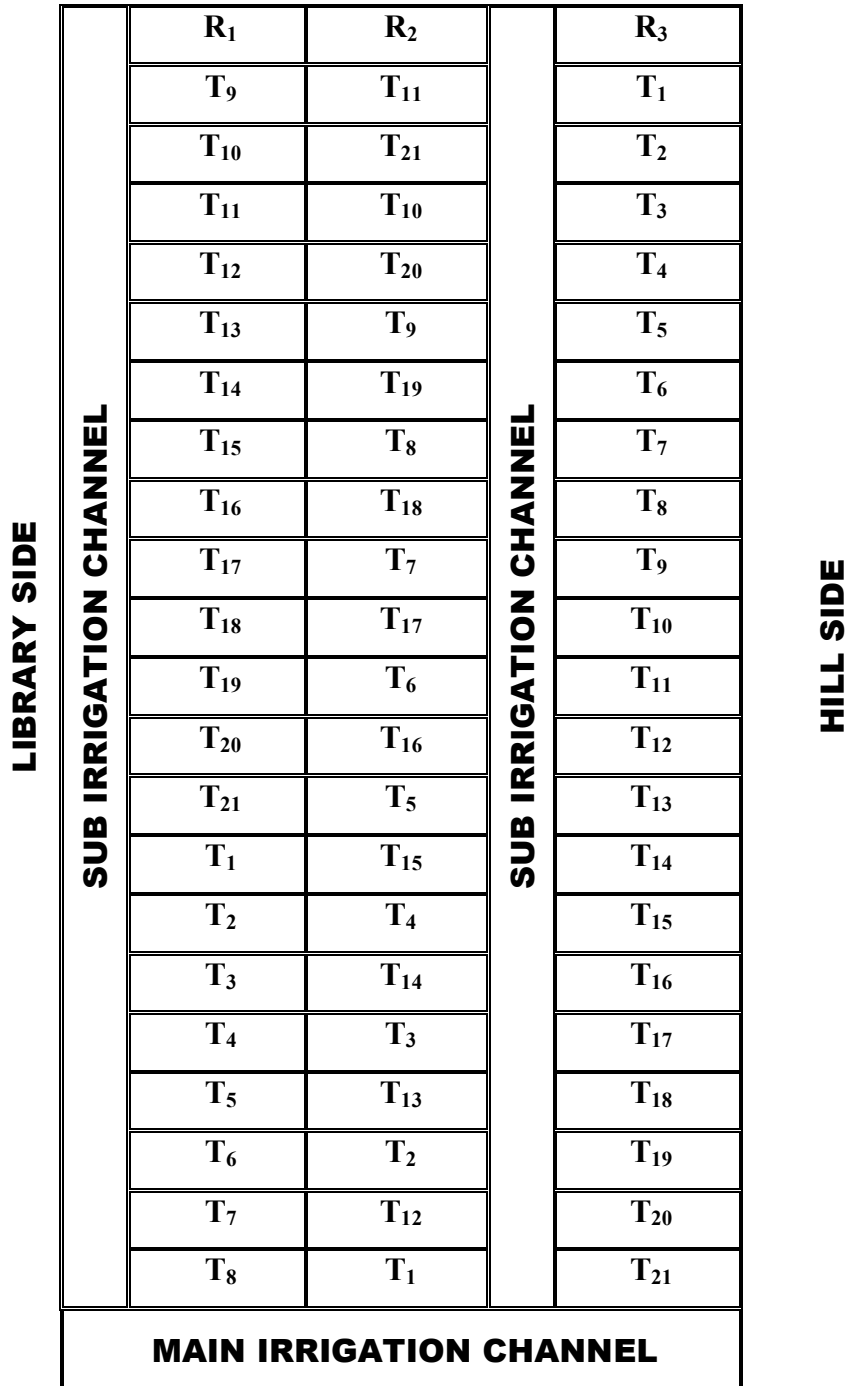
Treatment	Treatment details
T ₁	k ₁ t ₁
T ₂	k ₁ t ₂
T ₃	k ₁ t ₃
T ₄	k ₁ t ₄
T ₅	k ₁ t ₅
T ₆	k ₁ t ₆
T ₇	k ₁ t ₇
T ₈	k ₂ t ₁
T ₉	k ₂ t ₂
T ₁₀	k ₂ t ₃
T ₁₁	k ₂ t ₄
T ₁₂	k ₂ t ₅
T ₁₃	k ₂ t ₆
T ₁₄	k ₂ t ₇
T ₁₅	k ₃ t ₁
T ₁₆	k ₃ t ₂
T ₁₇	k ₃ t ₃
T ₁₈	k ₃ t ₄
T ₁₉	k ₃ t ₅
T ₂₀	k ₃ t ₆
T ₂₁	k ₃ t ₇

Table 3.5.3 Other details of experiment

Crop	:	Potato
Cultivar	:	Kufri Jyoti
Design	:	RBD
Spacing	:	60 x 20 cm
Treatment	:	21
Replication	:	3
Plot size	:	2.4 x 1.8 m



Layout of the Experimental Field



3.6 Description of variety

Potato variety Kufri Jyoti is a tall, erect, compact, vigorous having large, oval and white tubers. It is a medium maturing cultivar with low rate of degeneration. It possesses a high degree of field resistance to late blight. It is immune to wart disease. Yield is poor in short days and good in long days.

3.7 Land Preparation

The experimental field was tractorized and the soil was brought to a fine tilth. The hard compact soil clods were broken to bring the soil to pulverized mass and land was levelled. The field was then divided into 63 plots of size 2.4 x 1.8 m separating each plot from the adjacent plots by 30 cm wide small earthen bunds. The field was also provided with one main channel and two sub irrigation channels to facilitate plot to plot irrigation. The plot was levelled before planting.

3.8 Planting

The tubers were planted at a spacing of 20 cm from plant to plant and 60 cm from row to row. The tubers were planted in furrows and covered. Ridges were made with the help of tangroo.

3.9 Fertilizer Application

3.9.1 Inorganic fertilizers

Half dose of nitrogen and full dose of phosphorus through urea and Diammonium phosphate was applied as basal dose. The remaining half of nitrogen was top dressed at first earthing i.e., 40 days after planting.

3.10 Irrigation

A pre planting irrigation was given before preparing the field to ensure enough moisture. The crop was provided with irrigation as per its requirement. However

while irrigation care was taken to avoid overflowing of water over the ridges.

3.11 Harvesting

3.11.1 Dehaulming

Dehaulming was done after the foliage showed signs of senescence which was about ten days before harvest.

3.11.2 Digging and Curing

The crop was harvested by digging at about 120 days after planting. Tubers were dug out by opening the ridge and collected plot wise. The tubers collected from each plot were dried under shade and heaped for 10-15 days for curing.

3.12 Grading

Grading of tubers according to number and weight was done. Grading of the produce from each plot was done based on the number and weight of tubers in three categories as mentioned below:

Grade A: >75g

Grade B: 50g to 75g

Grade C: 25 to 50 g

Grade D: 0-25 g

3.13 Characters Studied and observational procedures

Observations were recorded on various yield and quality traits in order to study the response of Potato cv. Kufri Jyoti to varying levels and time of potassium application. Ten competitive plants were selected at random from each replication and tagged for recording the biometrical observations. Mean values for all the characters were worked out. Observations were recorded at the appropriate developmental stages

of plant growth as per the description given below.

The characters included for the present study were:

3.14 Growth parameters

3.14.1 Plant height (cm)

Plant height of the tagged plants was measured in centimetres as the distance from ground level to the tip of the plant after 90 days of planting and the average of ten plants of the treatment was worked out.

3.14.2 Plant spread (cm)

Plant spread of the tagged plants was measured in centimetre as the average spread from north to south and east to west directions after 90 days of planting and the average of ten plants of the treatment was worked.

3.14.3 No. of shoots per plant

The number of shoots of tagged plants from each plot were counted and averaged to get the number of shoots per plant.

3.14.4 Number of tubers per plant

Total number of marketable tubers produced by the tagged plants of each treatment was counted separately and averaged to get tuber number per plant.

3.14.5 Average tuber weight (g)

Ten tubers were selected randomly, weighed and the average was worked out to know the average tuber weight.

3.14.6 Weight of marketable tubers per plot (kg)

Total number of marketable tubers produced per plot of each treatment was weighed separately and average of three replications was worked out to get weight of

marketable tubers per plot.

3.14.7 Weight of unmarketable tubers per plot (kg)

Total number of unmarketable tubers produced per plot of each treatment was weighed separately and average of three replications was worked out to get weight of unmarketable tubers per plot.

