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INTERCROPPING SESBANIA GREEN MANURE WITH MUNGBEAN AT DIFFERENT ROW RATIOS UNDER IRRIGATED CONDITIONS

Nur-E-Elahi[1] and W. D. Pardee[2]

IRRI, Los Banos and Guimba, Philippines.

Abstract

Recent research has shown that food and green manure production may be combined to optimize resource use in the pre-rice period. A field trial was designed to examine the effect of intercropping sesbania [*Sesbania rostrata* (Brem)] with mungbean [*Vigna radiata* (L) Wilezek] at different row ratios under irrigated conditions at the International Rice Research Institute (IRRI) experimental farm, Los Banos and Guimba, Nueva Ecija. At both locations 2:2 mungbean : sesbania row combination were ideal for higher green manure nitrogen production. Mungbean grain yield was generally reduced significantly due to intercropping sesbania across locations. Rice yield levels of green manure and Urea- N treatments were comparable at both Los Banos and Guimba sites. N efficiency and grain N ratio were higher at Guimba than at Los Banos. Application of organic nitrogen from mungbean and sesbania intercroppings produced higher economic return than inorganic nitrogen.

Key words: Intercropping, Sesbania, Green manure, Mungbean, Rice.

Introduction

In the pre-rice dry-wet period of the tropical Asia when long day prevails favour high biomass and N production of sesbania (Becker *et al.* 1990). Growing sesbania in the pre-rice period would not be accepted by farmers as this crop has neither cash nor food value and requires human labour for its production (Agboola, 1974 and Martin *et al.* 1976).

In this situation an alternative to growing strictly a green manure crop in the pre-rice period is to grow a high value grain legume mungbean for food. But after harvesting the mungbean grain, the amount of N left in the mungbean residue is not enough to satisfy the N

[1] RFSD, BRRI, Gazipur-1701, Bangladesh.
[2] Dept. Crop Science, Cornell University, USA.

requirements for the next low land rice crop (Furoc *et al.* 1989).

It is now imperative to integrate grain legume and manure crops in the pre-rice drywet ecological niche which would give cash and nitrogen to the farmers.

Hence, this trial was conducted to determine productivity of intercropping sesbania *[Sesbania rostrata (Brem.)]* with mungbean *[Vigna radiata (L.)]* (var. pag-asa 1) at various row ratios under irrigated rice environments. Furthermore, this study aims to determine the comparative value and advantage of combining grain legume and green manure for grain production and effect of organic N in subsequent rice crop.

Materials and Methods

Mungbean and sesbania seeds were hand drilled in furrows 50-cm apart and covered with soil. In Los Banos and Guimba, sesbania and mungbean were planted on April 9, and April 23, 1989, respectively. Seeding rates were 25 kg ha^{-1} for mungbean and 30 kg ha^{-1} for sesbania. Sesbania was clipped 35 days after planting as a fodder source and to lessen competition with the mungbean crop at flowering stage. Crop protection from weeds, pests and diseases were done as necessary and as recommended.

The ten treatments (Table 1) were randomly allocated in three and four replications in Los Banos and Guimba sites, respectively, in Randomized Complete Block design. Plots measured 4m x 7m. Following the harvest of the green manure plots and incorporation of its biomass in the soil, four days later, rice was transplanted with no urea-N fertilizer. However, recommended doses of P_2O_5 and K_2O_5 were applied to all rice plots. Sampling for mungbean and sesbania biomass yields and other attributes were adjusted accordingly relative to row ratios. Sampling for rice yield was adjusted to ton/ha. The comparison of treatment means were done by using Standard Error (SE). For analysis of variance and regression, the Statistical Analysis System (SAS, 1982) was used. A simple cost and return technique was used to compare the benefit of different mungbean and sesbania intercropping systems with that of monoculture system in combination with rice. Material cost (seed, fertilizer, insecticide), power and labour cost for land preparation, seeding, transplanting, weeding, harvesting, threshing, sesbania biomass incorporation were used to determine variable cost. Standard labour and animal hours and their corresponding wage rate were collected from the IRRI Agricultural Economics Department (ECD). The farm gate price of mungbean, sesbania seed , and rough rice was also collected from the ECD. Total cost, total return and net return were used as an economic indicator.

