THE VALUE OF SOME LEGUMINOUS PLANTS AS GREEN MANURES IN COMPARISON WITH *CROTALARIA JUNCEA*[1][2]

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General conclusion

In the experiments located in Central and East Java green manuring was generally effective provided sufficient green matter was available to plough under. Also in cases where circumstances were not favourable for rice production increases in yield could be obtained.

In comparison with *Crotalaria juncea* the effect of various other leguminous plants was determined. The Leguminosae tested in the experiments were:

Crotalaria juncea (expt. 1, 2, 3, 4, 5)
Crotalaria anagyroides (expt. 1, 4)
Crotalaria usaramoensis (expt. 1)
Tephrosia vogelii (expt. 1)
Tephrosia purpurea (expt. 5)
Calopogonium mucunoides (expt. 1)
Indigofera spec. (expt. 2)
Sesbania sericea (expt. 3, 5)
Sesbania aculeata (expt. 3, 4, 5)
Cassia mimosoides (expt. 4)
Soybeans (expt. 5).

With the exception of the first experiment in which *Crotalaria anagyroides* proved to be the best, all other experiments resulted in *Crotalaria juncea* giving the highest increase in yield.

In most experiments it was not disadvantageous to grow the Leguminosae between the rows of the precedinn maize crop. In many cases, on the contrary, it even appeared to be favourable.

Introduction

In pre-war experiments the value of some of the more important leguminous plants for green manurial purposes has been estimated.

Crotalaria juncea as a quick growing plant has hitherto been the most important plant in areas where green manuring of irrigated rice is practiced. Seed production of this plant has, however, been the principal drawback for a more extensive application. It has therefore been the aim to select other plants which might have similar effect as *C. juncea* and at the same time an adequate seed production.

In order to obtain such information the effect of other leguminous plants with satisfactory seed production has been compared with that of *Crotalaria juncea* in the principal areas suitable for green manuring practices.

Not only the effect of green manuring rice, but also the influence of the growth of these plants after the harvest or between the rows of the preceding crops and the residual effect on the dry season crops of the green matter turned under has to be taken into account.

Results of experiments with various leguminous plants

Experiment 1 *Location:* Central Java, Pekalongan.

Altitude: 400 meters above sea level.

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[2]) Received for publication January 11, 1954.

Soil: Young vulcanic andesitic lateritic soil from the mountain Slamet. Altitude and soil are representative for a large area.

Design of experiment: Block design, plots of 10 × 10 = 100 sq.m., 8 replications, and six treatments.

Treatments: A Control, B *Crotalaria anagyroides,* C *Crotalaria usaramoensis,* D *Crotalaria juncea,* E *Tephrosia vogelii* and F *Calopogonium mucunoides.* The experiment was repeated during 4 successive years.

The leguminous plants except *Crotalaria juncea* were sown between the rows of maize which precedes rice in this area. They were sown about 6 weeks after maize was sown.

Crotalaria juncea which grows quickly (length of life 30—60 days) was sown after the harvest of maize. Maize was grown in the pre-westmonsoon when rainfall increases gradually. All green manuring plants were turned under about 10 days before rice was transplanted.

In table 1 the yields of maize are presented. The growth of leguminous plants was in most cases advantageous for the maize crop. The results are in accordance with those reported for Indonesia by OSSEWAARDE (1927) and VAN DE GOOR (1941). The total increase in yield obtained in four successive years was significant for *Crotalaria anagyroides, Crotalaria usaramoensis, Tephrosia Vogelii* and *Calopogonium mucunoides.* The total effect of *Crotalaria juncea* was insignificant although an increase in yield was stated in 3 years. This increase is due to the residual effect only, as maize could not benefit from the *Crotalaria juncea* plants in any other way as *C. juncea* was sown after the harvest of maize.

The results of the leguminous plants presented in Table 2 demonstrate that the largest quantities of green matter were produced by *Crotalaria anagyroides* and *Calopogonium mucunoides.* The production of *Crotalaria usaramoensis* was in most years the lowest of the group. The amount of green matter of *Tephrosia vogelii* was in three out of four years almost at the same level.

Crotalaria juncea on the average produced 1 quintal of green matter for every day of growth. The variation in production of the plants was due to excessive rain or drought. In the first year of the experiment *C. juncea, C. usaramoensis,* and *Tephrosia vogelii* showed irregular growth because of too much rain. In the next two years growth of *C. anagyroides* and *C. usaramoensis* was slow as a result of excessive drought. *Calopogonium* was evidently less influenced by climatic conditions.

The effect of green manuring on rice is presented in Table 3.

