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Effect of different levels of potassium and irrigation on starch content in potato

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Abstract
A field experiment was conducted with calcareous sandy loam soil of Pusa (water management field of R.A.U.) taking potato var. Rajendra Alu-3 as test crop to study the effect of potassium and irrigation on growth parameters, yield, K-uptake, quality parameters and water use efficiency.The starch content of potato tuber varied from 11.1 to 18.1% in the year 2005-06. Increasing levels of irrigation upto I_4 significantly increased starch content from 13.38 (I_1) to 16.22% (I_4). Likewise, starch content also increased significantly from 12.58% in K_0 to 17.05% in K_4 with increasing levels of K_2O application .Similar trend of data on starch content in potato tuber was found in second year (2006-07) of experimentation in which starch content ranged between 10.97 and 18.44%. Interaction between K and irrigation levels was found non-significant in both the years of experimentation.

Keywords: Potato, tuber, starch content, potassium and irrigation levels

Introduction
Potatoes are grown throughout the world as a major staple food crop in 18.95 million ha with productivity of 16.8 t/ha. India ranks 4th in area and 3rd in production occupying 1.37 m ha of land and producing 23.9 m.t. potato with average productivity of 18.2 t/ha. In Bihar, potato is grown in 0.12 m ha with productivity of 11 t/ha. India has to support 16% of the world population with 4% of the total water resources on the earth (Charyulu *et al*., 2007) [1]. By 2020 India will have a population of 1.3 billion bringing about a substantial pressure on land to produce more food. Moreover, with the improvement in living standards of people, there will be shift in dietary pattern from cereals to vegetables. This will require the country to produce around 49 million tons of potato and most of it has to come through increased productivity. Adoption of modern technologies would be imperative to achieve the desired productivity levels. Potato being short duration crop, highly responsive to inputs, high in nutrition and capable of being grown under wide range of soils and climatic conditions is a crop for providing food security to the ever increasing Indian population. Potato is one of the prime sources of human nutrition. As for its composition, potato tuber contains 70 to 82% water, 17 to 29% dry matter, 11 to 23% carbohydrate, 0.8 to 3% protein, 0.1% fat, 0.6% fibre, 1.1% minerals and fair amount of essential amino acids such as isoleucine, leucine and tryptophan. Potatoes are emerging as a raw material for setting up agrobased processing industries for the production of chips, french fries, namkin, sweets, biscuits as well as the production of alcohol and starch. Potato has some medicinal properties also, like it has anti-scorbutic, aperients, diuretic, galacagoue, nervous sedative, stimulant to gout and antispasmodic (Rai and Yadav, 2005) [11].

Introduction of high yielding potato varieties has emphasized the improvement in its important inputs like fertilizer, irrigation etc. The aspects gaining importance are the use of fertilizer and its interaction with irrigation. In plains of India potato is grown during dry season and irrigation water plays the most important role in sustaining growth of the plant and development of tuber. Potato is grown usually on the moisture stored in soil during preceding rains and as such the crop suffers from frequent moisture stress condition. Water is a costly input in present day agriculture and the water resources are depleting with time. Under such condition it becomes imperative to utilize water efficiently and to improve the water use efficiency of the crop with improved yields. Thus, optimum use of water and potassium is needed for improved yield and quality of potato.

Materials and Methods

Site of the experimental field: Experiments were conducted at the Water Management Field, R.A.U., Pusa (Samastipur) district of North Bihar during Rabi seasons of the year 2005-06 and 2006-07. Pusa is situated on the bank of river BurhiGandak. It lies at 25.98ºN latitude, 85.67ºE longitude and at an altitude of about 52 meter above the mean sea level. The soil of the experimental plot was sandy loam in texture having pH 8.5 i.e., alkaline in reaction and low in available nitrogen, phosphorus and potassium content. The field experiments were laid out in split-plot design with three replications. Twenty treatments combinations comprising of four levels of irrigation and five levels of potash were made.

Technical

Design = Split plot design
Replication = 3
Total number of treatments = 20
Total number of plots = 60
Gross plot area = 18 m^2 (6 m x 3 m)
Net plot size = 10.08 m^2 (4.2 m x 2.4 m)
Fertilizer dose (kg/ha) = N:P_2O_5, 150:90
Test crop = Potato
Variety = Rajendra Alu-3
Spacing = 60 x 20 cm

Treatments

Main plot: Levels of irrigation based on IW/CPE ratio: 4
I_1 = 0.6
I_2 = 0.8
I_3 = 1.00
I_4 = 1.20

Sub-plot: Levels of potash (K_2O kg/ha): 5
K = 0
K_1 = 50
K_2 =100
K_3 = 150
K_4 = 200

FYM was applied to the experimental field at the rate of 20 t/ha. Nitrogen (N) and phosphorus (P_2O_5) were applied @ 150 kg/ha and 90 kg/ha, respectively and the application of potassium was as per treatments. Half of total N, full P_2O_5 and scheduled dose of K_2O were applied as basal 2-3 cm below the seed tubers in the furrow. The rest half N was top dressed at the time of first common irrigation. The source of N, P_2O_5 and K_2O were urea, DAP and muriate of potash, respectively.

