EFFECT OF SPLIT APPLICATION OF POTASH ON YIELD AND YIELD RELATED TRAITS OF BASMATI RICE

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ABSTRACT

Effect of split application of recommended dose of potash on the yield and yield components of rice was studied at Rice Research Institute Kala Shah Kaku during Kharif season of two years i.e. 2006 & 2007. In this investigation a recommended dose of potash fertilizer (62 kg ha^{-1}) was tested in six different treatments i.e. T_1 (all potash applied as basal), T_2 (all potash applied at 25 DAT) T3 (all potash applied at 45 DAT), T_4 (½ potash applied as basal and remaining ½ at 25 DAT), T_5 (½ potash applied at 25 DAT and remaining ½ at 45 DAT) and T6 ($^1/_3$ potash applied as basal, $^1/_3$ at 25 DAT and remaining $^1/_3$ at 45 DAT). The treatment T_1, where whole potash was applied as a basal was compared with five other treatments. Means of paddy yield and yield components of rice averaged across two years showed that maximum value of plant height (126.62cm), tillers per hill (20.22), panicle length (28.74 cm), No. of grains per panicle (103.80), 1000 grains weight (20.91 gm) and paddy yield (3.34 t/ha) were obtained in treatment receiving split use of Potash as ½ at 25 DAT and ½ at 45 DAT. Treatment T_2 where whole potash was applied at 25 DAT ranked at second and least value of yield (2.86 t/ha) and all yield related attributes were achieved in the treatment T_1 where all potash was applied as basal. The increased grain yield of rice with split applying of potash in T_5 may be due to continuous supply of K to crop during crop growth stages. The efficient potash uptake by rice plant results in better growth and development when applied at maximum tillering stage (25 DAT) and at panicle initiation stage (45 DAT).

Keywords: Potash, rice, split application, Yield and yield traits.

INTRODUCTION

Rice being one of the richest starchy foods is consumed by about half of the world's population. Rice is one of the most important summer cereal crops of Pakistan and occupies second position after wheat. It covers traditional rice growing areas of the Punjab (61%), Sindh (31%), Baluchistan (4%) and high altitude valleys in the North West Frontier province (4%). It is a very important source of foreign exchange earning giving about US $ 1122 millions annually through its export. In Pakistan, rice is grown on an area of 2.58 million hectares, with an annual production of 5.438 million tons having average yield of 2107 kg ha^{-1} (Anonymous, 2006-07a). Many factors are responsible for increasing yield and quality of crops. Among these proper and balanced application of fertilizers is one of the most important factor contributing towards higher productivity (Ahmad, 1994). Researchers generally agree that with intensive cultivation, the need of K will increase (Awan *et al*., 2007). In rice cultivation, the farmers are giving much attention only to N fertilization and very often P and K applications are carried out at minimal level, mostly missing K fertilization. This practice of imbalance and inadequate fertilizer application affects the soil productivity in general and particularly depletes the essential nutrients (Cassman *et al*., 1996).

Soils in Pakistan have mixed mineralogy with dominance of hydrous mica. Other minerals present in these soils are smectite, kaolinite, vermiculite and chlorite. These soils are generally considered young and rich in K. But some soils have been subjected to weathering and thus contain secondary minerals (Ali *et al*., 2005). These secondary minerals may affect the availability of K irreversibly fixed it in the interlayer and wedge sides of soil clay and remained unavailable to growing plants (Arshad and Akram, 1999). During weathering, physical disintegration of mica into clay-size fractions resulted in replacement and release of interlayer K by more hydrated cations (Ca^{2+}, Mg^{2+}, or Na^+). Evidence of particle size reduction has been found in alluvial soils of Gujranwala, Lyallpur (Faisalabad), and Burhan series (Akhtar, 1989). The amount of K fixed increases with added K, whereas the present K fixed relative to total added K decreases (Bouabid *et al*., 1991). Fixation of K fertilizers may affect its recovery to crops. About 23 to 86 % of the applied K can be fixed and its fixation increases with increasing clay contents, lime and amount of K applied (Mehdi and Ranjha, 1995). Fauji Fertilizer Company's mobile soil testing labs have analysed the status of available nutrients including K, and generalize that more than 30 % of Pakistani soils are low in available K and require potash application (Akhtar *et al*., 2003). One of the reasons of low efficiency of fertilizer for enhancing crop productivity is imbalance use of applied nutrients. The ratio of potassium and nitrogen fertilizer used in Pakistan (0.02:1) is far below than that used in other countries of the world i.e. Japan (3.99:1), UK (0.37:1), Netherlands (0.30:1), China (0.15:1) and India (0.14:1) (Akhtar *et al*., 2003). In

