

NITROGEN ACCUMULATION AND BIOMASS YIELD OF SOME DUAL-PURPOSE GREEN MANURE CROPS IN THE LATOSOLS OF THE NORTHERN PROVINCE

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ABSTRACT

A study was carried out at Thirunelvely (calcic red latosol) and Kilinochchi (red latosol) during Yala 1990 and Yala 1991 to evaluate the potential of popularly grown dual-purpose grain legumes, cowpea, mungbean and blackgram and the leguminous crop, sunhemp for biomass production and N accumulation. At both locations, biomass yield at 45 days after seeding (DAS) ranged from 8-18 t/ha for mungbean, 6-17 t/ha for cowpea, 5-18 t/ha for blackgram and 9-21 t/ha for sunhemp. On the other hand, at 60 DAS, it was 7-11 t/ha for mungbean, 11-23 t/ha for cowpea, 7-18 t/ha for blackgram and 11-23 t/ha for sunhemp. In addition, at 60 DAS the grain legumes produced grain (mungbean 886-2040 kg/ha; cowpea 810-1540 kg/ha and blackgram 725-1323 kg/ha). The N accumulation by the green manures at 45 DAS amounted to 47-123 kg/ha for mungbean; 78-175 kg/ha for cowpea; 35-127 kg/ha for blackgram and 80-203 kg/ha for sunhemp. At 60 DAS, the N accumulation in the crop residues ranged from 32-51 kg/ha for mungbean, 54-159 kg/ha for cowpea, 32-93 kg/ha for blackgram and 94-218 kg/ha for sunhemp. These findings indicate that if short duration grain legumes such as cowpea, mungbean or blackgram are grown preceding a cash crop such as chilli or onion then farmers can obtain both grain, which can be consumed or sold, and crop residue, which can be applied as manure to the next crop. The crop residues also provide substantial amounts of N needed for the subsequent cash crops.

KEY WORDS: Biomass yield, Grain legume, Green manure, N accumulation.

INTRODUCTION

In the calcic red latosols which predominate in the Jaffna peninsula (De Alwis and Panabokke, 1972) high value crops such as chilli, onion, potato, grain legumes, vegetables and tobacco are intensively cultivated under lift irrigation (shallow wells). The soils are well-drained sandy clay loams with low organic matter content and rapid infiltration rate. Farmers in this region traditionally apply high levels of organic materials (25-50 t/ha) such as cattle manure, goat manure, green manure and leaves of various plants (both green and dried) along with chemical fertilizers (usually 3 to 4 times the recommended rates) to these crops.

Two methods of green manuring are practised in the Jaffna peninsula. The method which is popular involves the application of green matter such as branches of annuals and perennials grown elsewhere. Some commonly used plants are *Thespesia populnea*, *Gliricidia maculata* and *Tephrosia purpurea*. The green manures are cut and transported to the field. This operation is however, labour intensive and expensive. Furthermore, the quantities required of such green manures are fairly large and may be difficult to find. With urbanization and population increase, this practice may be applicable only to certain areas.

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In the second method, green manure such as sunhemp (*Crotalaria juncea*) grown *in situ* is incorporated into the soil before planting the next crop. Sunhemp is a popular green manure for potato cultivation. Despite the fact that sunhemp is drought tolerant, it is no longer popular because farmers do not like to devote 6-8 weeks exclusively for growing a green manure crop which does not give any direct benefits (either food or cash income).

To overcome the disadvantages of these methods of green manuring, dual-purpose green manure crops such as grain legumes (mungbean, blackgram, cowpea, soybean, groundnut, etc.) can be grown. Dual-purpose green manure crops provide grain for consumption and crop residue for recycling as manure to the succeeding crop. In a wheat-mungbean- rice rotation in India, mungbean produced 0.9 t/ha and crop residue effectively substituted for 60 kg N/ha (Meelu and Rekhi, 1983). Including grain legumes such as ground nut and soybean in cropping systems is followed in Vietnam, after harvesting the grains, the crop residues are incorporated into the soil before growing the next crop. (Nguyen and Thi, 1997).

A study was, therefore, carried out to determine the performance of some promising dual-purpose grain legumes such as mungbean, cowpea and blackgram in the latosols of the Jaffna and Kilinochchi districts. Since the major nutrient contributed by green manures is nitrogen, the study was specifically devoted to determine biomass production and N accumulation at different growth stages of the grain legumes. This paper discusses the results of this study.

MATERIALS AND METHODS

Experimental sites

The experiments were carried out at the Agricultural Research Station in Thirunelvely (calcic red latosol) and the Regional Agricultural Research Institute (presently known as the Regional Agricultural Research and Development Centre) in Kilinochchi (red latosol). Some important characteristics of the surface soils are given in Table 1.

Green manure crops

Three grain legumes, mungbean (*Vigna radiata* var. Type 77), cowpea (*Vigna unguiculata* var. M1 35) and blackgram (*Vigna mungo* L. var. M1 9) were evaluated as dual- purpose green manure crops. For comparison sunhemp (*Crotalaria juncea*) was also tested.

