International Journal of Plant & Soil Science

Volume 35, Issue 19, Page 310-315, 2023; Article no.IJPSS.104984
ISSN: 2320-7035

Effect of Potassium on Growth, Yield, Quality and Economics of Potato (*Solanum tuberosum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i193556

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/104984

Original Research Article

Received: 11/06/2023
Accepted: 14/08/2023
Published: 19/08/2023

ABSTRACT

The present investigation was carried out at Research farm of Abhilashi University, Chail Chowk, Mandi during *Rabi* season 2022 to evaluate the effect of potassium on growth and yield of potato. The experiment was laid down in randomized block design consisting eight treatments in which one is control and others are combination of potassium with three replications. There was significant effect found under various potassium treatments in terms of plant height, number of haulms and haulm diameter at various crop growth stages and fresh and dry weight of plants, marketable yield and harvest index and specific gravity and dry matter content of tubers. The maximum marketable tuber yield was obtained with the split application (basal + foliar spray) of potassium. The findings revealed that the growth and yield parameters were significantly influenced by different split potassium levels.

Keywords: Haulm diameter; potassium; growth; yield; economics.

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1. INTRODUCTION

"Potato (*Solanum tuberosum* L.) is a fourth major food crop after rice, wheat and maize. It is most widely grown vegetable crop in India as well as Himachal Pradesh. In Himachal Pradesh, it is a major off season vegetable crop. India ranks fourth in area (2226 ha.) and third in production (56176 million tonnes) in India with an average yield of 183.3 q/ ha. In Himachal Pradesh, area under potato is about 15.00 thousand hectare with a production of 196.30 metric tonnes /ha" [1]. It is the first crop among root and tuber crops, followed by cassava, sweet potato, and yams in production [2,3]. The potato is a versatile vegetable that can be used as a fresh vegetable, a raw ingredient in culinary items or other food ingredients, a source of starch and alcohol, and animal feed. From the nutritional point of view, potato is the best source of energy and vitamins. It contains high amount of carbohydrate (19.4%) in the form of starch, protein (2%) and fat Potato plants prefer deep, loose, light, well-drained soil with lots of organic content.

"A number of macro and micro plant nutrients are essential for the growth and development of potato. The macro nutrients like N, P and K are most required by potato" [4]. "Potassium is one of the macronutrients that is major for potato plant growth. It controls vigor of plant, development and quality of the tubers, which regulates the health and productivity of plant. It also helps in translocation of carbohydrates as well as the synthesis of sugars and starch. Application of potassium (K) increases plant height and resistant to diseases, drought, and frost. Application of K_2SO_4 is more beneficial to potato than KCl in terms of yield and quality of tubers. The harvest index and benefit: cost ratio also increases with the increasing levels of potassium" [5].

"High dry matter content improves the quality of potatoes" [6]. Higher the specific gravity the higher will be the quantity of dry matter and greater will be the yield. The potatoes having high specific gravity are mainly used for the preparation of chips and French fries where as low specific gravity potatoes are used for canning. Therefore, the present work was done with the objective to study the effect of potassium on growth, yield and quality of potato on growth, yield and quality of potato crop.