3.14.8 Grade wise number and weight of tubers(g)

The tubers per plot were graded on the basis of their number and weight into three classes as mentioned below:

Grade A: >75 g

Grade B: 50 to 70 g

Grade C: 50 to 25 g

Grade D: 0 to 25 g

The number of different grades was counted and weighted separately plot wise to know the number of each grade with corresponding weight

3.14.9 Total yield (q ha⁻¹)

Total yield was worked on meter square basis from each treatment and was converted into hectare.

3.15 Quality parameters

3.15.1 Total soluble solids (°Brix)

TSS in the tubers was estimated by a hand refractometer and the results were expressed in °Brix.

3.15.2 Vitamin C (mg 100 g⁻¹) (A.O.A.C. 1984)

The ascorbic acid content of finally harvested potatoes from each plot was

determined by titration method suggested by AOAC (1984)

Reagents

1. Meta phosphoric acid solution (3%):

30 gm of Meta phosphoric acid (HPO₃) sticks were dissolved in distilled water and diluted to 1000 ml.

2. Ascorbic acid solution

a, Standard or Stock solution:-

100 mg of L-ascorbic acid was dissolved in a small volume of 3% Meta phosphoric acid and diluted to 100ml with same (HPO₃)

b, Working Solution

10 ml of stock solution was transferred to 100ml volumetric flask and volume was made upto 100ml by dilution with Meta phosphoric acid (HPO₃)

3. Dye Solution

50 g sodium salt of 2,6 dichlorophenol indophenol put in a dessicator over soda lime was weight and dissolved in approximately 150 ml of glass distilled hot water containing 42 mg of sodium bicarbonate. The solution was then cooled and diluted with distilled water to 200ml. This solution was stored in brown bottle in refrigerator at about 3°C to be used for a week.

Procedure: Standardization of dye: 5 ml of standard ascorbic acid and 5ml of Meta phosphoric acid was taken into a beaker and was titrated with dye solution to faint pink colour persisting for 10 sec and burette reading was noted. The dye factor (mg of ascorbic acid per ml of dye) was determined as follows:

Dye factor (DF) = 0.5/Titre value (ml of dye)

Preparation of sample

10 g of potato flesh was blended with 3% Meta phosphoric acid and filtered volume of filtrate was made up to 100ml with 3% Meta phosphoric acid. Different samples of filtrate were prepared for different plots.

Procedure: 5ml of Meta phosphoric acid aliquot extract was titrated with the standard dye till a pink end point reach and the pink colour obtained during titration persisted for 10 seconds only. The titration was repeated 2-3 times for each sample to find average volume of dye used in titration

Calculation:

Ascorbic acid content was calculated with the help of following formula:

$$\text{Ascorbic acid mg } 100 \text{ g}^{-1} = \frac{\text{Titre value} \times \text{dye factor} \times \text{volume made up}}{\text{Total weight of the sample} \times \text{aliquot of sample}} \times 100$$

Where,

Dilution factor = 100 ml

Weight of sample = 10 g

Volume of filtrate = 5 ml

3.15.3 Specific gravity

Specific gravity of potato tubers was estimated through weight by volume method.

3.15.4 Dry matter content of tubers (%)

Dry matter content was determined by drying a known weight of the sample in an oven at $60 \pm 5^\circ\text{C}$ to a constant weight. The final weight of the sample after drying was weighed and expressed as per cent dry matter content.

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

3.15.5 Determination of protein (%)

Protein content of tubers (dried form) from each treatment was worked out by estimating the percentage of Nitrogen by Kjeldahls method. The percent N was multiplied by the factor 6.25 to estimate the protein content.

$$\text{N (\%)} = \frac{[\text{Sample titer (ml)} - \text{Blank titer}] \times 0.014 \times \text{Vol. of digest} \times \text{Normality of acid}}{\text{Aliquot taken (ml)} \times \text{Weight of sample (g)}} \times 100$$

3.16 Economics of crop production

Tabular analysis was performed to assess the economics of the crop. Gross returns were worked out by multiplying yield obtained with the market price. The cost of cultivation was subtracted from the gross returns and results obtained were presented in rupees per hectare.

3.17 Statistical analysis

The data collected on different observations were analyzed statistically using analysis of variance technique. The results are presented at 5 per cent level of significance. Wherever the 'F' test was found significant at 5 per cent probability, critical difference value was used to compare the treatment means. The software used for analysis was 'Mini Tab'.

Chapter-4

EXPERIMENTAL RESULTS

The experiment entitled “**Response of potato (*Solanum tuberosum* L.) cv. Kufri Jyoti to varying levels and time of potassium application**” was carried out at Vegetable Experimental Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar Campus during *Khariief*, 2011. A number of observations were recorded at different stages of plant growth. The data collected was subjected to Statistical analysis for proper interpretation of results. The analysis of variance tables for various parameters are presented in the Appendix – ii,iii and iv. The results obtained from the present investigation are presented under following headings.

4.1. Influence on the morphological traits.

4.1.1 Plant height (cm)

Perusal of data on plant height (Table-1) revealed that T₁₅ i.e., application of 150 kg potassium applied as basal significantly improved the plant height (75.16 cm) over other levels and time of potassium application followed by T₁₆ i.e., 150 kg potassium applied in splits i.e., $\frac{3}{4}$ basal and $\frac{1}{4}$ top dressing at 40 days after planting (72.01 cm) and T₁₇ i.e. 150 kg potassium applied in two splits of $\frac{3}{4}$ basal and $\frac{1}{4}$ top dressing at 60 days after planting (69.42 cm). All the levels and time of potassium application varied significantly among themselves. Significantly lowest plant height was recorded with T₇ i.e., application of 50 kg potassium applied as full at 40 days after planting (30.267 cm) which was statistically at par with treatment combination of T₅ application of 50 kg potassium, applied in two splits of $\frac{1}{2}$ basal + $\frac{1}{2}$ top dressing at 60 days after planting (30.66 cm).

Table-1: Effect of different levels and time of potassium application on the various growth characters of potato.

	Treatment	Plant height (cm)	Plant spread (cm)	No. of shoots/plant
T ₁	50 kg K ₂ O (full basal)	40.55	22.16	4.70
T ₂	50 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	38.56	19.33	4.66
T ₃	50 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	35.08	19.30	4.63
T ₄	50 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	32.57	19.16	4.63
T ₅	50 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60DAP)	30.66	18.86	4.43
T ₆	50 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	31.04	18.70	4.50
T ₇	50 kg K ₂ O (full at 40 DAP)	30.26	18.16	4.36
T ₈	100 kg K ₂ O (full basal)	64.45	31.16	5.96
T ₉	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	58.59	27.63	5.86
T ₁₀	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	56.00	27.34	5.80
T ₁₁	100 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	51.33	27.16	5.80
T ₁₂	100 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60 DAP)	48.08	27.13	5.46
T ₁₃	100 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	45.20	26.83	5.43

T ₁₄	100 kg K ₂ O (full at 40 DAP)	44.70	26.33	5.40
T ₁₅	150 kg K ₂ O (full basal)	75.16	44.15	9.36
T ₁₆	150 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	72.01	41.47	8.26
T ₁₇	150 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	69.42	37.75	7.63
T ₁₈	150 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	67.94	36.53	7.20
T ₁₉	150 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60DAP)	65.95	36.00	7.20
T ₂₀	150 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	63.92	35.16	7.10
T ₂₁	150 kg K ₂ O (full at 40 DAP)	61.20	35.00	6.43
CD_{0.05}		1.25	1.88	0.63

4.1.2 Plant spread (cm)

Persual of data on plant spread (Table-1) revealed that treatment T₁₆ i.e., application of 150 kg potassium applied basally significantly increased the plant spread (44.15 cm) followed by T₁₅ i.e., application of 150 kg potassium applied $\frac{3}{4}$ basal and $\frac{1}{4}$ top dressing at 40 days after planting (41.47) and T₁₇ i.e., application of 150 kg potassium applied in two splits of $\frac{3}{4}$ basal and $\frac{1}{4}$ top dressing at 60 days after planting (37.75) over other treatments. Significantly lowest plant spread (18.16 cm) was recorded with T₇ i.e., 50 kg potassium applied as full at 40 days after planting but were statistically at par with T₆ i.e., 50 kg potassium applied as $\frac{1}{2}$ top dressing at 40 days after planting and $\frac{1}{2}$ top dressing at 60 days after planting (18.70 cm) and T₅ i.e., 50 kg potassium applied as $\frac{1}{2}$ basal and $\frac{1}{2}$ top dressing at 60 days after planting (18.86 cm).

