

# Effects of Potassium on yield of Summer rice (*Oryza sativa*)

## ABSTRACT

The effects of potassium on growth and yield parameters of summer rice was assessed through an experiment at the agricultural farm of Uttar BangaKrishiViswavidyalaya, Pundibari, Coochbehar during the year 2018 and 2019. The important agronomic parameters were significantly influenced with potassium fertilization. Increasing doses of potassium enhanced economic produce of rice to the tune of 6.34 t ha<sup>-1</sup> with 150% potassium fertilization (T<sub>5</sub>) which was statistically at par with T<sub>4</sub>, viz., 125% of the Recommended Dose (RD) of K and T<sub>8</sub> (Nutrient Expert based potassium recommendation) treatment. The Straw yield (11.77 t ha<sup>-1</sup>) was also enhanced with increasing K levels @150% of the RD of potassium fertilization under same levels of nitrogen and phosphorus. It was concluded that, the current dose of potassium for rice has to be enhanced for desired yield and to keep balance of K<sup>+</sup> in soil.

**Key words:** Fertilizer, Nutrient Expert Software, Potassium, Rice, Yield

## 1. INTRODUCTION

Potassium (K) has been the “forgotten” nutrient in terms of quality of soil-environment during the last few decades, receiving less attention than nitrogen and phosphorus (Romheld *et al.*, 2010). For food security, a reducing effect of potassium balance is tremendously difficult in terms of food security in global scales (Cakmak, 2010). Potassium depletion in soil leads to reduction in yield and use efficiency of nutrients under high density cropping systems (Regmiet *et al.*, 2002). Although, the application of nitrogen in balanced proportion with phosphate and potash in soil is essential (Roy *et al.*, 1985). Nitrogen (N), Phosphorus (P), and Potassium (K) are required as the primary nutrients for rice production. These nutrients play a vital role in terms of correcting deficiencies in soils as well as their capacity for improving yield of rice (Sarkar *et al.*,

2017). In addition to that ,proper and balanced use of fertilizer arealso important for enhancing crop yield and quality parameters (Manzoo *et al.*, 2008) of rice.The crop establishment is restricted by insufficient amount of K (Rengele *et al.*, 2008). Potassium is essential in enzymatic activities, energy metabolism, synthesis of protein and solute transport. The cell turgor, especially in rapidly expanding cells is regulated by K-ions (White *et al.*, 2010). The K-nutrition in optimum level enhances the yield attributes of rice and improves strength to the plants which facilitate stand firm against strong winds and reduce lodging. Overall quality of the cereal crops is greatly affected by the application of potassic fertilizer (Pavithira *et al.*, 2017).

Being one of the important cereal crops in the world, rice takes on about 90% of the global rice area and production is represented by Asian countries(FAO, 2013)where productivity in India is 3632.9 kg ha<sup>-1</sup> (FAO, 2017).In India, rice production with 22.45 million tonnes in West Bengal, followed by Punjab (20.07 million tonnes) and Uttar Pradesh (19.91 million tonnes) have been reported (Pathak *et al.*, 2020).Rice, being an important source of proteins, vitamins, minerals, fiber, energy, antioxidants and other biomolecules may work in synergy and have a beneficial effects on health(Burlando&Cornara, 2014).It was reported that, 100 g of brown rice contain 7.3 g (N x 6.25) Protein, 2.2 g crude fat and 71.1 g carbohydrate. The energy value of 100 g of brown rice was estimated to be 384 kcal. Brown rice also contains thiamine (0.29 mg/100 g), riboflavin (0.049 mg/100 g), niacin (4.0 mg/100 g), vitamin E (0.8 mg/100 g), iron, zinc, amino acids (*i.e.*, lysine, threonine, methionine+cystine, tryptophan and tannin (Sen *et al.*, 2020). It has been reported that,twenty percentof the total calories and 15% of protein requirements of the global population are provided by rice (FAO, 2012).

Potassium in rice plants are absorbed for proper function of various activities (Zhang *et al.*, 2010). To form and transfer starch and sugars, potassium plays a vital role. The immature and

chaffy grains is decreased by potassium application. It also assists in the activation of enzymes involved in synthesis of protein, starch and translocation of leaf protein towards the grain (Mengel and Kirkby, 1980).

It was found (Liu *et al.*, 2011) that, the activity of grain filling regulatory enzyme is significantly decreased 20 days after heading and under K-deficient circumstances. This might explain the decrease in amylase content when rates of applied K fertilizer were increased at the time of heading and with late paddy harvest. The findings emphasize the importance of applying potassic fertilizer at the right time to help grain filling of rice plants.

