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EVALUATION OF DIFFERENT LEVELS OF POTASSIUM ON THE YIELD AND PROTEIN CONTENT OF WHEAT IN THE HIGH GANGES RIVER FLOODPLAIN SOIL

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Abstract

Balanced fertilization with optimum potassium management may lead to maximize wheat yield. The experiment was carried out at the Farming Systems Research and Development (FSRD site, Pushpapara, Pabna during the *rabi* seasons of 2003-04 and 2004-05 to ascertain the effect of potassium application on wheat. Five different levels of potassium (K) were tested on wheat crop. Yield contributing characters and yield exerted significant variation due to application of different levels of K and the best performance of the crop parameters was recorded when 36 kg K/ha was applied. Remarkable increase in grain, straw and total biomass yield was recorded in the same treatment. Regarding the grain quality of wheat, the highest protein content was recorded from 36 kg K/ha, which was 6.86% and 4.98% higher over omission of K (control) and recommended dose (100% estimated K). The highest net benefit was obtained from 36 kg K/ha, which was 40.52% higher over omission of K (control).

Kew Words: Potassium, yield, protein content, wheat.

Introduction

The High Ganges River Floodplain Soil is characterized by low fertility with medium level of K content (BARC, 1997). Wheat crop is generally fertilized by farmers in this region either with nitrogen only or with nitrogen (N) and phosphorus (P) fertilizers. Intensification of cropping system with greater use of K free chemical fertilizers and adoption of high yielding varieties have resulted in the mining of soils leading to K deficiency. There is immense scope of increasing productivity through adequate application of K (Bhattacharyya, 2000). Wheat has proved to have a higher agronomic K efficiency as indicated by a greater relative yield under K deficient conditions (El *et al.,* 2002). Better growth and yield of wheat crop has been observed with the addition of' K (Singh *et al.,* 2000), Potassium content in the plant tissue is crucial to the proper functioning of several important biochemical and physiological processes that directly determine crop productivity. Therefore, for sustaining soil fertility and optimum crop productivity on long term basis, K removal through the crops should be replenished with balanced and adequate K fertilization.

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Since no systematic attempt has been made so far with regard to K fertilization of wheat in the High Ganges River Floodplain Soils, the present study was, therefore, carried out to find out the effect of levels of applied K on the growth, yield and protein content of wheat.

Materials and Method

Site description

The experiment was carried out at the Farming Systems Research and Development (FSRD) site, Pushpapara, Pabna during the *rabi* seasons of 2003-04 and 2004-05, The experimental site was in Gopalpur soil series belonging to the High Ganges River Floodplain Soils (AEZ-II). Before starting the experiment, initial composite soil samples (0-15 cm depth) were collected from the experimental plots and were analyzed. The analytical result indicated that soil was silty loam with low organic matter content (1.22%) and slightly alkaline in nature. Nitrogen and P content of the soil were low but K, S, and B content were medium. Zinc 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.

Table 1. Nutrient status of the initial soil sample (0-15cm depth) of experimental plots at FSRD Site, 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 (µg/g soil)	11	Low
Available S (µg/g soil)	16	Medium
Available Zn (µg/g soil)	2.15	High
Available B (µg/g soil)	0.35	Medium
Exchangeable K (meq%)	0.20	Medium
Exchangeable Ca (meq%)	2.75	Low
Exchangeable Mg (meq%)	1.56	High

Treatments

Treatment consisted of five different levels of K, which were tested for wheat crop. Levels of K were estimated for high yield goal of wheat based on soil analysis value.

