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EFFECT OF DIFFERENT CROPPING SEQUENCES OF N UPTAKE AND PRODUCTIVITY OF SUCCEEDING WHEAT CROP*

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Residual effects of six cropping sequences including various legumes were examined with respect to N uptake and productivity of succeeding wheat crop. The results showed that all the preceding treatments except soybean (*Glycine max*) stimulated and enhanced the productivity of subsequent wheat crop significantly as compared to preceding cotton crop. Among various preceding treatments green manure with clusterbean (*Cyamopsis tetragonolobus*) was more potent in improving grain yield and N uptake followed by fallow and pigeon pea (*Cajanus cajon*), respectively.

Key words: Residual effects, *Cyamopsis tetragonolobus, Cajanus cajon, Glycine max,* Fallow, *Triticum estivum.*

INTRODUCTION

The soils of Pakistan are generally deficient in nitrogen and organic matter. Moreover, recent increase in the cost of commercial fertilizers in response to the acute oil crisis have caused a decline in N application rates to several crops [1, 2]. This shift may eventually result in lower crop yields. There is extensive evidence to indicate that legumes incorporated in a cropping sequence increases soil fertility, particularly soil N content [3, 4] and consequently the productivity of succeeding cereal crops [5-9]. Quantitative data on the contribution of various leguminous crops to succeeding cereals are meagre. The present investigations were, therefore, undertaken to evaluate the performance of different cropping sequences including leguminous and non leguminous crops on the productivity of a succeeding wheat crop.

MATERIALS AND METHODS

A field experiment was conducted at the experimental farm of Atomic Energy Agricultural Research Centre, Tandojam during 1984-85 on a sandy clay loam soil containing 0.033% N; 0.69% organic matter, 9.4 and 330 ppm available P (Olsen's method) and K (1N NH_4OAc extractable), respectively; and a pH of 7.4 in top 20cm of soil. The treatments comprised of six rotations *viz.* cotton-wheat, fallow-wheat, cotton plus soybean-wheat, clusterbean (*Cyamopsis tetragonolobus*)-wheat, soybean (*Glycine max*)-wheat and pigeonpea (*Cajanus cajon*)-wheat. The design of the experiment was a randomized complete block with 4 replications, using plots of 9x10m in size. Among summer crops, cotton received 75 kg N and 50 kg P_2O_5/ha as urea and single super phosphate, respectively. Legumes like pigeonpea and soybean (cv. Bragg) received 30 kg N and 60 kg P_2O_5/ha. Clusterbean was fertilized at the rate of 20 kg N and 60 kg P_2O_5/ha and ploughed into the soil on 25.6.1984 at peak flowering stage. The fallow (no crop) treatment was kept free of weeds throughout the growing season by hand hoeing. The legumes incorporated in cropping sequence were grown without any inoculation. After harvest of the summer crops, all above ground residues of the preceding crops were removed. The land was properly prepared and seeded to wheat as a second crop of the sequence on 4.12.1984. A recommended dose of 120 kg N and 60 kg P_2O_5/ha was applied to all the treatments uniformly. Grain and straw samples were obtained at maturity and analysed for total N content using micro kjeldahl method. The data regarding dry matter, grain and straw yields, N content and total N uptake by wheat were analysed statistically using Duncan's multiple range test.

RESULTS AND DISCUSSION

Studies on summer crops. The growth of summer crops was normal (Table 1) with pigeonpea producing significantly highest dry matter yield (14382 kg/ha) followed by sole cotton (10514 kg) and cotton + soybean (9981 kg). The differences between the N uptake of various crops was statistically non significant. Intercropping of coton and soybean produced higher N yield (133.49 kg/ha) than cotton alone (120.23 kg). The sequence of different crops with regards to total N uptake was pigeonpea (184.95 kg/ha), soybean (163.75 kg), cotton + soybean (133.49 kg), cotton (120.23 kg) and clusterbean (88.72 kg).

Effect of preceding crops on wheat. The data regarding of residual N left over by grain legumes (soybean and pigeonpea), green manuring of clusterbean and fallow treatments on subsequent wheat crop have been presented in Table 2. The results indicated that all previous treatments

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except soybean when grown alone or in combination with cotton on alternate rows influenced the dry matter yield of wheat significantly ($P<0.05$) as compared with cotton alone. The greatest increase occurred after fallow (44%) which was closely followed by plowdown clusterbean (42%) and pigeonpea (20%) respectively (not shown in table).

Table 1. Dry matter yield and N uptake in summer crops.

Crop system	Dry matter yield (kg/ha)	N yield (kg/ha)
		n.s.*
Cotton	10514 b	120.23
Cotton + soybean	9981 b	133.49
Cluster bean	3750 c	88.72
Soybean	7780 b	163.75
Cajanus cajon	14382 a	184.95

Means followed by same letter are statistically non significant at 5% level of DMRT.
* n.s. = non sitgnificant.

Table 2. Yield and harvest index of wheat as affected by preceding crops.

