▼ Journal of Research (Science), Bahauddin Zakariya University, Multan, Pakistan.
Vol.14, No.2, December 2003, pp. 247-252 ISSN 1021-1012

POST HARVEST FERTILITY STATUS OF SOME COTTON BASED LEGUMINOUS AND NON-LEGUMINOUS INTERCROPPING SYSTEMS

Muhammad Bismillah Khan[1] and Abdul Khaliq[2]
[1]Department of Agronomy, Bahauddin Zakariya University, Multan-60800, Pakistan. [2]Department of Agronomy, University of Agriculture, Faisalabad-38040, Pakistan.

Abstract: Residual effect of different leguminous and non-leguminous intercropping systems on cotton planted in two planting patterns was studied at Agronomic Research Area, University of Agriculture, Faisalabad under irrigated conditions of Central Punjab. Soil samples were collected from 0-15 cm and 15-30 cm depths before planting and after harvesting of each crop, each year to evaluate the impact of leguminous and non-leguminous crops included in this study. Experiment was laid out in randomized complete block design (R.C.B.D.) with split arrangement and four replications. Patterns were randomized in main plots and intercrops in sub plots. Plot size was 4.8 m x 7 m. All the intercrops produced substantially smaller yields when grown in association with cotton in either planting pattern compared to their sole crop yields. Residual nitrogen was improved in leguminous intercropping systems as compared to cotton alone as well non-legume intercropping systems. Similarly organic matter was also improved in all intercropping treatments, and maximum increase was recorded due to cowpeas. Phosphorus was depleted in all intercropping systems during both years under study as well as in relation to cotton alone. The same trend (depletion) was also observed in case of residual soil Potassium.

Keywords: Cotton, intercropping systems, N, P, K, organic matter, planting patterns, residual fertility.

INTRODUCTION

Pakistan is an important country of South Asia. Agriculture is the mainstay of its economy, contributing 24.50 % to GDP and cotton is the most important cash crop of Pakistan. It accounts for about 58.70 % of the total export earning and over 57.43 % of the domestic edible oil production [Govt. of Pakistan 2003]. However, Pakistan is still deficient in edible oil, wheat grain and pulses. Thus domestic demand is partially met by importing these food items. Such situation demands a simultaneous increase in the productivity of cotton, edible oilseeds, wheat grain, pulses and fodders to fulfill the increasing diversified needs of the ever growing population.

In the present scenario of preponderance of small landholdings, surplus farm family labor, overlapping of growing seasons of crops, low productivity of most of the crops and practice of subsistence farming, inter/relay cropping seems to be a promising strategy for increasing crop productivity particularly at small farms of Pakistan.

Total crop productivity and net return per unit area [Saeed *et al.* 1999] as well as land equivalent ratio are higher in intercropping than sole cropping [Rao 1991]. But magnitude of such agro-economic advantages depends upon the type of intercrop. To permit convenient intercropping in cotton, recently a new pattern of cotton plantation in widely spaced multi-row strips has been developed which not only gives seed cotton yields compatible with that of the conventional single-row plantation but also facilitates intercropping [Deshpande *et al.* 1989]. However, details of different aspects of intercropping in cotton at various patterns of cotton plantation need to be explored in order to make the cotton-based intercropping system more feasible, productive and economical.

The objectives of this study were to compare the single-row and strip plantation of cotton in order to find out a planting pattern of cotton, facilitating intercropping without affecting the productivity of cotton at large and to evaluate the impacts of different cotton-based intercropping systems on residual soil fertility.

MATERIALS AND METHODS

The experiments were conducted at Agronomic Research Area, University of Agriculture, Faisalabad (Pakistan) during 1996-97 and 1997-98. Cotton was sown in two planting patterns i.e. 80-cm spaced single rows and 120-cm spaced 2-row strips (40/120 cm). Experiment was laid out in randomized complete block design (R.C.B.D.) with split arrangement and four replications. Patterns were randomized in main plots and intercrops in subplots. Plot size was 4.8 m x 7 m. This site is located at latitude 31^0 $26^/$ N and longitude 73^0 $6^/$ E [Oxford Atlas for Pakistan 2000]. The research was conducted under irrigated conditions on soil series known as Hafizabad. It consists of very deep, well-drained medium textured soils, developed in mixed calcareous, medium textured (low in silt) alluvium. It occurs in arid and semi arid subtropical continental climates [Government of Pakistan 1976].

Table 1: Physico-chemical analysis of the experimental site (soil).