Level of K	kg/ha
Without K (control)	0
25% of estimated K	12
50% of estimated K	24
75% of estimated K	36
100% of estimated K	48

Field and crop management

The land was prepared by power tiller and laddering. Potassium fertilizer was applied as per treatment specification. A blanket dose (120-30-20-3-2 kg N-P-S-Zn B/ha) was applied for high yield goal of wheat. The full amount of P, K, S, Zn, B and half of N were applied at the time of final land preparation in the forms of triple superphosphate, muriate of potash, gypsum. zinc oxide, boric, acid and urea, respectively. Remaining half urea for N was applied as top dress at 17-21 days alter sowing (at crown root initiation stage). Wheat (var. Shatabdi) seed was sown on 20-24 November in line (20 cm apart) with continuous seeding at the rate of 120 kg/ha and harvested during 20-25 March in both the seasons. One irrigation was applied at crown root initiation stage. Other intercultural operations and plant protection measures were taken as and when required

Measurement

The data on crop parameters except grain, straw, and total biomass yield were measured from ten randomly selected plants of the sampling area of each treatment. Grain and straw yields were measured from the total area of each treatment. Grain yield per hectare was then calculated on l2% moisture content. The total nitrogen of the wheat grain sample was determined by micro- Kjeldahl method as described by Jackson (1973) and then the percentage of protein in grain was calculated by multiplying the standard factor. Collected data were statistically analyzed by using MSTAT software packages and mean differences for each character were compared by Duncan's New Multiple Range Test (DMRT). Cost and return analysis of different treatments were done for net benefit. Variable cost was counted from monetary cost (fertilizer) and opportunity cost (labour) only while the other cost was considered as fixed cost. Gross return was computed by adding market values of grain and straw yield.

Results and Discussion

Yield attributes and yield

Growth and yield contributing characters as influenced by level of K have been presented in Table 3. All the studied characters were significantly influenced by

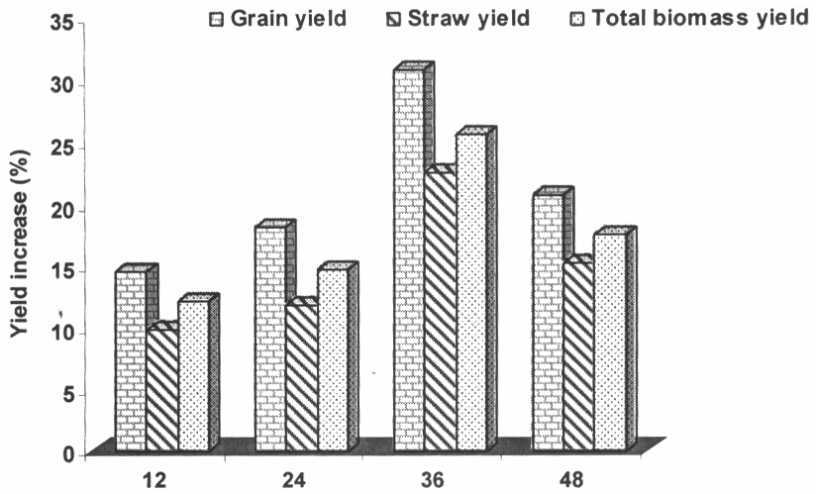
different levels of K. Potassium level had significant effect on the number of effective tillers/plant. Number of effective tillers/plant increased progressively with the application of increasing levels of K upto 36 kg K/ha.The highest number of effective tillers/plant was recorded from 36 kg K/ha, while the lowest one was found from control. Hagras (1985) also observed the similar response. The similar trend of response was noted in spikelets/spike, grains/ spike and 1000-grain weight. The values of the crop characters, such as spikelets/spike, grains/spike, and 1000-grain weight were increased with the increasing rate of K upto 36kg K/ha and thereafter it declined with higher levels of K. Ma *et al.* (2000) also stated that K application promoted spikelet development and increased the number of spikelets/spike. Number of grains/ spike exhibited significant variation as influenced by the levels of K and the maximum number of grains/spike was observed in 36 kg K/ha, which was followed *by* other treatments except control. Yongchun *et al.* (1997) also reported that applied K increased the number of grains/spike. The result revealed that K level had significant effect on 1000-grain weight of wheat, The highest weight of 1000-grain attained in 36 kg K/ha might be due to the balanced accumulation of different nutrient elements in the grain resulting higher grain weight. This result is also in agreement with the findings of Ma *et al.* (1999) who stated that 1000-grain weight progressively increased with the application of K.

