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Biomass partitioning of rice as affected by N sources and rates

G. DHEEBAKARAN AND S. RAMASAMY
Dept. of Agronomy, Tamil Nadu Agril. University, Coimbatore - 641 003, Tamil Nadu

Abstract : Effect of green manure in combination with different times of N splits as urea nitrogen on biomass partitioning was studied on irrigated lowland rice. Partitioning of photosynthates produced on leaf, stem and root continued up to heading, flowering and ripening phases, respectively. Confining basal N requirement through green leaf manure needs split application of urea-N at active tillering for the production of green leaves and culm production. Applying N in five splits @ 40kg each at basal and P, 20 kg ha^{-1} each at active tillering, a week after active tillering and at the time of heading was more useful to divert the photosynthates to leaf, stem, root and panicle in an efficient way for the entire growth period. *(Key words: Biomass partitioning, Nitrogen, Green leaf manure, Split application, Dry matter production)*

The concept of Integrated Nutrient Management (INM) seeks to sustain soil fertility through an integration of different available nutrient sources and their application methods that will produce maximum crop yield per unit input (De Datta *et al.* 1990)

Grain yield is decided, not only by the biomass produced by that time but, by partitioning of the biomass into various plant organs. Whereas partitioning is determined by many factors like nutrient availability, its quality and time of availability etc. To find the effect of various inputs like green leaf manure, urea and their combination with different times of splits on biomass partitioning and grain yield, field experiments were conducted at wetlands of Tamil Nadu Agricultural University, Coimbatore from November to April (winter season) and May to September (dry season).

Materials and Methods

The experiements were conducted with the variety IR72, under irrigated lowland condition of wetlands Coimbatore, between November and September 1997-1998. The soil of experimental field was medium in available N (320 and 336 kg ha^{-1}) and P (12.4 and 12.3 kg ha^{-1}), high in available K(540 and 560 kg ha^{-1}), pH with 7.7 and 7.6 and the organic carbon of 0.50 and 0.51 per cent in winter season and dry season fields, respectively. The experiements were laid out in a randomized block design and replicated thrice. There were nine treatments including control. In the winter season, the other eight treatments were two sources of N to supply 40 kg N ha^{-1} as basal (urea, and green leaf manure - *Sesbania rostrata* on equal N basis) and as well as in combination with 40-40-0, 0-40-40-, 20-40-20 and 40-30-30 kg N ha^{-1} splits combination for active tillering, panicle initiation and at heading stages, respectively. Based on the results of winter season, treatments were reconstituted for dry season. Nitrogen at active tillering stage was reduced from 40 to 20 kg N ha^{-1}. Accordingly, for the two sources of basal N, 20-40-20, 20-40-30; 20-40-40 and 20-20-40-20 were the combinations (refer tables for details). In the last combination of dry season experiment, the second 20-kg was applied one week after active tillering stage. All the treatments received 60 kg P_2O_5 as super-phosphate and 60 kg K_2O as Muriate of potash ha^{-1}. The full dose of P_2O_5 was applied at the time of transplanting and K_2O was applied in three equal splits as basal, PI, and heading stages along with urea. Fifty days old *Sesbania rostrata*, grown separately, was harvested and trampled on equal N basis, two days before rice transplanting. Irrigation was given at 5cm at standing water till panicle initiation (PI) and 5cm only after disappearance of ponded water. Samples were collected with an interval of 10 days and a week for winter season and dry season experiments, respectively.

Results and Discussion

In general, biomass partitioning to green leaves, culm, and root continued up to heading, flowering and dough stages, respectively. Sources of N appliction had distinct impact over the biomass partitioning.

Production of leaves (Functional leaves)

Production of leaves continued upto heading and then decreased towards maturity. The leaf production and as well as its maintenance till the maturity was higher in the dry season experiment probably due to varied seasonal weather conditions prevailing between the two seasons. The leaf production was rather slow initially for green manuring. It is reasonable to argue that the slow availability of N from the organic source in the beginning, compared to fertilizer N. It can also be confirmed that whenever fertilizer N was split applied at the earliesrt to a green-manured field, the rate of production of leaf was seen enhanced. Withholding the split application of N at tillering stage drastically reduced the leaf production when basal manuring was given as GLM only, whereas, it was not felt distinctly under fertilizer N basal. This might be due to immediate availability of inorganic ions from urea - N, as agreed by Palaniappan and Budhar (1989). They suggest that when basal manuring is done by GLM on equal N basis, even though GLM applied is *Sesbania rostrata,* which was claimed by many workers for its immediate N availability (Latha *et. al.*, 1989; Palaniappan and Siddeswaran, 1990), a starter dose of inorganic N at active tillering stage is needed. This could be inferred from the results of dry season experiment. Wherein, a better leaf production was attained for GLM followed by inorganic N as 20kg ha^{-1} at active tillering stage and another 20 kg ha^{-1} a week later. The heading N rates also had influence in maintaining the leaves in the dry season experiment but not in winter season experiment. This was mainly due to seasonal variations of the experiment, where, the winter season experiment was conducted during the periods of likely soil problems. Whereas, the dry season is reported with minimum soil problem as there is free drainage, since not the entire stretch of lands are cultivated, owing to limitations in the availability of irrigation water and less chances for prolonged submergence because of limited rainfall and further the situation is accelerated by high evaporative demand of seasonal wind and temperature.

