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Effect of K on nutrient content, uptake and K use efficiency by wheat under high Ganges river flood plain soil

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Abstract: An experiment was carried out at farmers field of Pushpapara, Pabna during the year 2005-06 to evaluate the effect of potassium on nutrient content, uptake and use efficiency by wheat. Five different levels of K were used in the investigation following randomized complete block design. The result revealed that the highest nutrient content specially N, P and K content in grain and N and K content in straw was attained with the application of 36 kg K ha^{-1}. The highest uptake of N, P, K and S by grain and straw was obtained from the application of 36 Kg K ha^{-1} followed by 48 Kg K ha^{-1}. It was also revealed that the total uptake of N, P, K and S was attained in 36 Kg K ha^{-1} which was 34.73%, 7.45%, 39.85% and 4.04% higher over control (K omission). The highest agronomic efficiency, physiological efficiency and apparent K recovery was attained with the application of 12 Kg K ha^{-1} and it was declined with further addition of K. The overall results indicated that the application of 36 kg K ha^{-1} contributed to the maximum nutrient content and uptake by wheat crop and agronomic efficiency, physiological efficiency and apparent K recovery was negatively correlated with applied K.

Key words: Wheat, K level, nutrient content, nutrient uptake and K use efficiency

Introduction

Proper and judicious application of potassium is required for optimum crop productivity of wheat. Potassium as a plant nutrient is becoming increasingly important in Bangladesh and crop response is being reported from many parts of the country. Large K mining has been reported in most intensive cropped areas of the country. Crops response and recovery to added K is not clear in many cases. Generally K availability is high in soil with high K bearing minerals (FRG, 2005). Many researchers have studied the behavior of K uptake by wheat with added potassium. Ranjha et al.(2002) investigated that K concentration in wheat increased with increasing K application. The response of wheat to K was related to the amount of exchangeable K and K supply rate in the soil. The low response to added potassium in soils with high K supply rate has been reported by Qian et al. (1998). Nutrient content by wheat grain and straw has been increased with added K fertilizer (Auti et al. 1999). Wheat has proved to have a higher agronomic K efficiency under K deficient conditions (El *et a*l., 2002). The information regarding nutrient content and uptake by wheat crop would be helpful to make rational use of K fertilizer. It is imperative to generate the information on nutrient uptake and use efficiency by wheat crop to added potassium which could contribute for maximizing production under High Ganges River Floodplain Soil. Keeping this, the experiment was carried at farmers' field to ascertain the effect of added potassium on nutrient content, uptake and use efficiency by wheat under High Ganges River Flood plain Soil.

Materials and Methods

The experiment was carried out at farmers' field of Pushpapara, Pabna during 2003-04 under Gopalpur soil series belongs to the High Ganges River Floodplain soils (AEZ-11). Before starting the experiment, initial composite soil samples (0-15 cm depth) were collected from the experimental plots and the physiochemical properties were analyzed. The analysis result indicated that the soil was silty loam with low organic matter content (1.22%) and slightly alkaline in nature. Nitrogen and P content of the soil was low but K, S and B content was medium. Zn content of the soil was high (Table 1).The experiment was laid out in randomized complete block (RCB) design with three replications. The unit plot size was 5 m x 4 m. Five different levels of potassium (0, 12, 24, 36 and 48 Kg ha^{-1}) were employed in the study.

The experimental plot was well prepared with a power tiller by ploughing and cross ploughing and the soil was brought into good tilth condition. Potassium fertilizer was applied as per treatment specification. A blanket dose of other nutrients (120-30-20-3-2 Kg N P S Zn B ha^{-1}) was applied for high yield goal. Half of nitrogen and the full amount of phosphorus, potassium, sulphur, zinc and boron were applied at the time of final land preparation in the forms of urea, triple super phosphate, muriate of potash, gypsum, and zinc oxide, respectively. Remaining half dose of urea was top dressed at 24 days after sowing. Wheat (var. Shatabdi) seed was sown on November 24 in line (20 cm apart) at the rate of 120 kg ha^{-1} and harvested on March 25, 2004. Recommended cultural practices were followed throughout the growing season.