4.1.3. Number of Shoots per plant

Persual of data on number of shoots plant (Table-1) revealed that treatment T₁₅ i.e., 150 kg potassium applied basally recorded significantly more number of shoots per plant (9.36) at crop growth period compared to other levels and time of application followed by T₁₆ i.e., 150 kg potassium applied as $\frac{3}{4}$ basal and $\frac{1}{4}$ top dressing at 40 days after planting (8.26). Significantly lowest number of shoots was recorded with T₇ i.e., 50 kg potassium applied as full at 40 days after planting (4.36) treatment which was statistically at par with T₆ i.e., 50 kg potassium applied as $\frac{1}{2}$ top dressing at 40 days after planting and $\frac{1}{2}$ top dressing at 60 days after planting (4.50). All the levels and time of potassium application varied significantly among themselves.

4.2 Yield attributes.

4.2.1. Number of tubers per plant.

Persual of data on number of tubers per plant (Table-2) revealed that treatment T₁₈ i.e., 150 kg potassium applied $\frac{1}{2}$ basal and $\frac{1}{2}$ top dressing at 40 days after planting significantly improved number of tubers upto 10.20 followed by T₂₁ i.e., 150 kg potassium applied as full top dressing at 40 days after planting (9.26) and T₂₀ i.e., 150 kg potassium applied in two splits of $\frac{1}{2}$ top dressing at 40 days after planting and $\frac{1}{2}$ top dressing at 60 days after planting (8.26). All the other levels and time of potassium application varied significantly among themselves. Significantly lowest number of tubers (4.10) were observed in T₆ i.e., 50 kg potassium applied in two splits of $\frac{1}{2}$ top dressing at 40 days after planting and $\frac{1}{2}$ top dressing at 60 days after planting which were statistically at par with T₅ i.e., 50 kg potassium applied in two splits of $\frac{1}{2}$ basal + $\frac{1}{2}$ top dressing at 60 days after planting (4.16), T₂ i.e., 50 kg potassium applied in two splits of $\frac{3}{4}$ basal and $\frac{1}{4}$ top dressing at 40 days after planting (4.10).

4.2.2 Average tuber weight (gms)

Persual of data on average tuber weight (Table-2) revealed that treatment T₁₈ i.e., 150 kg potassium applied ½ basal and ½ top dressing at 40 days after planting significantly increased the tuber weight upto 65.162 followed by T₂₁ i.e., 150 kg potassium applied as full top dressing at 40 days after planting (63.33 g) and T₂₀ i.e., 150 kg potassium applied in two splits of ½ top dressing at 40 days after planting and ½ top dressing at 60 days after planting (61.10 g) over other treatment. However, significantly lowest average weight of tubers (40 g) was recorded with treatment T₁ i.e., 50 kg potassium applied as basally during crop growth.

Table-2: Effect of different levels and time of potassium application on the various yield attributing characters of potato

Treatment		No. of tubers/plant	Average tuber weight (gm)
T ₁	50 kg K ₂ O (full basal)	4.20	40.00
T ₂	50 kg K ₂ O (¾ basal + ¼ TD at 40 DAP)	4.13	41.10
T ₃	50 kg K ₂ O (¾ basal + ¼ TD at 60 DAP)	4.13	43.00
T ₄	50 kg K ₂ O (½ basal + ½ TD at 40 DAP)	5.26	44.36
T ₅	50 kg K ₂ O (½ basal + ½ TD at 60DAP)	4.16	41.16
T ₆	50 kg K ₂ O (no basal + ½ TD at 40 DAP + ½ at 60 DAP)	4.10	42.06
T ₇	50 kg K ₂ O (full at 40 DAP)	4.23	43.03

T ₈	100 kg K ₂ O (full basal)	6.20	45.03
T ₉	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	6.23	46.50
T ₁₀	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	6.20	46.00
T ₁₁	100 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	7.23	51.33
T ₁₂	100 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60 DAP)	6.23	47.00
T ₁₃	100 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	6.26	48.00
T ₁₄	100 kg K ₂ O (full at 40 DAP)	6.26	49.20
T ₁₅	150 kg K ₂ O (full basal)	8.10	53.03
T ₁₆	150 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	8.16	58.13
T ₁₇	150 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	8.03	54.03
T ₁₈	150 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	10.20	65.16
T ₁₉	150 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60DAP)	8.23	55.03
T ₂₀	150 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	8.26	61.10
T ₂₁	150 kg K ₂ O (full at 40 DAP)	9.26	63.03
CD_{0.05}		0.55	1.50

4.2.3. Weight of marketable tubers per plot (Kg)

Marketable tubers per plot is an important economic parameter for Potato cultivation. Analysis of variance (Appendix – III) revealed that all the factors i.e. time and level of potassium application was highly significant for this trait.

Persual of data on weight of marketable tubers per plot (Table-3) revealed that treatment T₁₈ i.e., 150 kg potassium applied $\frac{1}{2}$ basal and $\frac{1}{2}$ top dressing at 40 days after planting significantly increased weight of marketable tubers up to 17.16 kg followed by T₁₉ i.e., 150 kg potassium $\frac{1}{2}$ basal and $\frac{1}{2}$ top dressing at 60 days after planting (15.93 kg) followed by T₂₀ i.e., 150 kg potassium applied in two splits of $\frac{1}{2}$ top dressing at 40 days after planting and $\frac{1}{2}$ top dressing at 60 days after planting (14.16kg). However lowest weight (7.00kg) of marketable tubers per plot was observed with T₆ i.e., no basal and $\frac{1}{2}$ top dressing at 40 days after planting and $\frac{1}{2}$ top dressing at 60 days after planting which was statically at par with T₂ i.e., $\frac{1}{2}$ top dressing at 40 days after planting and $\frac{1}{2}$ top dressing at 60 days after planting (7.03 kg)

4.2.4. Weight of unmarketable tubers per plot (Kg):

Persual of data on weight of unmarketable tubers per plot (Table -3) revealed that application of T₁ i.e., 50 kg potassium applied as basal increased weight up to 0.99 kg followed by T₃ i.e., 50 kg potassium applied as $\frac{3}{4}$ basal and $\frac{1}{4}$ top dressing at 40 days after planting (0.98 kg) which was statically at par with T₅ i.e., 50 kg potassium applied as $\frac{1}{2}$ basal and $\frac{1}{2}$ top dressing at 60 days after planting (0.98 kg) and T₆ i.e., 50 kg potassium applied in two splits of $\frac{1}{2}$ top dressing at 40 days after planting and $\frac{1}{2}$ top dressing at 60 days after planting (0.98 kg). However significantly lowest weight of marketable tubers per plot (0.33kg) was observed in T₁₆ i.e., application of 150 kg K applied in two splits of $\frac{3}{4}$ basal + $\frac{1}{2}$ TD at 40 days after planting.

Table-3: Effect of different levels and time of potassium application on the Marketable yield of potato.

	Treatment	Marketabl e (kg/plot)	Unmarketable (kg/plot)
T ₁	50 kg K ₂ O (full basal)	11.23	0.99
T ₂	50 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	7.03	0.95
T ₃	50 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	12.73	0.98
T ₄	50 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	8.06	0.98
T ₅	50 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60DAP)	12.56	0.98
T ₆	50 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	7.00	0.97
T ₇	50 kg K ₂ O (full at 40 DAP)	11.66	0.97
T ₈	100 kg K ₂ O (full basal)	13.5	0.85
T ₉	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	13.26	0.87
T ₁₀	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	15.5	0.67
T ₁₁	100 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	14.33	0.83
T ₁₂	100 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60 DAP)	16.6	0.83
T ₁₃	100 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	13.5	0.79
T ₁₄	100 kg K ₂ O (full at 40 DAP)	14.5	0.74

T ₁₅	150 kg K ₂ O (full basal)	11.53	0.74
T ₁₆	150 kg K ₂ O (¾ basal + ¼ TD at 40 DAP)	13.03	0.33
T ₁₇	150 kg K ₂ O (¾ basal + ¼ TD at 60 DAP)	11.33	0.78
T ₁₈	150 kg K ₂ O (½ basal + ½ TD at 40 DAP)	17.16	0.86
T ₁₉	150 kg K ₂ O (½ basal + ½ TD at 60DAP)	12.76	0.67
T ₂₀	150 kg K ₂ O (no basal + ½ TD at 40 DAP + ½ at 60 DAP)	14.16	0.76
T ₂₁	150 kg K ₂ O (full at 40 DAP)	15.93	0.76
CD_{0.05}		0.87	0.03

4.2.5. Grade wise number and weight of tubers (g).

4.2.5.1 Grade “A” tubers per plot

Tubers weighing more than 75 g were graded as “A”, weight and number of such tubers was worked out. Perusal of data on number and weight of Grade “A” tubers (Table-4 & 5) revealed that treatment T₁₈ i.e., 150 kg potassium applied ½ basal and ½ top dressing at 40 days after planting increased number (69) and weight (5.29 kg) of tubers followed by T₂₁ i.e., 150 kg potassium applied as full top dressing at 40 days after planting which increased number (66) and weight (5.10 kg).

