Vetch is an economical source of nitrogen in rice

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Interest in nitrogen fixed in rice fields by leguminous green manures has revived because of the rapidly rising costs of nitrogen fertilizers. We present here previously unreported data from experiments performed over 20 years ago on the best time to plant several vetch species in maturing paddy rice to produce a winter-grown green manure crop.

Vetch can easily be seeded aerially in a rice crop before harvest, but the question was whether it should be planted into the water or after drainage. It was thought that the sprouting vetch could use residual moisture from flood water after, and possibly even before, drainage in mid-September, because little rain occurs until late October or November.

Three field experiments were conducted at the Rice Experiment Station, Biggs, simulating aerial planting of vetch from 25 days before draining the flood water in a rice field up to 32 days after drainage. A device was made from large electric conduit that would drop the seed uniformly from a height of up to 3 feet. In each experimental unit, 100 vetch seeds were planted in a row 20 feet long, with rows 5 feet apart. Each vetch-species and time-of-planting combination was randomized and replicated four times in blocks. After the rice was harvested, the straw was removed from the rows to facilitate observations on the vetch.

In experiment A, four species — common, hairy, Lana woolypod, and purple vetches (*Vicia sativa, V. villosa, V. dasycarpa,* and *V. benghalensis*) — were seeded 1, 5, 9, and 25 days before the rice was drained. Purple vetch was also seeded 1, 2, 4, and 8 days after drainage.

Lana and purple vetches were more tolerant of submergence than were common and hairy vetches, but five or more days of submergence severely reduced stands of all species (see table). Pot tests under controlled conditions confirmed these differences. About one-third of the purple vetch seeds planted at all dates after drainage produced mature plants. A half inch of rain that fell 2 days after the 8-day planting tended to equalize moisture availability among the planting dates after drainage.

Because the rice was lodged, the harvester was run close to the ground at harvest time 21 days after drainage. Almost all of the vetch plants were cut off, leaving only a few inches of stem. The plants survived, but their final dry weights were probably reduced.

In experiments B and C, planting times ranged from 8 days before to 32 days after drainage, and only Lana and purple vetches were included. In both experiments, production of plants from seed of both species

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Stand Establishment of Vetch Green Manure in Maturing Paddy Rice as Affected by Planting Dates Before and After Drainage

Days before or after drainage	Experiment A. Establishment on April 8, 1957, per 100 seeds sown fall, 1956: Stand				Dry weight			
	Common	Hairy	Lana	Purple	Common	Hairy	Lana	Purple
	%	%	%	%	g	g	g	g
-25	0	0	0	0	0	0	0	0
-9	0	0	0	1	0	0	0	6
-5	0	0	3	5	0	0	17	30
-1	6	16	33	29	8	40	145	110
0*	—	—	—	—	—	—	—	—
1	†	†	†	31	†	†	†	99
2	†	†	†	30	†	†	†	99
4	†	†	†	39	†	†	†	133
8	†	†	†	36	†	†	†	137
LSD 0.05				9				115

Days before or after drainage	Experiment B. Establishment on April 27, 1959, per 100 seeds sown fall, 1958: Stand		Dry weight		Experiment C., Establishment on May 2, 1960, per 100 seeds sown fall, 1959: Stand		Dry weight	
	Lana	Purple	Lana	Purple	Lana	Purple	Lana	Purple
	%	%	g	g	%	%	g	g
-8	3	0	20	8	1	3	3	12
-4	12	5	158	58	3	4	10	15
-2	17	13	243	143	15	29	85	153
-1	26	8	305	105	17	34	72	162
0*	32	18	298	129	21	41	107	206
1	39	16	363	133	26	28	119	115
2	30	15	303	135	30	23	91	90
4	36	29	243	203	21	16	23	16
8	43	36	268	180	17	21	18	19
16	53	49	275	223	19	30	18	26
32	54	37	268	165	24	28	26	27
LSD 0.05	23	17	258	ns	13	14	60	96

NOTE: Data are means of four replicates of 100 seeds planted in a 20-foot row.
*Experiment A rice field drained September 7 and 8, 1956. Experiment B field drained September 17, 1958. Experiment C field drained September 22, 1959.
†Not measured.