At the time of harvesting ten randomly selected plants from each plot were collected for nutrient analysis. Grain and straw yields were recorded from the total area of each plot. Grain yield per hectare was then calculated on 12% moisture content. Grain and straw samples were dried in an oven at 65^{o}c for 48 hours and then ground in a grinding machine. The ground samples of grain and straw were digested with standard procedure and then analyzed for N, P, K and S contents. Total nitrogen and phosphorous in the digest was estimated by Kjeldahl method and Spectrophotometer respectively as outlined by Jackson (1973). Potassium was measured from the digest by using atomic absorption Spectrophotometer as described by Page *et. al* (1982). Sulphur content was determined by the procedure developed by Hunter (1984). The uptakes of different nutrients were calculated by multiplying the concentration of the nutrients in the grain and straw samples with the corresponding yields of grain and straw of wheat. Linear regression analysis was done using total K uptake, agronomic efficiency, physiological efficiency and apparent K recovery data against K levels. Collected data were statistically analyzed by using MSTAT software packages and mean differences for each character were compared by Least Significant Difference test (Gomez and Gomez, 1984).

Results and discussion

Nutrient content: Nutrient content of grain and straw of wheat influenced by different levels of potassium is presented in Table 1. The results indicated that the content of N, P and K in grain significantly affected by the application of levels of potassium whereas the effect of potassium on S content was non significant. The highest N, P and K content in grain was attained with the application of 36 Kg K ha^{-1} followed by 48 Kg K ha^{-1}. It is revealed that due to addition of each 12 Kg increment of potassium progressively increased three nutrients in grain upto 36 Kg K ha^{-1} and thereafter slightly declined. This result is also in agreement with the findings of Rawat and Pareek (2003). The lowest nutrient content in grain was observed in potassium omission treatment. Straw analysis indicated that only N and K content was significantly influenced due to potassium application while P and S content were not responded significantly with potassium. However, the highest N and K content in straw was obtained from 36 Kg K ha^{-1} followed by 48 24 Kg K ha^{-1}, respectively. Wang *et al.* (1995) reported that the application of potassium increased plant K content. It was also observed that the nutrient content in wheat grain was higher than straw except K. Potassium content in straw was higher than that of grain.

Table 1. Nutrient content of grain and straw of wheat as affected by different levels of Potassium

Level of K	Nutrient content (%)							
	Grain				Straw			
	N	P	K	S	N	P	K	S
0	1.81b	0.33 b	0.39 c	0.11	0.42 b	0.060	1.57 c	0.068
12	1.82 ab	0.35 ab	0.44 bc	0.12	0.48 ab	0.068	1.60 bc	0.074
24	1.85 ab	0.34 b	0.46 ab	0.14	0.52 a	0.080	1.72 abc	0.076
36	1.93 a	0.40 a	0.50 a	0.15	0.55 a	0.090	1.83 a	0.080
48	1.90 ab	0.38 ab	0.48 ab	0.14	0.53 a	0.086	1.78 ab	0.078
CV (%)	3.33	3.00	8.05	1.29	9.00	4.45	5.82	5.74
Level of significance	0.05	0.01	0.05	ns	0.05	ns	0.05	ns

Table 2. Nutrient uptake by grain and straw of wheat as affected by different levels of K

Level of K	Nutrient uptake (Kg ha^{-1})							
	Grain				Straw			
	N	P	K	S	N	P	K	S
0	56.99 d	10.43 d	12.41 d	3.47 e	18.12 c	2.58 d	66.90 d	2.90 e
12	68.95 c	13.30 c	16.69 c	4.55 d	22.97 b	3.28 c	76.50 c	3.55 d
24	73.22 bc	13.50 c	18.22 b	5.22 c	25.00 ab	3.88 b	82.37 bc	3.66 cd
36	80.31 a	15.93 a	20.78 a	6.11 a	29.34 a	4.58 a	98.37 a	4.31 a
48	75.58 ab	15.82 a	19.11 b	5.84 ab	26.56 ab	4.51 a	88.45 b	3.92 bc
CV (%)	4.13	1.93	4.65	3.57	10.13	7.54	5.99	5.04
Level of significance	0.01	0.01	0.01	0.01	0.05	0.01	0.01	0.01