Results and Discussion

The soil physical and chemical attributes of the experimental sites at Los Banos and Guimba are summarised in Table 2. Los Banos site is a heavier textured soil as indicated by the higher percentage of clay content and lower sand particles compared to Guimba site. In terms of chemical properties, all the macro nutrients (e.g. N, P and K) were substantially higher in Los Banos than in Guimba, but minor elements were comparable in both sites. Cation exchange capacity (CEC) is also higher in Los Banos than Guima. In general, Los Banos soil is more fertile than the Guimba site.

Green manure and grain legume attributes are shown in Table 3. At Los Banos,

Table 1. Definition of the treatments.

Treatment code	Description
T1	Clean fallow, 0 kg N/ha applied to rice
T2	Clean fallow, 45 kg N/ha applied to rice
T3	Clean fallow, 90 kg N/ha applied to rice
T4	One row of mungbean (MB) alternated with one row of Sesbania rostrata (SR) or 1 MB : 1 SR
T5	Two rows of mungbean alternated with one row of Sesbania rostrata (2 MB : 1 SR).
T6	Four rows of mungbean alternated with one row of Sesbania rostrata (4 MB : 1 SR)
T7	Two rows of mungbean alternated with two row of Sesbania rostrata (2 MB : 1 SR)
T8	Four rows of mungbean alternated with two row of Sesbania rostrata (4 MB : 2 SR)
T9	Sole mungbean (100 MB : 2 SR)
T10	Sole Sesbania (0 MB : 100 SR)

Table 2. Physical and chemical properties of surface soil (0-15 cm) of experimental field under irrigated condition at IRRI, Los Banos and Guimba.

Analysis	Unit	Los Banos	Guimba
I. Physical			
Clay	%	37	27
Silt	%	45	50
Sand	%	18	23
II. Chemical			
p^H	1 : 1 W/V H2O	6.30	7.40
Organic carbon	%	1.02	0.62
Total nitrogen	%	0.09	0.05
Exchangeable Na	m.e./ 100g ads*	1.12	0.95
Exchangeable K	m.e. / 100g ads	0.39	0.12
Exchangeable Mg	m.e. / 100g ads	8.40	9.90
Exchangeable Ca	m.e. / 100g ads	15.40	16.10
CEF	m.e. / 100g ads	26.70	20.50
Available Olsen P	ppm	40.00	2.50

* -air dried soil.

sole sesbania significantly yielded higher dry matter herbage (13.Vs 7.6 t ha^{-1}) with corresponding N accumulation of 260 Vs 127 kg N ha^{-1} than did the rest of the treatments over all means. Within intercropping treatments (e.g. T_4 to T_8) 4 MB: 2 SR row combination yielded significantly lower dry matter (7.3 t ha^{-1}) and lower N accumulation (124 kg ha^{-1}) than 1 : 1 and 2 : 2 mungbean : sesbania row combinations. This suggests that latter two row arrangements were ideal for higher green manure nitrogen production. Between monocrop, sesbania was the better source of organic nitrogen than mungbean residues after two primings with N yield of 260 and 15 kg N ha^{-1}, respectively.

Table 3. Grain, total dry matter and nitrogen yield of mungbean and sesbania at different row combinations under irrigated conditions, IRRI,Los Banos and Guimba.

Treatment code	Mungbean Sesbania Row Combinations	Los Banos			Guimba		
		Grain yield (kg/ha)	Total Dry matter (t/ha)	N yield (kg/ha)	Grain yield (kg/ha)	Total dry matter (t/ha)	N yield (kg/ha)
T_4	1 MB : 1 SR*	326	9.8	142	362	8.0	127
T_5	2 MB : 1 SR	310	8.3	132	390	6.5	115
T_6	4 MB : 1 SR	494	7.7	141	465	4.3	64
T_7	2 MB : 2 SR	421	10.9	209	292	6.7	133
T_8	4 MB : 2 SR	458	7.3	124	443	5.1	71
T_9	100 MB: OSR	747	1.3	15	637	1.3	17
T_4	OMB:100 SR	-	13.7	260	-	10.6	148
Mean		459	8.4	146	431	6.1	98
SE		146	1.1	18	71	1.2	14
CV(%)		39	16	17	23	27	20

* MB = Mungbean ; SR = *Sesbania rostrata*.