Preceding crops	Dry matter yield (kg/ha)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (kg/ha)
				n.s.*
Cotton	4625 b	1365 c	3260 b	0.30
Fallow	6639 a	2139 a	4500 a	0.32
Cotton + soybean	4736 b	1596 bc	3141 b	0.34
Clusterbean (plowdown)	6556 a	2206 a	4350 a	0.34
Soybean	4834 b	1613 bc	3221 b	0.33
Pigeonpea	5528 ab	1875 ab	3653 ab	0.34

Mean values followed by same letter are statistically non significant at 5% level of Duncan's multiple range test.
*n.s. = non significant

Grain and straw yields (Table 2) were also influenced considerably by the preceding crops. Among different treatments highest grain yield of wheat was recorded after plowdown clusterbean (2206 kg/ha) which was similar to fallow treatment (2139 kg/ha). Wheat grown after pigeonpea also produced significantly higher grain yield of 1875 kg/ha as compared to a preceding crop of cotton (1365 kg/ha). Marginal increase in grain yield was also noted after soybean, but it was statistically similar to that obtained after cotton alone (check plot).

Non significant yield differences between plowdown clusterbean and fallow treatment corresponds with the findings of Reddy *et. al.* [2], who reported that rye grass grown after green manuring of summer legumes like mungbean, pigeonpea, and velvetbean produced statistically similar yield to that planted in summer fallow treatment. The higher wheat yield after pigeonpea suggests that there was sufficient residual N in the soil which influenced the yield of subsequent wheat crop. Similar results have also been reported by Giri and De [8] where yields of pearl millet were significantly increasd when grown after various legumes including pigeonpea. Nitrogen contribution from legumes to succeeding cereals varies directly with the amount of N fixed and inversly with the N harvest indices. Soybean fixes lower quantities of N than either pigeonpea or clusterbean [10-14] and is less likely to contribute significantly N even to a soil low in N because of its higher N harvest index [15]. Comparatively low yield advantage after soybean in our study may probably be due to the aforesaid reasons. The relations between grain yield to dry matter yield has been referred to as harvest index [16, 17] and is a good indicator of the influence of fertilization on grain production per unit [18]. The calculated values of harvest index did show considerable but statistically non significant increase after legumes and fallow as compared with preceding cotton crop (Table 2). Wheat followed by fallow treatment had the greatest dry matter production but lower harvest index than preceding grain or plowdown legumes. These findings are in conformity with those reported by Papastylianou *et. al.* [19].

N uptake by wheat as affected by preceding crops. The data on N content (grain and straw) and total N uptake by wheat as influenced by different cropping sequences revealed that N concentration both in straw and grain was slightly improved by the preceding treatments (Table 3).

Table 3. Nitrogen uptake by wheat after various preceding crops.

Preceding crops	N content (%)		N yield kg/ha		
	Grain	Straw	Grain	Straw	Total
	n.s.*	n.s.*			
Cotton	2.19	0.38	29.91 c	12.20 c	42.11 d
Fallow	2.28	0.40	48.84 a	17.99 ab	66.83 ab
Cotton + soybean	2.22	0.39	35.51 bc	12.17 c	47.68 cd
Clusterbean (plowdown)	2.32	0.43	51.24 a	18.79 a	70.03 a
Soybean	2.23	0.39	35.86 bc	12.56 c	48.42 cd
Pigeonpea	2.23	0.40	41.73 ab	14.53 bc	56.27 bc

Mean values followed by same letter are statistically non significant at 5% level of Duncan's multiple range test.
*n.s. - non significant.

Higher N content was observed in plowdown clusterbean treatment followed by fallow (no crop) and pigeonpea respectively. Wheat following a sole cotton crop gave the lowest N concentration but it was statistically similar to that obtained after different preceding crops.

Wheat planted after various legumes and fallow also had a higher N uptake in grain and straw, and a greater total N uptake than when it was preceded by cotton alone (Table 3). Plowdown clusterbean gave the highest total N uptake (70.03 kg/ha) followed by fallow (66.83 kg/ha) and pigeonpea (56.27 kg/ha) respectively. The percent increase in total N uptake by wheat as compared to preceding cotton was 66, 59, 34, 15 and 13 after plowdown clusterbean, fallow, pigeonpea, soybean and cotton plus soybean respectively. Residual benefits were also realized in the N yield of straw and grain (Table 3). Maximum and significantly highest yields of grain and straw nitrogen were noted after plowdown clusterbean and the lowest after cotton. Significantly greater N harvest after grain or plowdown legumes was an indication of a higher level of soil fertility. Many early reports had indicated that the cultivation of legumes results in the enrichment of soil N [20, 21], this has been shown to be contingent upon the proportion of the legume's N that is fixed and its distribution in various plant organs [15, 22]. Varying quantities of N harvested by wheat after different legumes in our investigation substantiate the above reports. It has also been demonstrated that grain, stover and total N uptake by maize seeded after fallow or legumes was enhanced significantly as compared to preceding wheat crop [23]. Giri and De [24] while assessing various leguminous crops with regards to their N contribution to succeeding pearl millet also reported similar findings.

It is concluded that besides plowdown legumes or fallow, grain legumes are also instrumental and conducive to promote the yield of subsequent wheat even if all the above ground vegetative parts are removed. The magnitude of residual contribution varies with the legumes species incorporated in a cropping system.

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