Table 3. Total uptake of nutrients by wheat as affected by different levels of K

Level of K	Total uptake				% increase over control			
	N	P	K	S	N	P	K	S
0	75.10 d	13.04 e	79.36 d	6.47 d	-	-	-	-
12	91.91 c	16.61 d	93.22 c	8.21 c	16.81	3.57	13.86	1.74
24	98.14 bc	17.39 c	100.47 bc	9.29 b	23.04	4.35	21.11	2.82
36	109.83 a	20.49 a	119.21 a	10.51 a	34.73	7.45	39.85	4.04
48	101.61 ab	20.46 a	107.60 b	9.86 b	26.51	7.42	28.24	3.39
CV (%)	4.99	1.48	5.19	3.81	-	-	-	-
Level of significance	0.01	0.01	0.01	0.01	ns	ns	ns	ns

Nutrient uptake: The result presented in Table 2 showed a significant variation in nutrient uptake by grain and straw of wheat due to different levels of potassium. The similar trend of response regarding nutrient uptake was observed in both grain and straw. The uptake of nutrients by grain and straw were increasing with the increment of K up to 36 Kg K ha^{-1} and then declined. Dixit (1993) also stated that potassium application increased N uptake by wheat. The uptake of K was progressively increased with increased K levels. Regarding total K uptake the similar trend was also observed. This result indicated that K uptake by wheat is positively correlated with the added potassium (Fig. 1). The result is also in agreement with the findings of Panwar *et al*., (1996) who investigated that the K uptake in wheat grain and straw increased with increasing K levels. The highest uptake of N, P, K and S by grain and straw was obtained from the application of 36 Kg K ha^{-1} followed by 48 Kg K ha^{-1}. The uptake of nutrients specially N, P and S by wheat grain was comparatively higher than that of straw. But the uptake of K by straw was more pronounced than that of grain.

Total uptake of nutrients by wheat plant significantly responded with the application of potassium. It was observed that total uptake increased with the successive addition of potassium up to certain level. The highest total uptake of N. P, K and S was recorded from 36 Kg K ha^{-1} treated plot. Dahdoh (1997) reported that total P uptake increased with the increasing levels of potassium. It was revealed that the application of 36 Kg K ha^{-1} contributed to the maximum total uptake of nutrient and thereafter it reduced. The total uptake of N, P, K and S attained in 36 Kg K ha^{-1}, was 34.73%, 7.45%, 39.85% and 4.04% increased over control. The maximum increase in total uptake was recorded in K followed by N over potassium omission treatment.

Apparent balance: The negative balance of K indicated that the output was larger in quantity than input. The highest negative balance of K observed in K omission treatment, might be due to total uptake of K by wheat from the native source. This result is also supported by the findings of Prasad (1993) who investigated the highest negative balance of K in K untreated plot. The highest positive balance was recorded with 48 Kg K ha^{-1}treated plot (Table 4). Probably the application of the highest quantity of applied K to soil enhanced maximum positive balance.

Use efficiency:

The highest agronomic efficiency was observed when 12 Kg K $ha^{-1}$was applied and the efficiency value decreased with a further increase in the K level (Fig. 2). The lowest agronomic efficiency was recorded with 48 Kg K ha^{-1}. The physiological efficiency of K decreased with increasing level of applied K. The physiological efficiency of the applied K was the highest with 12 Kg K ha^{-1}. Similar investigation was reported by Mazid and Panaullah (1999) who stated that physiological efficiency of N in rice crop increased up to certain level and then decreased with increasing level of applied N. The plant recovery of applied K referred to as apparent K recovery decreased with the increase of K level. However, the apparent K recovery was the highest with 12 Kg ha^{-1} and the lowest with 48 Kg ha^{-1}. Regarding total K uptake, the value of the slope in linear regression equation suggests that the K uptake is positively correlated to apply K (Fig. 1). But considering the other equations, it is revealed that agronomic efficiency, physiological efficiency and apparent K recovery is negatively correlated to applied K (Fig. 2, 3 & 4).