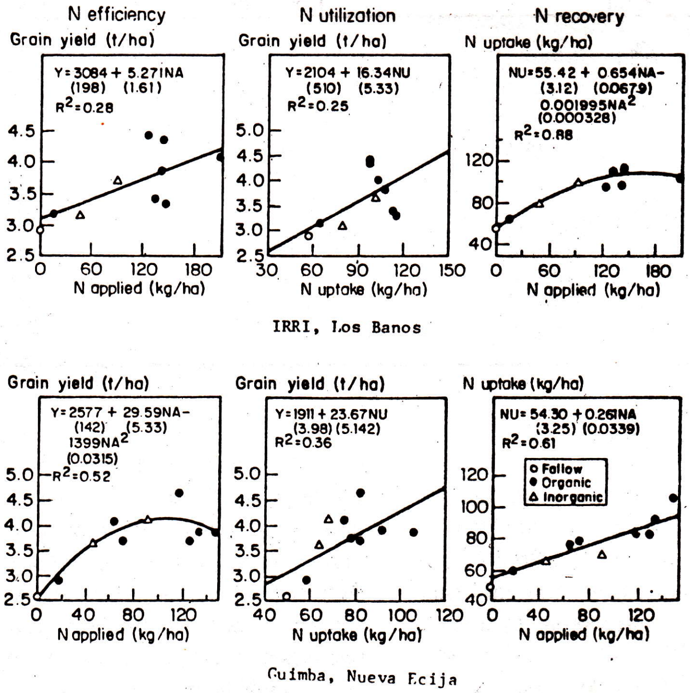

Fig 1. N efficiency, N utilization and N recovery responses of transplanted rice from application of organic and urea N in irrigated condition, IRRI and Guimba,

Table 4. Grian, total dry matter and nitrogen uptake of rice as influenced by application of urea and green manure-N under irrigated conditions, IRRI, Los Banos and Guimba.

Treatment		Los Banos			Guimba		
Code	Description	Grain yield (t/ha)	Total Dry matter (t/ha)	N uptake (kg/ha)	Grain yield (t/ha)	Total dry matter (t/ha)	N uptake (kg/ha)
T_1	Fallow, O kg N ha-1	2.92	6.77	57	2.58	7.55	49
T_2	Fallow, 45 kg N ha-1	3.12	8.70	79	3.61	7.85	64
T_3	Fallow, 90kg N ha-1	3.68	10.83	101	4.09	8.50	68
T_4	1 MB : 1 SR	3.85	11.30	108	3.68	9.53	82
T_5	2 MB : 1 SR	3.40	11.03	112	4.63	7.75	82
T_6	4 MB : 1 SR	4.35	11.70	9%	4.06	7.38	75
T_7	2 MB : 2 SR	4.09	11.23	104	3.88	8.80	92
T_8	4 MB : 2SR	4.44	9.83	98	3.71	8.38	78
T_9	Sole mungbean	3.18	7.83	64	2.91	7.60	59
T_{10}	Sole sesbania	3.30	10.65	115	3.84	11.13	106
Mean		3.63	9.99	94	3.70	8.45	76
SE		0.38	0.84	5.3	0.32	0.94	5.3
CV(%)		13	10	7	12	16	10

Table 5. cost and return analysis of intercropping mungbean and sesbania followed by rice cropping pattern under irrigated condition at Los Banos and Guimba.