Grain yield of wheat responded significantly due to application of different levels of K (Table 4) The result revealed that grain yield progressively increased with increasing levels of K application upto 36 Kg K/ha and then declined. The highest grain yield was achieved with the application of 36 kg K/ha. The data indicated that the cumulative effect of yield contributing characters, such as effective tillers/plant, spikelets/spike, grains/spike, and 1000-grain weight had positive contribution to higher grain yield obtained from 36 kg K/ha. In case of control, the growth and development of plants were hampered due to imbalance uptake of essential elements which resulted in poor performance of yield attributes and ultimately gave the lowest grain yield. Similar response of K on grain yield has also been reported by Dwivedi (2001). Variation of straw yield under different K levels was statistically significant. The maximum plant height and numbers of tillers probably attributed to higher straw yield in 36 kg K/ha followed by 48 kg K/ha. Total hiomass yield showed significant variation due to application of different levels of K. Likewise grain and straw yield, the highest total biomass yield was recorded in 36 kg K/ha, which was significantly higher than other treatments.

Table 3. Effect of different levels of K on yield attributes of wheat (pooled average of two years).

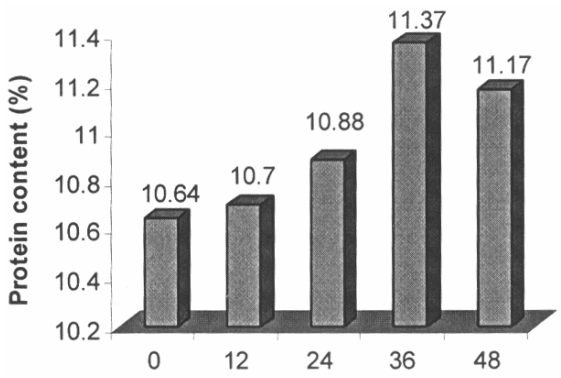
Levels of K (kg/ha)	Effective tillers/plant (no.)	Spikelets/spike (no.)	Grains/spike (no.)	Wt of 1000-grain
0	2.05c	16.33	41.58	40.01
12	2.29bc	17.25	43.80	40.58
24	2.57ab	17.87	43.95	41.13
36	2.75a	18.14	46.42	42.78
48	2.58ab	17.79	44.43	41.34
CV(%)	6.91	4.81	5.70	3.12
LSD(0.05)	0.32	0.27	1.41	0.86

Yield increase over the control varied with different levels of K (Fig. 1). The results indicated that increase in yield over control was progressive upto 36 kg K/ha and thereafter, it declined. In case of all yield categories, the highest increase in yield over control was achieved with 36 kg K/ha followed by 48 kg K/ha and the lowest increase in yield was recorded in 12 kg K/ha.



Level of K in kg/ha

Fig. 1. Yield increase of wheat over control



Level of K in kg/ha

Fig. 2. Effect of different levels of potassium on protein content of wheat

Protein content

The grain protein content of wheat was significantly influenced due to application of different levels of K (Fig. 2). The protein content varied from 10.64 to 11.37%. The highest protein content obtained from 36 kg K/ha, which was 6.86% higher over control. The highest protein content attained in 36 kg K/ha might be due to the highest N content in grain. The second highest protein content was attained in 48 kg K/ha, which was statistically similar to 24 and 12 kg K/ha, respectively. The lowest protein content was found in control. This result is also in agreement with the findings of Ragasits and Nemeth (1993).

Table 4. Effect of different levels of K on yield of wheat (pooled average of two years).

