



# Effect of Potassium Fertilization on Growth and Yield Attributes of Rice (*Oryza sativa* L.) Crop in an Inceptisol

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## Authors' contributions

This work was carried out in collaboration between both authors. Author KRR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors YVS managed the analyses of the study. Both authors read and approved the final manuscript.

## Article Information

DOI: 10.9734/JSRR/2021/v27i230358

Editor(s):

(1) Dr. Suleyman Korkut, Duzce University, Division of Wood Mechanic and Technology, Turkey.

Reviewers:

(1) Jagadish Jena, Indira Gandhi Krishi Vishwavidyalaya, India.

(2) João Paulo Saraiva Morais, Embrapa Algodão, Brazil.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/67166>

Original Research Article

Received 25 January 2021  
Accepted 29 March 2021  
Published 30 March 2021

## ABSTRACT

A pot experiment was designed for two consecutive years of (2018 and 2019) to investigate the effect of optimal use of potassium fertilizer by applying at different rates 0, 10, 20, 30, 40, and 50 mg K kg<sup>-1</sup> 10 kg pot<sup>-1</sup> soil. Rice cv. HUR-36 (Malaviya Dhan-36) crop was transplanted by maintaining four seedlings in each pot and potassium fertilization effect on plant growth and yield attributes of rice was recorded. The experiment was carried out in completely randomized design (CRD) with seven treatments viz., T<sub>1</sub>: absolute control (0:0:0), T<sub>2</sub>: 60:30:0 mg kg<sup>-1</sup>, T<sub>3</sub>: 60:30:10 mg kg<sup>-1</sup>, T<sub>4</sub>: 60:30:20 mg kg<sup>-1</sup>, T<sub>5</sub>: 60:30:30 mg kg<sup>-1</sup>, T<sub>6</sub>: 60:30:40 mg kg<sup>-1</sup> and T<sub>7</sub>: 60:30:50 mg kg<sup>-1</sup> corresponding to 120, 60, 60 (N:P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O) kg ha<sup>-1</sup>. The experiment was conducted in triplicate. The data pertaining to experiment revealed that plant height, effective no. of tillers, chlorophyll content and grain and straw yield were significantly increased as the scheduled rates of potassium fertilizer application increases. In treatment T<sub>5</sub> receiving 60:30:30 mg kg<sup>-1</sup>, potassium was general recommendation but due to intensive cropping of rice, mining of K was noticed. Therefore, increased dose of potassium should be recommended to maintain the replenishment of K in soil

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system and other side benefit cost ratio should not affect negatively. The treatment received extra doses of T<sub>6</sub> to T<sub>7</sub> (60:30:50 mg kg<sup>-1</sup>) showed highest growth in plant and yield of rice but in steady state which is not beneficial economically. Hence, in T<sub>7</sub> benefit cost ratio will be poor. In the present experiment, T<sub>6</sub> maintains all fulfillment of K whether in plant or soil system.

*Keywords: Rice crop; potassium fertilizer; straw and grain yield.*

## 1. INTRODUCTION

The stabilization in growth and productivity of cereals require an adequate amount of potassium [1]. Potash application at lower concentrations induces significant loss of plant-available K in soils, as well as other detrimental consequences such as restricting optimal nitrogen and phosphorus fertilizer use efficiency, threatening agricultural productivity (e.g., rice-wheat cropping systems), and eventually affecting land productivity. The science community faces a difficulty in standardizing and recommending fertilizer doses in order to meet crop nutrient demands while still maintaining the agricultural production system. For cereals, potassium is just about as essential as nitrogen [2]. Potassium, as a cationic primary nutrient, regulates and controls a diverse array of physiological processes in plant tissues, including photosynthesis, protein synthesis, enzyme activation, and water status management [3]. It also affects carbohydrate synthesis, translocation, transformation, transportation of food synthases and post-harvest characteristics, besides this reduce plant stress and mediate disease resistance [4,5]. Furthermore, where there is insufficient usable K in the soil, the quality of the product is usually poor [6,7]. Nutrient additions are dynamic in nature; the proportion of nutrient inclusion through irrigation water, crop residue, etc., to the total reserve of a nutrient in a soil is very low to meet the demand of crop under intensive cropping. This is particularly true for nutrients like K. The negative nutrient balance is observed when addition exceeds the removal because crop residues are largely removed from the fields along with the harvest of the economic products. Thus, it is suggested that such unnoticed depletion of K from the soil might seriously deplete the K fertility status of the soil that will require much higher investment in future to restore the fertility levels.

