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EFFECT OF GROWING LEGUMES ON SOIL FERTILITY FOR RUBBER PLANTS

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Abstract

Intercropping of soybean (*Glycine max* L.) and bush bean (*Phaseolus vulgaris* L.) were practised with deep rooted rubber plants and its effect on soil fertility status for rubber plants was studied. pH of soils was moderately lowered, the moisture status, contents of organic matter, total nitrogen, phosphorus, potassium, calcium, magnesium, iron, the C:N ratio, CEC and available nitrogen in soils increased while available magnesium and sulphur contents decreased or showed little change after cultivation. Significant correlation was obtained between total nitrogen and organic matter contents of the soils after cultivation of the legumes. Intercropping in rubber plantation with soybean made soil nutrients more available than doing it with bush bean.

Introduction

Intercropping is popular among small farmers in tropical and sub-tropical environments (1). The reason is a built-in balanced nutrition, supply of energy and protein, minimum agricultural risks (2) and efficient water utilization (3). Intercropping is an inexpensive way to control weeds (4) and to improve soil fertility (5). Multiple cropping has multiple advantages viz., (i) it gives the highest net return per unit area; (ii) ensures against crop failure due to diseases; (iii) provides possibility of continuous soil care throughout the year; (iv) increases the efficiency of utilization of farm labour and (v) can supply many kinds of nutritious food all the year round (6). Legumes occupy a unique position in this regard in intercropping. It has the added advantage of fixing atmospheric nitrogen which is made available to the associated non-lagumes. Soybean (*G. max* L.) and bush bean (dwarf french bean, *P. vulgaris* L.) were used in the prsent study considering the fact that these legumes are popularly grown in the hilly areas of Bangladesh. The use of the two beans as intercropping crop was also intended to compare the net beneficial effects of the two crops on soil fertility status of rubber garden during its management.

Materials and Methods

Seeds of soybean (*G. max* L.) and bush bean (*P. vulgaris* L.) were sown in between the fallow space of the rubber trees. Intercropping sites were selected in the recently managed immature rubber garden situated in Shahzibazar (Sylhet) area. The area consisted of hills with steep as well as slightly undulated and

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eroded slopes and flat valleys having good irrigation facilities. The intercropping was done on all of these land variations. The outward general condition of the garden was reasonably good. Surface soils were more friable than sub-surface soils. Short sungrass and other small hilly weeds covered the garden area as cover crops but did not cause any obstacle to the growth of the plant at the new plantation.

Four exerimental plots (106 x 76 cm sizes, two for each of the crops) were set up for soybean and bush bean cultivation between the fallow spaces of the rubber plantation rows.

Spade and other indigenous equipments were used for harrowing, crushing and levelling of the land. Soils of the plots were slightly moist and prior to sowing it was allowed to dry in the sun for 12 hours. Soybean seeds were procured from the Bangladesh Agricultural Research Institute and bush beans were procured from local market. The row to row and plant to plant spacings were 15 cm. The population density was 4,37,500 plants ha^{-1}. Twenty four soil samples (3 from each plot) before and after harvesting were collected randomly at a depth of 0-38 cm from the four experimental plots.

Soil samples were air dried, ground and screened through a 2 mm sieve. Physical and chemical analyses were carried out in the labratory. Particle size analysis was done by hydrometer method and the texture was determined by the USDA (7) method. Maximum water holding capacity was determined following the method (8) and the field capacity by the method (9). Soil pH was determined electro-chemically using a Corning glass electrode pH meter at a soil: water ratio of 1:2.5. Organic matter content was calculated from the organic carbon content determined by wet-oxidation method (10) and the total nitrogen was determined by alkali distillation from the micro-kjeldahl digest (11). Phosphorus was determined colorimetrically and potassium by flame photometry (12). Calcium and Magnesium was determined by EDTA titration (13). Total iron was determined colorimetrically with orthophenanthroline (13), water soluble sulphate by the turbidity method using $BaCl_2$ (14) and water soluble carbonate and bi-carbonate volumetrically using 0.05 M H_2SO_4 in presence of phenolphthalein and methyl orange indicator respectively.

Results and Discussion

The growth and yield of soybean and bush bean as a leguminous N_2-fixer largely depend on the physical and chemical conditions of the soil. Incorporation of additional nitrogen through N_2-fixation along with other nutrients after decomposition of the crop residue are shown in Tables 1-4.

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Table 1. Some physical characteristics of soybean and bush bean cultivated soils of Shahzibazar Rubber garden (in %).

Crops	Soil samples of	Sand	Silt	Clay	Textural class	Moisture field condition	Maximum water holding capacity	Field capacity
Soybean	Before cultivation	62.30	15.00	22.70	Sandy clay loam	8.77	24.31	17.64
	After cultivation	59.20	16.30	24.50	"	17.90	49.61	36.01
Bush bean	Before cultivation	63.10	15.60	21.30	"	9.70	26.26	13.26
	After cultivation	61.50	15.70	22.80	"	17.32	46.89	23.67

Table 2. Some chemical characteristics of soybean and bush bean cultivated soils (in %).

