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Effect of Different Doses of Nitrogen and Potassium on Growth and Yield of Potato (*Solanum tuberosum* L.) under New Alluvial Zone of West Bengal

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Authors' contributions

This work was carried out in collaboration among all authors. Author CKK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PSB, AG and SD managed the analyses of the study. Authors MKD and PB managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted during *the rabi* season of 2012-13 and 2013-14 at Instructional Farm, Jaguli, Nadia, West Bengal to find out the different doses of nitrogen and potassium on growth and yield of potato. The experiment was designed in RBD with 10 treatments replicated thrice in potato cultivated variety *Kufri Jyoti*. Different doses of nitrogen and potassium were considered as treatments. For all the treatments P_2O_5 dose was 150 kg ha^{-1}. The size of the experimental plots were 12 square meter and seed tubers were planted with 50 cm X 20 cm spacing. In this experiment, it was observed that the growth attributes like plant height, leaf area index, dry matter accumulation of tubers at 80 DAP, crop growth rate at 60-80 DAP were highest with the application of 250 kg ha^{-1} N, 200 kg K_2O (T_9) and statistically at par with 300 kg ha^{-1} N,

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150 kg ha^{-1} K_2O (T_{10}). Again among the yield parameters, T_9 recorded the highest tuber number per square meter and tuber yield which was closely followed by T_{10}. Highest B:C ratio was also observed in T_9.This result proves that T_9 can be recommended to get better growth and economic yield of potato than T_{10} (farmer practice does) in the new alluvial soil of West Bengal.

Keywords: Potato; different doses of nitrogen and potassium; tuber growth and yield.

1. INTRODUCTION

Worldwide one of the most important food crops is potato (*Solanum tuberosum* L.). After rice and wheat in terms of human consumption, its rank is third. Its tubers are a good source of carbohydrates, proteins, vitamins, and minerals for human nutrition (Blagoeva *et al*., 2004) [1]. Potato can provide necessary nutrients for the people of the low-income group through meeting vegetable demand (Islam *et al*., 2009; Hossain and Miah, 2012) [2,3]. It can produce more dry matter per unit area and per unit time compared to cereals. The high rate of dry matter production results in a large amount of nutrient removal per unit time and most of the soils are unable to meet the demand. Thus it is essential to apply nutrient from external sources such as fertilizers. The production of potato depends on many factors, among them, judicious application of nitrogen (N) and potassium (K) play a vital role. For producing 25 to 30 tonne ha^{-1}tuber a mature potato crop removes 120 to 140 kg N ha^{-1} (Patel and Patel, 2001) [4]. Tuber dry matter yield and the nitrogen content in potato plants are increased through nitrogen fertilization (Sharifi et al., 2007; Neshev et al., 2014) [5,6]. This crop feeds heavily on soil potassium and the tubers remove 1 to 5 times the amount of nitrogen and 4 to 5 times the amount of phosphate. Because of its high K requirement potato also acts as an indicator crop for K (Fageria et al., 1997) [7]. Potassium-deficient plants are short with pale-green leaves and later in vegetation, the leaves end and tops become necrotic (Kerin and Berova, 2008; Kumar and Sharma, 2013) [8,9]. Considering the significance of N and K on the productivity of potato an experiment was conducted to study the effect of different levels of nitrogen and potassium on the yield of potato grown on new alluvial soils.