	Units	Soil depth (cm)	
		0-15	15-30
Chemical characteristics			
pH	1:1	7.80	7.90
EC	dS m^{-1}	2.18	2.19
Available N	%	0.04	0.41
Available P	Ppm	7.60	7.70
Available K	Ppm	127.00	133.00
Physical characteristics			
Clay	%	21.0	19.0
Sand	%	64.5	65.5
Silt	%	14.5	15.5
Texture		Sandy clay loam	

The soil of the experimental site was analyzed for physico-chemical characteristics. For this purpose composite soil samples were collected from experimental plots from a depth of 15 and 15-30 cm. Details of the soil analysis are given in Table 1. The analysis revealed that soil was low in organic matter, phosphorus and nitrogen. However, the potash level in the soil was found to be adequate. The pH was 7.7 and textural class was clay loam. All crops included in this study were sown according to the experimental design and cropping systems. Agronomic practices followed were as follows:

The field was ploughed 3 times, followed by planking. Thereafter the field was irrigated and at the proper moisture conditions a fine seedbed was prepared by a cultivator followed by planking. It is important to mention that once the land was prepared for main crop sowing, it was also subsequently used for intercrops. Cotton cultivar NIAB 78 was sown in 80-cm spaced single rows and 120-cm spaced 2-row strips with the help of single row cotton drill on May 27 and 29 during *kharif* 1996 and 1997, respectively. A seed rate of 20 kg ha^{-1} was used. The crop was thinned at the 4-8 leaf stage for maintaining recommended plant stand and a plant to plant distance of 20 cm. Nitrogen (N) and phosphors (P_2O_5) were applied at a dose of 110:58 kg ha^{-1} by band placement at sowing time. During both years agronomic practices were kept uniform for planting cotton.

Mungbean (*Vigna radiata L.*) cv. NM 121, mashbean (*Vigna mungo L.*) cv. mash 88, soybean (*Glycine max (L.) Merr.*) cv. NARC 1, sesam (*Sesamum indicum L.*) cv. Punjab til-90, maize (*Zea mays L.*) cv. Neelum, sorghum (*Sorghum vulgare L.*) cv. BR-319, cowpeas (*Vigna unguiculata*) cv. P 76 and ricebean (*Vigna umbellata*) cv. IC 7588 were sown as intercrops in cotton. All the cultural practices were kept uniform during both of the years under study. It is important to mention that cottonseed was delinted by using commercial H_2SO_4 @ 1kg per 10 kg of seed. Soybean seed was inoculated with *Rhizobium japonicum* as per recommended dose and methodology. Weeds were controlled manually in all treatments. Fodder crops were harvested within 40-50 days after planting. Two cotton pickings were done each year. Each grain crop was harvested at physiological maturity. Grain crops were sun dried and threshed manually.

Soil samples were collected at pre-planting and post harvesting stages each year. Data were collected on agro-economic aspects to evaluate the performance of different cotton-based intercropping systems under irrigated conditions of Faisalabad.

RESULTS AND DISCUSSION

This is inferred from the data (Table 2) that even short term intercropping in cotton has a profound effect on the residual soil fertility. Growing of all the intercrops in cotton improved the organic matter content in the soil especially where legumes were intercropped [Asim 1998]. Maximum improvement occurred due to the ricebean (9.64%) followed by cowpeas (8.6%), soybean (6.17%), mungbean (4.82%) and mashbean (3.61%) [Ahmad *et al.* 1993]. There was also a slight addition of organic matter due to the non-legume. However, it slightly declined due to cotton alone. Slight addition of organic matter due to a non-legume is attributed to incorporation of roots and other crop residues. This improvement in organic matter also occurred in 1997-98 over 1996-97 in all intercropping systems with the maximum being due to cowpeas. Ricebean and soybean followed the order (Table 2). All intercropping increased organic matter content over cotton alone (Table 3). Maximum addition occurred due to ricebean (16.9%) followed by cowpeas (16%), soybean, mungbean (7.4%) mashbean (6.2%). There was also addition by non-legumes but comparatively less compared to the legume intercropping [Koraddi *et al.* 1990].

Table 2: Post-harvest fertility status of different cotton based leguminous/non-leguminous intercropping systems.

