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Research Article

Effects of potassium levels on growth and productivity of potato varieties in inner terai of Nepal

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ABSTRACT

Potassium is an essential nutrient for potato due to its direct effects on the growth, yield and quality of potato tubers. This study was carried out at Lamahi, Dang Nepal during winter season of 2018. Two potato variety (Local and Cardinal) and five levels of potassium (30, 40, 60, 80 and 100 kg K_2O/ha) were evaluated in two factorial randomized block design with three replications. The application of potassium at 100 kg/ha produced significantly highest plant canopy, stem diameter and leaf length for the both varieties. The highest tuber number per plant (10.3 for Local and 17.6 for cardinal) and tuber weight (19.7 g for Local and 49 g for Cardinal) were obtained with the application of 100 kg K_2O/ha. The highest gross margin was found with this level of potassium. Therefore, farmers should apply 100 kg K_2O to potato to achieve maximum production and benefit.

Keywords: Effect, Growth, Margin, Potassium, Potato, Tuber production

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INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important foods and cash crop is grown worldwide. It is the world's fourth-largest staple food crop. Globally, potato contributes about 80% of calorie intake by human (Leff *et al.,* 2004). Therefore, it is considered important for food security. Further, potato is enriched with vitamins (vitamin C, B) and minerals (like potassium and iron) (Lister and Munro, 2000). Potato contributes to improve the livelihood in the rural areas because it is a source of food and income Gildemacher (2012). In Nepal, potato is cultivated since 200 years (Ojha *et al.,* 2001). Currently, the area under potato cultivation is 185,879 ha and productivity is 13.94 t/ha (MoAD, 2017). Potato imparts 6.57 percent of total Agricultural Gross Domestic Product (AGDP) (MoF 2015). Nepal is one of the top twenty countries where potato contributes substantially for the human diet. Potatoes are used as subsidiary food as part of vegetables in Terai region, whereas as staple food in Hill and Mountain regions (Subedi et al., 2019).

Potato is a soil exhaustive crop. For appropriate growth and maturation of the plant, it requires a poised and adequate amount of plant nutrient. The essential elements for potato productivity are Nitrogen (N), Phosphorus (P), and Potassium (K). Most of the farmers apply Nitrogen and Phosphorus in a greater extent and the application of Potassium is usually ignored (Pervez *et al.,* 2013). Potassium is an important element that is absorbed by the plant in larger quantity after nitrogen (Havlin *et al*., 2005). It helps in photosynthate translocation, enzymes, photosynthesis activation and starch synthesis, which helps in higher productivity of potato tubers (Latiz *et al.*, 2011). Insufficiency of potassium makes the plant susceptible to disease and pest and consequently reduces the yield and quality (Umar and Moinuddin, 2002). The occurrence of potassium deficiency is majorly seen in the acidic soil where there is high rainfall that causes leaching of K (Getachew, 2009). In Nepal, most of the soil is sought to be acidic. The growth of potato under such condition may get hindered. Specially, under the farmer-managed condition, where the application of K fertilizer is quite low. This study is carried out to know the effect of different doses of potassium fertilizer on the growth parameter of potato in Dang district of Nepal.

MATERIALS AND METHODS

Study Site

The study was conducted in the Dang inner valley in the vegetable farm of Prithu Agricultural College. The study area lies in 28°00' 00" N latitude and, 82°15' 60" E longitude and an altitude of 701 meters above sea level. The soil of the experimental field was slightly acidic (pH 6.2) with silt loam texture.

Experimentation

This study was carried out using factorial RCBD with three replications at Lamahi, dang during winter season of 2018. The experiment consisted of combination of two treatments of varieties

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(local and cardinal) and five treatments of potassium dosses (30, 40, 60, 80 and 100 kg K_2O/ha). About 120 kg N/ha and 100 kg P/ ha was applied in each plot. The fields were fairly good in working condition and uniform in fertility status. The sprouted potato tubers were planted in the field on by ridge and furrow method of planting. As per recommendation, basal dose of fertilizer was applied at the planting time. The spacing between the plants was 60 cm x 25 cm. Total of forty plants was placed in each plot of size 2.4 m x 2.5 m. Plants were planted in the month of October 2018. Irrigation was provided after planting the tubers and during the critical growth stages. The intercultural operations were carried out in similar manner for all the treatments.

