Reprint **ISSN 1994-1978 (Web Version)**

Journal of Soil and Nature (JSN)

(*J. Soil Nature*)

Volume: 6 **Issue: 1** **March 2012**

J. Soil Nature 6(1):16-21(March 2012)

POTASSIUM BALANCE IN SOIL AS AFFECTED BY INTERCROPPING IN WHEAT

S. KHATUN, A.K. AZAD, P. BALA AND M.A. SADAT

An International Scientific Research Publisher

Green Global Foundation©

Publication and Bibliography Division

100 Leeward Glenway

Apartment # 1601

M3c2z1, Toronto, Canada

E-mails: publication@ggfagro.com, editor@ggfagro.com

http://ggfagro.com/ejournals/current issues

GGF

Nature is Power

JSN** issn 1994-1978, HQ:1-34 Central Place, Saskatoon, Saskatchewan, s7n 2s2, Canada

ISSN-1994-1978 (Online)
J. Soil Nature 6(1):16-21(March 2012)

POTASSIUM BALANCE IN SOIL AS AFFECTED BY INTERCROPPING IN WHEAT

S. KHATUN[1], A.K. AZAD[2], P. BALA[3] AND M.A. SADAT[4]

[1]Monitoring and Evaluation Officer, Department of Agricultural Extension, Dhaka Region, Dhaka, Bangladesh; [2]Assistant Professor, Agriculture, Mrigi Shaheed Dianot College,Kalukhali, Rajbari, Bangladesh; [3]Lecturer, Agriculture, Lalmia City College, Gopalgonj, Bangladesh, [4]Assistant Registrar, Hajee Mohammad Danesh Science & Technology University,Dinajpur, Bangladesh.

Corresponding author & address: Abul Kalam Azad, E-mail: kalam_rajbari@yahoo.com
Accepted for publication on 25 January 2012

ABSTRACT

Khatun S, Azad AK, Bala P, Sadat MA (2012) Potassium balance in soil as affected by intercropping in wheat. *J. Soil Nature* 6(1), 16-21.

A field experiment was conducted during November 2009 to April 2010 on intercropping of soybean, potato, lentil, mustard, cowpea, linseed and coriander with wheat crop at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to evaluate the soil potassium balance of different intercrop combinations compared to their respective sole cropping. The experiment was laid out in a randomized complete block design with seven intercrops and eight sole crops treatment combinations assigned in three replications. Depending on the yield level total K uptake ranged from 46.20 to 89.84 kg ha^{-1} in wheat sole and intercropping treatments. The balance of potassium was negative in wheat sole and all intercropping patterns. The highest negative balance of potassium was found (-13.24 kg ha^{-1}) in wheat + potato and the lowest negative value was found (-1.21 kg ha^{-1}) in wheat + lentil. The highest and lowest positive balances of potassium were found in potato sole (+29.32) and mustard sole (+ 0.24 kg ha^{-1}), respectively.

Key words: *potassium, wheat, intercropping*

INTRODUCTION

Two or more crops growing simultaneously in the same piece of land in the same piece of land in alternating rows or inset of rows are called intercropping. Intercropping has been recognized as a potential beneficial system of crop production and evidence suggests inter cropping can provide substantial yield advantage compared to sole cropping (Singh *et al.* 1992).

Fertilizer is one of the most important factors of increasing the productivity of crops. The farmers normally use recommended dose of' fertilizers for the intercropping systems. The fertility soil declines tremendously unless the adequate quantities of nutrients are added to soil and this is especially true for the intercropping practices. The fertilizer like potash has considerable residual effect for the subsequent crops if sufficient quantity is added. Potassium has been proved to be important in crop quality factors. It is needed in most crops when high yields, high fertilizer use efficiency and high profit are desired. Potassium has widely been demonstrated as an important plant nutrient for reducing the effects of' insects, diseases and natural stress for a wide variety of crops. In many instances, the presently recommended rates of K are too low to achieve high fertilizer use efficiency and high crop yields. In most cases, K mining occurs due to its insufficient supplementation based upon yield criteria. The relative amount of nutrient in the soil can affect the uptake of individual nutrients by the plants. A quantitative understanding of the potassium balance and soil potassium fertilizer supplying ability may provide information needed to develop improved potassium management strategies for optimizing yields and maintenance of the soil resource base in the context of. Intercropping practice where the recommended dose of potassium is used for the main crop. Therefore, the present study on intercropping of wheat and other seven crops was undertaken to observe the effect of potassium nutrient balance due to growing of different crops wheat as inter crops.