Farmers often ignore applying K-fertilizer, particularly in Asian subcontinent compared to N and P containing fertilizer (Li *et al.* 2014). Yield of rice is enhanced significantly by K fertilization ranging from 78 to 93 kg ha<sup>-1</sup>(Islam *et al.*, 2016). Organic matter application would be an inevitable practice for an alternative supply of nutrients to the crops especially under constraints in resources (Palm *et al.*, 1997); although, may not be supplemented by the sole application of organic matter at the present situation. Hence, an integrated nutrient management approach is effective way to enhance productivity of crop (Bandaraet *al.*, 2009). Hence, rice plants become susceptible to biotic and abiotic stresses due to K deficiency *vis-à-vis* applied nutrients (Johnston *et al.*, 2001), although, negative K-balances was observed (Miah *et al.*, 2008).

The lesser PBC<sup>K</sup> (K buffering capacity) of soils of Pundibari (Coochbehar) reflecting that K-fertilization is needed more frequently for higher production of crop. Without the use of K-fertilizer, the lower K status of subsurface soils may not sustain agricultural production system in future (Singh *et al.*, 2019). Potential buffering capacity refers to the capability of soil to maintain a given K level. Soil with any Potassium stress condition, there will be higher activity ratio of the soil K corresponding to the higher Potential buffering capacity of soil. In case of lower PBC<sup>K</sup>,

soil has tendency to rapid changes in the  $AR_e^K$  and thus needs to apply frequent K fertilization for better crop growth(Wang *et al.*, 2004;Lalitha *et al.*, 2015).

Based on the above perspectives, the present experiments were conducted to asses the effect of potassium on production potential of rice.

## 2. MATERIALS AND METHODS

The experiment in the field was carried out on rice in a randomized block design (RBD) with three replications at the farm of Uttar BangaKrishiViswavidyalaya, Coochbehar during two consecutive years, viz., 2018 and 2019 during Summer season. It consisted of eight treatment combinations which are as follows: T<sub>1</sub>- Farmer's Practice (120:60:60); T<sub>2</sub>- RD (Recommended dose) of NPK (140:70:70); T<sub>3</sub>- NP (RD) + K<sub>0</sub> (control); T<sub>4</sub>- NP (RD) +125% K; T<sub>5</sub>- NP (RD) +150% K; T<sub>6</sub>- NP (RD) + vermicompost(5 t ha<sup>-1</sup>); T<sub>7</sub>- NP (RD) + crop residue (rice straw) (5 t ha<sup>-1</sup>); T<sub>8</sub>- NP (RD) + Nutrient expert software based Potassium recommendation (80 kg ha<sup>-1</sup>).

Table 1: Initial soil characteristics (0-15cm) of the experimental site

Soil Parameters	1 <sup>st</sup> year	2 <sup>nd</sup> year	Mean
pH	5.56	5.81	5.69
EC (dsm <sup>-1</sup> )	0.19	0.2	0.20
OC (%)	0.65	0.72	0.69
Nitrogen (kg ha <sup>-1</sup> )	219.52	188.16	203.84
Phosphorus (kg ha <sup>-1</sup> )	23.22	21.15	22.19
Potassium (kg ha <sup>-1</sup> )	81.65	85.79	83.72

Initial soil physico-chemical properties were documented in Table 1. GotraBidhan -1, a popular high yielding variety of rice was used in the experiment with a spacing of 20 cm × 15 cm with 2-3 seedlings hill<sup>-1</sup> in 5 m × 4 m plot size. Each plot received a recommended dose of nitrogen and phosphorus as per the state recommendation except the plot where farmer's practice was employed. Split application of urea in three equal splits, viz., basal, first top dressing [21 Days after Transplanting (DAT)] and second top dressing (42 DAT) was applied. The

Phosphorus as single super phosphate (SSP) was applied after puddling. Muriate of Potash (MOP) was applied as a source of potassic fertilizer in two splits, 3/4<sup>th</sup> as basal and rest 1/4<sup>th</sup> in 42 DAT. All recommended agronomic practices including plant protection measures for rice were followed during the length of growing period of the crop. Plant samples were collected randomly from each net plot area to determine growth and yield parameters at harvest. Partial factor productivity and Agronomic potassium use efficiency were calculated as follows:

Partial Factor Productivity of potassium ( $PF\text{P}_K$ ) = Grain yield in kg/Amount of K applied in kg-----

Agronomic Potassium Use Efficiency (AKUE) = (Grain yield in fertilized plot - Grain yield in control plot)/Amount of K applied -----2

The statistical analysis was done by employing SPSS software (Version 26). The data were analyzed by using standard analysis of variance procedures.