Soil sampling was done from the experimental site with the help of soil sampling auger before first ploughing. Samples were taken randomly from nine spots (three from each replication) at the depth of 0-20 cm representing whole replication. These sub-samples were mixed, air dried, grounded and sieved and stored for analysis. The final composited soil samples were sent and analyzed in Soil Science Division (SSD) of Nepal Agriculture Research Council (NARC), Khumaltar.

The total nitrogen was determined by Kjeldhal distillation unit, available phosphorous by spectrophotometer and available potassium by Ammonium acetate method. Organic matter was determined by Walky and Black method, pH (1:2 soil: water suspension) by Beckman glass electrode pH meter and soil texture by hydrometer method. The physico-chemical properties of soil was rated based on value, fertility status was rated according to the rating chart of soil which is illustrated in Table 1. The physio-chemical properties of soil of the experimental site are presented in Table 1.

Table1: Physio-chemical properties of the soil of the experimental site (2018)

S.N.	Properties	Content	Category
1	Physical properties		
	Sand (%)	21.6	
	Silt (%)	58.80	
	Clay (%)	19.60	
	Soil texture		Silt loam
2	Chemical properties		
	pH (1:2)	6.2	Slightly Acidic
	Total Nitrogen (%)	0.10	Medium
	Available Phosphorus (P_2O_5 Kg ha^{-1})	45	Medium
	Available Potassium (K_2O Kg ha^{-1})	190.78	Medium
	Organic matter (%)	3.1	Medium

The analysis showed dominated amount of silt in the physical properties of soil than sand and clay, possessing the silt loam texture with slightly acidic in pH. The organic carbon content was medium and medium in total nitrogen content, available phosphorous and potassium.

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Data Collection and Analysis

When the plant reached maximum vegetative growth, growth parameters like plant canopy, stem diameter, and length of leaves were recorded. Th e number of tuber and weight of tuber per plant and tuber yield per hectare was measured. The experimental data were processed by using Excel 2010 and analyzed by using GenStat 13.2. The treatment means were compared by the Least Significant Difference (LSD) test at 5% level (Gomez & Gomez, 1984; Shrestha, 2019; Baral *et al*., 2016; Kandel & Shrestha, 2019).

Gross Margin Analysis

The total variable cost of potato cultivation was computed from the sum of all variable costs incurred during the cultivation. Similarly, the gross revenue from potato was estimated by multiplying mean tuber yield per hectare and the mean price per quintal of potato. And gross margin was computed as follows:

Gross margin = Total Variable Cost – Total Revenue

RESULTS

Growth Components

Different potassium levels and potato varieties had significant effects on plant canopy, stem diameter, and leaf length. The interaction of potassium doses and varieties had a significant effect only on plant canopy. Maximum plant canopy, stem diameter and leaf length per plant were in the plots treated with 100 kg potassium per hectare and minimum growth components were obtained from the control plot.

Table 2. Growth parameters of different potato variety under several K levels

K_2O (kg/ha)	Average Plant canopy per plant (cm)		Average Stem diameter per plant (cm)		Average Leaf length per plant (cm)	
	Local	Cardinal	Local	Cardinal	Local	Cardinal
40	37.82	41.58	2.98	3.08	4.80	5.31
60	40.12	42.78	3.03	3.28	4.91	5.46
80	43.67	44.80	3.30	3.55	5.32	5.52
100	45.54	45.87	3.56	3.76	5.50	5.73
Control (30)	37.61	40.38	2.53	3.05	4.60	5.28
CV (%)	1.8		8.7		7.4	
$LSD_{0.05}$						
Fertilizer	0.899		0.3358		0.4680	
Variety	0.568		0.2124		0.2960	
Fertilizer x variety	1.271		0.4749		0.6619	
P-value						
Fertilizer	0.001		0.001		0.035	
Variety	0.001		0.020		0.004	
Fertilizer x Variety	0.005		0.725		0.730	

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The interaction of several potassium levels and different varieties had significant ($p < 0.001$) consequence for plant canopy. Both the varieties responded positively for the application potassium at increasing doses. The improved variety cardinal had greater plant canopy, stem diameter, and, leaf length than that of local variety of potato.

Tuber Production

The treatments and their interaction had a considerable effect on the number of tuber and mean weight of tuber per plant, and the weight per tuber. With increasing potassium level, all the production parameter increases significantly (Table 2). The highest number of tuber-per plant, weight per tuber and per plant was obtained from the field with the application of 100 kg/ha potassium while the lowest was from the control plot. Also, there was a highly significant difference between the variety for the number of the tuber, and weight of tuber/ plant, and the mean weight/ tuber. The interaction between varieties and doses of the potassium results considerable difference for the number of the tuber, mean weight per tuber and mean weight of tuber per plant. For both the varieties, the increasing dose of potassium increases the tuber number and weight. The minimum number and weight of tuber were found in the control plot.

