Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP1: 1718-1721

Udit Kumar
Department of Horticulture, RPCAU, Pusa, Samastipur, Bihar, India

Girish Chandra
Department of Life Science, SGRR University, Dehradun, Uttarakhand, India

Correspondence
Udit Kumar
Department of Horticulture, RPCAU, Pusa, Samastipur, Bihar, India

A brief review of potash management in potato (*Solanum tuberosum* L.)

Udit Kumar and Girish Chandra

Abstract
Potato (Solanum tuberosum L.) is an important food and very popular vegetable crop of the world. It is also known as white or Irish potato. It is an annual herbaceous dicotyledonous plant with underground stems that give rise to several tubers. It is a starchy, tuberous crop from the perennial genus Solanum of the Solanaceae family (also known as the Nightshade family). The word potato may refer to the plant itself as well as the edible tuber. It has very unique place as far as human diet is concerned. It is important crop of sub-tropical and temperate regions which provides nutrient and sufficient energy for dietary consumption that's why it is regarded as staple food. As a food, it is one of the cheapest sources of carbohydrate and avails appreciable amount of vitamins B and C as well as minute quantity of some minerals. It is the world's fourth largest food crop, following rice, wheat, and maize.

Keywords: Review, Potash, Potato

Introduction

Potato originated in the environs of Lake Tritica basin in the Andes of Peru Bolivian region in high mountains of South America of the New World. It was introduced in India in the early part of the 17th century through British missionaries or the Portuguese traders. It was first mentioned in Terry's account of a banquet at Ajmer hosted by the Mughal King, Asaph Khan to Sir Thomas Roe in 1615. It was grown in Surat and Karnataka around 1675 and later in the Nilgiri Hills in 1822. It has extensive cultivation in Ireland, Germany, Netherland, France, Spain, Romania, Poland, Russia, China, India, USA, South America, Russia and the European countries.

India is the second largest producer of vegetables in world after China. In India, potato is being cultivated on 2.12 million hectare area with a total annual production of 434.17 lakh MT (Anonymous 2016). It is grown in almost all part of India, except Kerala, in diversified agro-climatic conditions. About 90% of the total potato area is located in subtropical plains, 6% in the hills and 4% in the plateau region of peninsular region (Chadha, 2009). It is grown under short day conditions in winter months from October to March in plains and a small area in the hilly regions where it is grown under long day conditions in summers from April to September. Potato is mainly *rabi* crop and is grown mainly in UP, Punjab, Haryana, West Bengal, Madhya Pradesh, Bihar, Andhra Pradesh, Tamil Nadu and Gujarat (Rana, 2008). Today, India is the second largest producer of potato after China, followed by Russian Federation, Ukraine and USA, in the world (FAO, 2013) with a production share of 12.4%.

Potato is an integral part of human diet. It produces more protein (524 kg/ha) as compared to wheat (254 kg/ha) (Sazid and Aftab, 2009). Potato tuber contains about 80% water and the rest is dry matter. Starch is the major component of the dry matter accounting for approximately 70% of the total solids. Potato produces more edible energy per unit area and time than wheat, rice and maize (Dutt, 2008). The average raw material composition of a potato tuber is as: dry matter (20%), starch (13-16%), total sugars (0-2%), protein (2%), fibre (0.5%), lipids (0.1%), vitamin A (trace/ 100 g fresh weight), vitamin C (31 mg/ 100 g fresh weight), minerals (trace), ash (1-1.5%), amylose (22-25%) and glycoalkaloids (<1 mg/100 g fresh weight) as an anti-nutritional factor. Due to its high nutritional value and production potential per unit time, it is able to sustain burgeoning population of country and ward off malnutrition and hunger.

Potato, because of their high potassium (K) requirement than any other vegetable crop sometimes regarded as an indicator crop for K availability (Ulrich and Ohki, 1966). Potato yield is greatly affected by nutrient availability, that is why research on appropriate fertilizer regimes has received much attention worldwide (Vos, 2009). Al-Moshileh and Errebi (2004) reported that K application rate upto 450 kg ha^{-1} significantly increased tuber yield over N and P application alone.

