https://doi.org/10.29321/MAJ.10.A04205

Studies on Green Leaf Manures*

A preliminary study on the comparative merits of the commonly used green leaves as manure for Paddy

by

S. VARADARAJAN & M. SANYASI RAJU
Agricultural College and Research Institute, Coimbatore

Introduction: It is well known that any kind of green leaf when incorporated into the soil adds organic matter to it, in addition to augmenting the nitrogen supply. There are so many varieties of plants that provide green manure that there is absolutely no restriction as to the choice of leaves. However, there appears to be a belief in the minds of farmers that particular kinds of green leaves play a greater part in enhancing the yield of paddy than others. It has also often been reported that some kinds of leaves have the property of rectifying or mitigating the saline or alkaline condition of soils. To see if this popular belief is based on facts the following studies were carried out, as it is reasonable to expect that the quality of any green leaf manure would depend upon its succulence, easy decomposability and nitrogen content.

Review of Previous Work: It is reported that studies were carried out on a few types of green leaves to test their relative merits at the Agricultural Research Stations at Tirurkuppam, Aduthurai and Pattambi. The experiments were conducted from the point of view of only the final yield of paddy. It was found at Tirurkuppam (1) in *Sornawari* season that *Croton sparsiflorus* at 8,000 to 10,000 lb. gave the maximum yield of grain. *Croton sparsiflorus* at 4,000 to 6,000 lb. was on a par with *Pongamia glabra* at 8,000 to 10,000 lb. In straw yield it was found that *Croton sparsiflorus* at 6,000 to 8,000 lb. and *Pongamia glabra* 4,000, 6,000, 8,000 and 10,000 lb. were virtually equal. At the Agricultural Research Station, Aduthurai (2, 3, 4) no difference was found during the three years of trial between the types of green leaves tried. At the Agricultural Research Station, Pattambi (5, 6) there was significant difference in the first crop in one year.

At Coimbatore, trials with *Sesbania*, *Daincha* and wild *Indigo* show that all of them were of equal value. Similar trials have been carried out in Nagina Farm in Uttar Pradesh and Suri,

*Paper presented at the 32nd Study Group Meeting of the Agricultural Research Institute, Coimbatore.

in Bengal, on different green leaves. The findings in those two places go to show that there is no appreciable difference among the various leaves when tried on equal nitrogen basis. In Nagerkoil green leaves such as *Konnai* (*Cassia florida*) *Pungam*, (*Pongamia glabra*) *Avarai* (*Cassia auriculata*) and *Vahai* (*Albizzia lebbeck*) were tried. It was found that though *Konnai* leaves contained the highest percentage of nitrogen, *Vahai* leaves gave a better response; *Avarai* was second. Similar differences were noted in Kumpta and Karjat Farms of Bombay State. Since these experiments had not conclusively proved the relative efficacy of the green leaves studied, a study was undertaken to assess the relative merits of the commonly used green leaf manures.

Materials and Methods: 1. *Laboratory Studies:* The more important of the green leaves available near about the Institute were collected just after the monsoon when the leaves were fresh and in full flush. The leaves were gathered in the same manner a ryot would do to manure his fields. Soon after collection the stem and leaf portions were separated and their weights recorded. Thus the leaf to stem ratio was available to get an idea of the nature of the material. Original moisture was also estimated to know the succulence. The leaves and stems were sampled and kept in a steam oven to arrest the action of enzymes. After drying they were sampled in the usual way. The kinds of leaves taken up for study were: *Delonix, Calotropis, Thespesia, Gliricidia, Pongamia, Croton sparsiflorus* and *Sesbania.*

Analytical Technique: The nitrogen content of both the leaf and stem was estimated by the Kjeldahl's method (7) (vide Table I).

The decomposability of the leaf and stem was determined by the method described by Fred and Waksman (7)

Nitrifiability: Nitrifiability of a material indicates the rapidity with which it undergoes decomposition in the soil leading to the formation of nitrates, in which form most plants take up the nitrogen. This was assessed by the usual method, i.e. thirty milligrams of nitrogen in the form of leaf and stem were added separately to 100 grammes of soil which were placed in jam jars under constant optimum moisture level and kept at room temperature (28°C) for six weeks. Samples were analysed periodically to find out the rate of nitrate formation.