MATERIAL AND METHODS

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from November 2009 to April 2010. Seven types of crops having dissimilar growth habits were used in the experiment. The crops were wheat (*Triticum aestivum* var. Kanchan), potato (*Solanum tuberosum* var. Cardinal), lentil (*Lens culinaris* var. BARI Mashur 4), mustard (*Brassica juncea* var. Daulat), cowpea (*Vigna unguiculata* Var. BARI Felon-1), linseed (*Linum usitatissimum* var. Nila), coriander (*Coriandrum sativum* var. BARI Dhania-1) and soybean (*Glycine max* var. PB-1). Among them wheat was grown as the main crop and other as component or secondary crops. Seeds were collected from the Bangladesh Agricultural Research Institute (BARI), Gazipur.

Fifteen treatments included in the experiments were as follows:

I. Wheat + soybean
II. Wheat + potato
III. Wheat + lentil
IV. Wheat + mustard
V. Wheat + cowpea
VI. Wheat + linseed
VII. Wheat +coriander

VIII. Potato sole
IX. Lentil sole
X. Mustard sole
XI. Cowpea sole
XII. Linseed sole
XIII. Coriander sole
XIV. Soybean sole
XV. Wheat sole

The experiment was laid out in a randomized complete block design with three replications. The treatments were randomly assigned within each block. The size of unit plot was 4.0 m x 2.5 m and each plot was separated by 0.5 m wide bund. The blocks were separated by 1.0 m. There were 45 unit plots in the experiment. The land was first opened with two cross ploughing given by country plough. Weeds and stubbles were removed from the field and visible larger clods were broken into small pieces by using wooden hammer. The layout of the experiment in the field was done according to the experimental design adopted. The sole intercropped wheat was fertilized as per recommendation. The fertilizer doses (kg ha^{-1}) were as follows.

Crop	Cowdung	Urea	TSP	MP	Gypsum	Zinc oxide
Wheat	-	200	180	50	120	-
Potato	10,000	276	185	322	-	-
Lentil	-	45	85	35	-	5
soybean	-	60	175	120	100	-
Mustard	-	250	160	75	150	-
Cowpea	-	30	50	30	-	-
Linseed	-	75	120	50	-	-
Coriander	10,000	150	120	100	-	-
Soybean	-	60	175	120	100	-

One third of urea N and full doses of TSP, MP, Gypsum and ZnO were applied during final land preparation in sole and intercropped wheat treatments. The rest two-thirds of urea N were top dressed in two equal splits at 21 days after sowing (DAS) and 55 DAS.

In case of sole soybean and lentil, fertilizers were applied during final land preparation. On the other hand, half of urea and full doses of other fertilizers and manure were applied at the same time (final land preparation) in sole potato and the rest of urea N was top dressed at 50 DAS.

The seed rates and other cultural operations were done by the recommendation of BARI (2006). Thinning and weeding were done on 4 and 30 December 2009. Urea fertilizer was applied as top dressing on the dates previously mentioned. The experimental plots were irrigated properly. Potato and soybean were attacked by blight disease, soybean hairy caterpillar, aphid and pod borer insect, respectively. Dithane M-45, Dimecron-100 EC, Diazinon 60 EC and ripcord 50 EC were applied at proper rates to control them.

Crops were harvested after full maturity. After harvest, all crops except potato were sun dried for a few days and then threshed. Seeds were cleaned and sun dried, and weighed plot wise to record the seed yield.

Data of different yield contributing characters were compiled and appropriate statistical analysis was made following the ANOVA technique. The mean differences among the treatments were adjudged by the Duncan's New multiple Range Tests (Gomez and Gomez, 1984).

Soil Sample Collection:

Initial Soil samples were randomly collected from each plot at a depth of 0-15 cm before final land preparation. For post-harvest analysis, soil samples were also collected according to treatment. All these samples were air dried and sieved to remove undesired materials and then preserved in poly bags for future laboratory analysis.

Soil, grain and straw sample analysis

The soil, grain and straw samples were analyzed in the Department of Soil Science, Bangladesh Agricultural University, Mymensingh, Bangladesh by following the procedures described below.

Particle Size Analysis

Mechanical analysis of the samples was done by using Hydrometer Method (Black 1965), and Marshall's Triangular Co-ordinates of USDA system was used to determine textural class of the soil samples.