### 3. RESULTS AND DISCUSSION

It was observed that, in general potassium application had no significant effect on the plant height of rice (Table 2). The plant height (Table 2) was recorded maximum (105.53 cm) in T<sub>4</sub> (125% of the RD of K) and lowest (93.97 cm) in T<sub>3</sub> qualifying the findings of Islam *et al.* (2016).

Different doses of potassium fertilization had influenced on number of tillers (Table 2) and panicle per m<sup>2</sup> (Table 2) at maturity. Number of tillers was significantly influenced by various K-levels. Average number of tillers m<sup>-2</sup> varied from 216 to 311, the highest being recorded under T<sub>5</sub> (150% of the RD of K). The agronomic parameters were enhanced by higher rate of potassium fertilization. Islam *et al.*, (2015)suggested that number of tillers and number of panicles were increased with application of K beyond 80 kg ha<sup>-1</sup>. Bagheriet *al.*, (2011)also mentioned that,

effective tillers per plant were affected by rate of potassium. Average number of panicle  $m^{-2}$  (Table 2) varied from 190 (Control) to 262 (150% RD of K)

**. Table 2: Effect of treatments on growth and yield contributing parameters of rice**

Treatment	Plant height (cm)			No. tillers m <sup>-2</sup>			No. of panicle m <sup>-2</sup>			Panicle length (cm)			No. of grains panicle <sup>-1</sup>		
	1 <sup>st</sup>	2 <sup>nd</sup>	Mean	1 <sup>st</sup>	2 <sup>nd</sup>	Mean	1 <sup>st</sup>	2 <sup>nd</sup>	Mean	1 <sup>st</sup>	2 <sup>nd</sup>	Mean	1 <sup>st</sup>	2 <sup>nd</sup>	Mean
	year	year		year	year		year	year		year	year		year	year	
T <sub>1</sub>	102.00 <sup>a</sup>	100.27 <sup>ab</sup>	101.13 <sup>a</sup>	249 <sup>cde</sup>	253 <sup>cd</sup>	251 <sup>d</sup>	207 <sup>de</sup>	220 <sup>bc</sup>	214 <sup>de</sup>	17.80 <sup>cd</sup>	19.03 <sup>c</sup>	18.41 <sup>cd</sup>	108 <sup>cd</sup>	116 <sup>cd</sup>	112 <sup>bc</sup>
T <sub>2</sub>	103.67 <sup>a</sup>	102.05 <sup>ab</sup>	102.86 <sup>a</sup>	256 <sup>bcd</sup>	272 <sup>bc</sup>	264 <sup>cd</sup>	221 <sup>cd</sup>	236 <sup>abc</sup>	229 <sup>cd</sup>	19.50 <sup>bcd</sup>	20.11 <sup>bc</sup>	19.81 <sup>bc</sup>	125 <sup>bc</sup>	122 <sup>bc</sup>	123 <sup>b</sup>
T <sub>3</sub>	96.67 <sup>a</sup>	91.27 <sup>b</sup>	93.97 <sup>b</sup>	215 <sup>f</sup>	217 <sup>e</sup>	216 <sup>e</sup>	193 <sup>e</sup>	187 <sup>d</sup>	190 <sup>f</sup>	17.27 <sup>d</sup>	16.37 <sup>e</sup>	16.82 <sup>d</sup>	94 <sup>d</sup>	94 <sup>e</sup>	94 <sup>d</sup>
T <sub>4</sub>	105.33 <sup>a</sup>	105.73 <sup>a</sup>	105.53 <sup>a</sup>	278 <sup>a</sup>	305 <sup>a</sup>	291 <sup>b</sup>	245 <sup>ab</sup>	256 <sup>a</sup>	250 <sup>ab</sup>	22.57 <sup>ab</sup>	20.88 <sup>ab</sup>	21.73 <sup>ab</sup>	138 <sup>ab</sup>	140 <sup>ab</sup>	139 <sup>a</sup>
T <sub>5</sub>	106.00 <sup>a</sup>	104.75 <sup>a</sup>	105.37 <sup>a</sup>	309 <sup>a</sup>	312 <sup>a</sup>	311 <sup>a</sup>	263 <sup>a</sup>	260 <sup>a</sup>	262 <sup>a</sup>	24.03 <sup>a</sup>	21.42 <sup>a</sup>	22.73 <sup>a</sup>	144 <sup>a</sup>	149 <sup>a</sup>	146 <sup>a</sup>
T <sub>6</sub>	101.33 <sup>a</sup>	97.06 <sup>ab</sup>	99.20 <sup>ab</sup>	226 <sup>ef</sup>	236 <sup>de</sup>	231 <sup>e</sup>	196 <sup>e</sup>	209 <sup>cd</sup>	203 <sup>ef</sup>	18.93 <sup>bcd</sup>	17.82 <sup>d</sup>	18.38 <sup>cd</sup>	103 <sup>d</sup>	101 <sup>de</sup>	102 <sup>cd</sup>
T <sub>7</sub>	103.67 <sup>a</sup>	101.20 <sup>ab</sup>	102.43 <sup>a</sup>	239 <sup>def</sup>	259 <sup>bcd</sup>	249 <sup>d</sup>	217 <sup>cd</sup>	226 <sup>bc</sup>	222 <sup>cd</sup>	17.90 <sup>cd</sup>	19.39 <sup>c</sup>	18.64 <sup>cd</sup>	113 <sup>cd</sup>	134 <sup>ab</sup>	124 <sup>b</sup>
T <sub>8</sub>	105.00 <sup>a</sup>	105.01 <sup>a</sup>	105.00 <sup>a</sup>	266 <sup>bc</sup>	286 <sup>ab</sup>	276 <sup>bc</sup>	229 <sup>bc</sup>	242 <sup>ab</sup>	236 <sup>bc</sup>	21.42 <sup>abc</sup>	19.89 <sup>bc</sup>	20.65 <sup>b</sup>	133 <sup>ab</sup>	141 <sup>a</sup>	137 <sup>a</sup>
SEM(±)	2.783	3.321	2.166	7.634	8.947	5.880	6.337	8.282	5.214	1.215	0.359	0.634	5.741	5.746	4.061
LSD	NS	NS	6.275	23.155	27.138	17.034	19.221	25.121	15.104	3.685	1.089	1.837	17.414	17.429	11.764