## 2. MATERIALS AND METHODS

### 2.1 Site and Soil Details

A pot experiment was conducted with rice as a test crop, which was transplanted during kharif

season of two successive years (2018 and 2019) at net house of the Department of Soil Science and Agricultural Chemistry, Banaras Hindu University, Varanasi (U.P.). The bulk of soil and soil samples were collected from Agricultural farm field, B.H.U. Varanasi district of eastern Uttar Pradesh. Surface layer (0-15 cm) soil was collected and processed for initial physico-chemical soil analysis in laboratory. For pot filling, ten kilogram (10 kg) of soil was passed through 10.0 mm sieve and kept in polythene lined earthen pots of ten kilogram soil carrying capacity.

### 2.2 Treatments Details

The experiment was carried out in completely randomized design (CRD) with seven treatments viz., T<sub>1</sub>: absolute control (no fertilizer), T<sub>2</sub>: 60 mg kg<sup>-1</sup> N, 30 mg kg<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> and 0 mg kg<sup>-1</sup> K<sub>2</sub>O, T<sub>3</sub>: 60 mg kg<sup>-1</sup> N, 30 mg kg<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> and 10 mg kg<sup>-1</sup> K<sub>2</sub>O, T<sub>4</sub>: 60 mg kg<sup>-1</sup> N, 30 mg kg<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> and 20 mg kg<sup>-1</sup> K<sub>2</sub>O, T<sub>5</sub>: 60 mg kg<sup>-1</sup> N, 30 mg kg<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> and 30 mg kg<sup>-1</sup> K<sub>2</sub>O, (100% NPK) T<sub>6</sub>: 60 mg kg<sup>-1</sup> N, 30 mg kg<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> and 40 mg kg<sup>-1</sup> K<sub>2</sub>O and T<sub>7</sub>: 60 mg kg<sup>-1</sup> N, 30 mg kg<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> and 50 mg kg<sup>-1</sup> K<sub>2</sub>O corresponding to 120, 60, 60 kg ha<sup>-1</sup> for 100% NPK and each treatment was replicated in thrice means R<sub>1</sub>, R<sub>2</sub> and R<sub>3</sub>. The sources of NPK were urea; single super phosphate (SSP) and muriate of potash (MOP).

Rice cv. HUR-36 (Malaviya Dhan-36)] crop transplanted early in the month of July and transplanting was done manually by sowing four hills per pot. The plant growth parameters like plant height, number of tillers and number of panicle per hill were measured at tillering stage, flowering stage and harvesting stage of rice crop. The chlorophyll content was taken at tillering, flowering and at harvesting stage. After that harvesting of rice crop weighing of seed grain and straw were recorded in gm per pot.

The statistical analysis of data was done under factorial completely randomized design (CRD) with three replications and data generated as a result of the experiments were statistically analyzed using ANOVA [8]. The variance ratio

test at  $p = 0.05$  was used to assess the significance of the treatment effect.

### 3. RESULTS AND DISCUSSION

#### 3.1 Plant Growth Parameters Yield Attributes

##### 3.1.1 Plant height

The plant height of rice crop was recorded at different growth stages viz., tillering, flowering and at harvesting and analyzed statistically which is depicted in the Table 1. Rate of K fertilizer when increased, significant growth in plant height at every stage of rice crop was noticed. At tillering stage  $T_7$  performed best and recorded

the plant height of 111.2 cm comparing with others treatments.  $T_1$  which was control recorded lowest plant height of 89.2 cm as compare with other treatments ( $T_2$  to  $T_5$ ). Similar effect of potassium fertilization was noticed [9,10].

