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Effect of Potassium and Sulphur Nutrient Management on Nutrient Balance, Efficiency and Disease Index in Jute-Rice-Chickpea Sequence

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ABSTRACT

Field experiment was conducted for 2 years (1998 to 1999 and 1999-2000) at Bidhan Chandra Krishi Viswavidyalaya (23° N, 89° E and 9.75 m AMSL) in sandy clay loam Entisol with pH 7.4, 0.52% organic carbon, 0.065% total N and 16.8, 198 and 16.5 kg of P, K and S ha^{-1}, respectively. The highest AE (11.73) resulted in the highest AE (11.73) in treatment receiving 8, 12 and 6 kg K ha^{-1} for jute-rice-chickpea. Whereas, the highest PE was 13.22 with 16, 24 and 12 kg K ha^{-1} along with 20 kg S ha^{-1} for all the crops in sequence. The RF was the highest (0.89) with 8, 12 and 6 kg of K ha^{-1}. The maximum improvement in soil nutrient status as compared to the initial values (+197, +14.6, +6.9 and +2.3 kg ha^{-1} for N, P, K and S, respectively), was observed with highest doses of K (16, 24 and 12 kg ha^{-1}) and S (40 kg ha^{-1}) in all the crops. The maximum positive balance of N (444.2 kg ha^{-1}) was observed with 16, 24 and 12 kg K ha^{-1} and maximum K balance (577.4 kg ha^{-1}) was maintained with 8, 12 and 6 kg K ha^{-1} along with 20 kg S ha^{-1}. There was negative correlation between plant K content and percentage of diseased plants were ($r = -0.688$, -0.882 and -0.926 for jute, rice and chickpea, respectively). In contrast, the K content of plants was positively correlated with crop yield ($r = 0.947$, 0.847 and 0.886 for jute, rice and chickpea, respectively). Balanced nutrition of K along with S is required for higher PE. For achieving highest AE and RF in this sequence of jute-rice-chickpea, addition of K is required and external application of S may be avoided. Regarding positive nutrient balance, improvement in yield and reduction in disease incidence in jute-rice-chickpea sequence, application of S (20 kg ha^{-1}) along with K is needed in the lower Gangetic alluvium of West Bengal.

Key words: Agronomic efficiency, chickpea, disease incidence, jute, nutrient status, physiological efficiency, potassium, sulphur

INTRODUCTION

The marginal and small farmers of lower Gangetic plains of West Bengal follows sequence of three crops including jute and rice (Mondal and Roy, 2001). But very limited work has been done to acquire information on different aspects of fertilizer use efficiency, nutrient balance etc. on jute-rice crop rotation including a leguminous pulse crop in sequence with special reference to potassium (K) and sulphur (S) fertilization. Keeping these in view, a field experiment on jute-rice-chickpea cropping sequence was designed to study the effect of nutrient management with special reference to K and S on nutrient balance, agronomic and physiological

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efficiency, recovery fraction, change of soil nutrient status, balance sheet of N and K and potassium content in plant and its relation with disease incidence and yield in jute-rice-chickpea sequence.

MATERIALS AND METHODS

The field experiment was conducted from April 1998 to March 2000 at the Jaguli Farm (23° N, 89° E and 9.75 m AMSL) of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal in sandy clay loam Entisol, neutral in reaction (pH 7.4). The soil had 0.52% organic carbon, 0.065% total N and 16.8, 198 and 16.5 kg of P, K and S ha^{-1}, respectively. The experiment was laid out in randomised block design replicated thrice with three levels each of K and S in 5m x 4m plots. Three levels of K were 0 (K_0), 8 (K_1) and 16 (K_2) kg K ha^{-1} for jute; 0 (K_0), 12 (K_1) and 24 (K_2) kg K ha^{-1} for rice and 0 (K_0), 6 (K_1) and 12 (K_2) kg K ha^{-1} for chickpea. In respect to S, three levels were same *viz.* 0 (S_0), 20 (S_1) and 40 (S_2) kg S ha^{-1} were applied to all the three crops in sequence. Recommended doses of N (40, 100 and 20 kg N ha^{-1} for jute, rice and chickpea, respectively) and P (4.5, 10, 6.5 kg P for jute, rice and chickpea, respectively) were applied to all the crops. The crop cultivars were JRO-524 (jute), IET-4094 (rice) and B-108 (chickpea). Agronomic efficiency (units of crop produced per unit of nutrient added), Physiological efficiency (units of crop produced per unit nutrient absorbed by the plant) and Recovery fraction (units of nutrient absorbed per unit of nutrient added) was calculated.

