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EFFECTS OF INTERCROPPING GROUNDNUT WITH SUNNHEMP ON TERMITE INCIDENCE AND DAMAGE IN INDIA

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Abstract—The effects of intercropping groundnut with sunnhemp on termite incidence and damage were studied in the rainy and post-rainy season at ICRISAT Center in central India. Termite incidence in different cropping systems was determined by baiting with bamboo stakes. Damage to groundnut plants and pods was evaluated at harvest.

Intercropping groundnut with sunnhemp did not affect termite abundance or damage to groundnut. These results contrast with a Colombian intercropping study in which sunnhemp exudates repelled cassava burrowing bugs. Termite biology, including recruitment of foragers and construction of protected runways, may have reduced exposure to sunnhemp, thereby minimizing effects.

Key Words Termites, *Microtermes Odontotermes* intercropping, groundnut, sunnhemp

Résumé—Au centre de l'ICRISAT en Inde centrale, une etude a ete effectuée au moment de la saison des pluies et de l'apres-saison des pluies sur les effets de l'association culturale arachide/*Crotolaria juncia* sur l'incidence et les degâts des termites. L'évaluation de l'incidence des termites dans les differents systemes culturaux a été effectuée a l'aide de piquets de bambou servant d'appâts. L'estimation des dégâts occasionnés sur les plants et les graines d'arachide a eté menée au moment de la recolte.

L'association culturale arachide/*Crotolaria juncia* n'a eu aucun effet sur l'abondance des termites et leurs dégâts sur l'arachide. Ces résultats sont en contradiction avec une étude colombienne portant sur l'association culturale dans le cadre de laquelle on a constaté que les éxudats de *Crotolaria juncia* repoussaient les punaises foreuses du manioc. Il est possible que la biologie des termites comprenant notamment le recrutement d'ouvrieres et la construction de voies de passage protégées ait limité leur exposition a *Crotolaria juncia*, minimisant ainsi son effet repoussant.

Mots Cléfs. Termites, *Microtermes*, *Odontotermes* association culturale, arachide, *Crotolaria juncia*

INTRODUCTION

Termites in the genera, *Microtermes* and *Odontotermes* are important pests of groundnut in semi-arid regions of India and Africa. Their attack may cause up to 50% reduction in groundnut yield, affect quality and market price (Johnson et al , 1981, Wightman and Amin, 1988). Damage and yield losses result from cutting of stems, removal of foliage, invasion of tap root (causing mortality of maturing plants), cutting of pegs (separating pods from haulms), pod scarification, pod boring and consumption of drying haulms (Johnson et al , 1981, Hebblethwaite and Logan 1985, Logan, 1988) Termites also remove manure and other organic matter from fields (Wood, 1976), which may reduce soil fertility and crop yield.

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Scarification of pods increases susceptibility to invasion of the fungi *Aspergillus flavus* Link and *A. parasiticus* Speare with correlated increases of aflatoxins (McDonald and Harkness, 1963, 1967). Scarification also weakens the pods, increasing post-harvest breakage and invasion by other fungi. As a result, market prices for scarified pods are reduced (Narasimham et al., 1985).

Microtermes spp. and *Odontotermes* spp. are primarily subterranean in habit (the latter may eventually build mounds), making nest location and destruction difficult. As social insects with high reproductive rates, mortality of foraging workers (by natural enemies or synthetic insecticides) may have limited effects on colony size. Termites are, in any case, late season (drought-associated) pests and evidence of attack often appears too late for farmers to respond.

Therefore, conventional control of termites in annual crops has relied heavily on prophylactic chemical barriers of organo-chloride insecticides, which persist from planting to harvest (Hebblethwaite and Logan, 1985). Environmental concerns, health hazards to applicators and residue problems have created a critical need to find alternative methods of termite control. One potential cultural control, manipulation of cropping systems, could provide an environmentally sound method to limit termite damage.

Multiple cropping systems tend to support lower herbivore levels than corresponding monocultures (Altieri and Letourneau, 1982; Risch et al., 1983). Hypotheses explaining lower herbivore abundance in diversified systems were first proposed in the early 1970s (Tahvanainen and Root, 1972; Root, 1973; Feeny, 1976) and more recently elaborated upon or modified (Andow, 1983; Risch et al., 1983; Kareiva, 1983; Sheehan, 1986). These include enhanced control by natural enemies in diversified systems, differential immigration rates and tenure time among systems, and modification of microenvironments. To our knowledge, no work has been done on intercropping and termites. An important consideration, however, is that termites are social insects and often present in crop fields prior to planting.

Intercropping with sunnhemp, *Crotalaria juncea* L. reduced cydnid, *Crytomenus bergi* Froeschner damage to cassava tubers from 90% in monoculture to 5% in systems where the two crops were grown in alternate rows (Vargas et al., 1987). Reduction in herbivore damage was attributed to nonpersistent phenolic exudates.

These promising results suggested that sunnhemp might also be effective in reducing incidence of other soil insects, including termites. This paper reports the effects of intercropping with sunnhemp on termite pests of groundnut, *Microtermes obesi* and *Odontotermes* spp. in India.

MATERIALS AND METHODS

Research was conducted at the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) located near Hyderabad, India, (17°N latitude, 500 m a.s.l.). There are two planting seasons, kharif (rainy) in mid June and rabi (irrigated post-rainy) in November or December. Fields supporting the highest termite populations are available for planting only in the kharif.