2. *Pot Experiments:* Pot experiments were also conducted to test the capacity of the different green leaves on the yield of paddy, as a knowledge of their chemical characteristics alone would not give a complete idea of their relative efficiency. In these tests paddy Co. 25 was grown in pots and crop response was studied to the different green leaf manures, incorporated at 45 lb. nitrogen per acre over a basal application of superphosphate at 30 lb. P_2O_5 per acre. In addition, the performance of the crop due to the green leaves was compared against those raised with ammonium sulphate and groundnut cake on the same nitrogen basis and against "No manure" also.

The experiment was carried out with a typical paddy soil starved of nitrogen for over seven years.

Technique:

(a) *Green Manure:* The green leaves were collected at the time of application, their nitrogen and moisture contents estimated, and the calculated amounts of leaves were applied to the pots, cut into small bits, after duly watering and puddling the soil. Treatments were replicated four times.

(b) *Watering:* A known quantity of water was added to each pot. The amount of water in all the pots was maintained at a constant level throughout the growth period.

(c) *Transplanting:* As is usual under field conditions, the green manure was allowed to rot for one week and one month-old seedlings were transplanted at the rate of eight per pot. The plants that did not get established were replaced with fresh seedlings.

(d) *Observations:* The following observations were recorded:

1. Rate of growth.
2. Tillering.
3. Duration of flowering.
4. Number of panicles.
5. Length of panicle.
6. Number of grains well-set and ill-set, and
7. Weight of 100 grains.

(e) *Harvest:* As the crop matured, the grains were harvested separately and the straw cut close to the roots. They were dried to constant weight and the yield data recorded. (Vide Table VI)

Results: The stem to leaf ratio, moisture content of stem and leaf and decomposability are presented in Table I. It may be seen that *Cassia auriculata* and *Delonix regia* are characterised by high proportion of leaf to stem. The decomposability of *Thespesia* is highest. The original moisture contents of *Sesbania, Gliricidia* and *Calotropis* are very high. Hence these are very succulent green manures.

The nitrogen content and nitrifiability of the leaf and stem are presented in Table II. The nitrogen content of all the green leaves is generally high but *Calotropis, Sesbania, and Croton sparsiflorus* nitrified far more rapidly than the leaves of other varieties. Nitrifiability of *Sesbania* is the highest while *Gliricidia, Calotropis, Croton sparsiflorus* and *Thespesia* may be said to be good.

The nitrogen content and nitrifiability afford the best index of the usefulness of green leaves. Judged by these criteria the value of the green leaf manures studied may be arranged in descending order as follows: *Sesbania speciosa, Gliricidia maculata, Calotropis gigantea, Thespesia populnea, Croton sparsiflorus, Delonix regia, Pongamia glabra, and Cassia auriculata.*

The rate of growth of paddy plants due to different green leaf manures are presented in Table III. It may be seen that in the earlier vegetative stages of growth the plants in *Gliricidia* series were tallest followed by those in groundnut cake series. Plants in ammonium sulphate series were only slightly better than the "No manure" treatment.

During the second fortnight the plants in ammonium sulphate series were tallest and the rate of growth was markedly superior to the rest of the treatments. This superiority was maintained throughout the growth period. This may be due to the fact that the ammonium sulphate being soluble, the nitrogen might not have been available within the reach of the plants till the roots were well developed and the plants were able to assimilate it to the best advantage.

TABLE I

Showing the stem to leaf ratio, original moisture and decomposability.

Green leaf manure	Ratio of stem to leaf	Percentage moisture in green state		Decomposability Mgm. of CO_2 Evolved in 24 hrs.	
		Stem	Leaf	Stem	Leaf
1. Delonix ..	1 : 3·90	55·85	66·28	..	..
2. Calotropis ..	1 : 0·80	81·87	85·04	18·37	18·90
3. Thespesia ..	1 : 2·30	51·53	62·92	29·96	42·35
4. Gliricidia ..	1 : 1·89	76·95	76·00	17·27	20·13
5. Pongamia ..	1 : 1·34	54·50	58·70	12·76	13·09
6. Croton sparsiflorus	1 : 1·20	47·18	64·22	12·91	10·28
7. Cassia ..	1 : 3·80	42·79	55·58	..	..