4.2.5.2 Grade “B” tubers per plot

Grade “B” tubers were categorized as the ones having tuber weight of 50 to 75 grams. The number and weight of such tubers was worked out. Analysis of variance revealed that the main effects of time and level of potassium application was significant.

Persual of data on number and weight of Grade “B” tubers (Table-4 & 5) revealed that treatment T₁₈ i.e., 150 kg potassium applied ½ basal and ½ top dressing at 40 days after planting increased number (122) and weight (7.88 kg) of tubers followed by T₂₁ i.e., 150 kg potassium applied as full top dressing at 40 days after planting which increased number and weight up to 117.67 and 7.57 kg respectively. Significantly lowest number (31) & weight (3.18 kg) of tubers were recorded with T₂ i.e., 50 kg potassium applied in two splits of ¾ basal and ¼ top dressing at 40 days after planting.

4.2.5.3. Grade “C” Tubers per plot

Grade “C” tubers were categorized as the ones having tuber weight of 25 to 50 gm. Persual of data on number and weight of Grade “C” tubers (Table-4 & 5) revealed that treatment T₁₈ i.e., 150 kg potassium applied ½ basal and ½ top dressing at 40 days after planting increased number (69) and weight (3.18 kg) of tubers followed by T₂₁ i.e., 150 kg potassium applied as full top dressing at 40 days after planting (68.33) and (2.347kg). However significantly lowest number (53) and weight of tubers (0.97 kg) was found in T₆ i.e., 50 kg potassium applied in two splits of ½ top dressing at 40 days after planting + ½ top dressing at 60 days after planting which was statistically at par with T₂ i.e., 50 kg potassium, ¾ basal + ¼ top dressing at 40 days after planting having number (53) and weight 2.24 kg.

Table-4: Effects of different levels and time of potassium application on different grades of potato (kg per plot)

Treatment		>75g	50 -75 g	25- 50 g	0-25g
T ₁	50 kg K ₂ O (full basal)	3.78	4.80	1.65	0.98
T ₂	50 kg K ₂ O($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	3.02	2.24	0.97	0.90
T ₃	50 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	4.17	5.45	1.69	0.99
T ₄	50 kg K ₂ O($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	2.95	2.78	1.2	0.99
T ₅	50 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60DAP)	4.07	5.52	1.7	0.99
T ₆	50 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	2.65	2.23	0.97	0.90
T ₇	50 kg K ₂ O (full at 40 DAP)	3.77	4.78	1.66	0.98
T ₈	100 kg K ₂ O (full basal)	4.42	6.24	1.89	0.90
T ₉	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	4.62	6.27	1.99	0.84
T ₁₀	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	5.10	7.23	2.34	0.83

T ₁₁	100 kg K ₂ O (½ basal + ½ TD at 40 DAP)	4.80	7.21	1.99	0.73
T ₁₂	100 kg K ₂ O (½ basal + ½ TD at 60 DAP)	5.10	7.57	2.09	0.83
T ₁₃	100 kg K ₂ O (no basal + ½ TD at 40 DAP + ½ at 60 DAP)	4.54	6.17	1.99	0.84
T ₁₄	100 kg K ₂ O (full at 40 DAP)	4.80	7.21	1.99	0.73
T ₁₅	150 kg K ₂ O (full basal)	3.79	4.99	1.60	0.93
T ₁₆	150 kg K ₂ O (¾ basal + ¼ TD at 40 DAP)	4.63	6.24	1.60	0.70
T ₁₇	150 kg K ₂ O (¾ basal + ¼ TD at 60 DAP)	3.77	4.80	1.64	0.98
T ₁₈	150 kg K ₂ O (½ basal + ½ TD at 40 DAP)	5.29	7.88	3.18	0.73
T ₁₉	150 kg K ₂ O (½ basal + ½ TD at 60DAP)	4.17	5.48	1.70	0.99
T ₂₀	150 kg K ₂ O (no basal + ½ TD at 40 DAP + ½ at 60 DAP)	4.68	6.30	1.99	0.75
T ₂₁	150 kg K ₂ O (full at 40 DAP)	5.10	7.57	2.34	0.83
CD_{0.05}		0.33	0.50	0.64	0.03

Table-5: Effect of different levels and time of potassium application on number of different grades of potato per plot.

Treatment		>75 g	50 -75 g	25- 50 g	0-25 g
T ₁	50 kg K ₂ O (full basal)	49.00	91.00	50.66	45.00
T ₂	50 kg K ₂ O($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	35.00	51.00	55.00	53.00
T ₃	50 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	54.00	96.00	55.00	44.33
T ₄	50 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	39.00	50.00	56.00	55.00
T ₅	50 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60DAP)	51.00	95.00	52.00	42.00
T ₆	50 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	34.00	57.00	56.00	53.00
T ₇	50 kg K ₂ O (full at 40 DAP)	49.66	90.00	50.00	43.30
T ₈	100 kg K ₂ O (full basal)	58.00	101.00	60.33	35.33
T ₉	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	59.00	108.33	60.66	36.33
T ₁₀	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	66.00	117.67	68.33	36.33

T ₁₁	100 kg K ₂ O (½ basal + ½ TD at 40 DAP)	63.00	114.67	65.33	37.00
T ₁₂	100 kg K ₂ O (½ basal + ½ TD at 60 DAP)	66.00	117.67	68.33	36.33
T ₁₃	100 kg K ₂ O (no basal + ½ TD at 40 DAP + ½ at 60 DAP)	59.33	111.33	60.33	38.00
T ₁₄	100 kg K ₂ O (full at 40 DAP)	63.00	115.00	65.66	37.00
T ₁₅	150 kg K ₂ O (full basal)	48.00	89.00	45.66	46.00
T ₁₆	150 kg K ₂ O (¾ basal + ¼ TD at 40 DAP)	59.00	112.33	61.33	37.33
T ₁₇	150 kg K ₂ O (¾ basal + ¼ TD at 60 DAP)	49.00	90.00	50.00	43.33
T ₁₈	150 kg K ₂ O (½ basal + ½ TD at 40 DAP)	69.00	122.33	69.00	36.33
T ₁₉	150 kg K ₂ O (½ basal + ½ TD at 60DAP)	53.00	97.67	55.33	41.00
T ₂₀	150 kg K ₂ O (no basal + ½ TD at 40 DAP + ½ at 60 DAP)	61.00	111.00	61.00	37.00
T ₂₁	150 kg K ₂ O (full at 40 DAP)	66.00	117.67	68.33	36.33
CD_{0.05}		1.37	2.72	1.22	1.83

4.2.5.4. Grade “D” tubers per plot

Tubers weighing less than 25 g were graded as Grade “D” tubers. Perusal of data (Table-4 & 5) revealed that none of the main factors was significant and hence the variation in the values among them has arisen exclusively because of sampling error and need not to be highlighted. However significantly highest number (55) and weight of tubers (0.997 kg) was observed in T₄ i.e., 50 kg potassium applied in splits of ½ basal and ½ top dressing at 40 days after planting per plot followed by T₂₁ i.e., 150 kg potassium applied full at 40 days after planting & T₂₀ i.e., 150 kg potassium applied in two splits as ½ top dressing at 40 days after planting and ½ at 60 days after planting.

4.2.6. Total Yield (q/ha)

This is the most important economic parameter in the potato crop. Analysis of variance (Appendix–III) revealed that all factors i.e., level and time of potassium application were significant.

Perusal of data on total yield (Table -6) revealed that treatment T₁₈ i.e., 150 kg potassium applied ½ basal and ½ top dressing at 40 days after planting significantly improved yield upto 301.59 q/ha followed by T₂₁ i.e., 150 kg potassium applied as full top dressing at 40 DAP (281.54 q/ha) which was statically at par T₂₀ i.e., 150 kg potassium applied in two splits of ½ top dressing at 40 days after planting and ½ top dressing at 60 days after planting (277.68 q/ha). Yield advantage of 42.6%, 33.2% and 31.38% was observed by T₁₈, T₂₀ and T₂₁ over the check i.e., T₈ (150 kg potassium applied as basal) respectively. Significantly lowest yield (162.80 q/ha) were observed in T₃ i.e., 50 kg potassium applied as ¾ basal and ¼ top dressing at 40 days which were statistically at par with T₆ i.e., 50 kg potassium applied in two splits of ½ top dressing at 40 days after planting and ½ top dressing at 60 days after planting (162.80 q/ha).