	1996-97				1997-98			
Intercropping systems	N (%)	P (ppm)	K (ppm)	Organic matter (%)	N (%)	P (ppm)	K (ppm)	Organic matter (%)
Cotton alone	0.038 (-5.0)	5.67 (+1.25)	127 (-2.31)	0.81 (-2.4)	0.037 (-2.63)	5.73 (+1.1)	120 (-5.57)	0.83 (+2.5)
Cotton + Mungbean	0.041 (+2.5)	4.67 (-16.6)	119 (-8.5)	0.87 (+4.82)	0.042 (+2.4)	4.84 (+3.64)	115 (-3.4)	0.89 (+2.3)
Cotton + Mashbean	0.041 (+2.5)	4.68 (-16.4)	115 (-11.5)	0.86 (+3.61)	0.042 (+2.4)	4.87 (+4.1)	113 (-1.74)	0.88 (+2.33)
Cotton + Sesame	0.038 (0)	4.6 (-17.9)	119 (-8.5)	0.84 (+1.2)	0.037 (-2.63)	4.82 (+4.78)	109 (-8.4)	0.85 (+1.19)
Cotton + Ricebean	0.04 (2.5)	5.38 (-3.93)	125 (-3.85)	0.91 (+9.64)	0.04 (0)	4.41 (-6.17)	118 (-5.6)	0.97 (+6.9)
Cotton + Maize	0.036 (-10)	4.78 (-14.0)	126 (-3.08)	0.85 (+2.41)	0.037 (+2.8)	5.0 (+4.6)	118 (6.35)	0.88 (+5.53)
Cotton + Sorghum	0.036 (-10)	4.83 (-13.8)	126 (-3.08)	0.86 (+3.61)	0.035 (-2.8)	5.1 (+5.6)	120 (-3.23)	0.87 (+1.16)
Cotton + Cowpeas	0.041 (+2.5)	5.35 (-4.5)	119 (-8.5)	0.88 (+6.17)	0.042 (+5)	5.35 (0)	116 (-2.52)	0.95 (+7.95)
Cotton + Soybean	0.041 (2.5)	4.7 (-16)	120 (-7.7)	0.91 (+9.64)	0.042 (+5)	3.94 (-6.2)	117 (2.5)	0.90 (+4.65)

Original values (O.V.) of N, P, K and organic matter are 0.04, 5.6, 130, 0.83 for 1996-97 and O. Vs. for 1997-98 are post-harvest values of 1996-97. The % increase (+) decrease (-) over original values.

N fertility generally declined especially in non-legumes. However, a slight improvement occurred in it under legume intercropped into cotton (Table 3). Improvement of nitrogen contents due to inclusion of leguminous crops in cropping systems is well documented [Agboola and Fayemi 1972, Legard and Steel 1992]. The N fertility decreased slightly in 1997-98 over 1996-97 especially in cotton and non-legume intercrops, with maximum decrease in sorghum fodder 2.8% followed by sesame and cotton alone. It improved in 1997-98 over 1996-97 under legume intercropping with maximum increase being observed in soybean and cowpeas. Under different cropping systems it improved over cotton except sorghum and maize, where it dropped to 5.3%.

However, maximum improvement recorded was due to mungbean/ mashbean followed by ricebean ~ cowpeas ~ soybean [Ishizuka 1992]. It improved during the second year over cotton alone especially in soybean, mungbean and mashbean (14.5%). With sorghum it declined by 8.4% but remained unaffected due to maize and sesame.

Table 3: Post-harvest fertility status of different cotton based leguminous/non-leguminous intercropping systems with respect to cotton alone.

	1996-97				1997-98			
Intercropping systems	N (%)	P (ppm)	K (ppm)	Organic matter (%)	N (%)	P (ppm)	K (ppm)	Organic matter (%)
Cotton alone	0.038 (0.0)	5.67 (.0.0)	127 (0.0)	0.81 (0.0)	0.037 (0.0)	5.73 (0.0)	120 (0.0)	0.83 (0.0)
Cotton + Mungbean	0.041 (+7.89)	4.67 (-17.6)	119 (-6.3)	0.87 (+7.4)	0.042 (+13.5)	4.84 (-15.5)	115 (-4.7)	0.89 (+7.2)
Cotton + Mashbean	0.041 (+7.89)	4.68 (-17.5)	115 (-9.45)	0.86 (+6.2)	0.042 (+13.5)	4.87 (-15)	113 (-5.8)	0.88 (+6.0)
Cotton + Sesame	0.038 (0.0)	4.6 (-18.9)	119 (-6.3)	0.84 (+3.7)	0.037 (0.0)	4.82 (-15.9)	109 (-9.2)	0.85 (+2.4)
Cotton + Ricebean	0.04 (+5.3)	5.38 (-3.9)	125 (-1.57)	0.91 (+12.3)	0.04 (+8.1)	5.59 (-2.4)	118 (-1.7)	0.97 (+16.9)
Cotton + Maize	0.036 (-5.3)	4.78 (-15.7)	126 (-0.79)	0.85 (+4.94)	0.037 (0.0)	5.0 (-12.8)	118 (-1.7)	0.88 (+6.0)
Cotton + Sorghum	0.036 (-5.3)	4.83 (-14.8)	126 (-0.79)-	0.86 (+6.17)	0.035 (-5.4)	5.10 (-11)	120 (0.0)	0.87 (+4.82)
Cotton + Cowpeas	0.04 (+5.3)	5.35 (-5.64)	119 (-6.3)	0.88 (8.6)	0.042 (+13.5)	5.35 (-6.6)	116 (-3.3)	0.95 (+14.5)
Cotton + Soybean	0.04 (+5.3)	4.7 (-17.1)	120 (-5.5)	0.86 (+6.2)	0.042 (+13.5)	4.41 (-23)	117 (-2.5)	0.90 (+8.43)

Original values (O.V.) of N, P, K and organic matter are 0.04, 5.6, 130, 0.83 for 1996-97 and O. Vs. for 1997-98 are post-harvest values of 1996-97. The % increase (+) decrease (-) over original values.