Conversion as dead leaves

In the winter season experiment, the leaf senescence was seen early and relatively more than dry season. It may be hypothesized that a poor soil condition as opined early might have played a role in winter season (Navarai season). Under the circumstance there is reason to believe, as reported by Ramasamy *et al*. (1994), that the poor soil condition might have caused poor root condition and consequently advanced leaf senescene. Higher amount of non-functional (senescent) leaves at maximum tillering stage was recorded with no N applied fields and also the fields not applied with N split at active tillering (T3 and T7). Interestingly, nitrogen applied at heading stage had retained conspicuously more biomass as green leaves.

Partitioning to stem biomass

The GLM applied fields continued to promote the culm production comparatively to a longer period compared to urea-N by prolonged tiller production. It could also be noted that a higher culm biomass reduction recorded with GLM fields towards maturity was due to higher degeneration of tillers. The rate of biomass increase was greater, corresponding to the period of maximum tillering, mainly because of increased tiller biomass.

Withholding the N split usually intended at active tillering, drastically reflected the culm biomass under both the sources of N. Increasing the N through additional 20 kg ha^{-1} a week after tillering (1 WAT) and at heading favoured the culm biomass. Loss in culm biomass, otherwise described as remobilization, was higher in urea-N manured fields.

Flow of biomass to roots

Nitrogen application favoured root biomass production and its maintenance also. Fertilizer N was useful to promote higher roots in the early growth period whereas GLM had its role starting at around PI stage onwards. The N applied after active tillering was more beneficial for the root maintenance and production. The heading N rates had impact on the root system with low N application rates for better maintenance. Reducing the quantity intended for first top dressing (40 kg N at active tillering) to half (20 kg) and utilizing this saving (20 kg) at heading was useful in terms of root maintenance and favoured to retain relatively higher root biomas at maturity. The hypothesis proposed in the green leaf section could be confirmed again, through the higher root biomass of dry season compared to winter season, mainly to a better soil condition (which was not studied directly in these experiments) and its combined effect with split application of nitrogen. Relatively a higher root biomass till maturity is an indicator of the prevalenceof good soil condition, as opined by Chang (1983).

Conversion of biomass to panicle (Table 1&2)

A perceptible change in the panicle biomass was recorded when the recommended 120 kg N was given in four splits (T1 & T5) compared to three splits in winter season. In the dry season, the total biomass of panicles (includes neck-node, rachis and chaffy grains) was significantly higher, when an additional split (20 kg) was given, one week after tillering followed by 40 kg N at PI (T4 & T8). Increasing the heading N more than 20 kg (30 or 40 kg) did not make any perceptible change on the panicle weight under fertilizer N basal, whereas in GLM basal, even 40 kg N at heading, had a positive effect on

Table 1. Biomass partitioning of rice as influence by N source & rates on rice during winter season of Coimbatore.

Treat-ment	Nitrogen kg ha⁻¹				Green leaves		Dead leaves		Culm		Root		Panicle
	B	AT	PI	H	60 DAT	Maturity	60 DAT	Maturity	Max	Maturity	Max	Maturity	Maturity
T_1	40	20	40	20	2679	797	195	1577	5126 (60)	3329	1729 (80)	1620	8729
T_2	40	40	40	0	2764	987	183	1494	4675 (70)	3983	2119 (80)	1288	8720
T_3	40	0	40	40	2451	969	249	1028	4219 (70)	3593	2255 (60)	1352	8157
T_4	40	40	40	30	2737	1065	211	1420	5347 (60)	3489	2168 (70)	1322	8100
T_5	40*	20	40	20	2446	840	199	1487	6144 (60)	4293	1885 (60)	1433	9528
T_6	40*	40	40	0	2765	898	164	1330	5574 (60)	3370	2002 (60)	1318	7846
T_7	40*	0	40	40	2244	841	245	1377	5233 (60)	4328	2129 (60)	1543	8862
T_8	40*	40	40	30	3232	886	163	1505	6533 (70)	4460	1994 (60)	1496	8602
T_9	No Nitrogen				1825	301	289	1321	4092 (70)	2986	1731 (60)	1220	5942
SEd					94	33	8	54	-	139	-	49	255
CD (P=0.05)					199	69	17	115	-	294	-	104	540

Table 2. Biomass partitioning of rice as influenced by N source & rates during dry season of Coimbatore.