2. MATERIALS AND METHODS

A field experiment was conducted in Gangetic alluvial sandy loam neutral soil (pH 6.9) at the Instructional Farm, Jaguli of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia (22.93° N, 88.53° E and 9.75 m altitude) during *rabi* season of 2012-13 and 2013-14. The experiment was designed with three replication in randomized block design (RBD), considering ten treatments [T_1: 150 kg ha^{-1} N, 100 kg ha^{-1} K_2O, T_2: 150 kg ha^{-1} N, 150 kg ha^{-1} K_2O ,T_3: 150 kg ha^{-1} N, 200 kg ha^{-1} K_2O T_4: 200 kg ha^{-1} N, 100 kg ha^{-1} K_2O, T_5: 200 kg ha^{-1} N, 150 kg ha^{-1} K_2O, T_6: 200 kg ha^{-1} N, 200 kg ha^{-1} K_2O, T_7: 250 kg ha^{-1} N, 100 kg ha^{-1} K_2O, T_8: 250 kg ha^{-1} N, 150 kg ha^{-1} K_2O, T_9: 250 kg ha^{-1} N, 200 kg ha^{-1} K_2O, T_{10}: 300 kg ha^{-1} N, 150 kg ha^{-1} K_2O] in 4.0 x 3.0 m size plots. For all the treatments P_2O_5 dose was 150 kg ha^{-1}. Seed tubers of cultivated variety *Kufri Jyoti* were planted with 50 cm X 20 cm spacing in the third week of November and harvested in the fourth week of February. All other standard agronomic practices including plant protection measures recommended for potato tuber production were followed. Observations on plant height, leaf area index (LAI), dry matter accumulation of tuber, tuber number per square meter, tuber yield were recorded and analyzed using the analysis of variance technique (One way ANOVA). Crop growth rate (gm-^{2} day^{-1}) was derived by adopting the procedure recommended by Watson (1958) [10] with certain modification.

$$\text{Crop growth rate (CGR)} = W_2\text{-}W_1 / t_2\text{-}t_1$$

Where W_2 and W_1 were the dry weight of sample plants on two different times t_2 and t_1 respectively.

Economic analysis was performed considering local market rates for inputs and the produce.

3. RESULTS AND DISCUSSION

3.1 Plant Height

At 80 DAP (days after planting) among all the treatments 250 kg ha^{-1} N and 200 kg ha^{-1} K_2O (T_9) recorded the highest plant height i.e. 71.10 cm whereas lowest plant height (44.97 cm) was found in 150 kg ha^{-1} N and 100 kg ha^{-1} K_2O (T_1). These observations corroborate the findings

Table 1. Effect of different doses of nitrogen and potassium on plant height, leaf area index, crop growth rate, dry matter accumulation, tuber number per square meter and tuber yield of potato (Two years pooled data)

Treatment	Details	Plant height at 80 DAP (cm)	Leaf area index at DAP	Crop growth rate (g m^{-2} day^{-1}) at 60-80 DAP	Dry matter accumulation of tuber at 80 DAP (g m^{-2})	Tuber number per square meter	Tuber yield (t ha^{-1})	B:C ratio
T_1	150 kg ha^{-1} N, 100 kg ha^{-1} K_2O	44.97	1.271	8.25	209.07	36.34	14.52	0.99
T_2	150 kg ha^{-1} N, 150 kg ha^{-1} K_2O	46.84	1.433	11.53	298.10	43.90	15.70	1.05
T_3	150 kg ha^{-1} N, 200 kg ha^{-1} K_2O	50.07	1.283	13.71	351.44	57.20	18.82	1.24
T_4	200 kg ha^{-1} N, 100 kg ha^{-1} K_2O	46.98	1.173	11.98	345.21	54.56	16.70	1.12
T_5	200 kg ha^{-1} N, 150 kg ha^{-1} K_2O	52.08	1.383	14.82	512.12	58.91	21.99	1.45
T_6	200 kg ha^{-1} N, 200 kg ha^{-1} K_2O	59.99	1.482	14.02	580.31	62.28	23.21	1.51
T_7	250 kg ha^{-1} N, 100 kg ha^{-1} K_2O	58.11	1.421	14.22	598.41	64.40	22.94	1.53
T_8	250 kg ha^{-1} N, 150 kg ha^{-1} K_2O	65.05	1.382	14.97	600.40	68.03	24.96	1.62
T_9	250 kg ha^{-1} N, 200 kg ha^{-1} K_2O	71.10	1.652	15.56	622.57	69.70	27.03	1.74
T_{10}	300 kg ha^{-1} N, 150 kg ha^{-1} K_2O	70.09	1.531	15.35	611.45	67.87	25.35	1.66
S. Em(±)		1.11	0.05	0.27	3.42	1.93	0.54	
CD (at 5%)		3.29	0.14	0.8	10.15	5.73	1.61	

obtained by Kumar et al., 2008 and Zelelew et al., 2016 [11,12]. According to Kumar et al. (2008) [11], there was an increased plant height in potato due to increased N dose up to 180 kg ha^{-1}. Zelelew et al., 2016 [12] demonstrated that application of 150 kg ha^{-1} K_2O recorded the highest plant in potato.