Soil pH

The samples were determined by using Glass Electrode pH Meter.

Organic matter

The organic carbon in the soil samples were determined by Wet Oxidation Method. Then the organic matter content of the soil samples was estimated by multiplying the %organic carbon with the van. Bemmelen factor 1.73 (Page *et al*. 1981).

Exchangeable Potassium

Using Flame Photometer, exchangeable was estimated on the normal ammonium acetate soil extract at pH 7.0 (Black 1965).

Bulk density

Bulk density was determined by the help of a Core Sampler made of metal cylinders of known volume. The soil samples were collected from each samplings site with the help of core samplers up 0 to 15 cm soil depth. Then the samples were dried at 105^0C in an oven until constant weights were attained. The oven dry weight of the soil samples of known volume were taken to calculate the Bulk density as follows:

Bulk density (D_b) = $\frac{Ws}{Vs} gcm^{-3}$

Where,

W_s = Oven dry weight of the soil

V_s= Volume of the including pore space in cm^3

Grain and straw analysis

Plant sample were analyzed for K contents. Grain and straw samples were dried in an oven and then ground in a grinding machine to pass through a 20 mesh sieve. The above ground plant materials (grain and straw) were stored in small paper bags and then analyzed. Potassium was measured from the digest by using Gallenkamp Flame Photometer.

Potassium uptake

The uptake of potassium nutrient was calculated from the yield and potassium concentrations of grain and straw.

Potassium balance sheet

The potassium balance sheet was worked out taking into account the available data relating to the inputs of potassium in soil plant system.
Input, output and balance sheet of potassium were calculated using the following formula.
Input of potassium = Initial potassium uptake by crop (kg ha^{-1}) + potassium in post harvest soil (kg ha^{-1})
Balance sheet = Input of potassium – Output of potassium.

Data analysis

Data of different yield contributing characters were complied and appropriate statistical analysis was made following the ANOVA technique. The mean differences among the treatments were adjudged by the Duncan’s New Multiple Ranges Test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Potassium balance

The present study was undertaken to evaluate the potassium balance resulted from intercropping of wheat with soybean, potato, lentil, mustard, linseed, coriander and cowpea. The results of this study have been presented in Tables 1 and 2, and discussed below.

Input of potassium

Input of potassium means initial potassium status in soil and added potassium through fertilizer. Initial potassium status of all plots was 81.08 kg ha^{-1}. The addition of potassium through fertilizer was 25 kg ha^{-1} in sole and intercropping of wheat. Application of potassium through fertilizer was 246.0, 17.5, 37.5, 15.0, 25.0, 135.0 and 60.0 kg ha^{-1} in potato, lentil, mustard, cowpea, and linseed coriander and soybean sole crop, respectively.

Output of potassium

Pattern of potassium uptake by crops

The pattern of potassium uptake by crops is presented in Tables 1 and 2. The potassium uptake was significantly influenced by all sole and intercropping treatments. The potassium uptake was higher (49.94 kg ha^{-1}) in wheat sole than intercropped with wheat due to higher yield and the lowest potassium uptake of wheat (24.66 kg ha^{-1}) was found in wheat + linseed than other intercropped wheat due to lower yield of wheat. This result was in partial agreement with that of Bharabwaj *et al*. (1994) who stated that the uptake of potassium by crops generally increased with the increase in crop yields.

Table 1. Potassium Balance sheet

Treatment	Input of potassium		Output of potassium				Potassium balance in soil (kg ha^{-1})
	Potassium added through fertilizer (kg ha^{-1})	Potassium status in soil (kg ha^{-1})	Potassium uptake by wheat (kg ha^{-1})	Potassium uptake by component crop (kg ha^{-1})	Total potassium uptake by crops (kg ha^{-1})	Status of potassium in post harvest soil (kg ha^{-1})	
Wheat + soybean	25	81.08	33.84	24.01	57.85f	50.44g	-2.21
Wheat + potato	25	81.08	36.46	53.38	89.84b	29.48i	-13.24
Wheat + lentil	25	81.08	38.30	18.93	57.23f	50.06g	-1.21
Wheat + mustard	25	81.08	26.54	29.61	56.15f	52.84g	-2.91
Wheat + cowpea	25	81.08	31.93	42.31	74.24d	36.85h	-5.01
Wheat + linseed	25	81.08	24.66	21.54	46.20h	61.55ef	-1.67
Wheat + coriander	25	81.08	31.75	37.87	69.62e	40.36h	-3.90
Wheat	25	81.08	49.94	-	49.94g	58.16f	-2.02
Potato	246	81.08	-	232.08	232.08a	65.68de	+29.32
Lentil	17.5	81.08	-	33.56	33.56k	68.53d	-3.51
Mustard	37.5	81.08	-	41.36	41.36i	77.46c	+024
Cowpea	15	81.08	-	76.03	76.03d	30.26i	-10.21
Linseed	25	81.08	-	37.53	37.53j	67.44d	+1.11
Coriander	135	81.08	-	82.65	82.65c	105.20a	+28.23
Soybean	60	81.08	-	41.73	41.73i	87.63b	+11.72
$S_{\bar{x}}$	-		-	-	1.259	1.546	-
CV (%)	-		-	-	3.13	4.56	-
Level of significance	-		-	-	0.01	0.01	-