Effect of potash on growth parameters

El-Baky *et al.* (2010) reported that increasing the rate of potassium fertilizer in sweet potato enhanced vegetative growth expressed as vine length, leaves and branches number/plant, leaves area, fresh weight of whole plant, and its fresh and dry weight of leaves and branches. The highest values of vegetative growth characters were recorded by the treatment that received 150 kg K_2O.Abd El-Latif *et al.* (2011) reported that the 120 kg K_2O/ fed. (1 feddan =1.038 acres) gave the highest significant values for plant height as compared with the other treatments. Dkhil *et al*. (2011) studied the effects of foliar potassium applications on plant vegetative performance and reported that increasing K_2O concentration from 0 to 0.95 g L^{-1} significantly and progressively increased height of potato shoots. From the 45th until the 95th day after planting, the 0.95 g K_2O/L gave the highest significant values for plant height compared with other treatments (79.1 cm at the 95 day). Ati and Nafaou (2012) found that the addition of potassium fertilizer (K_2SO_4) to soil has resulted an increase in vegetative growth of potato plant. Length and plant leaf area index were increased, and the increase was significant with the levels of irrigation in the study (after depletion of 50 and 75% of available water). Plant height and leaf area reached to 85.76 cm, 41.22 cm^2 per plant and 74.23 cm, 34.78 cm^2 per plant in irrigation with 50% and 75% depletion of available water, respectively in 600 kg K_2SO_4 ha^{-1} level. Singh and Lal (2012) reported that plant emergence was not influenced by nitrogen and potassium levels. Potassium also had significant effect on plant height, number of leaves per plant and chlorophyll content. The plant height, number of leaves and chlorophyll content increased significantly up to 100 kg K_2O/ ha (K100). Stems per plant were not influenced by N and K levels. A stem per plant is a factor of variety, seed size and its physiological status; hence, were not influenced by nitrogen and potassium levels. Jasim (2013) reported that the lengths of potato plants were significantly increased as a result of plant spraying with Alaska-Foliar High K fertilizer as compared with the control treatment with no spray.

Effect of potash on yield parameters

Singh (2010) reported that application of 100 kg K_2O/ha as MOP significantly increased number as well as tuber yield of large (>75g) and medium-large (50-75g) tubers which resulted in increase in overall tuber yield as well as the marketable yield of potato variety Kufri Pukhraj. Khan *et al.* (2010) conducted field experiment to study comparative effect of source, levels and methods of K fertilization on yield and quality of potato produce. Three K_2O levels, 0, 150 and 225 kg ha^{-1} from two sources of potash (SOP and MOP) were tested. Potassium was also applied as foliar spray at 1% K_2O solution at 30, 45 and 60 days after germination (DAG) and soil was also amended by 150 kg K_2O ha^{-1}. A significant increase in tuber yield with K application at 150 kg ha^{-1} as K_2O from both the K sources over NP treatment was recorded. Increase in tuber yield with K_2O @ 225 kg ha^{-1} was statistically non-significant compared to 150 kg K_2O ha^{-1}. Zhu *et al.* (2010) conducted a field trial with potato cv. Kenne beck to investigate the effects of top dressing on its yield. Four treatments were designed, *i.e.,* I) (as the control) with basal fertilizer DAP 16 kg + Urea 15 kg + K_2SO_4 15 kg/mu [1 mu =0.067 ha], II) with basal fertilizer DAP 16 kg + Urea 8.6 kg + K_2SO_4 15 kg/mu and with dressing fertilizer Urea 6.4 kg/mu, III) with basal fertilizer DAP 16 kg + Urea 15 kg + K_2SO_4 7.5 kg/mu and with dressing fertilizer K_2SO_4 7.5 kg/mu; and IV) with basal fertilizer DAP 16 kg + Urea 8.6 kg + K_2SO_4 7.5 kg/mu and with dressing fertilizers Urea 6.4 kg + K_2SO_4 7.5 kg. The yield was the highest when K fertilizer was dressed and the yield was the second highest when NK fertilizers were dressed, but the two treatments not differed significantly. For the percentage of marketable tuber yield, dressing NK fertilizers showed the best result. El-Baky *et al.* (2010) reported that increasing rate of potassium fertilizers from 60 to 150 kg K_2O resulted in a significant effect on the yield. In addition, total yield per plant and yield/fed. Showed a positive response to potassium. Abd El-Latif *et al.* (2011) while examining the effect of potassium levels on potato yield tuber ton/fed. Found that the highest significant values were obtained when plants treated with 120 K_2O kg/fed. Compared to other treatments of K fertilizer, while, the lowest one were recorded when control (without addition of K fertilizer) was practiced. Dkhil *et al.* (2011) reported that the foliar potassium gave no significant effects on tuber number which was arranged between 9.88 (plants treated with K1, K3 and K4) and 11.66 (plants treated with K2). Moreover, there were no significant differences in total tuber yield among treatments. The foliar potassium applications induced an increase on the total tuber yield which reached 1454 g/plant. The lowest value (1246 g/plant) was recorded with control. Bansal and Trehan (2011) reported that potassium application increases the size of tubers, especially, if K supply of the soil is low to medium. Larger tubers are preferred by the processing industry, thus the profitability for the potato grower will be higher.