Table 3. Production parameters of different potato variety under several K levels

K_2O (kg/ha)	Mean Number of tuber per plant		Average Weight per tuber (g)		Average Weight of tuber per plant (g)	
	Local	Cardinal	Local	Cardinal	Local	Cardinal
40	7.3	14.6	21.1	50.6	209.0	382.3
60	8.3	15.6	23.2	52.3	216.9	413.0
80	9.3	16.3	25.3	55.3	234.3	442.7
100	10.3	17.6	27.9	59.6	259.1	456.1
Control (30)	6.3	13.0	19.7	49.1	200.1	375.3
CV (%)	4.9		7.5		2.2	
$LSD_{0.05}$						
Fertilizer	0.6520		3.467		9.94	
Variety	0.4123		2.193		6.29	
Fertilizer x variety	0.9220		4.903		14.05	
P vlaue						
Fertilizer	0.001		0.037		0.001	
Variety	0.001		0.001		0.001	
Fertilizer x variety	0.018		0.004		0.001	

Gross Margin Analysis

Variable cost of production like fertilizers, seeds, electricity, labor, and others was calculated. Fixed cost of production is constant for all the treatment, therefore, it was not accounted. The gross margin was higher for the local variety of potato because of the greater price. However, the statistical difference between the varieties for gross margin was found non-significant. The study

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showed that with increasing potassium dose, the gross margin increases significantly at 1% level of significance. Maximum gross margin was obtained from the local variety at the 100 kg/ ha potassium application.

Table 4. Gross margin of different potato variety under several K levels

K_2O (kg/ha)	Cost (NRs./ha)		Gross Margin (NRs./ha)	
	Local	Cardinal	Local	Cardinal
40	109037.5	113485.4	108981.5	105733.2
60	110970.2	114487.6	128648.6	121930.5
80	112497.5	115927.1	152676.4	131045.8
100	114443.6	116670.9	172013.9	169973.6
Control (30)	108575.8	112531.5	89976.8	89409.7
CV (%)	0.5		14.7	
$LSD_{0.05}$				
Fertilizer	728.4		22263.0	
Variety	460.7		14080.3	
Fertilizer x variety	1030.1		31484.6	
P value				
Fertilizer	0.001		0.001	
Variety	0.001		0.766	
Fertilizer x variety	0.055		0.503	

DISCUSSION

The growth and development of potato plant increases with the raising dose of potassium fertilizer, and thus the plant canopy, stem diameter and leaf length increases (Ati and Nafaou, 2012). Al-Moshileh *et al.* (2005) also reported that leaf area of potato plant increases with the application potassium fertilizer. This could be due to the enzymatic activity of potassium for starch synthesis, and N metabolism. Different variety of potato has significant effect on the growth parameter. The highest plant growth parameters were found from improved variety cardinal. The differences in the growth pattern of varieties may be due to the genetic make-up of the plants. In our experiment, highest dose of potassium increased the number of tubers per plant. Adhikary and Karki (2006) also reported that use of potassium fertilizer in potato up to 100 kg/ha increased the number of tuber-per plant and the mean weight of tuber per plant. This could be due to the significant role of potassium on photosynthesis, favors high energy status which helps the crop for timely and appropriate nutrients translocation and water absorption by roots. This results in availability of more photosynthates to produce more number of tubers per plant (Bergmann, 1992). In our experiment, the highest level of potassium application increased the gross margin. The increase in gross margin from the crops for every addition of potassium levels could be due to the positive yield responses of the varieties used as a result of low soil fertility of the experimental field.

CONCLUSION

It is concluded that application of potassium fertilizers has significant and positive effect on the growth and yield of potato. There were significant differences among potato varieties in their performance. The interaction effect of potato varieties and fertilizer was found significant. It was

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found that the application of potassium at 100 kg/ha significantly increased growth, yield and gross margin in both potato varieties. Therefore, farmers are suggested to apply this dose to achieve higher production and profit.

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Author contributions
S. Bartaula, A. Adhikari, S. Khanal, K. Timalsena and Susan Subedi guided research and revised the article for the final approval of the version to be published. U. Panthi conducted the trial and recorded data, analyzed and wrote the final manuscript.

Conflict of interest
The authors declare no conflicts of interest regarding publication of this manuscript.

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