Treat-ment	Nitrogen kg ha⁻¹					Green leaves		Dead leaves		Culm		Root		Panicle
	B	AT	WA	PI	H	60 DAT	Maturity	60 DAT	Maturity	Max	Maturity	Max	Maturity	Maturity
T_1	40	20	0	40	20	3483	1476	200	1134	4654 (74)	4292	2784 (84)	2155	8573
T_2	40	20	0	40	30	3997	1577	236	1186	5787 (84)	5641	2824 (84)	8349	8456
T_3	40	20	0	40	40	3313	1320	276	1317	5123 (84)	5141	3056 (84)	2843	8295
T_4	40	20	20	40	20	3863	1667	197	1968	5446 (84)	5065	2738 (84)	2325	9211
T_5	40*	20	0	40	20	3431	1470	154	1240	4873 (74)	4338	3413 (74)	2643	8125
T_6	40*	20	0	40	30	3589	1592	164	1613	5862 (74)	5242	2981 (84)	2039	8254
T_7	40*	20	0	40	40	3750	1637	139	1699	5878 (74)	5259	2369 (84)	2328	9268
T_8	40*	20	20	40	20	4263	1732	263	1768	5826 (84)	4998	3182 (84)	2575	9413
T_9						3037	1055	398	1889	3913 (74)	3230	2601 (57)	1436	6044
SEd						136	74	8	55	-	180	-	81	216
CD (P=0.05)						289	158	18	117	-	383	-	172	458

B-Basal ; AT - Active Tillering ; WA - Week after active tillering ; PI - Panicle Initiation ; H - Heading ; * Nitrogen through green leaf manure. Figures in parentheses are DAT able 3. Total dry matter production of rice as influenced by N source & rates on rice during winter season of Coimbatore

Treat-ment	Nitrogen kg ha^{-1}				Days after transplanting							
	B	AT	PI	H	10	25	40	50	60	70	80	95
T_1	40	20	40	20	420	2167	3346	5660	10665	11040	12231	16052
T_2	40	40	40	0	647	2173	4093	5324	9961	11466	13907	15772
T_3	40	0	40	40	486	2173	4367	5033	9561	10833	11634	15097
T_4	40	40	40	30	504	2282	4101	5310	10849	11647	12438	15936
T_5	40*	20	40	20	387	1903	3534	5066	11964	12268	13837	17581
T_6	40*	40	40	0	460	2002	2995	5943	11519	11554	11971	15762
T_7	40*	0	40	40	489	2202	3197	5392	11744	11688	12763	16942
T_8	40*	40	40	30	614	2009	3224	5727	9200	12746	12765	16943
T_9	No Nitrogen				441	1807	2912	4025	9267	10073	11581	11770
	SEd				18	80	136	176	363	426	466	525
	CD (P=0.05)				38	171	288	372	770	904	989	1113

3-Basal; AT - Active Tillering; PI - Panicle Initiation; H - Heading;

* Nitrogen through green leaf manure

he panicle biomass. This might be due to slow but steady growth of tillers and panicle, which ought to have lead to positive response without any ill effects of applied chemical fertilizers as seen by Ramasamy et al (1997).

Total dry matter production (DMP) (Table 3&4)

As seen through partitioning the production of total dry matter got influenced by sources of N. Confining N application as GLM in spite of sluggish growth in the tillering stage, continued to accumulate the biomass with prolonged growth rate later and finally had apparent higher biomass with inorganic basal. GLM basal application could not gain initial momentum mainly because of slow conversion of organic N to inorganic N (Halepyati and Sheelavantar, 1993). Neither skipping the active tillering N nor increasing the heading N from 0 to 40 kg could alter the final biomass. As seen in the winter season, the dry season also responded to sources of N. But contrary to winter season the rates of heading N had impact on the DMP. The growth rate was seen comparatively higher, wherever GLM basal was supported by active tillering N as seen by Duhan and Mahendra Singh (1994). The biomass production was altered by heading N rates also (Ladha *et al.* 1989, Kalidurai and Kannaiyan, 1990). Thirty kilogram N was better than 20 kg under chemical fertilizer (urea) basal, whereas, in GLM basal even 40 kg was positive. It was also interesting to record that a 20 kg N applied IWAT and another 20 kg at heading (T4 & T5), an improved version of T1 and T5 of winter season, was able to produce higher dry matter at maturity.