Ati and Nafaou (2012) found that marketable tuber yield increased significantly with increasing K rates up to 600 kg K_2SO_4 ha^{-1}. Higher K rates did improve yield reached to 30.26 and 25.66 t ha^{-1}. Highest yield and other quality parameters were achieved when a rate of 600 kg K_2SO_4 ha^{-1} was used. Mohr and Tomasiewicz (2012) reported that pre-plant application of KCl increased total and marketable yield at one site, and tended to increase total and marketable yield at three additional sites. At three of the four K-responsive sites, soil test K levels were <200 mg NH_4OAc-extractable K kg^{-1}, the level below which K fertilizer is recommended based on existing guidelines. Effects of timing of KCl application on total and marketable yield were limited although, averaged across sites, KCl applied at hilling reduced the yield of small tubers (<85 g) and increased the proportion of larger tubers (170 to 340 g) compared with pre-plant application. Singh and Lal (2012) reported that the harvest index and bulking rate increased with increase in nitrogen dose up to 150 kg/ha and potassium dose up to 100 kg K_2O/ha. Progressive application of K significantly increased the aggregate as well as large and medium grade tuber yield up to 100 kg K_2O/ ha. Potato yield was 22.2, 29.0, 32.3 and 33.5 t/ha due to main effect of 0, 50, 100 and 150 kg K_2O/ ha, respectively. The total tuber yield increased by 36.6, 44 and 45 percent at 50, 100 and 150 kg K_2O/ha, respectively, as compared to control. The yield of large sized tuber increased by 35.3, 49.5 and 53.4 percent at 50, 100 and 150 kg K_2O/ha, respectively as compared to control with concomitant decrease in the yield of small and very small grade tubers. The highest population of large and medium grade tubers was recorded with application of 150 kg K_2O/ ha. The growth and yield performance reflected gross and net returns. The cost of cultivation increased with increasing levels of N and K application but at the same time gross and net returns also increased. Cost of cultivation was maximum with the application of 225 kg N/ ha and 150 kg K_2O/ ha. But simultaneously the gross as well as net returns, and B: C ratio was also maximum with it.