Field experiments

Seeds of the green manure crops were broadcast sown in 3 m x 6 m plots at the rate of 20 kg/ha for the grain legumes and 60 kg/ha for sunhemp. Each replicate consisted of 4 plots and there were three replicates. The grain legumes received a basal application of NPK (6:25:18) fertilizer mixture at the rate of 100 kg/ha and a top dressing of 12.5 kg/ha urea at flowering. No fertilizers were applied to the sunhemp. Irrigation was provided once a week from shallow wells. The experiments were carried out at both locations in Yala 1990 and Yala 1991.

Biomass and grain yield

Fresh biomass yield and N accumulation were determined at 30, 45 and 60 days after seeding, grain yield of mungbean, cowpea and blackgram was determined at 60 days after seeding; only one pick was taken.

Plant analysis

Total NB in plant samples was determined by the micro-Kjeldahl method.

RESULTS AND DISCUSSION

Biomass production of green manure crops

Table 2 gives the fresh biomass yield of mungbean, cowpea, blackgram and sunhemp at 30, 45 and 60 days after seeding (DAS). The biomass yield of cowpea, blackgram and sunhemp increased up to 60 DAS; the increase was steep from 30 to 45 DAS and gradual thereafter. In the case of mungbean, the biomass yield increased up to 45 DAS and decreased thereafter. At both locations, biomass yield of all green manure crops was higher in Yala 1990 than in Yala 1991. This may be due to differences in the climate and water availability between the two Yala seasons.

Biomass yield at 45 DAS ranged from 8.4 to 17.9 t/ha for mungbean, 6.0 to 17.3 t/ha for cowpea, 5.4 to 17.6 t/ha for blackgram and 8.6 to 2.6 t/ha for sunhemp (Table 2). At 60 DAS, it ranged from 7.1 to 10.5 t/ha for mungbean, 11.0 to 22.7 t/ha for cowpea, 7.3 to 18.3 t/ha for blackgram and 10.9 to 22.7 t/ha for sunhemp.

In addition, at 60 DAS mungbean, cowpea and blackgram produced grain yields in the range of 886-2040, 810-1540 and 725-1323 kg/ha, respectively (Table 3). Comparable green manure yields for sunhemp, cowpea and mungbean have been reported by other workers (Gonzales, 1962; Vachhani and Murty, 1964; Panse *et al.*, 1965). Thus it can be observed that the three grain legumes have the advantage of producing both green manure residue for the succeeding crop and

grain yield which could be consumed or sold in the market giving additional benefits to the farmer.

N accumulation by green manure crops

Direct application of green manure to the soil can have several beneficial effects. The main benefit is the supply of nitrogen to the crops. The nitrogen accumulation by mungbean, cowpea, blackgram and sunhemp at 30, 45 and 60 DAS at Thirunelvely and Kilinochchi is presented in Table 4.

N accumulation by the three grain legumes increased up to 45 DAS and then decreased whereas in sunhemp it increased continuously up to 60 DAS. This could be due to the transfer of N to the grain between 45 and 60 DAS in the case of the grain legumes, mungbean, cowpea and blackgram. In sunhemp there was no seed production up to 60 DAS and hence N would remain in the leaves. As in the case of biomass yield, N accumulation by the green manures was higher in Yala 1990 than in Yala 1991 at both locations.

N accumulation at 45 DAS varied from 47 to 123 kg N/ha for mungbean, 78 to 175 kg N/ha for cowpea, 35 to 127 kg N/ha for blackgram and 80 to 203 kg N/ha for sunhemp (Table 4). At 60 DAS it was 32 to 51 kg N/ha for mungbean, 54 to 159 kg N/ha for cowpea, 32 to 93 kg N/ha for blackgram and 94 to 218 kg N/ha for sunhemp. Similar N accumulation by these green manure crops has been reported by several workers from India and Philippines (Table 5). In Sri Lanka, Amarasiri and Perera (1975) reported very low N removal by the above ground parts (excluding pods) of mungbean (9 kg N/ha), cowpea (6-10 kg N/ha) and blackgram (16 kg N/ha) grown at Maha Illuppallama in the dry zone. The reason could be that these crops

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Table 1. Some characteristics of the experimental soils.

Soil characteristic	Thirunelvely (Calcic red latosol)	Kilinochchi (Red latosol)
pH (1:1 H ₂ O)	7.50	7.70
Sand (%)	72.00	65.00
Silt (%)	11.00	12.00
Clay(%)	17.00	23.00
Texture	Sandy loam	Sandy clay loam
Organic matter (%)	1.80	2.40
Total N%	0.13	0.13
CEC (c mol _c /kg)	6.20	3.70
Exchangeable K (c mol _c /kg)	0.57	0.29
Olsen P (ppm)	22.00	16.00

Table 2. Biomass yield of green manure crops at different times of harvest.