RESULTS AND DISCUSSION

Agronomic Efficiency

The highest value (10.88) of agronomic efficiency (AE) irrespective of sulphur (S) doses was observed with medium level of K (K_1) treatment and the lowest AE (9.65) was noted with no K treatment (**Table 1**). The AE for applied S doses was not followed similar pattern as of K. The AE in respect to S was decreased gradually with increasing S doses from 0 to 40 kg ha^{-1}.

Physiological Efficiency

The physiological efficiency (PE) values were significantly differed with different doses of K and S (**Table 1**). The highest PE (12.92) was recorded with the lowest K dose which was at par with medium dose of K (K_1). In respect to S, the highest PE (12.88) was observed with 20 kg S ha^{-1}.

Regarding PE, similar trend was observed by Mondal and Chetri (1998) and Pradhan and Mondal (1997).

Recovery Fraction of Fertilizer

The highest recovery fraction (RF) value (0.85) in respect to K was recorded with medium dose of K (K_1) which was at par with the RF obtained from the highest dose of K (K_2). In respect to S doses, the highest RF (0.85) was calculated with no S application. The results are

Table 1: *Two way table showing agronomic efficiency (AE), physiological efficiency (PE) and recovery fraction (RF) of nutrients as affected by potassium and sulphur fertilization in jute-rice-chickpea sequence*

Treatments	Total Yield ($kgha^{-1}$)				Agronomic Efficiency				Physiological Efficiency				Recovery Fraction			
	S_0	S_1	S_2	Mean	S_0	S_1	S_2	Mean	S_0	S_1	S_2	Mean	S_0	S_1	S_2	Mean
K_0	5313	6158	6928	6133	10.22	9.62	9.12	9.65	12.95	12.81	12.99	12.92	0.79	0.75	0.70	0.75
K_1	7625	8198	9130	8318	11.73	10.65	10.26	10.88	13.17	12.62	12.68	12.82	0.89	0.84	0.81	0.85
K_2	8387	9354	9485	9075	10.75	10.39	9.30	10.15	12.25	13.22	11.25	12.24	0.88	0.79	0.81	0.83
Mean	7108	7903	8514		10.9	10.22	9.56	.	12.79	12.88	12.31		0.85	0.79	0.77	
C.D. at 5%	495.46				0.68				0.66				0.035			

in agreement with the findings of Pradhan and Mondal (1997) and Mondal and Chetri (1998).

Change of Soil Nutrient Status as Compared to the Initial Soil Test Values

The nutrient status (N, P, K and S) of soil after harvest of 6th crop in sequence was improved where balanced nutrition of N, P, K and S was given to all the crops (**Fig. 1**). The maximum improvement (+197, +14.6, +6.9 and +2.3 kg ha^{-1} of N, P, K and S) was observed in K_2S_2 treatment, where balanced nutrition in terms of N, P, K, and S were added to all the crops in sequence. It was closely followed by the improvement in soil nutrient status (+187, +13.5,