Table -6: Effect of different levels and time of potassium application on the yield of potato

Treatment		Total yield (q/ha)
T ₁	50 kg K ₂ O (full basal)	192.83
T ₂	50 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	164.30
T ₃	50 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	162.80
T ₄	50 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	192.80
T ₅	50 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60DAP)	165.80
T ₆	50 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	162.80
T ₇	50 kg K ₂ O (full at 40 DAP)	165.84
T ₈	100 kg K ₂ O (full basal)	211.35
T ₉	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	209.03
T ₁₀	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	210.60
T ₁₁	100 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	210.57
T ₁₂	100 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60 DAP)	209.03
T ₁₃	100 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	209.03
T ₁₄	100 kg K ₂ O (full at 40 DAP)	209.03
T ₁₅	150 kg K ₂ O (full basal)	256.08
T ₁₆	150 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	260.71
T ₁₇	150 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	258.40
T ₁₈	150 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	301.59
T ₁₉	150 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60DAP)	277.68
T ₂₀	150 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	256.08
T ₂₁	150 kg K ₂ O (full at 40 DAP)	281.54
CD_{0.05}		18.10

4.3. Quality parameters

4.3.1. Total Soluble Solids (°Brix)

Persual of data on Total Soluble Solids (Table-6) revealed that treatment T₆ i.e., 50 kg potassium applied in two splits of ½ top dressing at 40 days after planting and ½ top dressing at 60 days after planting increased total soluble solids upto (7.67°Brix) which was statically at par with T₇ i.e., 50 kg potassium applied as full top dressing at 40 days after planting (7.20 °Brix). Significant decrease in total soluble solids (4.70°Brix) were recorded with T₁₇ i.e., 150 kg potassium applied in two splits of ¾ basal and ¼ top dressing at 60 days after planting.

4.3.2. Vitamin C (mg 100 g⁻¹)

Persual of the data on the effect of time and level of potassium application on vitamin C content (Table-6) revealed that application of T₁₈ i.e., 150 kg potassium applied in two splits of ½ basal and ½ top dressing at 60 days after planting increased vitamin C upto (23.12 mg) followed by T₂₁ i.e., 150 kg potassium applied as full top dressing at 40 days after planting (21.60 mg). Significant decrease in vitamin C (14.48 mg) were recorded with T₁ i.e., 50 kg potassium applied as basal.

Table-7: Effect of different levels and time of potassium application on various quality traits of potato.

	Treatment	T.S.S (°Brix)	Protein content(%)	Specific gravity	Dry matter (%)	Vitamin C mg/100 g
T ₁	50 kg K ₂ O (full basal)	6.83	1.48	1.04	20.20	14.48
T ₂	50 kg K ₂ O (¾ basal + ¼ TD at 40 DAP)	6.93	1.64	1.04	19.67	16.21
T ₃	50 kg K ₂ O (¾ basal + ¼ TD at 60 DAP)	6.86	1.43	1.04	19.53	15.52
T ₄	50 kg K ₂ O (½ basal + ½ TD at 40 DAP)	7.06	1.63	1.05	19.47	17.52
T ₅	50 kg K ₂ O (½ basal + ½ TD at 60DAP)	7.05	1.47	1.05	19.45	15.5
T ₆	50 kg K ₂ O (no basal + ½ TD at 40 DAP + ½ at 60 DAP)	7.67	1.38	1.05	19.07	16.54
T ₇	50 kg K ₂ O (full at 40 DAP)	7.20	1.40	1.05	19.25	17.01
T ₈	100 kg K ₂ O (full basal)	6.30	2.18	1.06	21.60	18.41
T ₉	100 kg K ₂ O (¾ basal + ¼ TD at 40 DAP)	6.67	2.32	1.06	21.54	19.35
T ₁₀	100 kg K ₂ O (¾ basal + ¼ TD at 60 DAP)	6.60	2.12	1.06	21.50	18.69
T ₁₁	100 kg K ₂ O (½ basal + ½ TD at 40 DAP)	6.76	2.43	1.07	21.23	20.55
T ₁₂	100 kg K ₂ O (½ basal + ½ TD at 60 DAP)	6.70	2.15	1.06	22.66	19.24
T ₁₃	100 kg K ₂ O (no basal + ½ TD at 40 DAP + ½ at 60 DAP)	6.80	2.07	1.07	21.16	20.45

T ₁₄	100 kg K ₂ O (full at 40 DAP)	6.73	2.10	1.07	21.33	20.48
T ₁₅	150 kg K ₂ O (full basal)	4.70	2.55	1.08	22.33	21.30
T ₁₆	150 kg K ₂ O (³ / ₄ basal + ¹ / ₄ TD at 40 DAP)	4.96	2.53	1.08	23.38	21.40
T ₁₇	150 kg K ₂ O (³ / ₄ basal + ¹ / ₄ TD at 60 DAP)	4.70	2.48	1.08	23.37	21.32
T ₁₈	150 kg K ₂ O (¹ / ₂ basal + ¹ / ₂ TD at 40 DAP)	5.30	2.62	1.09	22.91	23.12
T ₁₉	150 kg K ₂ O (¹ / ₂ basal + ¹ / ₂ TD at 60DAP)	5.0	2.52	1.08	22.34	21.40
T ₂₀	150 kg K ₂ O (no basal + ¹ / ₂ TD at 40 DAP + ¹ / ₂ at 60 DAP)	6.20	2.46	1.14	22.10	21.41
T ₂₁	150 kg K ₂ O (full at 40 DAP)	5.63	2.47	1.09	22.42	21.60
CD_{0.05}		0.62	0.150	0.022	1.50	1.05

4.3.3. Specific gravity

Persual of data on specific gravity (Table-7) revealed that treatment T₂₀ i.e., 150 kg potassium applied in two splits of ½ top dressing at 40 days after planting and ½ top dressing at 60 days after planting increased specific gravity upto (1.14) followed by T₁₈ i.e., 150 kg potassium applied in two splits of ½ basal and ½ TD at 40 days after planting (1.09) which was statically at par with T₂₁ i.e., 150 kg potassium applied full at 40 days after planting (1.09). Significantly lowest specific gravity (1.04) were observed in T₁ i.e., 50 kg potassium applied as basally which were statistically at par with T₃ i.e., 50 kg potassium applied in two splits of ¾ basal and ¼ top dressing at 40 days after planting (1.04) and T₃ i.e., 50 kg potassium applied in two splits of ¾ basal and ¼ top dressing at 60 days after planting (1.04)

4.3.4. Dry matter (%)

Dry matter accumulation in plants is a photosynthetic, nutrient assimilation and utilization efficiency measurement. Persual of data on dry matter of tubers (Table-6) revealed that treatment T₁₆ i.e., 150 kg potassium applied ¾ basal and ¼ top dressing at 40 days after planting significantly improved dry matter of tubers upto 23.38 which were statistically at par with T₁₇ i.e., 50 kg potassium applied in two splits of ¾ basal and ¼ top dressing at 60 days after planting (23.37) Significantly lowest dry matter of tubers (19.07) were observed in T₆ i.e., 50 kg potassium applied in two splits of ½ top dressing at 40 days after planting and ½ top dressing at 60 days after planting which was statically at par with T₅ i.e., 50 kg potassium applied in two splits of ½ basal and ½ top dressing at 60 days after planting(19.45)

4.3.5. Protein Content (%)

Persual of data on protein content of tubers (Table-6) revealed that treatment T₁₈ i.e., 150 kg potassium applied as ½ basal and ½ top dressing at 40 days after planting

increased protein content up to (2.62) followed by T₁₅ i.e., 150 kg potassium applied as basal (2.55) . Significantly lowest protein content (1.38) were observed in T₆ i.e., 50 kg potassium applied in two splits of ½ top dressing at 40 days after planting and ½ top dressing at 60 days after planting.

4.4 Economics of potato production

Persual of Table-8 reveals that treatment T₁₈ with 150 kg potassium applied in two splits of ½ basal and ½ top dressing at 40 days after planting proved to be most remunerative, yielding a net profit of Rs 251585.60 per hectare over an overall expenditure of Rs 110322.36 i.e., return of Rs 2.28 per rupee invested.

Table:-8 Effect of different levels and time of potassium application on Relative economics of potato.