Green manure	*Fresh biomass yield (t/ha)											
	Thirunelvely						Kilinochchi					
	Yala 1990			Yala 1991			Yala 1990			Yala 1991		
	1	2	3	1	2	3	1	2	3	1	2	3
Mungbean	5.9	15.6	7.7	5.1	14.1	7.1	7.5	17.9	10.5	4.5	8.4	7.2
Cowpea	9.6	17.3	20.8	2.4	13.5	15.1	7.9	17.3	22.7	2.8	6.0	11.0
Blackgram	6.3	17.6	18.3	3.9	11.2	12.4	8.0	16.5	17.7	2.6	5.4	7.3
Sunhemp	9.4	15.5	20.2	5.1	12.4	14.1	10.8	20.6	22.7	4.3	8.6	10.9
CV (%)	24.1	20.8	15.9	25.9	24.0	26.4	19.8	13.2	11.9	28.4	16.9	16.7
LSD (0.05)	3.0	ns	4.3	1.7	ns	5.1	2.7	3.8	3.5	1.6	1.9	2.4

* Mean of 3 replicates; 1=30 days after seeding (DAS); 2=45 DAS; 3=60 DAS; ns=not significant

Table 3. Grain yield of mungbean, cowpea and blackgram at 60 DAS.

Green manure crop	Grain yield (kg/ha)			
	Thirunelvely		Kilinochchi	
	Yala 1990	Yala 1991	Yala 1990	Yala 1991
Mungbean	1227.0	886.0	2040.0	1020.0
Cowpea	810.0	812.0	1540.0	1129.0
Blackgram	874.0	725.0	1323.0	786.0
CV (%)	9.7	15.9	15.1	32.7
LSD (5%)	162.0	ns	426.0	ns

ns=not significant

Table 4. Nitrogen accumulation by green manure crops at 30, 45 and 60 DAS.

Green manure	Nitrogen accumulation (kg N/ha)											
	Thirunelvely						Kilinochchi					
	Yala 1990			Yala 1991			Yala 1990			Yala 1991		
	1	2	3	1	2	3	1	2	3	1	2	3
Mungbean	31	87	39	25	99	40	50	123	51	30	47	32
Cowpea	66	125	98	17	92	77	55	175	159	18	78	54
Blackgram	40	127	93	16	79	70	56	123	92	15	35	32
Sunhemp	77	140	179	38	114	129	100	203	218	30	80	94

1=30 DAS; 2=45 DAS; 3= 60 DAS

Table 5. Nitrogen accumulation in green manure crops reported by researchers.

Green manure	Country	Duration (days)	Total N accumulation (kg/ha)	Reference
Mungbean	Philippines	45	75	Morris <i>et al.</i> , 1986
Cowpea	India	60	74	Sanyasi Raju, 1952
	India	45	32	Rajbhandari, 1984
	Philippines	40	86	Morris <i>et al.</i> , 1986
Blackgram	Philippines	45	75	Morris <i>et al.</i> , 1986
Sunhemp	India	60	134	Sanyasi Raju, 1952
	India	56	78	Bhardwaj <i>et al.</i> , 1981
	Philippines	45	69	Meelu and Morris, 1988

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were harvested at full maturity (about 90 DAS) and hence major part of N taken up by the plant would have been transferred to the grain. In fact, in the above study N removal by the grains varied from 42-55 kg/ha. Therefore, time of harvesting is important if the crop residues of these grain legumes are to be used to provide N to the subsequent crop.

In the grain legumes, maximum N accumulation occurred at 45 DAS. Although N accumulation by grain legumes at 60 DAS was lower than that at 45 DAS, it was substantial. Furthermore, at 60 DAS mungbean, cowpea and blackgram will provide grain which will be beneficial to the farmer. These facts should be considered when deciding the time of harvesting of the grain legumes. The time of harvesting will also depend on the time of planting of the next crop such as chilli, onion etc., for which the crop residues of the grain legumes can be added to provide part of its (chilli or onion) N requirement.

CONCLUSIONS

The results show that the leguminous green manure crop sunhemp, produces sufficient biomass which can be applied to supply part of the N needs of the succeeding crop. But farmers who follow an intensive cropping schedule (as in the Jaffna peninsula) will not be keen to set apart 6-8 weeks exclusively for growing a green manure crop with no direct benefit. However, growing a short duration dual-purpose food legume crop (grain and green manure) such as mungbean, cowpea, blackgram etc., and adding the crop residue to the following crop (usually chilli, onion, potato or vegetables) can be acceptable to the farmers. The present study shows that biomass production and N yield of these grain legumes are substantial and hence their (crop residues) addition can provide a major part of

the N requirement of the subsequent crop. However, the feasibility of using mungbean, cowpea, blackgram and other grain legumes as green manures for intensive cropping schedules followed in the Northern and other similar regions needs careful evaluation.

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