The young vulcanic soil of the experimental field was very pervious. In all four years water was inadequate for regular irrigation. Yields were generally low.

In 4 years the effect of *Crotalaria anagyroides* and *Calopogonium mucunoides* was high and significant (average 8 and 7.2 quintals per ha dry paddy).

The effect of *Crotalaria juncea* was significant at P = 0.01 percent level in the first two years and significant at P = 0.05 in the consecutive two years. Response to *Tephrosia vogelii* was significant in the first three years and insignificant in the last year of the experiment. The response to *Crotalaria usaramoensis* was only significant in 2 years.

When the average increases in yield are compared with the average amounts of green matter turned under it appears that there is a close correlation between the quantity of matter applied and the increase in yield.

Table 1.

Treatments	Yield of maize in quintals per ha harvest dry cobs								Total increase in yield
	1929/30		1930/31		1931/32		1932/33		
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase	
A Control	26.1	–	33.4	–	18.4	–	24.2	–	–
B *Crotalaria anagyroides*	30.6	4.5 ± 3.0	43.0	9.6 ± 5.1	24.2	5.8 ± 3.4	25.2	1.0 ± 4.2	20.9 ± 8.0
C *Crotalaria usaramoensis*	32.1	6.0 ± 4.2	39.3	5.9 ± 5.2	24.4	6.0 ± 4.4	27.7	3.5 ± 3.1	21.4 ± 8.6
D *Crotalaria juncea*	26.4	0.3 ± 3.3	38.3	4.9 ± 5.3	25.6	7.2 ± 4.2	25.8	1.6 ± 3.8	14.0 ± 8.4
E *Tephrosia vogelii*	24.5	–1.6 ± 3.6	39.3	5.9 ± 4.9	27.1	8.7 ± 4.1	26.4	2.2 ± 3.1	15.2 ± 8.0
F *Calopogonium mucunoides* ..	28.8	2.7 ± 4.4	41.8	8.4 ± 5.0	22.7	4.3 ± 4.1	28.8	4.6 ± 3.4	20.5 ± 8.5

Table 2.

Treatments	Age in days and yield in q/ha green matter of leguminous plants									
	1929/30		1930/31		1931/32		1932/33		Average	
	Age	Yield	Age	Yield	Age	Yield	Age	Yield	Age	Yield
A Control	–	–	–	–	–	–	–	–	–	–
B *Crotalaria anagyroides*	106	140.9 ± 8.7	113	83.4 ± 13.2	113	17.8 ± 2.4	114	137.5 ± 13.7	111	95.0
C *Crotalaria usaramoensis*	106	17.0 ± 3.7	113	10.5 ± 2.2	113	25.1 ± 4.9	114	59.0 ± 13.0	111	27.9
D *Crotalaria juncea*	32	44.4 ± 4.2	45	52.8 ± 5.8	65	23.6 ± 2.9	46	63.4 ± 12.0	47	46.1
E *Tephrosia vogelii*	106	44.2 ± 7.9	113	47.0 ± 9.7	113	47.8 ± 7.1	114	24.6 ± 4.0	111	40.9
F *Calopogonium mucunoides* ..	106	107.4 ± 8.9	113	94.1 ± 12.9	113	80.5 ± 5.5	114	86.4 ± 11.2	111	92.1

Table 3.

Treatments	1929/30 Var.: Andel (bulu)		1930/31 Variety: Tjina		1931/32 Variety: Tjina		1932/33 Var.: Andel (bulu)		Average increase in dry paddy	Average amount of green manure
	Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase		
	in dry stalk paddy		in dry paddy		in dry paddy		in dry stalk paddy			
A Control	21.4	–	13.8	–	14.3	–	25.8	–	(15.9)	0
B *Crotalaria anagyroides*	35.4	14.0 ± 2.1	22.4	8.6 ± 1.2	18.5	4.2 ± 1.1	37.3	11.5 ± 3.0	8.0	95.0
C *Crotalaria usaramoensis*	25.5	4.1 ± 2.6	18.1	4.3 ± 1.3	17.6	3.3 ± 1.2	30.9	5.1 ± 2.7	3.7	27.9
D *Crotalaria juncea*	28.5	7.1 ± 2.7	19.9	6.1 ± 1.9	17.4	3.1 ± 1.4	32.0	6.2 ± 2.9	4.8	46.1
E *Tephrosia vogelii*	29.9	8.5 ± 2.6	20.2	6.4 ± 1.7	20.8	6.5 ± 1.2	28.7	2.9 ± 2.8	5.4	40.9
F *Calopogonium mucunoides* ..	32.3	10.9 ± 2.9	21.2	7.4 ± 1.9	22.2	7.9 ± 1.4	32.6	6.8 ± 2.4	7.2	92.1

Conclusion. Under the particular conditions of the experiment the most suitable leguminous plant for green manurial purposes was definitely *Crotalaria anagyroides* and the second best *Calopogonium mucunoides.* The yields of the control being low on these pervious soils with inadequate irrigation facilities (mean yield 15.9 quintals dry paddy per ha) could be improved considerably. The effect of the growth of these plants on maize between the rows of which they were grown was significantly favourable.