Biological control of brownbanded cockroaches

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Cockroaches, described in a 1976 National Pest Control Association report as second only to termites in economic importance, have been the object of major control efforts by the pest control industry. Little consideration, however, has been given to natural enemies for cockroach control.

In 1948 it was reported that a parasitic wasp, *Comperia merceti* (Compere), "had practically wiped out" brownbanded cockroaches, *Supella longipalpa* from some places in Honolulu, and releases of the parasite were made. The wasp lays its eggs only in brownbanded cockroach egg cases, and the developing wasp larvae feed on the contents. In about 30 to 60 days, 3 to 24 adult parasites emerge from each egg case.

In recent years some research efforts have been directed at predominantly outdoor cockroach (*Periplaneta*) populations. Other wasp species released in Texas experiments reported in 1978 effectively suppressed *Periplaneta*. However, the question of how practical the use of natural enemies would be for controlling cockroaches in an operational structural pest management program remained unanswered.

In 1977 we had an opportunity to demonstrate the feasibility of egg-parasite releases for the suppression of *S. longipalpa* at the University of California, Berkeley. The brownbanded cockroach was probably first introduced on the campus about 13 years ago. Between 1967 and 1975 it had infested six large buildings containing more than 2,000 rooms. In these facilities brownbanded cockroaches largely replaced the German cockroach, *Blattella germanica*, which had previously been the major domiciliary pest. When the parasite *C. merceti* was first discovered in a small insectary room in 1973, little consideration was given to it except to note that both the parasite and the cockroach were abundant.

By 1975, however, without application of additional control measures, the host cockroach was difficult to find anywhere in the insectary or the rest of the entire 240-room building. On discovery of this initial success, we decided to compare potential control techniques—spray applications, baiting, trapping, and parasite rearing and releases. The results indicated that *C. merceti* had the greatest potential for use in almost all of the University research facilities harboring this cockroach. Major factors considered in the analysis were:

- Use of materials and techniques that would not affect the results of research being performed in treated or nearby facilities.
- Practicality within limitations of available staffing and materials.
- Requirements of the U.S. Food and Drug Administration, U.S. Department of Agriculture. U. S. Environmental Protection Agency, National Institutes of Health, and California Department of Industrial Relations governing pest control in the work place, animal care and research facil-

Vetch continued

planted 8 days before drainage was poor, and in experiment C, it was also poor from seed planted 4 days before drainage.

Counts made in November and February showed that most seedlings from seeds planted 4 to 32 days after drainage did not become established until the post-November rainy season. These late seedlings made good progress in 1959 but not in 1960, reflecting the benefit of early establishment.

Considering both experiments, planting from 2 days before to 2 days after drainage produced the best results with both species. In experiment B, Lana vetch produced over twice the number of plants and dry weight as purple vetch, but in experiment C, purple vetch was somewhat more successful than Lana vetch from plantings made 2 days before to 2 days after drainage.

These experiments support the following conclusions on planting vetch as a green manure in a maturing rice crop:

- The best time to broadcast the vetch seed by air is from 2 days before to 2 days after water leaves the field.
- Purple vetch and Lana vetch are the preferred species.

Amount of N fixed

Vetch green manure can be an economical source of nitrogen, fixing over 100 pounds of atmospheric nitrogen per acre under favorable conditions. The typical nitrogen-fixing potential on rice stubble is between 30 and 60 pounds per acre, a worthwhile contribution toward the nitrogen requirement of rice.

An estimate of the amount of nitrogen fixed by vetch can be obtained by cutting and obtaining the fresh weight of vetch from 16 square feet (for example, plants within a square made of four 4-foot laths) and multiplying by 20 to get pounds of nitrogen per acre.

Example: If from 16 square feet you cut 3 pounds of green vetch, $3 \times 20 = 60$ pounds of nitrogen per acre.

Samples should be taken from about 10 random locations in the field and averaged. The average value may then be used in considering the need for additional nitrogen from fertilizer for the next crop.

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