Cropping Pattern 1st Crop	2nd crop	Total cost ($/ha)	Total return MB+ Rice ($/ha)	Net return ($/ha)
	Los Banos			
Fallow	Rice with 0kg N/ha	223	413	190
Fallow	Rice with 45kg N/ha	246	504	258
Fallow	Rice with 90kg N/ha	266	603	337
1 MB : 1 SB	Rice	426	963	537
2 MB : 1 SB	Rice	442	1193	751
4 MB : 1 SB	Rice	445	1213	769
2 MB : 1 SB	Rice	431	1018	587
4 MB : 2 SB	Rice	382	763	381
Sole mungbean	Rice	372	908	536
Sole sesbania	Rice	280	471	308
Mean		365	877	512
	Guimba			
Fallow	Rice with o kg N/ha	202	276	74
Fallow	Rice with 45 kg N/ha	225	437	212
Fallow	Rice with 90 kg N/ha	244	535	291
1 MB : 1 SB	Rice	380	756	376
2 MB : 1 SB	Rice	385	833	448
4 MB : 1 SB	Rice	383	864	481
2 MB : 1 SB	Rice	376	720	344
4 MB : 2 SB	Rice	382	763	381
Sole mungbean	Rice	372	908	536
Sole sesbania	Rice	280	471	308
Mean		323	656	333

At Guimba, sesbania monocrop exhibited similar trend of dry matter production and N yield than mungbean residues to that of Los Banos. At this site, 4 MB : 1 SR exhibited markedly lower dry matter and N yields than did the 1 : 1 and 2 : 2 mungbean : sesbania row proportions. This again suggests that 1 : 1 and 2 : 2 mungbean : sesbania row combinations were ideal for higher nitrogen production.

Between the two locations, Los Banos had higher total dry matter and nitrogen yields of the green manure and grain legume crops compared to those obtained at Guimba across all treatment combinations. This may have been associated to the better inherent soil fertility attributes at Los Banos than Guimba.

The effect of intercropping sesbania on mungbean at different row rations significantly reduced the grain yield of mungbean by and average of 345 kg ha^{-1}, respectively at Los Banos and Guimba. Within intercropping treatments mungbean yields were comparable on both locations although mean yield levels were slightly higher in Los Banos than in Guimba sites.

Grain, total dry matter and N yields of rice crop as influenced by green manure and urea-N applications is shown in Table 4. At Los Banos, most of the green manure treatments were as effective as urea-N applications. Similar trend was also found in Guimba site. This suggests that sesbania can substitute as much as 45 to 90 kg N ha^{-1} from urea.

N efficiency, utilization and N recovery responses using regression models are illustrated in figure 1. The grain : nitrogen ratio for Los Banos was 3.27 :1 and 30 :1 for Guimba. The higher N efficiency at the Guimba site was associated with a higher N utilization of 23.67 kg grain per kg N taken up which as 31% higher than that obtained from Los Banos. Although the apparent N recoveries at Los Banos were higher than at Guimba, these were not reflected in both N efficiency and N utilization responses.

Economic analysis indicated that application of organic nitrogen from the intercropping systems produced consistently higher net return ($ 537 to 796 in Los Banos and $ 376 to 481 in Guimba) than the inorganic nitrogen ($ 190 to 337 to in Los Banos and $ 74 to 291 in Guimba) in a mungbean + sesbania - rice cropping pattern (Table 5). Though sole mungbean produced higher net return ($ 722 in Los Banos and $ 536 in Guimba), this system may not be agroenvironmentally feasible as sole mungbean could not produce enough organic nitrogen and may be damaged by uncertain natural hazards like typhoon, hail storm and diseases at the time of it's reproductive phase. Sole sesbania produced the lower net return than the intercropping systems in both the sites. Los Banos site earned higher net return ($512) than Guimba site ($333).

Conclusion

It was evident from the discussion that sesbania can be intercropped with mungbean as source of green manure N for the following rice crop. In both locations, 2 : 2 mungbean : sesbania row combinations yielded significantly higher nitrogen yield than the other treatments.

Mungbean grain yield was significantly reduced by a sesbania intercrop by an average of 345 and 245 kg ha^{-1}, respectively at Los Banos and Guimba.

The rice yield levels of green manure and urea-N treatments were comparable in both locations. N efficiency of rice was lower at Los Banos than at Guimba which was associated with correspondingly lower N utilization efficiency.

Mungbean and sesbania intercropping systems could be a better source of organic nitrogen for economic benefit than inorganic nitrogen in a mungbean + sesbania - rice cropping pattern.

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