2. MATERIALS AND METHODS

The field experiment was conducted during winter season 2022 at research farm of Abhilashi University, Chail Chowk, Mandi (H.P.). The experimental farm is situated at 31°33, 32"N and 77°00, 53"E longitudes having an altitude of 1,411 meters above mean sea level. The soil of the experimental plot is acidic having pH 5.13 having available nitrogen (173 kg N/ha), available phosphorus (44kg P/ha) and available potassium (269 kg K/ha). The experiment was laid out in randomized block design with three replications and eight treatments *viz*., T_1(Control without potassium application), T_2(75% of recommended dose of Potassium as basal application and 25% of RDF as top dress at 30 Days After Planting), T_3(50% of recommended dose of Potassium as basal application and half dose of potassium as top dress at 30 DAP), T_4(75% recommended dose of Potassium as basal application and one spray of potassium sulphate @ 2% at 30 DAP), T_5 (50% recommended dose of Potassium as basal application and one spray of potassium sulphate @ 2% at 30 DAP), T_6(125% potassium as basal), T_7(Half dose of T_6 as basal application and half dose of T_6 as top dress at 30 DAP) and T_8(Full dose of T_6 as basal application and one spray of potassium sulphate @ 2% at 30 DAP). The recommended dose of fertilizers was 160 kg N/ha, 100 P_2O_5/ha and 120 kg K_2O/ha. Half dose of nitrogen and full dose of phosphorus was applied at the time of planting and remaining half dose of nitrogen was applied at the time of earthing up. The potassium was applied as per the treatments. The source of nitrogen, phosphorus and potassium were applied in the form of Urea, SSP (Single Super Phosphate) and MOP (Muriate of Potassium) and potassium sulphate respectively. The field and plots were prepared with net plot size 3× 2.5 $m^{2.}$ The well sprouted tubers of Kufri Jyothi variety were planted at 60× 20 cm. "The crop was dehaulmed after 70 days after planting and after 12 days of dehaulming harvesting of tubers was done. Other agronomic practices were adopted as per recommendations. The observations for plant height, number of haulms and haulm diameter were recorded at 30, 45, 60 days after planting and at dehaulming stage while fresh and dry weight of plants were recorded at dehaulming stage. The yield attributing characters were observed at the time of harvest. Dry matter content of tubers was determined by drying tubers in oven at 70ºC till constant weight. Yield

parameters of tuber were recorded at harvest. Dry matter content of tubers was determined by drying tubers in oven at 70ºC till constant weight" [7]. The harvest index per hectare [8] was calculated by:

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Where,

Economic yield= Total tuber yield (t/ha) and
Biological yield= Total tuber yield + total bio-mass yield (t/ha)
Specific gravity was determined using the method described by Dinesh et al. [9]:

$$\text{Specific gravity of tubers} = \frac{\text{Weight of tuber (g)}}{\text{Volume of tuber (cm3)}}$$

B: C ratio is calculated by the formula described by Singh and Lal [5]

$$\text{B: C ratio} = \frac{\text{Gross income (₹/ha)}}{\text{Total expenditure (₹/ha)}}$$

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

1. Emergence

Emergence is a developmental stage, when first leaves of plant emerge from the soil. After two weeks of planting, the plants started emerging out from several tubers in each plot. Within a month, the emergence was almost complete. Emergence count was done at 30 days after planting (DAP) Emergence percent is determined after 30 days after planting. From data, the emergence percent of potato was not influenced by various potassium treatments. The maximum emergence percent (97.47) was recorded in treatment T_1 (Control without potassium application). Singh and Lal [5] also reported that the emergence of potato was not influenced by the potassium treatments.

2. Plant Height

The plant height was significantly affected at all stages of crop growth. The plots having split doses of potassium (basal + top-dress + spray) gives higher plant height. The maximum plant height at 30 (29.70 cm), 45 (40.42 cm), 60 (40.15 cm) days after planting and at dehaulming stage (42.57 cm) was recorded in the treatment T_5 (50% recommended dose of Potassium as basal application and one spray of potassium sulphate @ 2% at 30 DAP). It is indicated that split application (basal + spray) gives higher plant height than control. Gunadi [10] also reported that the split application of potassium (basal + foliar spray) gives higher plant height.

3. Number of haulms per hill

The number of haulms per hill was not affected by different treatments. The maximum number of haulms at 30 (4.37), 45 (4.59), 60 (5.82) days after planting and at dehaulming stage (5.29) was recorded in the treatment T_6 (125% potassium as basal). The application of potassium did not have any impact on number of haulms. Al-Moshileh and Errebi [11] also reported that the number of haulms per hill was not affected by the various potassium applications.