( $p=0.05$ )

Note: NS: Non significant

Values with small letters indicate differences at 5% level of significance

The grains per panicle (Table 2) was influenced by potassium fertilization which varied from 94 in control plot to 146 in T<sub>5</sub> (150% of the RD of K) plot and no significant effect between T<sub>5</sub> (150% of the RD of K), T<sub>4</sub> (125% of the RD of K) and T<sub>8</sub> (Nutrient expert software based Potassium recommendation which was 80 kg ha<sup>-1</sup>) was observed. Where, T<sub>2</sub> and T<sub>7</sub> were also statistically at par. Bahmani *et al.*, (2007) found that, application of potassium in field has significantly affected the number of grains per panicle. Zaman *et al.*, (2015) also documented that K fertilization in addition to nitrogenous fertilizer increased yield of rice due to improved grain quality and enhanced the grains per panicle.

Length of panicle was improved by the application of K and their pooled data reflected that the panicle length ranged from 16.82 cm (T<sub>3</sub> - control) to 22.73 cm (T<sub>5</sub> - 150% of the RD of K). Similar result was obtained by Fageria (2015). The test weight (Table 3) was recorded maximum (24.04 g) in T<sub>5</sub> (125% of the RD of K) and lowest (23.48 g) in T<sub>3</sub> (control). Addition of potassium did not affect the test weight significantly but was certainly improved with increasing rate of potassium to some extent. Similar result was also observed by Islam *et al.* (2015). The sufficient amount of mineral nutrition, including K fertilization improved number of panicle, length of panicle and 1000-grain weight (Fageria *et al.*, 2011).