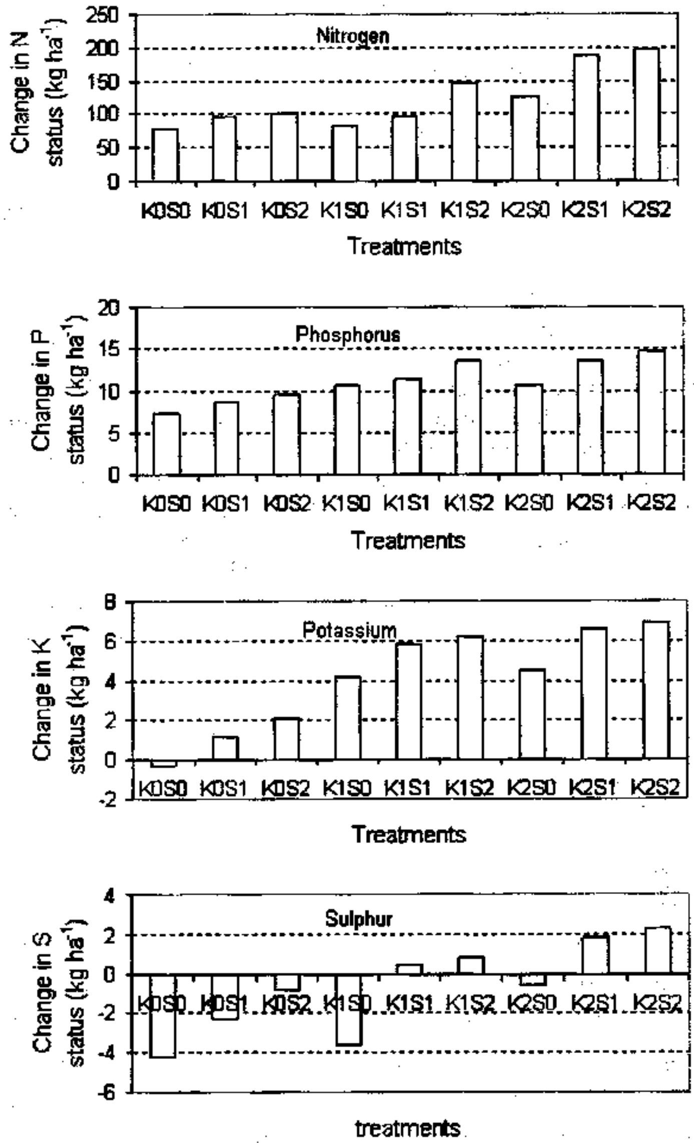

Fig. 1: *Change in soil nutrient status as compared to the initial values under jute-rice-chickpea sequence after harvest of 6th crop*

+6.6 and +1.8 kg ha^{-1} of N, P, K and S) obtained in K_2S_1. Sanyal *et al.* (1993) reported similar findings from an experiment conducted in the soil of lower gangetic alluvium. Brahmachari (1996) also reported that the maximum improvement in S status was noticed when all the crops in sequence were fertilized with elemental S along with N, P and K. Panda and Sahoo (1989) suggested application of S containing fertilizer to avoid depletion of the said nutrient from soil. Deletion of K fertilizer from the treatment caused imbalance and depletion of soil K status (-0.3) as compared to initial values. Similar observations have been reported by Jayaram *et al.* (1990).

Balance Sheet of Nitrogen and Potassium under Intensive Cropping

The maximum positive balance of N (444.2 kg ha^{-1}) was maintained by jute-rice-chickpea sequence, where all the crops were fertilized with higher doses of K and S (K_2S_2) in addition to N and P (**Table 2**). Further, the balance sheet for N recorded in K_2S_1 treatment was (+413.8 kg ha^{-1}), which was as good as the maximum N balance (444.2 kg ha^{-1}). The minimum N balance (52.8 kg ha^{-1}) was recorded when the crops were not treated with K and S (K_0S_0). In a similar finding, Pradhan and Mondal (1997) opined that the maximum N balance was maintained where the rice crop was grown after green manure crop along with N, P and K in rice-*lathyrus* (green manure)-rice-*dhaincha* (green manure) sequence. Brahmachari (1996) also observed that higher positive N balances were maintained when all the crops in sequence were fertilized with balanced nutrition of N, P, K and S.

The highest positive balance for K (+577.4 kg ha^{-1}) was maintained by jute-rice-chickpea sequence where all the crops were fertilized with K_1S_2 in addition to the recommended dose of N and P. Omission of K and S fertilizer from the sequence recorded the minimum (+427.3 kg ha^{-1}) K balance. Nambiar (1986) reported that application of K in optimal dose showed marginal build up of K in the alluvial soil.