The figures having common letter(s) in a column are not significantly different as per DMRT

Table 2. Effect of intercropping of wheat on the potassium (K^+), pH and organic matter contents of post harvest and initial soil

Treatment	Soil characteristics		
	K^+ (me/100g)	pH	Organic matter (%)
Wheat + soybean	0.061g	7.340ef	1.50c
Wheat + potato	0.036i	7.410abc	1.26h
Wheat + lentil	0.061g	7.400abcd	1.48c
Wheat + mustard	0.064g	7.407abc	1.31g
Wheat + cowpea	0.045h	7.437a	1.53b
Wheat + linseed	0.075ef	7.377cde	1.27h
Wheat + coriander	0.049h	7.320fg	1.28h
Wheat	0.071f	7.270h	1.35e
Potato	0.080de	7.260h	1.40d
Lentil	0.084d	7.390bcd	1.53b
Mustard	0.094c	7.400abcd	1.34ef
Cowpea	0.037i	7.430ab	1.58a
Linseed	0.082d	7.360de	1.32fg
Coriander	0.128a	7.380cde	1.39d
Soybean	0.107b	7.287gh	1.60a
Initial soil	0.099bc	7.250h	1.41d
Sx	0.009	0.012	0.009
CV (%)	1.69	0.30	1.17
Level of significance	0.01	0.01	0.01

The figures having common letter(s) in a column are not significantly different as per DMRT

The total highest potassium uptake was 232.08 kg ha^{-1} in potato sole crop than any sole or intercropping combination due to high amount of potassium fertilizer (246 kg ha^{-1} from MP and cowdung) and higher potato yield. This result was in partial agreement with that of Das (1997). He found that potassium uptake of wheat generally increased with potassium application rate. The total lowest potassium uptake was 33.56 kg ha^{-1} in lentil sole crop than other crops due to application of lower amount of potassium fertilizer (25 kg K ha^{-1} from MP) and lower yield of lentil.

Among the intercropping treatments, the highest total potassium uptake (89.94 kg ha^{-1}) was found in wheat + potato intercropping treatment due to higher combined yield (wheat + potato intercropped). The lower potassium uptake (46.20 kg ha^{-1}) was found in wheat + lentil than other intercropping combination.

Status of potassium in post harvest soil

The status of potassium in post harvest soil is presented in Table 1. The status of potassium in post harvest soil differed significantly due to intercropping. The higher potassium of post harvest soil was found (61.55 kg ha^{-1}) in wheat + linseed intercropping treatment than other intercropped with wheat due to low potassium uptake and low yield of wheat + linseed intercropping combination. The lowest potassium of post harvest soil was found (29.48 kg ha^{-1}) in wheat + potato intercropping system than other intercropping treatments due to higher potassium and higher yield of wheat + potato (Table 1). Among the sole and intercropping treatments the highest potassium in post harvest soil (105.20 kg ha^{-1}) was found in coriander sole which was statistically different due to application of cowdung and higher rate of K fertilizer, and the lowest potassium was found (29.48 kg ha^{-1}) in wheat + potato which was statistically similar to cowpea sole (30.26 kg ha^{-1}).

Apparent potassium balance

The apparent balance of potassium in sole and intercropping are presented in Table 1. The negative balance of potassium indicated that the output was larger in quantity than input. The output of potassium was more than input of potassium in all sole and intercropping, except sole crops of potato, mustard, linseed, coriander and soybean.