The crop was planted on 15th November, 2005 and 15th November, 2006 for two consecutive Rabi seasons.

Tubers of variety Rajendra Alu-3 of uniform size weighing 30-40 g were taken for planting. Seed tubers were treated with 0.2% solution of Indofil M-45 for 10 minutes and were planted after drying in shade. Tubers were planted in the line just adjacent to the furrow of fertilizers at spacing 60 cm between rows and 20 cm between the plants. It was followed by earthing up. The height of the ridge was maintained at 15 cm

The starch content was estimated as described by Mahadevan and Sridhar (1986) [7] + using anthrone reagent (10-keto, 9, 10-dihydro anthracine

One hundred milligram of the sample was extrated in 5 ml of 80% hot ethyl alcohol and centrifuged at 3000Xg in a REMI table centrifuge for 5 minutes. The residue was washed with 80% alcohol or made it completely free from sugar.

Anthrone reagent – 0.2% solution (w/v) of anthrone in concentrated H_2SO_4.

Residue was mixed with 6.5 ml 52% per chloric acid and 5 ml.H_2O. It was kept for 20 minutes at 0 °C. This solution was known as starch solution. The volume was made upto 100 ml by adding distilled water into it. A total of 0.1 ml of this solution was taken in a graduated tube and distilled into 1.0 ml with distilled water. Four millilitre of chilled anthrone reagent was added to the tube allowing it to run down the side of the tube followed by rapid mixing. A glass marble was placed on the top of the tube to prevent loss of water by evaporation. The absorbance of bluish green colour was recorded at 620 nm against a blank that contained all the reagent except the extract which was replaced with water. The amount of starch present in extract was calculated using a standard curve.

Results and Discussion

Data on starch in potato tuber are presented in Table 1 for the year 2005-06 and 2006-07. It is observed from these data that irrigation and potassium significantly influenced the starch content in potato tuber.

The starch content of potato tuber varied from 11.1 to 18.1% in the year 2005-06. Increasing levels of irrigation up to I_4 significantly increased starch content from 13.38 (I_1) to 16.22% (I_4). Likewise, starch content also increased significantly from 12.58% in K_0 to 17.05% in K_4 with increasing levels of K_2O application.

Similar trend of data on starch content in potato tuber was found in second year (2006-07) of experimentation in which starch content ranged between 10.97 and 18.44%. Interaction between K and irrigation levels was found non-significant in both the years of experimentation.

Increasing levels of irrigation and potassium have improved K availability to plants and further improved the concentration of K in potato tubers. It is reported that K activates the enzyme starch synthase which is responsible for the formation of starch (Mengel and Kirkby, 1987) [9] which might be the reason for recorded improvement in starch content of potato tuber in the experiment. Lal and Singh (1983) [6] observed that application of K significantly increased starch content in potato tubers. Similarly, Singh *et al*. (2007) [12] also reported improvement in starch content of potato due to increasing levels of fertilizers and irrigations.

Higher starch content obtained with application of higher dose potassium might be due to positive response of this crop to the nutrients like nitrogen, phosphorus and potash. Nutrients play a greater role in photosynthesis and translocation of photosynthates from leaves to tubers and subsequent starch synthesis by activation of starch synthase enzyme (Kumar *et al*., 2008) [5]. The result is close conformity with the findings of Mona *et al*. (2012) [10] also reported that the content of starch significantly increases with the higher fertilizer application. Jatav *et al*. (2017) [4] reported that the increase in starch content with increasing dose of nitrogen upto 150 kg/ha. Similar results were also reported by El-Hadidi *et al*. (2017) [2], Mankotia *et al*. (2020) [8] and Gautam *et al*. (2012) [3].

Table 1: Effect of levels of potassium and irrigation on starch content (%) in potato tuber during 2005-06 and 2006-07

Treat-ment	2005-06						2006-07					
	K_0	K_1	K_2	K_3	K_4	Mean	K_0	K_1	K_2	K_3	K_4	Mean
I_1	11.10	12.00	13.20	14.80	15.70	13.38	10.97	12.60	13.08	14.21	14.86	13.13
I_2	12.00	13.10	14.30	15.90	16.80	14.42	12.08	13.42	14.52	15.72	16.49	14.44
I_3	13.20	14.20	15.30	16.50	17.60	15.36	12.94	14.27	15.44	16.77	17.53	15.39
I_4	14.00	15.20	16.30	17.50	18.10	16.22	13.61	15.02	16.24	17.65	18.44	16.19
Mean	12.58	13.63	14.78	16.17	17.05		12.40	13.82	14.82	16.09	16.83	

Source	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
Irrigation	0.19	0.46	0.24	0.80
Potassium	0.32	0.63	0.25	0.70
Irrigation x Potassium	0.64	NS	0.51	NS

Conclusion

I_4 level of irrigation was found the best for all the quality parameters like reducing sugar, starch content, T.S.S., specific gravity and crude protein. Increasing levels of potassium increased starch content and crude protein content in potato tuber during both the years. Thus for K_3 level of potassium application was found the best and for starch up to K_4 level of K_2O application.

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