Crops	Soil samples of	pH	O. C	O. M.	Total N	C/N ratio	C. E. C meq%
Soybean	Before cultivation	4.57	0.58	0.99	0.085	6.80	5.66
	After cultivation	5.42	0.94	1.63	0.109	8.64	6.17
Bush bean	Before cultivation	4.68	0.59	1.01	0.085	6.92	5.70
	After cultivation	5.42	0.93	1.60	0.108	8.54	5.92

From Table 1 it is seen that silt and clay contents were increased after soybean and bush bean than before which might be due to removal of loose sand from the surface. Both maximum water holding capacity and field capacity were increased due to legume culture. However, the field capacity was found to be relatively higher in soil under soybean than in soil under bush bean. Intercropping helped in raising the soil pH to moderately acidic condition from strongly acidic condition (Table 2). More than 50% increase in organic matter and about 30% increase in total N were induced due to intercropping with legumes. Accordingly, the C:N ratio also increased. The increase was found slightly higher under soybean which may be due to the incorporation of higher organic matter contents from this legume.

From Tables 3 and 4 it is apparent that except N, the available forms of most of the nutrients decreased due to legume culture while the total contents of them increased. Total P was increased after cultivation but the available contents decreased after cultivation in both cases. Average net rate of P influx decreased in soybean with increasing plant age (15).

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Table 3. Total nutrient contents of soybean and bush bean cultivated soils (in %).

Crops	Soil Samples of	P	K	Ca	Mg	S	Fe	HCO_3^-
Soybean	Before cultivation	0.023	0.27	0.31	0.34	0.017	3.92	0.0041
	After cultivation	0.032	0.29	0.42	0.37	0.019	2.96	0.0044
Bush bean	Before cultivation	0.023	0.29	0.48	0.29	0.018	3.97	0.0032
	After cultivation	0.031	0.26	0.40	0.36	0.023	3.42	0.0046

Table 4. Available nutrient contents of soybean and bush bean cultivated soils (in ppm).

Crops	Soil samples of	N	P	K	Ca	Mg	S
Soybean	Before cultivation	58	12	85	250	290	18
	After cultivation	110	4.60	51	300	300	15
Bush bean	Before cultivation	61	9.80	80	340	410	19
	After cultivation	94	6.00	50	340	250	20

Total K was increased after soybean cultivation but in case of bush bean it was decreased. Available K decreased after soybean and bush bean cultivation which could be due to enhanced plant uptake as legumes need relatively higher amounts of K than other crops. The incorporation of these materials gave rise to increased contents of total nutrients. Total and available Ca contents increased in case of soybean but decreased in soils where bush bean was cultivated, while total Mg was found to have increased under bush bean. The available amount of this latter element however, increased in soil under soybean. Both total and available sulfur increased under bush bean while the available S decreased under soybean. Total iron was found to have depleted under both the crops. The variations in the chemical composition due to cultivation of the two crops might be due to differential requirements of the two crops which in fact are different in terms of their physiological behaviours as well as their specificity to rhizobium infection.

Simple correlation coefficients between nitrogen content of soil and the corresponding organic matter content before and after cultivation of soybean are presented in Table 5. The line between N and organic matter before and after soybean cultivation (Fig. 1 A,B) indicates that all the observed values are within close proximity of the regression line for the soils before soybean cultivation

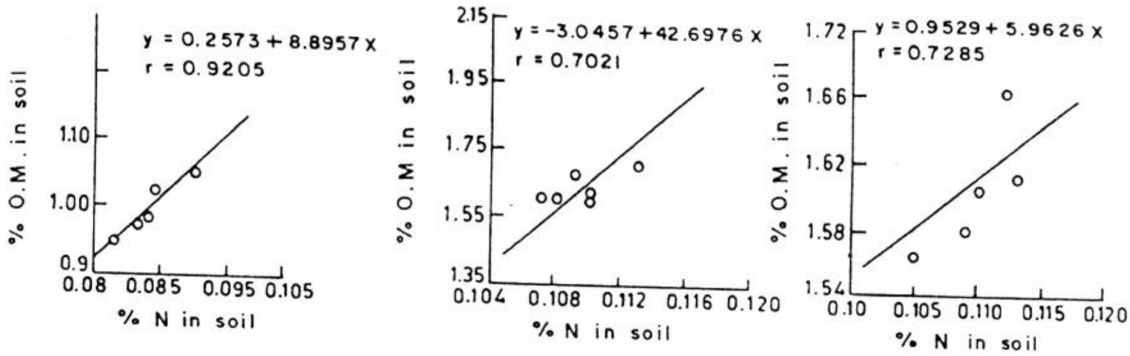

Fig. 1. Relationship between total nitrogen and organic matter in soil : (A) before soybean cultivation : (B) after soybean cultivation; (C) after bush bean cultivation.

while those after cultivation bear a weak relationship. The weaker relationship may be attribiuted to loss of N by leaching due to rainfall, microbial activity and compartively greater competition for the element by weeds. For bush bean, there was a poor relationship between the total N and the organic matter content before cultivation while the correlation improved after cultivation (Fig. 1 C).

Table 5. Correlation co-efficient between total nitrogen and organic matter contents in soybean and bush bean cultivated soils.

Crops	Before cultivation	After cultivation
Soybean	+0.9206 **	+0.7021 *
Bush bean	0.2237	+0.7285*

*, ** Indicates level of significance at 10% and 1%, respectively.

Improvement in both physical and chemical characters of the soils due to intercropping of legumes in rubber garden is definite to lessen fertilizer requirement and its management and help in maintaining a sustainable forest culture.

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