Table 4. Apparent balance of potassium as influenced by different levels of K

K added through fertilizer (Kg ha^{-1})	Total uptake of K by wheat (Kg ha^{-1})	K uptake from fertilizer (Kg ha^{-1}) (K treated treatment- K omission treatment)	K balance in soil (Kg ha^{-1}) (K added- K uptake from fertilizer)
0	79.36 d	-	-79.36
12	93.22 c	13.86	-1.86
24	100.47 bc	21.11	+2.89
36	119.21 a	39.85	-3.85
48	107.60	28.24	+19.76
CV (%)	5.19	-	-
Level of significance	0.01	ns	ns

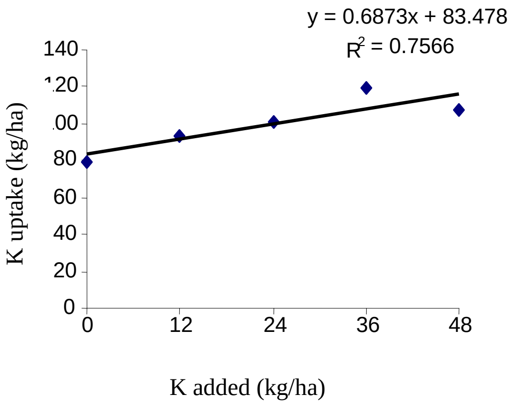

Fig. 1 Effect of different levels of K on total K uptake of wheat

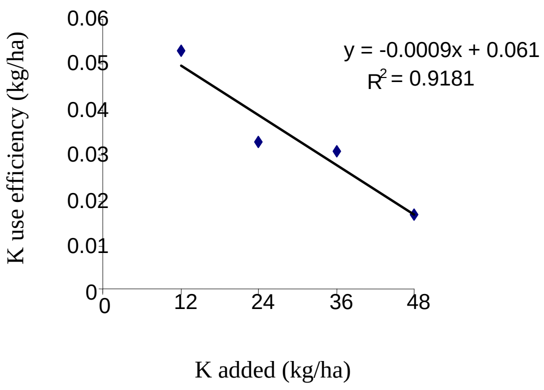

Fig. 2 Effect of different levels of K on agronomic efficiency of wheat

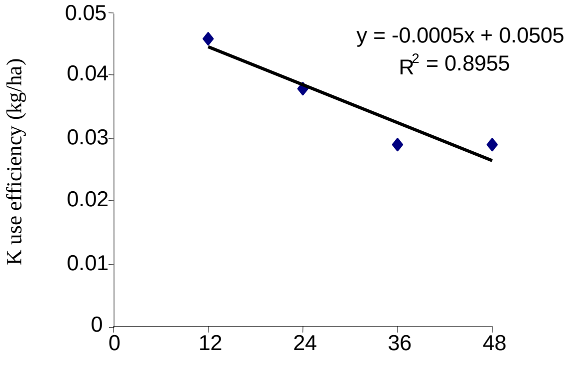

Fig. 3 Effect of different levels of K on physiological efficiency of wheat

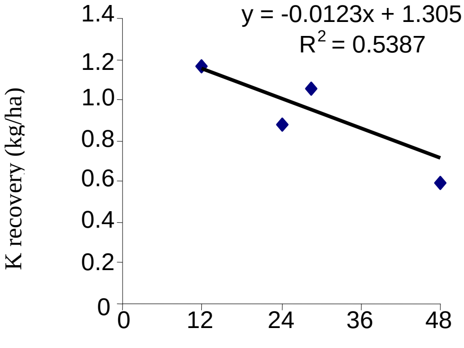

Fig. 4 Effcet of different levels of K on apparent K recovery of wheat

Table 5. Nutrient status of the initial soil sample (0-15cm depth) of experimental plots at Pushpapara Pabna.

Soil properties	Values	Interpretation
Soil pH	8.1	Slightly alkaline
Organic matter content (%)	1.22	Low
Total N (%)	0.10	Low
Available P (µgg^{-1} soil)	11	Low
Available S (µgg^{-1} soil)	16	Medium
Available Zn (µgg^{-1} soil)	2.15	High
Available B (µgg^{-1} soil)	0.35	Medium
Exchangeable K (meq%)	0.20	Medium
Exchangeable Ca (meq%)	2.75	Low
Exchangeable Mg (meq%)	1.56	High

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