Thus, green leaf manure basal and inorganic N urea basal had differential impact over the partitioning. Skipping a split at active tillering had a drastic effect over the partitioning when the basal manuring given was green leaf but not as chemical fertilizer. Twenty kg N ha^{-1} at active tillering produced controlled number of tillers and later higher productive tillers compared 40 kg. Split application of 20 kg each at active tillering a week later and heading was more useful to partition the photosynthates at correct proportion among various parts to produce better panicle biomass. Increasing the heading N rate more than 20 kg was found susceptible in maintaining root and translocation of stored reserves and thus poor panicle biomass.

References

Chang, Y.S. (1983). Effects of drainage on the characteristics of paddy soils in China. Organic matter of rice. IRRI.P.O.Box 933, Manila,

Table 4. Total dry matter production of rice as influenced by N source & rates of rice during dry season of Coimbatore

Treat-ment	Nitrogen kg ha^{-1}					Days after transplanting									
	B	AT	WA	PI	H	22	29	36	43	50	57	64	74	84	94
T_1	40	20	0	40	20	1778	2554	3996	5105	7718	9454	11022	12329	15586	17630
T_2	40	20	0	40	30	2031	2865	4141	5008	7430	9664	12025	12786	16428	19209
T_3	40	20	0	40	40	1941	2878	4685	4750	6514	8384	10546	12043	15795	18916
T_4	40	20	20	40	20	2004	3161	3742	4703	6937	9183	11630	13865	17240	20236
T_5	40*	20	0	40	20	1810	2453	3365	4685	6348	8386	11257	13384	16105	17816
T_6	40*	20	0	40	30	1943	2446	3142	4252	6849	8276	11125	12646	16232	18740
T_7	40*	20	0	40	40	1886	2625	3685	4349	6422	8613	11110	13028	16554	20191
T_8	40*	20	20	40	20	1699	2421	3605	5480	7714	9904	12670	14705	16619	20486
T_9	No Nitrogen				1582	2244	3138	4004	6122	8537	9453	10109	13172	13654	
SEd						65	87	138	166	210	335	446	482	603	650
CD (P=0.05)					138	185	292	352	466	710	946	1021	1278	1378	

B-Basal; AT - Active Tillering; WA - Week after active tillering; PI - Panicle Initiation; H - Heading;
* Nitrogen through green leaf manure

p.417-427.

De Datta, S.K., Buresh, R.J. and Mamaril, C.P. (1990). Increasing nutrient use efficiency in rice with changing needs. *Fert.Res.* **26** : 157-167.

Duhan, B.S., and Mahendra singh. (1994). Integrated nutrient management in rice with green manuring. *Haryana J. Agron.* **10** : 249-254.

Halepyati, A.S. and Sheelavantar, M.N. (1993). Effect of incorporation of different densities of *Sesbania rostrata* and nitrogen substitution rates on growth and yield of rice. *Oryza,* **30** : 67-72.

Kalidurai, M and Kannaiyan, S. (1990). Effect of Sesbania and azolla on rice grain and straw yield. *IRRN.* **15** : 26.

Ladha, J.K., Miyan, S. and Garcia, M. (1989). *Sesbania rostrata* as green manure for low land rice. Growth, N_2 fixation of *Rhizobium* sp., inoculation, and effects of succeeding crop yields and nitrogen balance. *Biol.Fertl. Soils.* **7** : 191-197.

Palaniappan, SP and Siddeswaran, K (1990). Evaluation of the potential green manures and grain legumes in rice farming systems. National symposium on rice farming systems. 2-3 Feb, 1990. Agrl. College and Res.Inst. Madurai, Tamil Nadu.

Palaniappan, SP and Budhar, M.N.(1989). Study on increasing nitrogen use efficiency in transplanted rice. *Indian J. Agron.* **34** : 154-155.

Ramasamy, S., Purusothaman, S and Rajagopal, A. (1994). The effect of drainage, Plant density and yield of irrigated low land rice. **In:** Ten Berge, H.F.M., Wooperies, M.C.S. and Shinm, J.C., (Eds.). *SARP Research proceedings.* Nitrogen economy of irrigated rice : field and simulation studies, ISBM 90-733-22-**2** : 165-184.

Ramasamy, S., Ten Berge, H.F.M . and Purushothaman, P. (1997). Yield formation in rice in response to drainage and nitrogen application. *Field Crop Res.* **51** : 65-82.

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