4. Haulm girth (mm)

The haulm girth was significantly affected at all stages of crop growth. The maximum haulm girth at 30 (7.17mm), 45 (7.50mm), 60 (7.90mm) days after planting and at dehaulming stage (8.30 mm) were recorded in the treatment T_8 (100% of T_6 as basal + one spray of potassium sulphate @ 2% at 30 DAP). The haulm girth is increased with the split application (basal + spray) than the control. Yingang [12] also reported that haulm girth was significantly increased with the increasing rates of potassium fertilizer.

5. Fresh and dry weight of plants (g)

The significant increase in fresh and dry weight of plants at dehaulming stage. The maximum fresh weight (212.45 g) and dry weight (34.84 g) at dehaulming stage was recorded in the treatment T_8 (100% of T_6 as basal + one spray of potassium sulphate @ 2% at 30 DAP). The results indicated that the fresh and dry weight of plants were increases with increasing levels of potassium. Adhikary and Karki [13] also reported that maximum plant weight is reported in the treatment treated with 100 kg/ha potassium. Gunadi [10] reported that higher dry weight of plants is recorded in split doses of potassium (basal+ foliar spray).

Table 1. Effect of potassium on emergence %, plant height (cm) and Number of haulms

Treatment	Emergence %	Plant height (cm)				Number of haulms			
		30 DAP	45 DAP	60 DAP	At dehaulming	30 DAP	45 DAP	60 DAP	At dehaulming
T_1	97.47	12.43	26.47	30.04	33.76	2.90	3.35	4.88	4.93
T_2	97.18	14.36	33.42	35.71	40.20	3.55	4.06	5.09	5.21
T_3	91.97	13.36	32.98	35.21	39.94	3.59	4.07	5.12	5.27
T_4	92.77	12.48	31.08	34.87	39.80	4.06	4.28	5.17	5.30
T_5	97.21	29.70	40.42	40.15	42.57	4.00	4.11	5.15	5.27
T_6	93.09	17.33	33.52	36.65	40.91	4.37	4.59	5.82	5.59
T_7	92.48	29.20	34.88	36.98	41.84	4.06	4.11	5.15	5.29
T_8	91.47	21.19	33.98	36.67	41.18	3.17	4.01	5.07	5.15
SE(±)	1.45	2.68	1.88	1.82	1.7	0.23	0.20	0.13	0.09
$CD_{0.05}$	4.46	0.87	0.61	0.59	0.55	0.71	0.63	0.42	0.28

Table 2. Effect of potassium on haulm girth (mm), fresh weight and dry weight of plants (g)

Treatment	Haulm girth (mm)				Fresh weight (g)	Dry weight (g)
	30 DAP	45 DAP	60 DAP	At dehaulming		
T_1	5.50	6.00	6.30	6.43	163.73	22.89
T_2	6.09	6.50	6.90	7.40	182.22	30.51
T_3	6.37	6.76	7.16	7.57	183.57	30.86
T_4	6.59	6.90	7.30	7.70	189.30	31.02
T_5	6.90	7.30	7.70	7.90	212.06	33.70
T_6	6.23	6.63	7.02	7.43	182.37	30.69
T_7	5.90	6.30	6.70	7.10	207.41	32.97
T_8	7.17	7.50	7.90	8.30	212.45	34.84
SE(±)	0.10	0.07	0.13	0.14	5.54	1.71
$CD_{0.05}$	0.33	0.23	0.4	0.43	16.97	5.23

3.2 Yield Parameters

1. Total number of tuber per plant and per plot

The total number of tubers was significantly affected with various potassium treatments. The maximum number of tubers per plant (11.02 g) and per plot (575.46 g) was observed in the treatment T_8 (100% of T_6 as basal + one spray of potassium sulphate @ 2% at 30 DAP) whereas minimum number of tubers were recorded in treatment T_1 (Control without potassium application). Moinuddin et al. [14] reported that increase in number of tubers is due to increase in the rates of potassium fertilizer.