Levels of K (kg/ha)	Grain yield (t/ha)	Straw yield (t/ha)	Total biomass yield (t/ha)
0	2.60	3.73	6.35
12	2.98	4.10	7.12
24	3.07	4.17	7.29
36	3.40	4.57	7.98
48	3.14	4.30	7.46
CV (%)	4.77	6.78	4.04
LSD(0.05)	0.27	0.15	0.41

Cost and return

Cost and return analysis demonstrated that the highest net benefit was obtained from 36 kg K/ha, which was 40.52% higher over control (Table 5). Probably higher production in 36 kg K/ha enhanced the highest return. The second highest

net benefit was recorded in 24 kg K/ha. The lowest net benefit obtained from control might be due to lower production with imbalanced fertilization.

Table 5. Partial budget analysis for fertilizer use in wheat production.

Level of K (kg/ha)	Gross return (Tk./ha)			Variable cost (Tk./ha)			Net benefit (Tk./ha)	Net benefit increases over control
	Wheat		Total	Monetary cost (fertilizer)	Opportunity cost (labour)	Total		
	Grain	Straw						
0	31300	2120	33420	5515	280	5795	27625	-
12	37700	2375	40075	5755	280	6035	34040	6415
24	39400	2430	41830	5995	350	6345	35485	7860
36	42800	26+05	4505	6235	350	6585	38820	11195
48	39600	2490	42090	6475	420	6895	35195	7570

Conclusion

In the light of the findings of two years' research works, it can be concluded that wheat responded significantly to added K. The highest yield advantage was attained when 36 kg K was applied per ha. In addition to that grain quality specially protein content of wheat was also improved by K application upto 36 kg/ha. Regarding economic return, the maximum net benefit was achieved with 36 kg K/ha. Therefore, the application of 36 kg K per hectare can be the optimum dose fhr maximizing wheat yield and economic return in Gopalpur series soil under the High Ganges River Flood Plain Soil.

References

BARC (Bangladesh Agricultural Research Council). 1997. Fertilizer Recommendation Guide. Bangladesh Agril. Res. Co. Farmgate, New Airport Road, Dhaka. p.44.

Bhattacharyya, B. K. 2000. Response to applied potassium in important crops and cropping systems in West Bengal. Workshop Proc. PPIC-IP, Calcutta. pp. 55-60.

Dwivedi, B. S. 2001. Response of wheat *(Triticum aestivum)*, potato *(Solanum tuherosuin)* and Indian mustard *(Brassica juncea)* to varying particle size of potassium applied through muriate of potash. *Indian J. Agril. Sci.* **71**(10): 634-638.

El, D. H., Claasen, N. and Steingrobe, B. 2002. Potassium efficiency mechanism of wheat, barley and sugarbeet grown on a K fixing soil under controlled conditions. J. *Plant Nut. Soil Sci* **165**(6) : 732-737.

Hagras, A. M. 1985. Response of wheat to nitrogen, phosphorus and potassium fertilization. *Ann. Agril. Sci.* **23**(2) : 1023-1035.

Jackson, M. L. 1973. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi. India. pp. 10- 144.

Ma, A. G., Z. L. Zhan, P Zhen, and L. P. Fan. 1999. The effect of potassium fertilizer in super high yield wheat fields. *J. Henan Agril. Sci.* **9:** 24-25.

Ma, X. M., X. C. Wang, and J. Ding. 2000. Effect of potassium on spike and grain development and physiological characteristics in different wheat cultivars on shajiang black soil. Sci. *Agric Sinica* **33**(3): 67-72.

Ragasits, I and I. Nemeth. 1993. Effect of potassium on the yield and baking quality of wheat. Acta Agron. *Hungarica*. **42**(3-4): 311-314.

Singh, J., H. L. Sharma, and C. M. Singh. 2000. Effect of levels and phases of potassium application on growth and yield of rice and wheat. *J. Pot. Res.* **16**(1-4): 35-40.

Yongchun, Y., Y. Yin, S. Lao, G. Wang, and G. Liu. 1997. The effect of potassium fertilizer application on yield of wheat in potassium deficient soils. *Jiangsu Agril. Sci.* **1:** 47-48.