3.2 Leaf Area Index

250 kg ha^{-1} N and 200 kg ha^{-1} K_2O (T_9) resulted in the highest i.e. 1.652 (Table 1) leaf area index (LAI) at 80 DAP which established the fact that nitrogen and potassium had a profound influence on the growth of the potato. However, these observations are in consistency with the findings obtained by Watson *et al.* (1963) [13] and Veeranna and Khalak (1997) [14]. 200 kg ha^{-1} N and 100 kg ha^{-1} K_2O (T_4) recorded the lowest (1.173) LAI at 80 DAP.

3.3 Crop Growth Rate

The highest crop growth rate (15.56 gm^{-2} day^{-1}) was observed at 60-80 DAP by the application of 250 kg ha^{-1} N and 200 kg ha^{-1} K_2O (T_9) which is statistically at par with 300 kg ha^{-1} N and 150 kg ha^{-1} K_2O (T_{10}) (15.35 gm^{-2} day^{-1}). The lowest crop growth rate i.e. 8.25 gm^{-2} day^{-1} was found in by the application of 150 kg ha^{-1} N and 100 kg ha^{-1} K_2O (T_1). This result had a similar trend with the observations of Yadav et al. (1999) [15].

3.4 Dry Matter Accumulation of Tuber

At 80 DAP T_9 (application of 250 kg ha^{-1} N and 200 kg ha^{-1} K_2O) recorded maximum (622.57 gm^{-2}) tuber dry matter accumulation. The minimum dry matter accumulation of tuber was observed in T_1 (application of 150 kg ha^{-1} N, 100 kg ha^{-1} K_2O) at 80 DAP in potato. Comparable dry matter accumulation of tuber was observed by Zhao *et al*. in 2005 [16].

3.5 Tuber Number per Square Meter

The maximum number of tuber per square meter was found in T_9 (application of 250 kg ha^{-1} N and 200 kg ha^{-1} K_2O) i.e. 69.70 m^{-2} which was statistically at par with T_8 (application of 250 kg ha^{-1} N and 150 kg ha^{-1} K_2O) and T_{10} (application of 250 kg ha^{-1} N and 150 kg ha^{-1} K_2O). This result reveals that higher levels of N and K increase the number of tuber per square meter.

3.6 Tuber Yield

The tuber yield differed significantly due to different doses of nitrogen and potassium on the crop. T_9 (application of 250 kg ha^{-1} N and 200 kg ha^{-1} K_2O) produced the highest yield (27.03 t ha^{-1}) (Table 1). The next best treatment was T_{10} (application of 250 kg ha^{-1} N and 150 kg ha^{-1} K_2O) which recorded 25.35 t ha^{-1} tuber yield. The increase in tuber yield due to the application of N and K is also documented by Sharma and Arora in 1988 [17].

3.7 B:C Ratio

Maximum B:C ratio was obtained (1.74) in T_9 (application of 250 kg ha^{-1} N and 200 kg ha^{-1} K_2O) followed by T_{10} (application of 250 kg ha^{-1} N and 150 kg ha^{-1} K_2O) i.e. 1.66 and T_8 (application of 250 kg ha^{-1} N and 150 kg ha^{-1} K_2O) i.e. 1.62. The minimum B:C ratio was found in T_1 (application of 150 kg ha^{-1} N and 100 kg ha^{-1} K_2O) i.e. 0.99 due to poor growth and productivity of the crop.

4. CONCLUSION

From the experiment it can be concluded that application of 250 kg ha^{-1} N and 200 kg ha^{-1} K_2O significantly increased the plant height, leaf area index, crop growth rate, dry matter accumulation of tuber and tuber number per square meter which eventually increased the tuber yield and B:C ratio in *Kufri Jyoti* variety of potato. Therefore, it can be recommended that farmers of the new alluvial zone of West Bengal may apply 250 kg ha^{-1} N and 200 kg ha^{-1} K_2O along with 150 kg K_2O ha^{-1} to get optimum tuber yield and maximum B:C ratio.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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