The analysis of the other three green leaf manures has not been completed.

TABLE II

Showing nitrogen content and nitrifiability of the different green leaves.

Green leaf manure	Nitrogen percentage (Dry basis)		Nitrifiability of leaf %	Time in weeks
	Stem	Leaf		
1. Delonix ..	1·47	2·27	−3·09	6
2. Calotropis ..	1·40	3·52	23·17	4
3. Thespesia ..	1·56	3·28	21·33	6
4. Gliricidia ..	1·84	3·98	26·67	6
5. Pongamia ..	1·89	3·79	6·13	6
6. Croton sparsiflorus ..	2·10	3·85	23·53	4
7. Sesbania ..	..	..	34·73	4

TABLE III

Showing the rate of growth of paddy due to different green-leaf manures.

(at fortnightly intervals)

Intervals	I	II	III	IV	V	VI	VII	VIII
Treatments :								
1. Delonix ..	51·9	62·4	64·4	65·7	68·7	77·9	100·6	103·3
2. Calotropis ..	49·6	57·5	58·6	61·9	63·8	70·2	89·9	91·8
3. Thespesia ..	51·9	54·1	56·2	57·4	50 4	67·9	85·5	90·5
4. Datura ..	50·7	54·2	57·6	60·8	62·0	67·8	77·3	90·1
5. Gliricidia ..	58·1	59·6	63·9	68·0	68·4	75·6	96·6	98·3
6. Pongamia ..	50·2	55·7	58·6	62·2	63·6	70·7	89·7	89·3
7. Croton sparsiflorus ..	52·1	53·6	60·5	63·3	64·0	72·1	90·9	97·2
8. Cassia ..	49·4	56·7	63·2	65·2	67·7	80·6	98·8	100·6
9. Sesbania ..	50·3	56·5	60·8	64·1	65·6	72·9	93·1	95·6
10. Enterolobium ..	47·6	55·6	62·5	64·3	68·8	76·3	96·3	98·7
11. Groundnut cake ..	55·1	58·6	64·3	68·0	69·7	79·5	97·6	97·2
12. Ammonium sulphate ..	47·0	65·5	74·6	77·1	82·7	94·1	109·7	113·1
13. No manure ..	45·1	48·6	51·7	51·2	55·3	61·0	76·2	81·9

The vegetative characters are presented in Table IV. In the matter of tillering also the ammonium sulphate series was again the best, followed by *Delonix*. The rest of the treatments were about the same.

TABLE IV.

Showing the vegetative characters due to different treatments.

Treatments	Average number of tillers	Average number of earheads	Length of earhead in cms.
1. Delonix ..	2·25	11·8	19·38
2. Calotropis ..	1·88	10·0	17·37
3. Thespesia ..	1·68	10·0	16·56
4. Datura ..	1·68	10·5	16·75
5. Gliricidia ..	1·63	10·3	17·56
6. Pongamia ..	1·88	10·8	18·56
7. Croton sparsiflorus ..	1·75	9·5	14·12
8. Cassia ..	1·78	9·3	19·69
9. Sesbania ..	1·75	10·5	18·44
10. Enterolobium ..	1·78	9·8	18·38
11. Groundnut cake ..	2·20	9·8	18·31
12. Ammonium sulphate ..	3·60	21·5	19·38
13. No manure (control) ..	1·33	9·0	16·81

Flowering was observed in all the treatments simultaneously except in the ammonium sulphate series which was delayed by a couple of days. The duration of flowering was five days in almost all cases. The maximum earhead formation was in the ammonium sulphate treatment; *Delonix* occupying the second place. In the matter of length of earhead, however, the *Cassia* series topped the list followed by ammonium sulphate and *Delonix*. The maximum number of grains was found in the *Cassia* series followed by ammonium sulphate series. Groundnut cake ranked third and the other series such as *Pongamia, Sesbania, Gliricidia, and Croton sparsiflorus* were fairly good. (Table V). But the proportion of well-set grains to ill-set grains was highest in ammonium sulphate series (85·96%) followed closely by groundnut cake and *Cassia* series. *Delonix* and *Thespesia* were the poorest in this respect.