Effect of potash on quality parameters

El-Baky *et al.* (2010) reported that total sugars, total carbohydrates and crude protein were increased with increasing K rates. The highest values of tuber quality, total sugars, total carbohydrates and crude protein were recorded when potassium was applied at the rate of 150 kg K_2O/fed. + 30 ppm $ZnSO_4$. Khan *et al.* (2010) conducted field experiments comprising of three K_2O levels, 0, 150 and 225 kg ha^{-1} from two sources of potash (SOP and MOP). They reported that the quality parameters like dry matter, specific gravity, starch contents, vitamin-C and ash contents were affected. Specific gravity a quality measure related to the dry matter contents was positively affected by K fertilization. The dry matter was higher in potato harvested from the plots treated with SOP than those of MOP. A large increase in tuber dry matter was recorded with 150 kg K_2O ha^{-1} in case of SOP and higher rates of SOP, 225 kg K_2O ha^{-1} depressed the total dry matter contents (TDM). Increase in TDM content with MOP application at 150 kg K_2O ha^{-1} was non- significant but 225 kg K_2O ha^{-1} significantly increased the TDM content. Bansal and Trehan (2011) reported a review of many field experiments conducted by PRII and CPRI on response of potato to potassium application revealed a yield increase between 1.0 t ha^{-1} and 5.2 t ha^{-1} at different sites. There was less weight loss and rottage of tubers with potassium application. Results of many experiments indicated that potassium nutrition influences tuber size, dry matter content, susceptibility to black spot bruise, after-cooking darkening, reducing sugar content, fry colour and storage quality. Potassium application is reported to increase the size of tubers, especially, if K supply of the soil is low to medium. High K concentrations of above 2% in tuber dry matter due to an oversupply with potassium may lower the contents of dry matter. In most experiments, starch content in tubers was positively correlated to potassium application. About 1.8% K in tuber dry matter is reported to be necessary for high starch concentration. Singh and Lal (2012) reported that tubers accounted for 76.6 and 76.4% of total dry matter production at harvest with 150 kg N/ha and 100 kg K_2O/ha, respectively. The average tuber weight and its dry matter content increased with increasing potassium levels up to 100 kg K_2O/ ha. Mohr and Tom asiewicz (2012) reported that KCl applied pre-plant or at hilling reduced specific gravity as compared with the 0 KCl treatments. Petiole and tuber K and Cl^- concentration, K and Cl^- removal in harvested tubers, and post-harvest soil test K concentration increased with KCl application. Petiole K concentration measured 82 to 85 days after planting predicted only 24% of the variability in relative marketable yield for sites containing between 164 and 632 mg NH_4OAc-extractable K kg^{-1} to 15 cm. Ati and Nafaou (2012) reported that both plant nutritional status and tuber quality parameters responded positively to increasing K application rates. The specific gravity did not respond to K application. Tuber potassium content increased significantly with K rates to reach a statistical maximum of 3.34% and 2.87% in irrigation with 50% and 75% depletion of available water, respectively at K rate of 600 kg K_2SO_4 ha^{-1}. Carbohydrate per cent was increased significantly with increasing K rates. The highest level was reached with application of 600 kg K_2SO_4 ha^{-1} to 12.69 and 11.74% in irrigation with 50% and 75% depletion of available water, respectively. Pervez *et al.* (2013) reported that the results for specific gravity and tuber dry matter per cent did not show significant difference among the treatments yet a small difference was traced. K levels had negligible affect related to specific gravity and tuber dry matter. Wibowo *et al.* (2014) reported that dry matter contents of cvs. Tenggo and Krespo ranged between 19.11 and 20.46% which indicates that different level of K application did not significantly influence dry matter content.

Effect of potash on soil and plant analytical parameters

El-Baky *et al.* (2010) reported that increasing rate of potassium caused significant increment in K and Zn contents in sweet potato leaves. Plants that received 150 kg/ K_2O had the highest K and Zn contents in comparison with other treatments. Abd El-Latif *et al.* (2011) found that N content in leaves was increased significantly by addition of 96 kg K_2O/ fed. As compared with the other treatments. Potassium content in leaves was affected significantly by all K rates compared with control treatment while P content in leaves wasn't affected by K rates. N content in tuber has increased significantly by adding 96 K_2O kg/fed. While P content has increased when 72 K_2O kg/fed. Was applied. K content in tuber has increased by adding the high level of K fertilizers (120 K_2O kg/fed.). On the other hand, the lowest N, P and K contents were recorded when control (without addition of K fertilizers) was practiced. Singh and Lal (2012) reported that the total N and K uptake increased with increasing levels of potassium application. Among different K doses, the highest uptake of N (116.2 kg/ha) and K (167.2 kg/ha) was recorded with application of 150 kg K_2O/ha. The recovery efficiencies of K (REK) and increase in use efficiency of N fertilizer on potato was higher at 100 kg K_2O and 150 kg N/ ha for K and N positive interactions on nutrient uptake and yield. However REK and nitrogen use efficiency increase was reduced at 150 kg K_2O/ha when N application rate was raised to 225 kg/ha. At each level of N, increasing levels of K application increased N and K uptake by potato at harvest. The recovery efficiencies of K and N fertilizer on potato increased at 100 kg K_2O and 150 kg N/ ha.

Conclusion

It can be concluded that the split application of potash found more beneficial to the potato crop as compared to basal application. It not only save the valuable nutrient but also improve their availability to the crop.