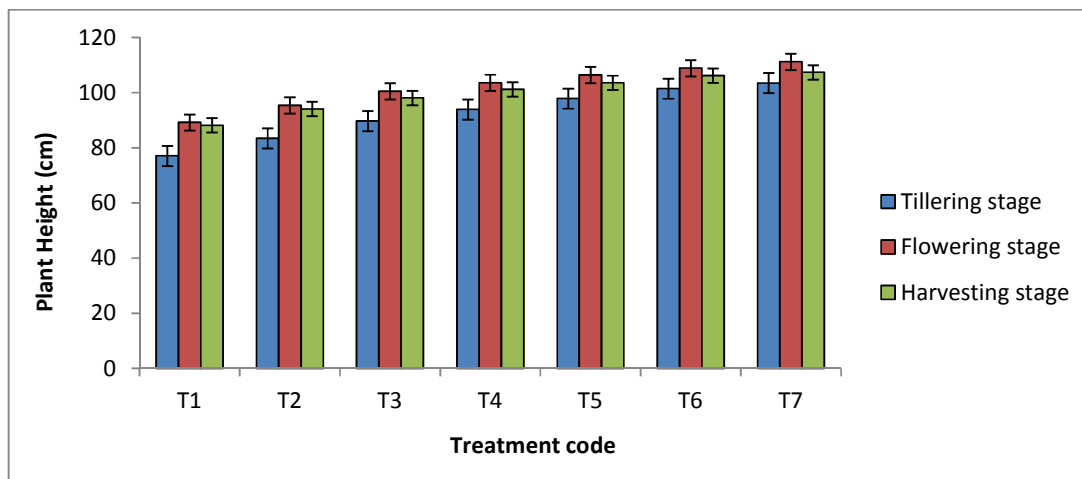
##### 3.2 Chlorophyll Content (SPAD Value)

The data analyzed in each year of rice crop in which chlorophyll content was recorded. Treatment  $T_6$  (43.4) gave better chlorophyll content value over  $T_5$  (43.1) and  $T_7$  (43.0) which is depicted through graph in Fig. 2. The chlorophyll content in treatment  $T_5$ ,  $T_6$  and  $T_7$  are more or less similar but significant from remaining treatments.

**Table 1. Effect of different rates of potassium fertilizer application on plant height of rice**

Treatment code	Plant height (cm)								
	Tillering stage			Flowering stage			Harvesting stage		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
$T_1$	75.7	78.5	77.1	88.0	90.4	89.2	87.3	89.0	88.2
$T_2$	82.3	84.6	83.5	94.8	96.0	95.4	93.0	95.2	94.1
$T_3$	88.4	90.9	89.7	99.1	101.8	100.5	97.1	99.0	98.1
$T_4$	94.8	92.9	93.9	104.3	102.9	103.6	101.5	100.8	101.2
$T_5$	97.2	98.6	97.9	105.7	107.1	106.4	102.8	104.4	103.6
$T_6$	100.2	102.7	101.5	108.4	109.3	108.9	105.3	107.0	106.2
$T_7$	103.8	103.1	103.5	110.8	111.5	111.2	106.5	108.2	107.4
SEm ( $\pm$ )	1.28	1.18	1.23	1.59	1.55	1.57	1.44	1.31	1.38
CD ( $p=0.05$ )	3.89	3.59	3.74	4.82	4.70	4.76	4.38	3.97	4.18