In the matter of yield of grain ammonium sulphate ranked first, being distinctly superior to the rest of the treatments with an increase in yield of 304% of grain and 283% of straw over the "No manure". Among the green leaves there was no significant difference in yield. In regard to straw also, ammonium sulphate ranked as the first (Vide Table VI.)

TABLE V

Showing the number of grains per earhead in each series with the percentage of well-set and ill-set grains

	Treatments	Well-set	Ill-set	Total	Well-set %	Ill-set %
1.	Delonix ..	68·9	32·4	101·3	68·03	31·97
2.	Calotropis ..	68·3	22·3	90·6	75·39	24·61
3.	Thespesia ..	49·1	23·8	72·0	67·36	32·64
4.	Datura ..	64·1	17·4	81·5	78·65	21·35
5.	Gliricidia ..	80·0	29·5	109·5	73·05	26·95
6.	Pongamia ..	88 0	29·4	109·1	80·67	19·33
7.	Croton sparsiflorus ..	95·5	21·1	117·4	81·34	19·36
8.	Cassia ..	104·3	21·9	126·2	82·62	17·38
9.	Sesbania ..	74·3	26·7	100·4	74·01	25·99
10.	Enterolobium ..	83·3	25·5	108·8	76·54	23 46
11.	Groundnut cake ..	101·1	20·6	121·7	83·08	16·92
12.	Ammonium sulphate ..	107·0	17·5	124·5	85·96	14·04
13.	No manure ..	55·8	17·8	73·6	75·80	24·20

(Average value of 8 ear-heads per series)

TABLE VI.

Showing the summary of results of the comparative manurial values of various green leaf manures for paddy. (Pot-culture experiments)

	Treatments	Particulars			
		Grain		Straw	
		Average yield per pot	Percentage on control	Average yield per pot	Percentage on control
1.	Delonix ..	11·48	168·8	23·25	193·9
2.	Calotropis ..	8·15	119·9	15·75	131·3
3.	Thespesia ..	6·98	102·6	16·75	139·6
4.	Datura ..	8·73	128·3	16·75	139·6
5.	Gliricidia ..	9·75	143·4	19·00	158·3
6.	Pongamia ..	9·53	140·1	15·75	131·3
7.	Croton ..	11·08	162·9	18·00	150·0
8.	Cassia ..	12·25	180·1	20·25	168·8
9.	Sesbania ..	8·23	121·0	19·00	158·4
10.	Enterolobium ..	10·78	158·4	19·75	164·6
11.	Groundnut cake ..	11·08	162·9	19·50	162·5
12.	Ammonium sulphate ..	27·43	399·6	46·00	383·3
13.	No manure ..	6·80	100·0	12·00	100·0
	General-mean ..	10·94		20·14	
	Standard error ..	1·65		4·88	
	'Z' test satisfied or not	Yes		Yes	
	Critical difference at 1·0% level ..	4·9		13·27	

Conclusion :— GRAIN : 12 | 8 1 7 11 10 5 6 4 9 | 2 3 13

STRAW : 12 | 1 8 10 11 9 5 7 4 3 2 | 6 13

The weight of 100 grains of paddy from the different treatments are presented in Table VII. The weight of grains obtained from *Croton sparsiflorus* and *Cassia auriculata* was distinctly greater than the rest. Grains from *Calotropis* and *Thespesia* were distinctly poorer in weight and there was no significant difference between the other treatments. Ammonium sulphate, therefore, is noted not to have influenced the weight of grain. This, it has made up by the increased number of well-set grains per panicle and increased branching of the panicle.

From the data it is clear that ammonium sulphate is far superior to the green leaf manures in the matter of yield of grain and straw when applied on equal nitrogen basis. The factor responsible for the increased yield is evidently due to the readily-available nitrogen supplied by ammonium sulphate. Such an indication was also noted by Karunakar et. al (8).