Pakistani Punjab, use of potash was recorded 0.9 million tonnes in 2001-02 which was 0.1 million tonnes lower than the previous year, whereas, in Indian Punjab, its use was 3.6 million tonnes in 2001-02 which was 0.7 million tonnes higher than last year (FAI, 2002).

Problem of K fixation can be reduced to some extent and efficiency may be improved by different K application methods. Also sources of K and their time of application may affect the K recovery. Ravi and Rao (1992) and Samrathlal *et al.* (2003) claimed that grain and straw yields of rice crop were increased significantly owing to potash fertilization to the level of 62.5 kg ha^{-1} when applied in two equal splits. Stevens *et al*., (2001) also claimed that the highest yield of Baldo rice was obtained when potash was applied in two splits at mid season. Ali *et al*., (2005) reported that among the different methods and time of potash application treatments maximum paddy yield was obtained from the treatment where whole of potash was broadcasted at 25 DAT. Awan *et al*. (2007) while performing field experiments across six districts of Punjab concluded that potash application @ 62.5 kg ha^{-1} in two splits ½ as basal and ½ at 25 DAT resulted in more number of grains $panicle^{-1}$, highest 1000 grain weight and maximum paddy yield. Nutrient management practices determine the sustainability of the most intensively cropped systems (Flinn and DeDatta, 1984; Flinn *et al.*, 1982). However the practice of correct dose and timely application of fertilizer nutrients plays an important role in efficient use of fertilizers. At times, the indiscriminate and improper application with unfavourable conditions may not provide adequate nutrients supply because of its poor absorption and translocation in plant system. So the present investigation was planned to find out the best suited scheme / timing of potassium fertilizer application for rice crop.

MATERIALS AND METHODS

Experiments were conducted at the experimental area of Rice Research Institute, Kala Shah Kaku, Lahore, Pakistan during the kharif seasons of two successive years 2006 & 2007 to investigate the most appropriate time for split application of potash fertilizer for rice. The physiochemical properties of experimental site are given in table 1.

The nursery of rice variety Super Basmati was sown on 12^{th} June and was transplanted on 12^{th} July for the year 2006 and was sown on 7^{th} June and transplanted on 7^{th} July for the year 2007. Urea was applied @ 0.25 kg $marla^{-1}$ to nursery at 15 DAS (days after sowing) in both years. For both the successive years 2006 & 2007 experiments were laid out in Randomized Complete Block Design (RCBD) with three replications. The plot size was kept 6 m x 9 m (54 m^2). Nitrogen, phosphorus and potash were applied @ 133-85-62 kg ha^{-1} respectively to the field where rice was transplanted.

Table 1: Some physical and chemical properties of the soil used for the study

Parameter	0-6 (Inch Depth)	6-12 (Inch Depth)
E.C. (mS cm^{-1})	1.1	0.9
Soil pH	7.6	8.2
Organic Matter (% age)	0.77	0.50
Nitrogen % (ppm)	0.039	0.025
Available Phosphorous (ppm)	9.3	8.3
Available Potash (ppm)	80	65
Saturation (% age)	40	38
Texture	Clay Loam	Clay Loam

Urea was applied for nitrogen, diammonium phosphate (DAP) for phosphorus and sulphate of potash (SOP) for potassium. Whole phosphorus along with $^1/_3$ dose of nitrogen were applied at transplanting time as basal where as remaining nitrogen was applied in two equal splits i.e. $^1/_3$ at 25 DAT (maximum tillering stage) and $^1/_3$ at 45 DAT (panicle initiation stage) to all treatments while potash was applied according to treatment schedule given in table 2 in both years. $ZnSO_4$ (35 % Zn) was applied @ 12.5 kg ha^{-1} as source of zinc at 12 DAT to eliminate Zn deficiency. The other management practices were kept same for both years. In each of the two successive years crop was harvested in the second week of November..