**Table 3: Effect of treatments on economic produces of rice**

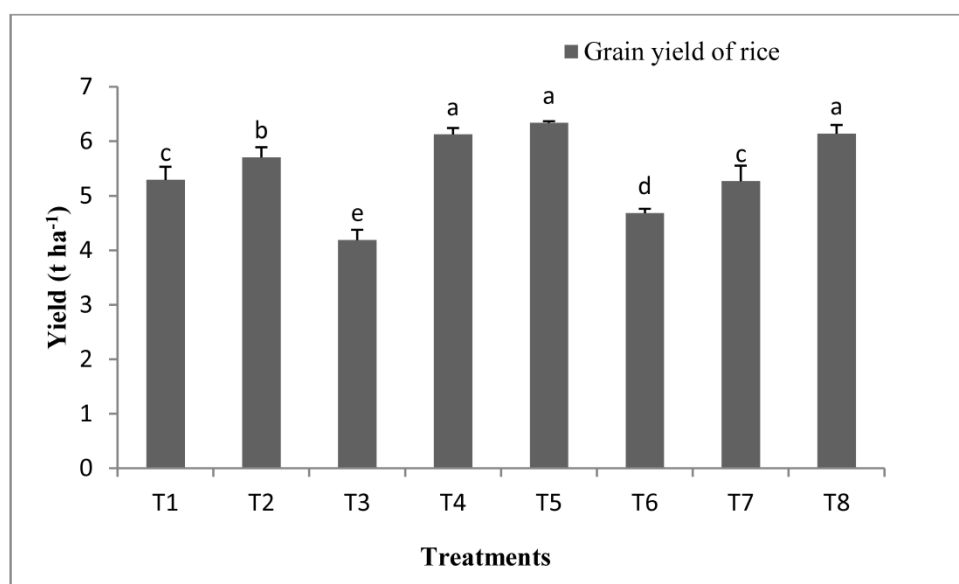
Treatment	Grain yield (t ha <sup>-1</sup> )			Straw yield (t ha <sup>-1</sup> )			Harvest Index (%)			1000-grain weight (g)		
	1 <sup>st</sup> year	2 <sup>nd</sup> year	Mean	1 <sup>st</sup> year	2 <sup>nd</sup> year	Mean	1 <sup>st</sup> year	2 <sup>nd</sup> year	Mean	1 <sup>st</sup> year	2 <sup>nd</sup> year	Mean
T1	5.35 <sup>bc</sup>	5.23 <sup>c</sup>	5.29 <sup>c</sup>	10.02 <sup>c</sup>	10.16 <sup>cd</sup>	10.09 <sup>d</sup>	34.79 <sup>a</sup>	34.00 <sup>abc</sup>	34.40 <sup>ab</sup>	23.69 <sup>a</sup>	23.74 <sup>a</sup>	23.71 <sup>ab</sup>
T2	5.60 <sup>b</sup>	5.81 <sup>b</sup>	5.70 <sup>b</sup>	10.81 <sup>bc</sup>	10.57 <sup>bc</sup>	10.69 <sup>c</sup>	34.14 <sup>a</sup>	35.47 <sup>a</sup>	34.81 <sup>ab</sup>	23.85 <sup>a</sup>	23.87 <sup>a</sup>	23.86 <sup>ab</sup>
T3	4.09 <sup>e</sup>	4.28 <sup>e</sup>	4.19 <sup>e</sup>	7.79 <sup>e</sup>	8.91 <sup>e</sup>	8.35 <sup>e</sup>	34.44 <sup>a</sup>	32.46 <sup>c</sup>	33.45 <sup>b</sup>	23.42 <sup>a</sup>	23.53 <sup>a</sup>	23.48 <sup>b</sup>

T4	6.13 <sup>a</sup>	6.12 <sup>ab</sup>	6.13 <sup>a</sup>	11.34 <sup>ab</sup>	11.21 <sup>ab</sup>	11.27 <sup>ab</sup>	35.11 <sup>a</sup>	35.32 <sup>a</sup>	35.22 <sup>a</sup>	24.09 <sup>a</sup>	23.95 <sup>a</sup>	24.02 <sup>ab</sup>
T5	6.31 <sup>a</sup>	6.37 <sup>a</sup>	6.34 <sup>a</sup>	11.71 <sup>a</sup>	11.84 <sup>a</sup>	11.77 <sup>a</sup>	35.04 <sup>a</sup>	34.99 <sup>ab</sup>	35.02 <sup>ab</sup>	23.96 <sup>a</sup>	24.12 <sup>a</sup>	24.04 <sup>a</sup>
T6	4.59 <sup>d</sup>	4.78 <sup>d</sup>	4.68 <sup>d</sup>	8.24 <sup>de</sup>	9.67 <sup>d</sup>	8.96 <sup>f</sup>	35.75 <sup>a</sup>	33.06 <sup>bc</sup>	34.41 <sup>ab</sup>	23.55 <sup>a</sup>	23.57 <sup>a</sup>	23.56 <sup>ab</sup>
T7	5.13 <sup>c</sup>	5.41 <sup>c</sup>	5.27 <sup>c</sup>	9.05 <sup>d</sup>	9.99 <sup>cd</sup>	9.52 <sup>e</sup>	36.22 <sup>a</sup>	35.11 <sup>a</sup>	35.67 <sup>a</sup>	23.66 <sup>a</sup>	23.79 <sup>a</sup>	23.73 <sup>ab</sup>
T8	6.04 <sup>a</sup>	6.24 <sup>a</sup>	6.14 <sup>a</sup>	11.05 <sup>ab</sup>	11.11 <sup>ab</sup>	11.08 <sup>bc</sup>	35.35 <sup>a</sup>	35.95 <sup>a</sup>	35.65 <sup>a</sup>	23.94 <sup>a</sup>	23.98 <sup>a</sup>	23.96 <sup>ab</sup>
SEM(±)	0.143	0.107	0.089	0.270	0.231	0.178	0.866	0.616	0.531	0.219	0.200	0.148
LSD ( <i>p</i> =0.05)	0.434	0.325	0.258	0.819	0.701	0.516	NS	1.868	NS	NS	NS	NS