Regarding the source of organic nitrogen in the form of different green leaves, the variety of green leaf has no material influence on the yield of paddy among themselves but, compared with "No manure" the green leaf manures have definitely increased the yield.

Summary and Conclusions:

(1) The stem to leaf ratio, original moisture content, nitrifiability and decomposability of the different green leaves were determined.

(2) The growth characteristics and the yield behaviour of the paddy crop due to the application of the different green leaf manures were studied in pots.

(3) Ammonium sulphate was found to be distinctly superior to any organic nitrogen supplied, in the form of green leaf manures and groundnut cake.

(4) Ammonium sulphate was found to significantly increase the yield of grain and straw.

(5) Grain weight with ammonium sulphate was significantly less; that with *Delonix* being the best.

(6) Supply of readily available nitrogen as in the case of ammonium sulphate may be taken as the factor influencing high yield.

(7) While application of green leaves gives enhanced yields generally, the variety of green leaves applied has no influence on the increase of yield.

(8) Ammonium sulphate is more quick-acting than green manure, but green manures are a cheaper source of nitrogen supply. The evidence, therefore, points to a combination of ammonium sulphate plus green manure as the most efficient and economical way of supplying nitrogen to paddy.

TABLE VII

Showing the weight of 100 paddy grains from the different green-leaf manure series

Treatments	Particulars	
	Average weight of grains	Increase or decrease in weight over control
A. Delonix	1·777	99·72
B. Calotropis	1·743	98·17
C. Thespesia	1·740	98·02
D. Datura	1·783	102·30
E. Gliricidia	1·775	100·00
F. Pongamia	1·775	100 00
G. Croton sparsiflorus	1·863	105·00
H. Cassia	1·835	103·40
I. Sesbania	1·795	101·10
J. Enterolobium	1·813	102·10
K. Groundnut cake	1·765	99·65
L. Ammonium sulphate	1·783	102·30
M. No manure	1·775	(100·00)
General Mean	1·786	
Standard error	0·00774	
'Z' test satisfied or not	Yes	
Critical difference at 1% level	0·021	

Conclusions:— G H J I L D A E F M K B C

List of botanical names of the green-leaf manures used in this experiment

1. *Delonix regia* Rafin
2. *Calotropis gigantea* R. Br.
3. *Thespesia populnea* Soland
4. *Datura Metel*
5. *Gliricidia sepium* Steud (*Gliricidia maculata* H. B. K.)
6. *Pongamia glabra* Vent.
7. *Croton sparsiflorus* Mor.
8. *Cassia auriculata* Linn.
9. *Sesbania speciosa* Soland
10. *Enterolobium saman* Prain

LITERATURE CITED

Station Report	(1945—1946)	Agricultural Research Station, Aduthurai.
Station Report	(1946—1947)	Agricultural Research Station, Tirurkuppam.
Station Report	(1946—1947)	Agricultural Research Station, Aduthurai.
Station Report	(1947—1948)	Agricultural Research Station, Aduthurai.
Station Report	(1948—1949)	Agricultural Research Station, Pattambi.
Station Report	(1949—1950)	Agricultural Research Station, Pattambi.
Frod, E. B. and Waksman, S. A.	(1938)	Laboratory Manual of General Microbiology, McGrawHill, Book Co., Inc.
Karunakar, P. D., Sanyasi Raju, M., and Verghese, E. J.,	(1951)	Proceedings of the First Scientific Workers' Conference. Madras Agricultural Department.
Sethi, R. L., Ramiah, K., and Abraham, T. P.	(1952)	Manuring of Rice in India; Indian Council of Agricultural Research — Bull. No. 38.

Chelates in Agriculture — Sequestrenes and Versenols of Commerce

(A Review)

by

T. SESHAGIRI & A. MARIAKULANDAI

It has been recently discovered that iron chlorosis in fr and garden crops could be completely cured by the use of cer complex organic iron compounds known as "iron chelates". metallic elements in this complex form are referred to technicall being "chelated", or "sequestered" to denote the manner in wl