EXPERIMENT 2. *Location:* East Java, Besuki.

Altitude: 15 meters above sea level.

Soil: Brown grey clay on gravel-hardpan. This location is representative foi a large rice and maize rotationing area.

Design of experiment: Block design, plots 10 × 15 = 150 sq.m., 7 replications and 3 treatments.

Treatments: A Control, B *Crotalaria juncea,* C *Indigofera spec.* The experiment was repeated during 3 successive years.

Maize and *Indigofera* were sown simultaneously, *C. juncea* was sown after the harvest of maize. The variation in yield of maize, green manure and rice was small; therefore, only the average results of the three consecutive years are presented in Table 4.

Table 4.

Treatments	Yields in q/ha			Increase in yield in q/ha	
	Maize dry cobs	Green matter	Dry stalk paddy	Maize	Dry stalk paddy
A Control	17.6	–	33.3	–	–
B *C. juncea*	18.2	174.8	47.6	0.6	14.3
C *Indigofera*	21.1	139.6	46.0	3.5	13.0

The average life span of *C. juncea* was 65 and of *Indigofera* 160 days.

The effect of *Indigofera* on maize was favourable, that of *C. juncea* grown after maize was insignificant. Both leguminous plants increased the yield of rice significantly.

Conclusion. Although *Indigofera* needs more time to produce sufficient green matter it is feasible to grow this plant because no harmful effect on maize was stated when maize and *Indigofera* were sown simultaneously; on the contrary, a significant increase in yield of maize was stated.

Crotalaria juncea grows more quickly and produced an equal amount of green matter when sown after the harvest of maize.

Both leguminous plants are suitable for this area.

EXPERIMENT 3. *Location:* East Java, Madiun.

Altitude: 100 meters above sea level.

Soil: Grey brown, old, andesitic ash-loam, soil. Soil and altitude are representative for the plain in which the experiment was located.

Design of experiment: Block design, plots of 10 × 10 = 100 sq.m., 6 replications and 5 treatments.

Treatments: A Control, B *Crotalaria juncea,* C Soybeans (strain no 29) in the first year and *Tephrosia purpurea* in the next two years, D *Sesbania sericea,* E *Sesbania aculeata.* The experiment was repeated during 3 successive years.

A single analysis of variance was constructed for the three years.

As the leguminous plants of treatment C failed to grow sufficiently, the results were not considered in the analysis.

The results of green manure and rice are presented in Table 5.

Table 5.

Treatment	Yield in q/ha		Increase in yield
	Green matter	Dry paddy	
A Control	–	18.0	–
B *Crotalaria juncea*	171.5	26.4	8.4
C *Sesbania sericea*	66.3	22.9	4.9
D *Sesbania aculeata*	76.4	24.0	6.0
Significance at P = 0.05:	76.36	–	4.52
Significance at P = 0.01:	150.69	–	7.97

The yield of green matter of *Crotalaria juncea* was much more than of both *Sesbania* species. All plants were grown in about 60 days. The average increase in yield was for these three years 8.4 for *C. juncea*, 6 for *Sesbania aculeata* and 4.9 for *Sesbania sericea.*

Conclusion. In this area where about two months are available to grow leguminous crops after the dry season crop (sweet potatoes a.o.) *Crotalaria juncea* shows the best growth. This must be due to the fact that *C. juncea* is more resistant to excessive droughts. Both *Sesbania* species are more favourable for areas which are subject to excessive moisture.

EXPERIMENT 4. *Location.* Central Java, Semarang.

Altitude: 360 meters above sea level.

Soil: Grey brown, young andesitic lateritic soil, rich in biotite.

Design of the experiment: Block design, plot size 6.5 × 8 = 52 and 6.5 × 7 = 45.5 sq.m., 6 replications and 5 treatments.

Treatments: A Control, B *Crotalaria anagyroides*, C *Crotalaria juncea*, D *Cassia mimosoides*, E *Sesbania aculeata.*

In order to show the general trend of the experiment only the results of the single analysis of variance of the consecutive three years will be presented in Table 6.