Where,  $T_1=N:P_2O_5:K_2O::0:0:0 \text{ mg kg}^{-1}$ ,  $T_2=N:P_2O_5:K_2O::60:30:0 \text{ mg kg}^{-1}$ ,  $T_3= N:P_2O_5:K_2O::60:30:10 \text{ mg kg}^{-1}$ ,  $T_4=N:P_2O_5:K_2O::60:30:20 \text{ mg kg}^{-1}$ ,  $T_5= N:P_2O_5:K_2O::60:30:30 \text{ mg kg}^{-1}$ ,  $T_6= N:P_2O_5:K_2O::60:30:40$  and  $T_7=N:P_2O_5:K_2O::60:30:50 \text{ mg kg}^{-1}$



**Fig. 1. Impact on rice plant height at different stages by applying different potash fertilization**

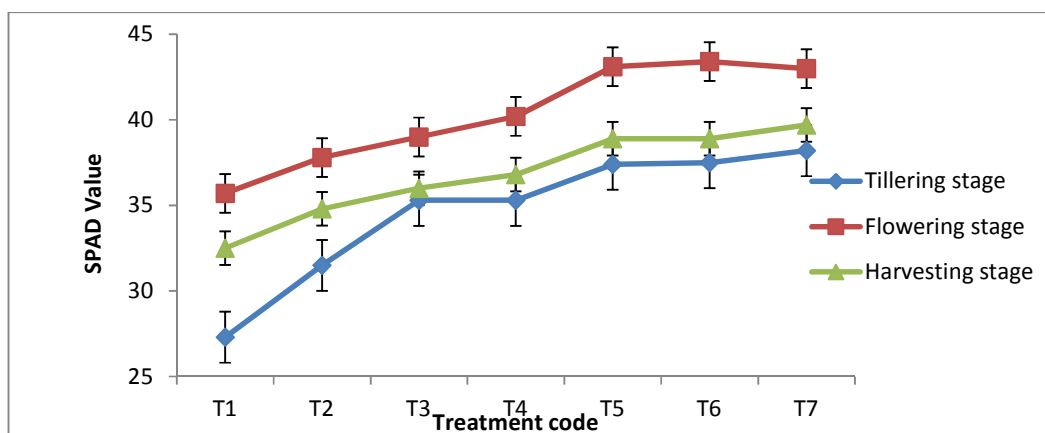


Fig. 2. Effect of potassium fertilizer on chlorophyll content of rice crop

### 3.3 Effective Number of Tillers Per Hill

Throughout, the life cycle of rice crop maximum number of tillers were recorded in flowering stage. Influenced of potassium fertilization were found maximum in the treatment of T<sub>7</sub> followed by T<sub>6</sub> and T<sub>5</sub> and it was significantly higher than rest of the treatments (T<sub>1</sub> to T<sub>4</sub>) shown in Fig. 3. Similar findings were also reported [11,12]. T<sub>7</sub> and T<sub>6</sub> performed non-significantly to each other but highly significant with other remaining treatment. Hence based on cost benefit ratio T<sub>6</sub> will be preferred for crop production. The result (Fig. 3) on tiller number showed significant response to potassic fertilizer at all growth stage of rice crop.

(Table 2.) and was found highest in treatment T<sub>7</sub>. Treatment T<sub>6</sub> also reveals significant amount of yield compare to T<sub>7</sub>. The positive impact of potassium fertilizer application was also recorded [13]. Similar type of response was also observed [14]. Treatment T<sub>6</sub> and T<sub>7</sub> are more or less significant to each and highly significant with other treatments except T<sub>5</sub>. Hence the grain and stover yield of rice at harvest stage (Table 2) depicted significant response to K fertilizer application. These results reveal an idea about optimum dose of potassium fertilizer application so as to sustain significant yield response of rice crop.

### 3.4 Grain Yield

Grain and straw yield is the cumulative effect or due to complex inter relationships of its components which is determined by vegetative and reproductive phases of the plant. Grain and straw yield of rice was recorded in gm pot<sup>-1</sup>

### 3.5 Harvest Index

The data related to harvest index (%) of rice was found highest in treatment T<sub>7</sub> (44.57 %) followed by T<sub>6</sub> (44.54) and lowest was recorded in treatment T<sub>1</sub> (41.42%) which was controlled, means no any fertilizer was given (Table 2).