	Treatment	Cost of cultivation (treatment cost/ha)	Production (q/ha)	Gross Returns	Net Profit (Rs/ha)	Return /rupee invested
T ₁	50 kg K ₂ O (full basal)	108321.58	210.6	252720	144398.4	1.33
T ₂	50 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	108321.58	164.3	197160	88838.42	0.82
T ₃	50 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	108321.58	162.8	195360	87038.42	0.80
T ₄	50 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	108321.58	192.8	231360	123038.4	1.14
T ₅	50 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 60DAP)	108321.58	165.8	198960	90638.42	0.84
T ₆	50 kg K ₂ O (no basal + $\frac{1}{2}$ TD at 40 DAP + $\frac{1}{2}$ at 60 DAP)	108441.58	162.8	195360	86918.42	0.80
T ₇	50 kg K ₂ O (full at 40 DAP)	108321.58	165.84	199008	90686.42	0.84
T ₈	100 kg K ₂ O (full basal)	109310.23	211.35	253620	144309.8	1.32
T ₉	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 40 DAP)	109310.23	209.03	250836	141525.8	1.29
T ₁₀	100 kg K ₂ O ($\frac{3}{4}$ basal + $\frac{1}{4}$ TD at 60 DAP)	109310.23	192.83	231396	122085.8	1.12
T ₁₁	100 kg K ₂ O ($\frac{1}{2}$ basal + $\frac{1}{2}$ TD at 40 DAP)	109310.23	210.57	252684	143373.8	1.31

T ₁₂	100 kg K ₂ O (½ basal + ½ TD at 60 DAP)	109310.23	209.03	250836	141525.8	1.29
T ₁₃	100 kg K ₂ O (no basal + ½ TD at 40 DAP + ½ at 60 DAP)	109310.23	209.03	250836	141525.8	1.29
T ₁₄	100 kg K ₂ O (full at 40 DAP)	109430.23	209.03	250836	141405.8	1.29
T ₁₅	150 kg K ₂ O (full basal)	109310.23	256.08	307296	197985.8	1.81
T ₁₆	150 kg K ₂ O (¾ basal + ¼ TD at 40 DAP)	110298.64	260.71	312852	202553.4	1.84
T ₁₇	150 kg K ₂ O (¾ basal + ¼ TD at 60 DAP)	110310.50	258.4	310080	199769.5	1.81
T ₁₈	150 kg K ₂ O (½ basal + ½ TD at 40 DAP)	110322.36	301.59	361908	251585.6	2.28
T ₁₉	150 kg K ₂ O (½ basal + ½ TD at 60DAP)	110334.22	277.68	333216	222881.8	2.02
T ₂₀	150 kg K ₂ O (no basal + ½ TD at 40 DAP + ½ at 60 DAP)	110466.08	256.08	307296	196829.9	1.78
T ₂₁	150 kg K ₂ O (full at 40 DAP)	110357.94	281.54	337848	227490.1	2.06

Remarks: Sale price of potato@ Rs 12/Kg
 Cost of 1Kg Urea = Rs 5.62
 Cost of 1Kg DAP = Rs 12.6
 Cost of 1Kg MOP = Rs 11.86
 Cost of labour = Rs 120 per manday

Chapter-5

DISCUSSION

Potato is a short duration, high yielding and exhaustive crop. It is, therefore imperative to apply balanced fertilizers for qualitative and quantitative production from this crop. All essential nutrients must remain available with sufficient amounts to sustain the highest yield with quality tubers and to replenish soil nutrients to achieve desirable growth and development of potato crop. (Patricia and Bansal, 1999). Overall, there are sixteen indispensable nutritional elements considered to be obligatory for better plant growth and yield. Amongst those Carbon, Hydrogen and Oxygen are naturally available from air and water whereas, rest of the elements need to be supplemented for desirable growth and development (Pushkarnath and Sardana, 1965). The use of essential elements is very critical for the harvesting of crops on sustainable basis. The applications of nitrogen and phosphorus nutrient elements have been mainly considered while Potassium is being ignored due to the common consensus that the soils contain sufficient amount of Potassium. In fact, Potassium is depleting at alarming rate in the soils.

The Potassium regulates nutritional solution concentration throughout the plant which affects not only the general health and vigor of plant but also yield and quality. It controls cell sap contents which maintain the turgor and supports the movements of all materials within the plant. Potassium has a vital role in photosynthesis process that favors high energy status, regulates opening and closing of leaf stomata, nutrients translocation, water uptake, vitamin contents and organic acid concentration in plants (Bergmann, 1992). It maintains tissue water relation (Marschner, 1995). Potassium acts as catalytic agent only and is not a part of plant molecules, in contrast to nitrogen and phosphorus. However, Potassium predominantly exists as a free or absorptive bound cation and can therefore, be

replaced easily on the cellular level as well as in the whole plant (Lindhauer, 1985). Thus, the high mobility in plant explains the major fundamental characteristic of potassium as the main cation to involve in neutralization of charges and as the most important inorganic osmotic active substance (Clarkson and Hanson, 1980). The present investigation was therefore initiated to study the effect of levels and time of potassium application for obtaining maximum yield and quality of potato under temperate conditions.

The results obtained are discussed here under the following paragraph headings.

5.1 Plant height (cm)

The height of plant was markedly influenced by increasing levels of potassium application, as shortest height (30.66 cm) have been measured at lowest level of 50 kg and taller height (75.16 cm) have been measured at highest level of 150 kg applied basally. Identical results have been reported by Singh and Singh (1995). This increase in height might be due to fact that easily availability of potassium enhances the metabolic activities of plant and brings about increased growth in plants. Potassium is also responsible to promote photosynthesis and to speed up the translocation of assimilates production of proteins and sugars and to improve Nitrogen use efficiency which might have stimulated plant growth. Potassium also played a positive role in phloem loading with sucrose and transport rate of phloem sap solutes as well as in phloem unloading. Consequently it enhanced the potato plant growth (Herlihs, 1989). However the results revealed that increase in plant height was mainly due to increase in potassium concentration rather than its time of application.

5.2 Plant spread (cm)

The plant spread was significantly influenced by increased potassium application as increase in spread (44.15 cm) was recorded at 150kg potassium applied basally

while the shortest height (18.70 cm) at 50 kg potassium applied in two splits of half at 40 days after planting and half at 60 days after planting. This increase in spread might be due to the fact that potassium activates more than 60 enzymes in plants which are responsible for promoting the rate of photosynthesis and produce high energy status in the form of ATP which is utilized by the plant for enhancing its physio-morphological activities resultantly supportive for rapid growth.

5.3 Number of shoots per plant

Treatments showed significant difference in number of shoots per plant. Maximum number of shoots (9.36) was observed with 150 kg potassium applied basally which was significantly higher as compared to other treatments. This increase in spread might be due to the fact that since Nitrogen was applied at a constant rate to all treatments along with potassium, so with the combination of these elements, availability of Nitrogen in proper quantity which are required for metabolic processes had led to increase in the number of shoots per plant.

5.4 Number of tubers per plant

Treatments exhibited significant differences in relation to tuber number per plant. Maximum tuber number per plant (10.20) was observed with 150 kg potassium applied half at the time of planting and half at 40 days after planting followed by 150 kg potassium applied full at 40 days after planting. The difference in the means of treatment were significant. Similar finding have been reported by Mazur *et al.* (1991), Grewal and Kolar (1993) and Singh *et al.* (1998).

Tuber number per plant increased significantly with increase in potassium levels upto 150 kg. maximum tuber number of (10.20) tubers per plant was obtained due to combined effect of levels and time of potassium application i.e., 150 kg potassium applied half at the time of planting and half at 40 days respectively. This may be attributed to the fact that availability of potassium at 40 days after planting

increased physiological activities within the plant resulting in increased tuber number. Potassium is responsible to promote photosynthesis and to speed up the translocation of assimilates as well as to activate enzymes (Perrenoud, 1993) which are fundamental to metabolic processes for the production of proteins and sugars and to improve nitrogen use efficiency (Grewal and Singh, 1980). Increase in tuber number per plant may be due to increased photosynthetic activity and translocation of photosynthates to the roots that might have helped in initiation of more stolons (Anand and Krishnappa, 1989).

5.5 Average tuber weight (g)

Average tuber weight plant⁻¹ is the most important component of the yield which in term is influenced by plant phenology Average tuber weight was found to be maximum (65.16 g) in 150 kg potassium applied half at the time of planting and half at 40 days after planting followed by 150 kg potassium applied full at 40 days after planting Similar finding have also been reported by Singh *et al.* (1998).

Significant increase in average tuber weight was observed when potassium level was increased from 50 to 150 kg. At 100 kg potassium per hectare applied half at the time of planting and half at 40 days after planting and at 50 kg potassium per hectare applied half at the time of planting and half at 40 days after planting recorded average tuber weight of 51.33 and 44.36 g respectively. The increase in average tuber weight could be due to excessive amount of potassium which increases tuber initiation and tuber growth. More over potassium influenced quality and quantity of tubers indirectly by its positive interaction with other nutrients (especially with Nitrogen) and management practices (Usherwood, 1985). The combined effect of levels and time of potassium application i.e., 150 kg potassium per hectare applied half at the time of planting and half at 40 days after planting with respect to tuber

weight showed significant superiority over the treatment combinations in all the levels.