Table 2: Scheme of potash application

Treatment	Time of potash fertilizer application
T_1	Potash applied @ 62 kg ha^{-1} as basal
T_2	Potash applied @ 62 kg ha^{-1} at 25 DAT (Days after transplanting)
T_3	Potash applied @ 62 kg ha^{-1} at 45 DAT
T_4	Potash applied @ 62 kg ha^{-1}, ½ as basal and ½ at 25 DAT
T_5	Potash applied @ 62 kg ha^{-1}, ½ at 25 DAT and ½ at 45 DAT
T_6	Potash applied @ 62 kg ha^{-1}, $^1/_3$ as basal, $^1/_3$ at 25 DAT and $^1/_3$ at 45 DAT

Data regarding plant height, number of tillers $hill^{-1}$ and panicle length were recorded at crop maturity while data relating number of grains $panicle^{-1}$, 1000 grain weight and paddy yield were recorded at harvest. Data were analyzed using Fisher's analysis of variance technique and treatment means were compared with standard (control) by Least Significant Difference (LSD) test (Steel *et al*., 1997). The differences were only considered when significant at $p \leq 0.05$. The weather data of maximum & minimum temperature (^oC), total rainfall (mm) and relative humidity (%) for the years 2006 & 2007 is presented in table 3 (Anonymous, 2006-07b).

Table 3: Weather data for the years 2006 & 2007 of rice season

Parameter	Year	May	June	July	August	September	October	November
Mean Maxi. Temp. (^oC)	2006	39.5	37.8	35.0	34.1	32.2	31.6	26.0
	2007	38.9	38.3	35.3	35.4	33.9	32.5	27.5
Mean Mini. Temp. (^oC)	2006	27.4	26.8	27.6	26.9	24.9	21.6	16.1
	2007	26.2	28.1	26.9	27.7	25.5	19.8	14.9
Total Rain Fall (MM)	2006	22.4	87.9	185.5	145.7	157.6	46.0	9.0
	2007	19.1	196.9	81.7	101.7	75.8	0.0	10.2
Humidity at 0800 AM (%)	2006	51	52	76	79	76	74	81
	2007	43	59	76	76	76	67	81
Humidity at 0800 PM (%)	2006	28	32	61	67	57	49	55
	2007	25	40	58	65	59	35	52

RESULTS AND DISCUSSION

The data regarding different yield and yield relating traits are presented in Table 4. As the results obtained during two years were similar therefore these were pooled. The mean data of two years 2006 & 2007 are presented in Table 4 showed that longest panicle (28.74cm) along with highest 1000 grain weight (20.91 gm) were obtained from the treatment where potash was applied in two equal splits ½ at 25 DAT and ½ at 45 DAT (T5) which was statistically at par with the treatment where whole of potash was applied at 25 DAT (T2) and were significantly different from other treatments. The smallest panicles having length 27.97 and least 1000 grain weights 19.86 gm were obtained from T_1 where whole potash was applied as basal. This increase in panicle length and in 1000 grain weight may be due to continuous supply of K to the crop during crop growth stages. The efficient potash uptake by rice plant results in better growth and development when applied at maximum tillering stage (25 DAT) and at panicle initiation stage (45 DAT). Similarly results were reported by Sarkar *et al.* (1995) and Raju *et al*. (1999) Samrathlal *et al*. (2003).

Rice plant produced more number of grains per panicle (103.80) by applying potash in two splits ½ at 25 DAT and ½ at 45 DAT (T_5) which was similar with T2 and T_4. The lowest value of number of grains per panicle (100.55) was recorded in T_1 where whole of potash was applied as basal. The increase in number of grains per panicle might be due to increased potash uptake efficiency when applied at maximum tillering and at panicle initiation stages. The positive response of potash application on number of grains per panicle in rice crop has also been reported by Smid and Peaslee (1976), Lauchli and Pfluger (1979), Sharma *et al.,* (1980) and Malik *et al.* (1988), Ahmad *et al*. (1994) Ramos *et al.*(1999)., and also clamed that split application of potash at active growth stages resulting in adequate potash supply which increased plant photosynthesis rate because potash is required in the activation of starch synthesis and then conversion of soluble sugars into starch is vital step in the grain filling process.