Potassium Content in Plant and its Relation with Disease Incidence and Yield

Potassium content of all the crops in jute-rice-chickpea sequence showed negative correlation (r) with disease incidence (**Table 3**). The negative r values (between K content and diseased plant), -0.688, -0.882 and -0.929 were recorded in jute, rice and chickpea, respectively. In contrast, the K content of plants were positively correlated with the yield (r = 0.947,

Table 2: *Balance sheet of nitrogen and potassium after completion of two cropping cycles as affected by different fertilizer management in jute–rice-chickpea sequence.*

Treat-ments	Total N source	Nitrogen recovery (kg ha^{-1})			Nitrogen Balance (+)	Total K source	Potassium recovery (kg ha^{-1})			Potassium Balance (+)
		In soil	By crop	Total			in soil	by crop	total	
K_0 S_0	1563	1320	295.8	1615.8	52.8	198	197.7	427.6	625.3	427.3
K_0 S_1	1563	1340	345.6	1685.6	122.6	198	199.2	477.3	676.5	478.5
K_0 S_2	1563	1345	366.0	1711.0	148.0	198	200.1	526.9	727.0	529.0
K_1 S_0	1563	1325	406.0	1731.0	168.0	328	202.2	581.2	783.4	455.4
K_1 S_1	1563	1340	453.1	1793.1	230.1	328	203.8	634.3	838.1	510.1
K_1 S_2	1563	1390	475.6	1865.6	302.6	328	204.2	701.2	905.4	577.4
K_2 S_0	1563	1370	474.9	1844.9	281.9	458	202.5	679.8	882.3	424.3
K_2 S_1	1563	1430	546.8	1976.8	413.8	458	204.6	766.2	970.8	512.8
K_2 S_2	1563	1440	567.2	2007.2	444.2	458	204.9	790.4	995.3	537.3

Table 3: *Inter-relationship of potassium content of plant, yield and disease incidence in jute-rice-chickpea sequence*

Treatments	Jute			Rice			Chickpea		
	Yield (q ha^{-1})	K content (%)	Dead plant (%)	Yield (q ha^{-1})	K content (%)	Dead plant (%)	Yield (q ha^{-1})	K content (%)	% Disease index
K_0 S_0	18.20	0.43	3.90	28.80	1.22	33.50	6.13	1.63	12.80
K_0 S_1	21.48	0.45	0.95	32.10	1.23	32.15	8.00	2.05	12.40
K_0 S_2	26.25	0.47	0.75	33.70	1.22	31.95	9.33	2.15	10.30
K_1 S_0	33.05	0.51	1.75	36.55	1.43	30.65	6.65	1.85	9.70
K_1 S_1	34.70	0.54	0.65	38.50	1.43	28.15	8.78	2.33	8.60
K_1 S_2	35.25	0.57	0.10	43.00	1.37	26.75	13.05	2.63	6.50
K_2 S_0	33.20	0.56	1.60	43.30	1.39	27.20	7.37	2.28	8.20
K_2 S_1	36.75	0.59	0.35	46.21	1.49	24.65	10.58	2.91	5.30
K_2 S_2	36.95	0.60	0.10	44.05	1.52	24.10	13.85	3.05	5.20
Correlation coefficient	r = (+) 0.947 r = (–) 0.688			r = (+) 0.847 r = (–) 0.882			r = (+) 0.886 r = (–) 926		

0.847 and 0.886 for jute, rice and chickpea, respectively). This relationship clearly indicated that K fertilizer increased the K content of plant, which reduced the disease incidence and ultimately increased the yield of the crops. This view is in agreement with the findings of Mandal *et al.* (1970), Mondal *et al.* (1984) and Brahmachari (1996). Dey and Chattopadhyay (1992) reported that there was a gradual decline in the levels of stem rot infestation in jute when the rate of applied K was increased over a range of 0 to 42 kg K ha^{-1}.

Therefore, nutrition of K in higher doses (16, 24 and 12 kg K ha^{-1} for jute, rice and chickpea) along with 20 kg S ha^{-1} for all the three crops in sequence in addition to recommended doses of N and P are required for achieving higher fertilizer use efficiency, higher recovery fraction, positive nutrient balance, improvement in yield and reduction in disease incidence in jute-rice-chickpea sequence in the lower Gangetic plains of West Bengal.

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