5.5 Weight of marketable tubers per plot (Kg)

A significantly increase in weight of marketable tubers per plot with increase in level of potassium application was observed. Thus highest weight of marketable tubers (17.16 kg) per plot was recorded at 150 kg potassium per hectare applied half at the time of planting and half at 40 days after planting. The results corroborate with the observations of Trehan and Grewal (1991), Khan (1993) and Govindakrishnan *et al.* (1994).

The higher yield at highest potassium level of 150 kg applied half at the time of planting and half at 40 days after planting was due to availability of potassium which enhanced the size and weight of tubers (Martin, 1989) and also increased the proportion of large sized marketable tubers which ultimately resulted in higher weight of marketable tubers per plot. A similar finding has also been reported by Perrenoud (1993).

5.6 Weight of unmarketable tubers per plot (Kg)

The weight of unmarketable tubers per plot was not significantly affected by the different potassium levels. However marginal increase in weight of unmarketable tubers (0.99) was recorded when 50 kg potassium per hectare applied basally. Identical results have been reported by Khan (1993).

Like potassium levels, time of potassium application has not significantly affected the weight of unmarketable tubers per plot. It can be concluded that neither level nor time of potassium application have any significant role in encouraging the weight of unmarketable tubers per plot. This may be due to the fact that the number of tubers that achieve maturity is related to available moisture and nutrition.

Optimum moisture and nutrient levels early in the growing season are critical to the maintenance and development of tubers. The plant initially produces 20- 30 small tubers but only a few typically reach to maturity. The growing plant even have some of the tubers in original set.

5.7 Grade wise number and weight of tubers per plot

5.7.1 Grade “A” (above 75 g)

Tubers weighing more than 75g were graded as “A” and the yield and number of such tubers kg per plot was worked out. Maximum Grade “A” tubers were obtained with 150 kg potassium followed by 100kg and 50 kg. However all the treatments were found to be significant. Like potassium levels, time of potassium application has significantly affected the yield and number of Grade “A” tubers.

The highest yield (5.29 kg) of Grade “A” tubers per plot was observed at 150 kg potassium applied half at the time of planting and half at 40 days after planting .The difference in yield of Grade “A” tubers by different levels and time of potassium application have also been reported by Trehan and Grewal (1991) and Govindakrishnan *et al.* (1994).

The highest number (69) of Grade “A” tubers per plant was observed at 150 kg potassium applied half at the time of planting and half at 40 days after planting .The interaction between the levels and time of potassium application produced significant effect on production of Grade “A” tubers. This may be attributed to the fact that availability of potassium at 40 days after planting played an important role in transport of assimilates and nutrients and improved the water use efficiency by controlling stomatal opening and closing. Potassium is also involved in activation of enzymes which are fundamental to metabolic processes. Thus, the food manufactured with the process of photosynthesis is transported from the source to the sink of their

use or storage promptly i.e., tubers (Mengel, 1997) which has resulted in increasing the number and weight of Grade “A” tubers.

5.7.2 Grade “B” (50-75 g)

The treatments differed significantly in production of Grade “B” tubers. Maximum Grade “B” tubers (7.88 kg) were observed at 150 kg potassium applied half at the time of planting and half at 40 days after planting followed by 150 kg potassium applied full at 40 days after planting (3.18 kg).

Increase in level of potassium increased the yield (7.88 kg) of Grade “B” tuber production upto 150 kg potassium but this increase was significant from other treatments. The results are in confirmation with finding of Trehan and Grewal (1991) and Govindakrishnan *et al.* (1994).

The highest number (122) of Grade “B” tubers per plant was observed at 150 kg potassium applied half at the time of planting and half at 40 days after planting. The highest yield and number of Grade “B” tubers was obtained with 150 kg potassium applied half at the time of planting and half at 40 days after planting. The interaction between levels and time of potassium application with respect to production of Grade “B” tubers exhibited significant effect.

5.7.3 Grade “C” (25 – 50 g)

The yield and number of these tubers increased significantly with addition of potassium. Highest yield (3.18 kg) and number (69) of these tubers was recorded at 150 kg potassium per hectare applied half at the time of planting and half at 40 days after planting. However, the yield and number increased when the potassium level was raised from K₁ to K₄. The results are in agreement with the finding of Trehan and Grewal (1991) and Govindakrishnan *et al.* (1994) who were of the view that potassium play an important role in increasing the number and weight of tubers.

Unlike potassium levels, time of potassium have a positive role in contributing the yield and number of these tubers. However, maximum yield and number of these tubers were recorded when 150 Kg potassium was applied half at the time of planting and half at 40 days after planting.

5.7.3 Grade “D” (below 25 g)

No significant difference among the treatment in production of Grade “D” tubers was observed. However, maximum yield (0.99 kg) of Grade “D” tubers was observed with 50 kg potassium applied half at the time of planting and half at 40 days after planting were maximum number of Grade “D” tubers (55) were observed. However all the treatments were not found to be significant. Like potassium levels, time of potassium application has not significantly affected on the yield and number of Grade “D” tubers.

Increase in the levels and time of potassium increased the yield of Grade “D” tubers but this increase was non significant. The highest yield of Grade “D” tubers was observed at 150 kg potassium per hectare and lowest at 50 kg potassium per hectare. The results obtained are in line with the findings of Grewal (1991) and Govindakrishnan *et al.* (1994). This may be attributed to the fact that the tuber cells expand with the accumulation of water nutrients and carbohydrates. Tuber bulking is the growth stage of longer duration where only a few reach/achieve maturity as on harvesting of the crop.

5.8 Total yield (q ha⁻¹)

The treatments differed significantly in their yield potential. The highest tuber yield (301.28 q/ha) was obtained from 150 kg potassium applied half at the time of planting and half at 40 days after planting which was significantly higher than other treatments followed by T₂₁ i.e., 150 kg potassium applied full at 40 days after planting (281.54 q/ha). Similar finding has been reported by Mc Dole (1978),

Satyanarayana and Arora,(1985)Anand and krishnappa (1988), Sharma and Arora (1989), Furunes (1990), Mazur *et al.* (1991), Trehan and Grewal (1991), Sud and Grewal (1991), Mazur and Kreft (1991), Sharma (1991), Sud and Grewal (1992), Sharma and Arodra (1992), Sharma (1993), Grewal and Kolar (1993), Chadachan *et al.* (1993), Jagroop *et al.* (1993), Khan (1993), Govindakrishnan *et al.* (1994), Lal and Arora (1994), Nakashgir (1994), Westermann *et al.* (1994), Mishra *et al.* (1994),Singh and Singh (1995), Singh and Singh (1996), Singh *et al.* (1996), Panique *et al.* (1997), Savita and Khalik (1998), Singh *et al.* (1998), Savita *et al.* (2000), Qin-fang (2003), Kumar *et al.* (2004), Moinuddin and Umar (2004) and Nikardi (2009).

Effect of levels and time of potassium application in the present study revealed that tuber yield increased significantly with increase in potassium level up to 150 kg applied half at the time of planting and half at 40 days after planting (301.28) followed by 150 kg potassium applied in two splits as $\frac{3}{4}$ basal and $\frac{1}{4}$ TD at 40 DAP. This increase might be due to high availability and mobility of potassium in plant which is believed to activate more than 60 enzymes in plants which might have enhanced and promotes the rate of photosynthesis, thus responsible to produce high energy status in the form of ATP which is utilized by the plant for enhancing its physio-morphological activities resultantly supportive for rapid growth and productivity. More over potassium was found helpful in the maintenance of cell turgor and regulation of leaf stomatal activities which are favorable in promoting water uptake and phloem performance with regard to the regulation and speeding up the flow of assimilates and nutrients translocation to all parts of the plant and improving the water use efficiency. The presence of potassium was also found encouraging for carbohydrate built-up, its transportation and storage in plants. Potassium has also been reported to be encouraging in nitrogen use efficiency by favoring protein formation and starch synthesis. (Kiraly, 1976; Perrenoud, 1993). High potassium rates influences early tuberization which accounts for high tuber

weight per plant. Above narrated multiple functions of potassium in many metabolic processes, lead to abundant beneficial effects on potato growth, quality and productivity by increasing leaf area and chlorophyll concentration, enhancing tuber size and weight: and reducing infestation by insects through increasing thickness and strength of stems (Grewal and Singh, 1980). All these factors resulted in increase of overall tuber yield. The increase in yield by split application might be due to minimum loss of potassium through leaching and maximum availability during crop growth stages especially tuber set and tuber bulking.