Note: NS: Non significant

Values with small letters indicate differences at 5% level of significance

**Figure 1: Effects of treatments on grain yield of rice. The error bar indicates the standard deviation at 5% level of significance**



The grain yield of rice was observed (Figure 1) where, variation in yield corresponding to

each treatment combination was noted. The grain yield (Table 3) of rice varied from 4.19 to 6.34 t ha<sup>-1</sup> in T<sub>5</sub> (150% of the RD of K). Maximum grain yield (6.34 t ha<sup>-1</sup>) obtained under application of 150% of the RD of K (T<sub>5</sub>) in soil was statistically at par with T<sub>4</sub> (125% of the RD of K) and T<sub>8</sub> (Nutrient expert software based potassium recommendation which was 141: 44: 80 kg ha<sup>-1</sup>). The yield attributes of rice are heavily influenced with higher doses of K results in higher yield of rice crop (Islam *et al.*, 2015). Nath and Purkayastha (1988) observed that increasing doses of potassium when applied to soils, the grain yield could increase significantly on application of 80 kg K<sub>2</sub>O ha<sup>-1</sup>, which was at par with that of 120 kg K<sub>2</sub>O ha<sup>-1</sup>. The treatments T<sub>1</sub> (Farmer's practice- 120: 60: 60 kg ha<sup>-1</sup>) and T<sub>7</sub> [110% of the RD of K replaced by crop residue (rice straw)] for grain yield of rice were also statistically at par. Application of rice straw could build up a soil conditions favorable for improving establishment of rice (Sarkaret *al.*, 2017). Singh *et al.*, (2001) also reported that incorporation of straw could increase the soil fertility and enhance crop yield.

The yield of straw was found to be increased with increasing rate of potassium. Straw yield (Table 3) was recorded highest (11.77 t ha<sup>-1</sup>) in T<sub>5</sub> (150% of the RD of K). Enhanced potassium rate facilitates production of starch and also translocates the photosynthets efficiently to the spikelets (Beringer, 1978). Hence, K induced the grain as well as the straw of rice to obtain greater volume and weight (Islam *et al.*, 2015). In recent times, rice residues have been also emerged as an alternative source of energy which reduces production of CO<sub>2</sub> (Matsumura *et al.* 2005). Increase in Harvest Index results in enhancing grain yield which indicates more partitioning of assimilates to grain and/or total biomass production (Richards, 2000). It was noted that, the harvest index had negligible influences on the added doses of K (Table 3). Highest harvest index (35.61%) was obtained at T<sub>8</sub> and lowest (31.77%) was at control. It was observed

that harvest index was decreased in highest potassium receiving plot and tends to increase with decreasing rate of potassium. This might be due to production of more straw than grain with application of higher doses of K. Bagheriet *al.*, (2011) observed that, higher doses of potassium application reduced the harvest index and enhanced the biological yield. Similar result was obtained by Islam *et al.*, (2015).

**Table 4: Effect of treatments on Partial factor productivity and Agronomic potassium use efficiency of rice**

Treatment	Partial factor productivity (kg kg <sup>-1</sup> )		Agronomic potassium use efficiency (kg kg <sup>-1</sup> )	
	1 <sup>st</sup> year	2 <sup>nd</sup> year	1 <sup>st</sup> year	2 <sup>nd</sup> year
T1	89.11	87.22	20.89	15.89
T2	80.00	82.95	21.52	21.81
T4	70.10	69.94	23.31	21.03
T5	60.06	60.67	21.08	19.90
T6	119.13	124.07	12.81	12.90
T7	66.67	70.22	13.51	14.63
T8	75.54	77.96	24.38	24.46

Partial Factor Productivity of K (PFP<sub>K</sub>) [total grain yield (kg) per kg applied K] varied from 59 (T<sub>6</sub>) to 89 (T<sub>1</sub>) in 2018 and 60 (T<sub>5</sub>) to 87 (T<sub>1</sub>) in 2019 (Table 4). With increasing rate of potassium, there was gradual decline in partial factor productivity of K except T<sub>7</sub> treatment where crop residue was applied. Crop residue (especially rice straw) contain higher amount of potassium which causes low PFP<sub>K</sub> value. On another side, marginal increase in potassium

application did not result in much yield increment and hence, the  $PF\text{P}_K$  value of  $T_1$  was greater than even  $T_2$ . Though in  $T_6$  treatment  $PF\text{P}_K$  was higher but due to low potassium content in vermicompost, appreciable yield was not achieved. The highest Agronomic Potassium Use Efficiency (AKUE) was observed in both years with  $T_8$  treatment (24.38 in 2018 and 24.46 in 2019) (Table 4) followed by  $T_4$  treatment as yield increment over control in these treatments were much higher; the lowest was observed in  $T_6$  treatment (12.81 in 2018 and 12.90 in 2019) (Table 4). On treatment  $T_6$  and  $T_7$ , the yield increment over control was very less and resulting the lower Agronomic Potassium Use Efficiency (AKUE). Nutrient Expert-based potassium recommendation which was based on SSNM (Site Specific Nutrient Management) performed best. It was observed from this experiment, that, the crop did not respond well beyond 80 kg  $K_2O$   $ha^{-1}$ .