2. Total tuber yield per plant and per plot

The tuber yield was significantly affected with the various potassium treatments. The maximum tuber yield per plant (820.67 g) and per plot (78.27 kg) were recorded in the treatment T8 (100% of T_6 as basal + one spray of potassium sulphate @ 2% at 30 DAP) where as minimum was recorded in Control treatment. Khan et al. (2004) reported that increase in the tuber yield is due to the enhancement of foliar application of potassium.

3. Marketable tuber yield (t/ha)

The marketable tuber yield was affected with the various potassium treatments. The maximum marketable tuber yield (31.49 t/ha) was obtained in the treatment T_8 (100% of T_6 as basal + one spray of potassium sulphate @ 2% at 30 DAP) where as minimum marketable tuber yield was obtained in T_1 (Control without potassium application). Gunadi [10] also reported that split application of potassium (basal + foliar spray) had significantly higher marketable tuber yield.

4. Harvest index (%)

The harvest index was significantly affected with the various treatments. The maximum harvest index (59.29 %) in the treatment T_3 (50% RDF as basal + 50% RDF as top dress at 30 DAP) whereas lowest value was observed in treatment T_1 (Control without potassium application). Singh and Lal [5] also reported that increase in harvest index with increase in the potassium rates.

Table 3. Effect of potassium on yield parameters of potato

Treatment	Tubers/plant	Tubers/plot	Tuber yield (g/plant)	Tuber yield (kg/plot)	Marketable Yield (t/ha)	Harvest index (%)
T_1	8.25	476.20	320.09	51.86	17.23	50.42
T_2	9.22	486.40	500.07	61.94	29.40	51.10
T_3	10.16	513.62	700.73	69.62	20.83	59.29
T_4	10.41	528.60	760.47	66.69	30.20	58.45
T_5	10.70	571.44	800.78	72.43	31.29	53.15
T_6	8.80	494.68	600.00	64.00	22.95	56.12
T_7	10.32	543.16	761.00	66.94	30.74	55.14
T_8	11.02	575.46	820.67	78.27	31.49	53.02
SE(±)	0.49	6.36	12.18	1.71	0.38	0.94
$CD_{0.05}$	1.05	19.47	37.30	5.25	1.18	2.90

3.3 Quality Parameters

The quality parameters like dry matter content of tubers (%) and specific gravity (g/cm^3) were significantly affected with the various potassium rates of different treatments. The maximum dry matter content of tubers (17.79 %) and specific gravity (1.08 g/cm^3) were recorded in the treatment T_8 (100% of T_6 as basal + one spray of potassium sulphate @ 2% at 30 DAP) than the control or basal only. Khan et al. (2010) also reported that potassium sulphate also increases the dry matter content of tubers.

3.4 Economics of the Treatment

The growth and yield performance was reflected by the gross income and net profit. The maximum gross return (448005 Rs/ha) and net profit (344376.84 Rs/ha) with benefit: cost ratio(1:3.32) were recorded in the treatment T8 (100% of T_6 as basal + one spray of potassium sulphate @ 2% at 30 DAP). It is revealed that highest net return and B: C ratio was obtained in the treatment having split application (basal + spray) of potassium application.

Table 4. Effect of potassium on quality parameters of potato

Treatment	Dry matter content of tubers (%)	Specific gravity (g/cm^3)
T_1	14.08	1.01
T_2	15.10	1.02
T_3	15.50	1.03
T_4	16.10	1.03
T_5	16.60	1.07
T_6	16.20	1.05
T_7	16.43	1.06
T_8	17.79	1.08
SE(±)	0.24	0.03
$CD_{0.05}$	0.73	0.03