5.9 Economics (Benefit-Cost Ratio)

Perusal of the Table-7 revealed that the application of 150 kg potassium per hectare applied half at the time of planting and half at 40 days after planting gave the net returns and benefit:cost ratio of Rs. 251585.60 and 2.28 respectively compared to other treatments. Prakash and Singh (1976) reported that use of fertilizers, apart from irrigation is recognized as one of the quickest ways of increasing the production of field crops. The extra returns obtainable depends on many other factors like climate, soil type, integrated insect pest management, cultural management practices and other factors. Under unfavorable weather conditions and poor crop husbandry, use of fertilizers may give only marginal returns. Therefore for a farmer it is essential to know optimum manipulation of different production factors to harvest higher economic returns.

5.10 Quality Parameters

5.10.1 Protein content (%)

In the present investigation the combination of level and time of potassium application exhibited significant response, as with each increase in level of potassium, there was equally significant increase in protein content of potato tubers. Therefore highest content was recorded at 150 kg per hectare. Thus increase in

protein content may be attributed to the sufficient availability of potassium, because it plays a crucial role in stimulating several biochemical reaction, which show their influence on quality parameters viz. protein (Perrenoud, 1993)

Combination of levels and time of potassium application had a profound influence on the protein content in potato tubers and the highest protein percentage (2.62) was recorded with when T₁₈ 150 kg of potassium was applied half at the time of planting and half at 40 days after planting which was statically at par with T₁₉ i.e., 150 kg K, applied half at the time of planting and half at 40 days after planting. The results corroborate with the findings of Mazur and Kreft (1991), Singh and Singh (1996) Singh *et al.* (1998). This increase in protein content might be attributed to sufficient availability of potassium which is responsible to promote photosynthesis and to speed up the translocation of assimilates as well as to activate enzymes which are fundamental to metabolic processes for the production of proteins (Perrenoud, 1993). The results of the investigation reveal that potassium levels along with the time of application play a significant role in augmenting the protein yield in tubers.

5.10.2 Total soluble solids (°Brix)

The results of the present investigation indicate that total soluble solids in potato tubers decreased significantly with each increase in potassium levels and time of potassium application. Similar findings have also been reported by Singh and Singh (1996).

The interaction effect between the potassium levels and time of potassium application was more pronounced at T₆ i.e., 50 kg potassium per hectare and maximum response (7.67) was noticed when potassium was applied half at the 40 days after planting and half at 60 days after planting which was statically at par with T₇ i.e., 50 kg potassium per hectare applied as basal. It can be concluded that the

decrease in total soluble solids might be due to consistent increase in cell turgidity which increased potassium supply resulting in decrease in total soluble solids

5.10.3 Dry matter percentage

Dry matter percentage was not significantly influenced with the time of potassium application and level of potassium. However it was comparatively higher (23.38) at 150 kg potassium per hectare applied $\frac{3}{4}$ basal and $\frac{1}{4}$ at 40 days after planting which was statically at par (23.37) with 150 kg potassium per hectare applied $\frac{3}{4}$ basal and $\frac{1}{4}$ at 60 days after planting. It could be visualized that the qualitative character of tuber dry matter percentage was not affected much with the method of potassium application. These results are the same as reported by Trawczynski (2001) also concluded that the method of application had no significant effect on tuber dry matter percentage.

5.10.4 Specific gravity

The result of the present investigation indicate that specific gravity in tuber increased significantly with each increase in the level of additional potassium and method of potassium application and high specific gravity of (1.14) was recorded at 150 kg potassium per hectare applied half at 40 days after planting and half at 60 days after planting and significantly lowest specific gravity (1.04) was recorded with in T₁ i.e., 50 kg potassium applied basally.

Combination of level and time of potassium significantly influenced the specific gravity in potato tubers. The specific gravity is a qualitative character which reflects upon the maturity of tubers. It can be concluded that more of specific gravity might be due to the availability of necessary inputs including potassium at the initial stages of plant growth as the plants did not face any stress during the crop growth and they performed better. Such results have also been reported by Perrenoud (1993) and

Martin Prevel (1989) who indicated that the specific gravity was influenced with the method of potassium application.

5.10.5 Vitamin C (mg/100g)

Potassium was effective in increasing Vitamin C in potato crop and maximum Vitamin C (23.12) was recorded when 150 kg potassium was applied and minimum vitamin C was recorded when 50 kg potassium per hectare was given, indicating that a greater part of potassium was made available to the plant which was utilized for enhancing the quality of tubers. These results are in conformity with the findings of Singh *et al.* (1998) who indicated that combined effect of levels and time of potassium application had significant effect on Vitamin C content of tubers. The highest level (23.12) was recorded at T₂₀ i.e., 150 kg potassium applied half at the time of planting and half at 40 days after planting and followed by T₂₁ i.e., 150 kg potassium applied full top dressing at 40 days after planting and lowest (15.50) with 50 kg potassium applied half at the time of planting and half at 40 days after planting indicating that high concentration of potassium usually leads to an increase in organic acid concentration also having a beneficial effect on ascorbic acid levels (Bergmann, 1992; Perrenoud, 1993).

Chapter-6

SUMMARY AND CONCLUSION

The present investigation entitled, “**Response of potato (*Solanum tuberosum* L.) cv. Kufri Jyoti to varying levels and time of potassium application**” was undertaken at Vegetable Experimental Farm, Division of Vegetable Science, SKUAST-K, Shalimar, Srinagar, during *Kharies* 2011.

The experiment was laid out in a randomised block design with three replications and observations were recorded on potassium levels and its time of application. The potato cultivars viz. Kufri Jyoti were planted in the experimental plot with the spacing of 60 x 20 cm, while as three levels each of potassium (50, 100, 150 kg K₂O/ha) and their time of application (Full basal, $\frac{3}{4}$ basal + $\frac{1}{4}$ top dressing at 40 days after planting, $\frac{3}{4}$ basal + $\frac{1}{4}$ top dressing at 60 days after planting, $\frac{1}{2}$ basal + $\frac{1}{2}$ top dressing at 40 days after planting, $\frac{1}{2}$ basal + $\frac{1}{2}$ top dressing at 60 days after planting, No basal + $\frac{1}{2}$ top dressing at 40 days after planting + $\frac{1}{2}$ Top dressing at 60 days after planting, full top dressing at 40 days after planting were tried in subplots. Nitrogen and Phosphorus was applied as per packages and practices. The size of experimental plot was 2.4 x 1.8 m. Entire quantity of phosphorus was applied as basal dose. Half of nitrogen was applied at the time of planting and second half at the time of first earthing up. Observations was recorded on different growth, yield and quality characters viz., specific gravity, total soluble solids (⁰B), vitamin C content (mg 100 g⁻¹), dry matter content (%) and protein content (%). The data obtained from these characters were subjected to statistical analysis and the results obtained from the investigation are summarized as follows:

The analysis of variance revealed that significant differences were observed among treatments for all the characters under study. Among the potassium levels, 150 kg potassium recorded the maximum performance with respect to growth yield

component and quality traits. As regards to potassium levels 150 kg recorded the highest tuber yield which was significantly higher than 100 kg and 50 kg.

Of the two factors potassium levels and time of application, there was significant effect on all the characters studied except dry matter and small sized (0-25 g) tubers due to potassium application. Among the levels and time of potassium application, 150 kg per potassium applied half basal and half top dressing at 40 days after planting significantly recorded the highest tuber yield and other yield contributing characters viz., number of tubers per plant, average tuber weight and size of tubers (grades) per plot. Similarly high potassium application applied half basal and half top dressing at 40 days after planting resulted in improved quality except dry matter, specific gravity and total soluble sugars.

From the present investigation it appears that:

- Split application of 150 kg potassium applied half basal and half top dressing at 40 days after Planting is recommended for harnessing maximum marketable tubers.
- It has been observed that increase in level of potassium increases the overall yield.
- The treatment combination of 150 kg potassium applied half basal and half top dressing at 40 days after planting gave the highest tuber yield of 301.28 q/ha.
- The treatment combination of 150 kg potassium applied half basal and half top dressing at 40 days after planting was economically feasible giving a cost-benefit ratio of 2.28 and a net profit of 251585.60 Rs/ha.

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*Original not seen.

Certificate

This is to certify that all the modifications/corrections as suggested by External Examiner(s) during evaluation and viva-voce examination in the manuscript entitled, **“Response of Potato (*Solanum tuberosum* L.) cv. Kufri Jyoti to varying levels & time of Potassium application submitted by Ms. Alima Shabir (Regd. No. 2010-A-849-M) have been taken care of before final binding of the same.**

Dr. Shabir Hussain Khan

Major Advisor