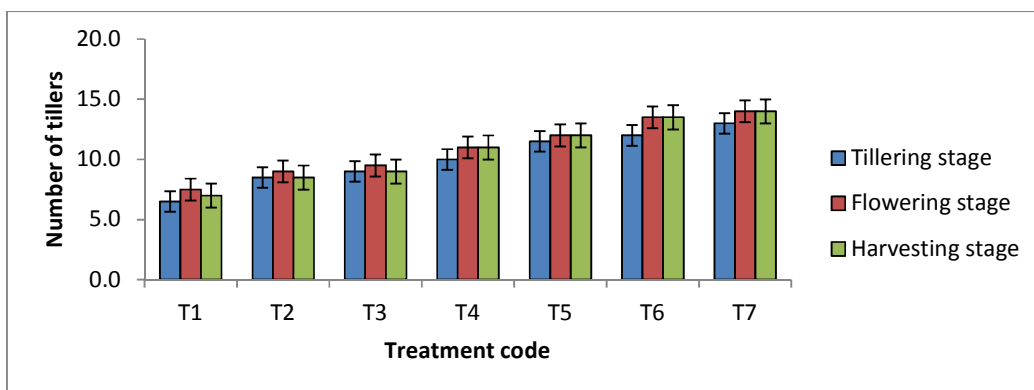


Fig. 3. Effect of different rates of potassium fertilization on tiller number of rice crop

**Table 2. Effect of different rates of K fertilizer application on grain and straw yields of rice**

Treatment code	Mean yield (gm pot <sup>-1</sup> )		Harvest index (%)
	Grain	Straw	
T <sub>1</sub>	16.9	23.9	41.42
T <sub>2</sub>	21.5	28.6	42.91
T <sub>3</sub>	26.5	34.5	43.44
T <sub>4</sub>	36.4	45.7	44.34
T <sub>5</sub>	40.3	50.4	44.43
T <sub>6</sub>	42.0	52.3	44.54
T <sub>7</sub>	42.7	53.1	44.57
SEm (±)	0.54	0.58	0.49
CD (P=0.05)	1.62	1.76	1.50

Where, T<sub>1</sub>=N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O:0:0:0 mg kg<sup>-1</sup>, T<sub>2</sub>=N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O:60:30:0 mg kg<sup>-1</sup>, T<sub>3</sub>= N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O:60:30:10 mg kg<sup>-1</sup>, T<sub>4</sub>=N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O:60:30:20 mg kg<sup>-1</sup>, T<sub>5</sub>= N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O:60:30:30 mg kg<sup>-1</sup>, T<sub>6</sub>= N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O:60:30:40 and T<sub>7</sub>=N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O:60:30:50 mg kg<sup>-1</sup>

#### 4. CONCLUSION

A pot experiment was conducted in rice crop with different levels of potassium fertilization to assess the influence of K alone and with combinations of nitrogen and phosphorus to understand the contribution of K on growth and yield of crop. We came to the conclusion that on the basis of nitrogen and phosphorus interaction with potassium fertilizer has different and positive significance regarding to their use efficiency by rice crop. The data pertaining to experiment revealed that plant height, effective no. of tillers, chlorophyll content and grain and straw yield were significantly increased as the scheduled rates of potassium fertilizer application increases. In treatment T<sub>5</sub> receiving 60:30:30 mg kg<sup>-1</sup>, potassium was general recommendation but due to intensive cropping of rice, mining of K was noticed. Therefore, increased dose of potassium should be recommended to maintain the replenishment of K in soil system and other side benefit cost ratio should not affect negatively. The treatment received extra doses of T<sub>6</sub> to T<sub>7</sub> (60:30:50 mg kg<sup>-1</sup>) showed highest growth in plant and yield of rice but in steady state which is not beneficial economically. Hence, in T<sub>7</sub> benefit cost ratio will be poor. In the present experiment, T<sub>6</sub> maintains all fulfillment of K whether in plant or soil system.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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