Residual phosphorus (P_2O_5) fertility declined in all the intercropping systems except cotton alone. Maximum reduction occurred due to sesame (17.9%) followed by mungbean ~ mashbean (16.6, 16.4%) and soybean (16%). This greater depletion in legumes indicates their greater requirement of P_2O_5 [Koraddi *et al.* 1990]. An improvement in P_2O_5 fertility was observed during second year of the study with the exception of soybean (Table 2). This slight addition of P_2O_5 is attributed to addition of P_2O_5 during the second year by the different intercrops. With respect to cotton alone P_2O_5 was decreased in all the intercropping systems [Ahmad *et al.* 2001] and also during the next year of the study (Table 3).

Potassium (K) depletion occurred in all the intercropping systems (Table 2). It further declined during the second year of study. When the depletion was compared to removal by cotton alone, maximum depletion was recorded due to mungbean [Ahmad *et al.* 2001] followed by mashbean ~ mungbean ~ sesame and soybean (Table 3).

CONCLUSION

Residual N was improved in leguminous intercropping systems as compared to cotton alone as well non-legume intercropping systems. Similarly organic matter was also improved in all intercropping treatments, and maximum increase was recorded due to cowpeas. P was depleted in all intercropping systems during both years under study as well as in relation to cotton alone. The same trend (depletion) was also observed in the case of residual soil K.

References

Agboola, A.A. and Fayemi, A.A. (**1972**) "Fixation and extraction of N by tropical legumes", *Argon. J.*, 64, 409-412.

Ahmad, R., Anwer, M.A., Nazir, M.S. and Mahmood, T. (**1993**) "Agronomic studies on mash-soybean intercropping systems", *Pak. J. Agric. Res.*, 14(4), 304-308.

Ahmad, Z., Akram, M., Mian, S.M. and Gill, K.H. (**2001**) "Crop response to applied Potassium by soil texture, clay type and soil test Potassium", *Pak. J. Soil Sci.*, 19 (1-2), 77-80.

Ahmad, Z., Gill, M.A., Qureshi, R.H., Aslam, M.A. and Rehman, H. (**2001**) "Phosphorus Acquisition by cotton cultivars under deficiently-buffered-P conditions", *Pak. J. Soil Sci.*, 19(1-2), 63-70.

Asim, M. (**1998**) "Bio-economic efficiency of diverse cotton-based intercroping systems at different geometric configurations", M. Sc. (Hons) Agric. Thesis, Department of Agronomy, University of Agriculture, Faisalabad, Pakistan.

Deshpande, R.M., Kharche, S.G. and Rawankar, H.N. (**1989**) "Studies on intercropping with legumes in relation to planting pattern of hybrid cotton", *PKV Res. J.*, 13, 100-104.

Govt. of Pakistan (**1976**) "Soil Survey of Pakistan", pp. 80-83.

Govt. of Pakistan (**2003**) "Economic Survey of Pakistan", Govt. of Pakistan, Ministry of Food, Agriculture and Livestock, Islamabad.

Ishizuka, I. (**1992**) "Biological Nitrogen Fixation For Sustainable Agriculture", Kluwer Academic Publishers, Netherlands.

Koraddi, V.R., Rao, G.G., Guggari, A.K. and Kamath, K.S. (**1990**) "Overlapping versus simultaneous planting of intercrops in cotton", *Karnataka J. Agric. Sci.*, 3, 189-194.

Legard, S.F., Steel, K.W. (**1992**) "Biological N Fixation For Sustainable Agriculture", Kluwer Academic Publishers, Netherlands, pp. 137-153.

Oxford University (**2000**) "Oxford Atlas of Pakistan", Oxford University Press, Karachi, Pakistan.

Rao, V.P. (**1991**) "A study on intercropping of cotton with grain legumes under rainfed conditions", *J. Res. APAU*, 19, 73-74.

Saeed, M., Shahid, R.M., Jabbar, A., Ullah, E., Khan, M.B. (**1999**) "Agro-economic assessment of different cotton-based inter/relay cropping systems in two geometrical patterns", *Internat. J. Agric. and Biol.*, 4(1), 234-237.