Table 5. Effect of potassium on economics of the treatments

Treatment	Total cost (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B: C ratio
T_1	101625.48	309090	207464.52	1: 3.04
T_2	103079.88	436005	332925.12	1: 4.22
T_3	103079.88	363630	260550.12	1: 3.52
T_4	105266.28	418185	312918.72	1: 3.97
T_5	104902.68	327270	222367.32	1: 3.11
T_6	103443.48	318180	214736.52	1: 3.07
T_7	103443.48	409095	305651.52	1: 3.95
T_8	105629.88	448005	342375.12	1: 4.24
T_1	101625.48	309090	207464.52	1: 3.04
T_2	103079.88	436005	332925.12	1: 4.22

4. CONCLUSION

On the basis of present investigation, it can be concluded that the split application of potassium (basal + foliar spray) is more beneficial to the growth and yield of potato crop than the no control or basal application only. It improves availability of nutrients in terms with higher yield.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Anonymous. Department of Agriculture and Farmers Wekfare, horticulture statistics; 2022. Available:https://agricoop.nic.in/en/StatHortEst.
2. Gelaye Y, Alemayehu M, Ademe D. Potato (*Solanum tuberosum* L.) growth and quality as influenced by inorganic fertilizer rates in northwestern Ethiopia. International Journal of Agronomy. 2022;2022.
3. Patel A, Gurjar PK, Patel P. Study on the effect of organic manures and bio-fertilizers on growth, yield and quality of Potato (*Solanum tuberosum* L.). The Pharma Innovation Journal. 2022;11(2): 507-11.
4. Banerjee H, Rana, L, Ray K, Sarkar S, Bhattacharyya K, Dutta SK. Differential physiological response in potato (*Solanum tuberosum* L.) upon exposure to nutrient omissions. Indian Journal of Plant Physiology. 2016;21:129-136.
5. Singh SK, Lal SS. Effect of potassium levels and its uptake on correlation between tuber yield and yield attributing characters in potato (*Solanum tuberosum* L.) van Kufri Pukhraj. Asian Journal of Horticulture. 2012;7:392-396.
6. Wibowo C, Wijaya K, Sumartono GH and Pawelzik E. Effect of potassium level on quality traits of Indonesian potato tubers. Asia Pacific Journal of Sustainable Agriculture, Food and Energy. 2014;2: 11-6.
7. Thriveni V, Mishra HN, Pattanayak SK, Maji A. Effect of integrated nutrient management on nutrient uptake and recovery of bittergourd (*Momordica charantia* L.) [Special Issue]. The Ecoscan 2015;7:85-89.
8. El-Naim AM, Jabereldar AA, Ahmed SE, Ismaeil FM and Ibrahim EA. Determination of suitable variety and plants per stand of cowpea (*Vigna unguiculata* L. Walp) in the sandy soil, Sudan. Advances in Life Sciences. 2012;2:1-5.
9. Dinesh K, Ezekiel R, Singh, B. and Ahmed, I. Conversion table for specific gravity dry matter and starch content from under water weight of potatoes grown in North India plains. Potato Journal. 2005;32:79-84.
10. Gunadi N. Response of potato to potassium fertilizer sources and application methods in Andisols of West Java. Indonesian Journal of Agricultural Science. 2009;10: 65-72.
11. Al-Moshileh AM, Errebi MA. Effect of various potassium sulfate rates on growth, yield and quality of potato grown under sandy soil and arid conditions. InProceedings of the IPI Regional Workshop on Potassium and Fertigation Development in West Asia and North Africa, Rabat. 2004;24-28.
12. Yingang L. Effects of K fertilizer application on potato yield in high altitude localities. Chinese Potato Journal. 2003;17:67-69.
13. Adhikari BH and Karki KB. Effect of potassium on potato tuber production in acid soils of Malepatan, Pokhara. Nepal Agriculture Research Journal. 2006;7: 42-48.
14. Moinuddin,Singh K, Bansal SK and Pasricha NS. Influence of graded levels of potassium fertilizer on growth, yield, and economic parameters of potato. Journal of Plant Nutrition. 2004;27:239-59.

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The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/104984