#### **4. Conclusion**

On the basis of the two years' experiment, it can be concluded that, application of potassium increased the yield of summer rice. The results indicated that, 125% of the RD of K gave a better yield of rice, being at par with 150% of the RD of K. The application of potassium through Nutrient Expert gave best result with respect to growth and yield which was at par with 150% of the RD of K and 125% of the RD of K. Rice straw incorporation in soil at harvest might be an alternative source of potassium build-up in soil.

#### **Acknowledgements:**

The authors acknowledge infrastructural facilities provided by the Department of Soil Science and Agricultural Chemistry, Directorate of Research and Directorate of Farm under Uttar Banga Krishi Viswavidyalaya during the tenure of the experiment.

## REFERENCES

- Bagheri R, Mobasser HR, Malidarreh AG, Dastan S. Effect of seedling age and potassium rates on morphological traits related-lodging, yield and yield components of rice (*Oryza sativa L.*) in Iran. American-Eurasian Journal of Agricultural & Environmental Sciences. 2011;11(2):261-268.
- Bahmaniar MA, Ranjbar GA. Response of Rice Cultivars to Rates of Nitrogen and Potassium Application in. Pak. J. Biol. Sci. 2007;10(9):1430-1437.
- Bandara, W. M. J., Wickramasinghe, W. M. A. D. B., Sirisena, D. N. and Wijewardana, J. D. H. Response of rice to applied potassium in soils of Sri Lanka. Use of phosphorus and potassium fertilizers in SriLankanagriculture.(Kumaragamage, D., Satyanarayana, T., Singh, H. and Majumdar, K. Eds.). International Plant Nutrition Institute (IPNI), Gurgaon, Haryana, India, 89-117;2009.
- Beringer H. Functions of Potassium in Plant Metabolism with Particular Reference to Yield. In: Sekhon GS (ed). Potassium in Soils and Crops, Potash Research Institute of India, 1978. New Delhi, India, pp: 185-202;1978.
- Burlando B, Cornara L. Therapeutic properties of rice constituents and derivatives (*Oryza sativa L.*): A review update. Trends in food science & technology.2014;40(1): 82-98.
- Cakmak I. Potassium for better crop production and quality. Plant Soil. 2010;335:1–2.
- Fageria NK, Baligar VC, Jones CA. Growth and mineral nutrition of field crops, 3<sup>rd</sup> ed. Boca Raton, FL: CRC;2011
- Fageria NK. Potassium requirements of lowland rice. Commun Soil Sci Plant Anal. 2015;46(12):1459-1472.

FAO (2012): *FAO statistical yearbook*. <http://www.fao.org/statistics/yearbook>.

FAO STAT online database. January 2013.

FAO.FAO Statistical data, 2017.http: stat. [www.faostat.org.in](http://www.faostat.org.in).

Islam A, Chandrabiswas J, SirajulKarim AJM, Salmapervin MST, Saleque MD. Effects of potassium fertilization on growth and yield of wetland rice in grey terrace soils of Bangladesh. *Research on Crop Ecophysiology*. 2015;10(2):64-82.

Islam A, Muttaleb A. Effect of potassium fertilization on yield and potassium nutrition of Boro rice in a wetland ecosystem of Bangladesh. *Arch. Agron. Soil Sci*. 2016;62(11):1530-1540.

Johnston AE, Poulton PR and Syers JK.Phosphorus, potassium and sulphur cycles in agricultural soils.Proceedings No. 465. York (UK): The International Fertiliser Society; p. 44;2001.

Lalitha M, Dhakshinamoorthy M. Quantity-intensity characteristics of Potassium (K) in relation to potassium availability under different cropping system in alluvial soils. *Afr. J. Agric. Res*. 2015;10(19): 2097-2103.

Li J, Lu J, Li X, Ren T, Cong R, Zhou L. Dynamics of potassium release and adsorption on rice straw residue. *PLoS One*. 2014;9(2): e90440.

Li-Jun LIU., Chang EH, Miao-Miao, FAN, Zhi-Qin WANG, Jian-Chang YANG. Effects of potassium and calcium on root exudates and grain quality during grain filling. *ActaAgron.Sin*.2011;37(4): 661-669.