References

1. Anonymous. Statical Data Base of the National Horticulture Board and Ministry of Agriculture, Government of India, 2016
2. Abd El-Baky MMH, Ahmed AA, El-Nemr MA, Zaki MF. Effect of potassium fertilizer and foliar zinc application on yield and quality of sweet potato. Research Journal of Agriculture and Biological Sciences. 2010; 6(4):386-394.
3. Al-Moshileh AM, Errebi MA. Effect of various potassium sulfate rates on growth, yield and quality of potato growth under sandy soil and arid conditions. *In*: Regional workshop on Potassium and Fertigation Development in West Asia and North Africa; Rabit, Morocco, Available at, 2004, 24-28. http://www.ipipotash.org/udocs/Effect%20of%20Various%20Potassium%20Sulfate%20Rates%20on.pdf (accessed 11 January 2016).
4. Ati AS, Nafaou SM. Effect of potassium fertilizers application on growth, yield and water use efficiency of potato under regulated irrigation treatments. *AL-Taqani*.

2012; 25(8):1-6.

5. Bansal SK. 2003. Effect of potassium and accompanying anions of potassium fertilizers on tuber yield and processing quality of potato grown on alluvial soils of northern India. *In*: Proceedings of CIEC International Symposium of Fertilizers, June, Tokat, Turkey. 2002, 9-13
6. Bansal SK, Trehan SP. Effect of potassium on yield and processing quality attributes of potato. Karnataka J Agric. Sci. 2011; 24(1):48-54.
7. Chadha KL. Potato. In: Handbook of Horticulture. ICAR, New Delhi, 2009, 494-498.
8. Dkhil BB, Mounir DD, Aboud S. Foliar potassium fertilization and its effect on growth, yield and quality of potato grown under loam-sandy soil and semi-arid conditions. International Journal of Agricultural Research. 2011; 6:593-600.
9. Dutt S. Potato food: an antidote to hunger. *Indian Horti*. 2008; 53:2.
10. Eden T. The manuring of potatoes: the Rothamsted experiments. J Minist. Agric. Fish. 1926; 32:889-892.
11. El-Latif KMA, Osman EAM, Abdullah R, El-Kader NA. Response of potato plants to potassium fertilizer rates and soil moisture deficit. *Adv. Applied Sci. Res.* 2011; 2:388-397.
12. Jasim AH. Effect of foliar fertilizer on growth and yield of seven potato cultivars (*Solanum tuberosum* L.) *Scientific Papers. Series B, Horticulture.* 2013; 57:77-80.
13. Khan MZ, Akhtar ME, Safdar MN, Mahmood MM, Ahmad S, Ahmed N. Effect of source and level of potash on yield and quality of potato tubers. Pak. J. Bot. 2010; 42(5):3137-3145.
14. Mohr RM, Tomasiewicz DJ. 2012. Effect of rate and timing of potassium chloride application on the yield and quality of potato (*Solanum tuberosum* L. ‘Russet Burbank’). Can. J. Plant Sci. 92:783-794.
15. Pervez MA, Ayyub CM, Shaheen MR, Noor MA. Determination of physiomorphological characteristics of potato crop regulated by potassium management. Pak. J Agri. Sci. 2013; 50(4):611-615.
16. Rana MK. Potato. *In*: Olericulture in India. Ed. Kalyani publications, New Delhi, 2008, 1-4.
17. Sazid ZA, Aftab F. Effect of Thidiazuron (TDZ) on *in vitro* micropropagation of *Solanum tuberosum* L. cvs. Desiree and Cardinal. Pakistan J Bot. 2009; 41:1811-1815.
18. Singh SK. Nitrogen and potassium nutrition management in Kufri Pukhraj. *Annual Report*, Central Potato Research Station, Patna, 2010; 2009-10.
19. Singh SK, Lal SS. Effect of potassium nutrition on potato yield, quality and nutrient use efficiency under varied levels of nitrogen application. *Potato* Journal. 2012; 39(2):155-165.
20. Vos J. Nitrogen responses and nitrogen management in potato. *Potato Res.* 2009; 52:305-317.
21. Wibowo C, Wijaya K, Sumartono GH, Pawelzik E. Effect of potassium level on quality traits of Indonesian potato tubers. Asia Pacific Journal of Sustainable Agriculture Food and Energy. 2014; 2(1):11-16.
22. Zhu H, Ma L, Men W. Influence of top dressing on yield of a potato cultivar Kennebeck. Chinese Potato Journal. 2010; 24(3):153-155.