The leguminous plants were sown 6 weeks after maize was sown. The results of maize are therefore also taken into consideration.

Table 6.

Treatment	Yields in q/ha			Increase in yield	
	Maize dry seed	Green matter	Dry paddy	Maize	Rice
A Control	9.0	–	15.4	–	–
B *Crotalaria anagyroides*	11.4	90.5	19.9	2.4	4.5
C *Crotalaria juncea*	9.5	187.6	23.0	0.5	7.6
D *Cassia mimosoides*	10.3	59.3	15.7	1.3	0.3
E *Sesbania aculeata*	9.8	149.0	21.8	0.8	6.4
Significance at P = 0.05:	–	90.7	–	1.22	4.07
Significance at P = 0.01:	–	159.7	–	2.05	6.81

In these three years the effect of *Crotalaria anagyroides* on maize was high and significant, the effect of *Cassia mimosoides* was less but also significant.

The growth of both other species did not influence the production of maize significantly. The response of rice was significant at P = 0.01 percent level in the case of *Crotalaria juncea,* and significant at P = 0.05 percent level for *Sesbania aculeata* and *Crotalaria anagyroides. Cassia mimosoides* did not affect the yield of rice.

Conclusion. The best leguminous plant under the prevailing circumstances appeared to be *Crotalaria juncea*; *Cassia mimosoides* was without effect as far as rice is concerned, it increased the yield of maize significantly simply by its growth between the rows. Maize was also favourably affected by *Crotalaria anagyroides.* The other two leguminous plants which produced more green matter did not increase the yield of maize. This probably may be due to the more luxuriant growth of these plants by which a possible favourable affect was counteracted.

EXPERIMENT 5. *Location:* East Java, Surabaja.

Altitude: 75 meters above sea level.

Soil: Grey, young andesitic ash-sand soil. In this area green manuring, especially with *Crotalaria juncea,* becomes a common practice. *Crotalaria juncea* is sown between rows of maize or after maize or other dry season crops.

The treatments of the experiments varied in number and kind of treatment. The design was similar to that of the experiments 1–4 as far as plot size and number of replications are concerned.

The ash soils where the experimental fields were located are very light, with a very low organic matter content and consequently with a low nitrogen level. Effect of green manure, therefore, can be expected to be high. The rice crop is liable to excessive water when the level of the water table reaches the surface of the soil or to excessive drought because of the perviousness of the soil.

The results of two experiments in the season of 1938/39 presented in Table 7 are examples of both.

Table 7.

Treatment	Yields in quintals per ha			
	Green matter	Dry paddy	Green matter	Dry paddy
A Control	–	9.3	–	5.7
B *Sesbania aculeata*	55.1	11.1 (1.8)	165.5	7.0 (1.3)
C *Crotalaria juncea*	70.9	10.2 (0.9)	128.8	8.4 (2.7)
D Soybeans	15.9	11.2 (1.8)	–	5.6

The yields were low in the first experiment due to too much water, in the second experiment to inadequate water supply. The increases in yield as a result of *Sesbania aculeata* and soybeans in the first and of *Sesbania aculeata* and *Crotalaria juncea* in the second experiment were low but significant.

In Table 8 results of two experiments in which the leguminous plants were sown between maize rows are presented. The decreasing effect on maize of

the green manure crop in the first experiment may be due to excessive drought during the growth of maize. The leguminous plants competed for soil moisture.

Table 8.

Treatments	Yields and increases in yield in quintals per ha									
	Maize dry cobs	Difference	Green matter	Dry paddy	Increase in yield	Maize	Difference	Green matter	Dry paddy	Increase in yield
A Control	25.6	—	—	22.1	—	22.9	—	—	17.6	—
B *Sesb. aculeata* .	20.9	— 4.7	126.6	30.6	8.5	28.2	5.3	234.0	34.1	16.5
C *Crot. juncea* ..	19.6	— 6.0	228.2	35.0	12.9	25.3	2.4	248.9	35.8	18.2
D' Soybeans	24.2	— 1.4	11.3	23.3	1.2	—	—	—	—	—
D" *Teph. purpurea*	—	—	—	—	—	28.9	6.0	12.2	18.7	1.1
E *Sesb. sericea* .	22.8	— 2.8	10.9	23.4	1.3	26.3	3.4	216.4	31.5	13.9

When the leguminous plants produced an adequate amount of green matter the effect of this matter applied to the rice crop was high and significant.

Results with soybeans and *Tephrosia purpurea* were disappointing.

References

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