The apparent balance of potassium was negative wheat sole and all wheat intercropping patterns. The highest negative balance (-13.24 kg ha^{-1}) was found in wheat + potato intercropping. This result is supported by Roy and Srivastava (1996). They found that the potassium balance was negative in wheat + potato intercropping pattern. The lowest negative balance of potassium (-1.21 kg ha^{-1}) was found in intercropped of wheat + lentil pattern. The addition of potassium to soil would depend on irrigation, fixed-K exchanged to available K and precipitation.

The positive balance of potassium indicated that the input was large in quantities than output. The highest positive balance of potassium (+29.32 kg ha^{-1}) was found in sole crop of potato, whereas the lowest positive balances of potassium (+0.24 kg ha^{-1}) was found in sole crop of mustard. The depletion of potassium from the soil depends on what part of the plant was harvested and what amount of the leaching loss and fixation of potassium was occurred in the soil.

From the above stated results, it was observed that the grain yield of wheat was significantly affected due to intercropping. Sole wheat produced the highest grain yield which was supported by yield contributing characters of the crops. Intercropping decreased the yield of both main and companion crops compared to their respective sole crops probably due competition for light, space, water, nutrients and other growth resources but the total productivity was higher in all intercropping treatments.

The potassium uptake was significantly influenced by intercropping treatments. The balance of potassium needs to be improved through adopting potassium management strategies for optimizing yields and maintenance of the soil resource base in long run.

CONCLUSION

The total potassium uptake of different crops was significantly affected by different intercropping treatments. The total highest potassium uptake was 232.08 kg ha^{-1} in potato sole crop than all sole and intercropping combination due to high amount of potassium fertilizer (246 kg ha^{-1} K for MP and cowdung) and higher potato yield. The total lowest potassium uptake was 33.56 kg ha^{-1} in lentil sole crop than other crops due to application of lower amount of potassium fertilizer and lower yield of lentil. The potassium uptake was higher (49.94 kg ha^{-1}) in wheat sole than in intercropped with wheat due to higher yield and the lower potassium uptake of wheat (24.66 kg ha^{-1}) was found in wheat + linseed than other intercropped wheat due to lower yield of wheat. The output of potassium was more than input of potassium in all sole and intercropping patterns, except sole crops of potato, mustard, linseed coriander and soybean. The balance of potassium was negative in wheat sole and all wheat intercropping system. The highest negative balance (-13.24 kg ha^{-1}) was found in wheat + potato and the lowest negative balance of potassium (-1.21 kg ha^{-1}) was found in intercropped of wheat + lentil pattern. The highest positive balance of potassium (+29.32 kg ha^{-1}) was found in sole crop of potato, whereas the lowest positive balance of potassium (+0.24 kg ha^{-1}) was found in sole crop of mustard. Therefore, the balance of potassium was negative in wheat sole and wheat intercropping patterns. The issue of negative balance of potassium with its recommended dose needs to be addressed properly to overcome this problem.

REFERENCES

BARI (2006) Krishi Projukti Hatboi (In Bangla). Bangladesh Agricultural Research Institute, Gazipur, Bangldesh. pp. 55-150.

Bharabwaj V, Omanwar PK, Sharma RA, Vishwanath (1994) Long term effects of continuous rotational cropping and fertilization on crop yields and soil properties. 1. Effects on crop yield and nutrient uptake. *J. Indian Soc. Soil. Sci.* 42(2), 247-253.

Black CA (1965) Methods of Soil Analysis. Part I and II, Amer. Soc. Agron. Inc. Publisher, Madison Wisconsin, USA. pp. 545-567.

Das JC (1997) Influence of seed hardening and potassium fertilizer on plant water status and nutrient uptake of rainfed wheat. Ann. Agril. Res. 18(3), 277-280.

Gomez KA, Gomez AA (1984) Stasistical Procedures for Agricultural Research (2nd ed). A Wiley Inter-science Publication, John Wiley and Sons, New York. pp680-685.

Page AL, Miller RH, Keeney DR (1981) Methods of Soil Analysis. Part II. Amer. Soc. Agron. Madison. USA. pp. 539-622.

Roy K, Srivastava VC (1996) Effect of potassium on potato + wheat intercropping system. *J. Potassium Res.* 12(2), 169-173.

Singh SB, Singh BN, Maura ML (1992) Comparative Performance of mixed and intercropping systems with different winter crops under dry land conditions. *Indian J. Agron*. 37(1), 40-43.