Maximum paddy yield (3.34 t/ha) was recorded in T_5 where potash was applied in two equal splits ½ at 25 DAT and ½ at 45 DAT, which was statistically higher than T_1, T_3, T_4 and T_6 and at par with T_2 where whole of potash was applied at 25 DAT having paddy yield of 3.16 t/ha. The increased paddy yield of rice due to potassium fertilizer application at recommended rate having two equal splits (half at maximum tillering stage + half at panicle initiation stage) was attributed directly to continuous supply of K to the crop during crop growth stages. The rice plant ultimately proved more beneficial and resulted in a significant increase in panicle length, number of grains per panicle and 1000 grain weight ultimately resulted in maximum paddy yield. Similar findings have been reported by Ravi and Rao (1992); Thakur *et al.* (1999); Dwivedi *et al.* (2000) and Ali *et al.* (2005) who reported that significant increase in paddy yield was recorded when potash was applied in splits at different growth stages over a single application as basal. Samrathlal *et al.* (2003) and Awan *et al.* (2007) also claimed that grain and straw yields of rice crop were increased significantly due to potash fertilization to the level of 62.5 kg K ha^{-1} when applied in two equal splits. The analysis of variance of mean square of yield and yield related components presented in table 5 indicated a non significant difference observed among the replications for the characters studied. Whereas a significant difference was found among treatments for panicle length, no. of grains $panicle^{-1}$, 1000 grain weight and paddy yield.

The study suggests that basal application of potash (traditional method) may be replaced by a late application of potash at 25 DAT (maximum tillering stage) fore single split application in rice crop. For getting maximum benefit, split application of potash in two splits ½ at 25 DAT and remaining ½ at 45 DAT may be promoted. However, it needs further investigation in subsequent studies, involving a greater number of rice varieties to formulate a general recommendation.

Table: 4 Effect of split application of potash fertilizer on yield and yield components of rice crop (mean of two years 2006 & 2007).

Tr. No.	Plant height (cm)	No. of tillers / hill	Panicle length (cm)	No of grains/ panicle	1000 grain weight (gm)	Paddy yield (t/ha)
T_1	125.83	19.19	27.97 c	100.55 c	19.86 c	2.86 c
T_2	126.34	19.94	28.44 ab	103.23 ab	20.55 ab	3.16 ab
T_3	126.00	19.24	28.10 bc	101.58 bc	20.10 bc	2.97 bc
T_4	126.17	19.63	28.26 bc	102.08 abc	20.29 bc	3.04 bc
T_5	126.62	20.22	28.74 a	103.80 a	20.91 a	3.34 a
T_6	126.07	19.42	28.19 bc	101.69 bc	20.18 bc	2.99 bc
LSD Value	0.8630	1.044	0.4638	1.833	0.5113	0.2818

Means having different letters in a column differ significantly ($p \leq 0.05$)

T_1 = Potash applied @ 62 kg ha^{-1} as basal
T_2 = Potash applied @ 62 kg ha^{-1} at 25 DAT
T_3 = Potash applied @ 62 kg ha^{-1} at 45 DAT
T_4 = Potash applied @ 62 kg ha^{-1} 1/2 as basal & 1/2 at 25 DAT
T_5 = Potash applied @ 62 kg ha^{-1} 1/2 at 2 & 1/2 at 45 DAT
T_6 =Potash applied @ 62 kg ha^{-1} 1/3 as basal, 1/3 at 25 DAT & remaining 1/3 at 45 DAT as basal

Table: 5 Analysis of variance table of means square of yield and yield components

Source	DF	Plant height (cm)	No. of tillers/hills	Panicle length (cm)	No. of grains/ panicle	1000-grain weight (gm)	Paddy yield (t/ha)
Replications	2	0.281 ns	0.031 ns	0.124 ns	0.728 ns	0.101 ns	0.002 ns
Treatments	5	0.235 ns	0.499 ns	0.226 *	4.190 *	0.411 *	0.085 *
Error	10	0.225	0.329	0.065	1.015	0.079	0.024

ns= Non significant, * = P > 0.05, ** = P > 0.01

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