Manzoor Z, Awan TH, Ahmad M, Akhter M, Faiz FA. Effect of split application of potash on yield and yield related traits of basmati rice. *J. Anim. Pl. Sci*, 2008;18(4):120-124.

Matsumura Y, Minowa T, Yamamoto H. Amount, availability, and potential use of rice straw (agricultural residue) biomass as an energy resource in Japan. *Biomass Bioenergy*. 2005;29: 347-354.

Mengel K, Kirkby EA. Potassium in crop production. *Adv. Agron.* 1980;33: 59-110.

Miah MM, Saha PK, Islam A, Hasan MN, Nosov V. Potassium fertilization in rice-rice and rice-wheat cropping system in Bangladesh. *Bangladesh J. Agric. and Environ.* 2008;4:51-67.

Nath AK, Purkaystha S. A study on soil test and crop response in respect of potassium in acid alluvial soils of Assam. *J. Indian Soc. Soil Sci.* 1988;36(1):120-124.

Palm CA, Myers RJ, Nandwa SM. Combined use of organic and inorganic nutrient sources for soil fertility maintenance and replenishment. *Replenishing soil fertility in Africa.* 1997;51:193-217.

Pathak H, Tripathi R, Jambhulkar NN, Bisen JP, Panda BB. (2020). Eco-regional Rice Farming for Enhancing Productivity, Profitability and Sustainability. *NRRI Research Bulletin No. 22*, ICAR-National Rice Research Institute, Cuttack 753006, Odisha, India. pp 28.

Pavithira E, Sirisena DN, Herath HMS. Effect of potassium fertilizer split applications together with straw on optimum level in leaf and stem of Rice. *J. Agric. Sci.* 2017;12(1):24- 33.

- Regmi A, Ladha J, Pasuquin E, Pathak H, Hobbs P, Shrestha, L, Gharti D, Duveiller E. The role of potassium in sustaining yields in a long-term rice-wheat experiment in the Indo-Gangetic Plains of Nepal. *Biol. Fertil. Soils*. 2002;36(3):240–247.
- Rengel Z, Damon PM. Crops and genotypes differ in efficiency of potassium uptake and use. *Physiol. Plant*. 2008;133(4):624-636.
- Richards RA. Selectable traits to increase crop photosynthesis and yield of grain crops. *J. Exp. Bot*. 2000;51:447-458.
- Romheld V, Kirkby EA. Research on potassium in agriculture: needs and prospects. *Plant Soil*. 2010;335(1):155–180.
- Roy RN, Braun H. (1985). Systems approach to nutrient management with special emphasis to nitrogen. Nitrogen management in farming systems in humid and subhumid tropics. 1985;339-348.
- Sarkar MIU, Islam MN, Jahan A, Islam A, Biswas JC. Rice straw as a source of potassium for wetland rice cultivation. *Geol. ecol. landsc*. 2017;1(3):184-189.
- Sen S, Chakraborty R, Kalita P. Rice-not just a staple food: A comprehensive review on its phytochemicals and therapeutic potential. *Trends Food Sci Technol*. 2020;97: 265-285.
- Singh M, Singh VP, Reddy KS. Effect of integrated use of fertilizer nitrogen and farmyard manure or green manure on transformation of N, K and S and productivity of rice-wheat system on a Vertisol. *J. Indian Soc. Soil Sci*. 2001;49(3): 430-435.

Singh NK, Banik GC, Ghosh A. Spatial Variation of Potassium Quantity/Intensity Relationships and Buffering Capacity of Some Entisols of the Himalayan Floodplain. J. Indian Soc. Soil Sci. 2019;67(3):321-328.

Thao HM, Hong NH, Tuyen NT, Van Toan N, Quyen LN. Study on the effect of some of N, P, K fertilizer compounds on the yield and quality of Bp53 rice variety. Journal of Agricultural Technology. 2015;11(8): 2149-2156.

Wang JJ, Harrell DL, Bell PF. Potassium buffering characteristics of three soils low in exchangeable potassium. Soil Science Society of America Journal. 2004;68(2): 654-661.

White PJ, Karley AJ. 2010. Potassium. In Cell biology of metals and nutrients. Springer, Berlin, Heidelberg. pp. 199-224.

Zaman U, Ahmad Z, Farooq M, Saeed S, Ahmad M, Wakeel A. Potassium fertilization may improve stem strength and yield of Basmati rice grown on nitrogen-fertilized soils. Pak. J. Agric. Sci. 2015; 52(2):437-443

Zhang F, Niu J, Zhang W, Chen X, Li C, Yuan, L. and Xie, J. Potassium nutrition of crops under varied regimes of nitrogen supply. Plant soil. 2010;335(1): 21-34.