Termites are often abundant in or around groundnut fields prior to sowing. However, as the number and distribution of nests was unknown and as field size was limiting, the number of replicates in experimental treatments was high and plot size small. This was to compensate for the anticipated non-random distribution of nests.

Trial 1 Rabi season 1987–1988

An intercropping trial was conducted in an alfisol field with abundant termite sheeting on the soil surface. The field had previously been planted with maize.

Seeds were sown on 9 December 1987 on ridges 70 cm apart and 10 cm between seeds. Groundnut (cv Robut-33) and sunnhemp were grown in monoculture and intercropped at a 2:1 ratio. The three treatments were replicated 12 times in a complete randomized block design. Each plot consisted of 10 rows (9 m long). Border rows in intercrops were always sunnhemp and alleys were 2 m wide.

Fields were kept clean by hand weeding. Whereas emerging sunnhemp was heavily attacked by the arctiid, *Utethesia pulchella*, the entire field had to be sprayed with dichlorovos (800 ml a. i. in 400 l water) on 11 and 28 January 1987. Thereafter, arctiid larvae were removed by hand. Groundnut was harvested on 18 April at which time the sunnhemp was still in the flowering stage.

Twenty termite baits (50 cm bamboo pegs; 2 or 3 per crop row) were placed flat on the soil surface. They were inspected for termite attack, without regard to species at weekly intervals from 4 to 18 weeks after planting (WAP). Attacked baits were shaken free of termites and moved at least 1 m to require re-discovery. Border rows were not sampled.

Trial 2 Kharif season 1988

The second trial was conducted in an alfisol field with a history of high termite populations. The field was inaccessible to irrigation and had no pesticide applications for at least 15 years.

Treatments and arrangements were similar to trial 1 except plots consisted of 13 rows (10 m long) with ridges separated by 60 cm, and treatments were replicated 24 times. Twenty-two bamboo baits were placed per plot (two or three per row, excluding outer two rows) and inspected biweekly from 4 to 14 WAP.

Planting was on 23 June 1988, following first rains of the kharif season. Sunnhemp was protected against *U. pulchella* by hand removal of larvae. Pods were harvested 14 weeks after planting and dried for 10 days within plots. During this period, sunnhemp was still in the flowering stage. The percentage of pods showing scarification (termite) and/or pod boring (from termites and other soil insects) was determined.

Analysis of variance (ANOVA) was conducted for percentage of attacked baits for individual sampling dates and for the entire trial (repeated measures). Rabi season data were square root transformed to stabilize variance.

RESULTS

Trial 1 (Rabi)

Termite (mostly *Odontotermes* spp.) attack of baits was generally less than 10% and equal among cropping systems (Table 1). Mortality of groundnut plants and pod damage was low (< 2%) and not significantly different in the intercrop and monoculture.

Trial 2 (Kharif)

Termite incidence was considerably higher in this trial than in the rabi (Table 2). Baits were attacked equally by *Microtermes obesi* and *Odontotermes* spp. Attack appeared within a week of planting and was similar among treatments for five of the six sampling dates. At 14 WAP, attack was lowest in sunnhemp monoculture and highest in the intercrop. In repeated measures, analysis for the entire trial, termite attack of baits was identical among treatments.

Mortality of groundnut plants was < 5% and equal in monoculture and intercrop. Drying groundnut pods suffered slightly, albeit

Table 1. Percentage of bamboo baits attacked by termites *Microtermes obesi* and/or *Odontotermes* spp. at ICRISAT Center, Andhra Pradesh, India, Dec. 1987–April 1988 (rabi season) (N = 12 replicates; 20 baits per plot)

	Weeks after planting							
Treatment	1	2	3	4	5	6	7	8
Groundnut mono	12.9	8.6	3.6	15.4	9.6	8.3	5.8	5.0
Groundnut/sunnhemp	10.2	3.4	2.1	9.6	8.3	8.3	5.4	7.1
Sunnhemp mono	10.3	6.2	2.1	14.2	8.3	7.1	5.4	5.0
F value*	0.05	2.33	0.93	0.45	0.33	0.01	0.04	1.04

	Weeks after planting							
Treatment	9	10	11	12	13	14	15	Trial[+]
Groundnut mono	6.3	10.1	9.2	10.0	3.8	4.2	7.5	8.2
Groundnut/sunnhemp	3.3	10.8	9.2	7.1	6.3	8.3	6.7	7.1
Sunnhemp mono	3.3	10.8	6.7	4.6	2.9	4.2	5.8	6.5
F value	1.06	0.55	0.05	2.36	1.12	0.78	0.12	2.21

*From square root transformed values; all values insignificant at $P < 0.05$; df (2,22).
[+]Repeated measures analysis for trial.

Table 2. Percentage of bamboo baits attacked by termites *Microtermes obesi* and/or *Odontotermes* spp. at ICRISAT Center June–Sept. 1988 (kharif) (N = 24 replications; 22 baits per plot)

Treatment	Weeks after planting 4	6	8	9	12	14	Trial*
Groundnut mono	38.2	38.2	35.9	34.5	56.4	53.6	42.7
Groundnut/sunnhemp	35.0	37.3	30.9	35.4	52.3	58.6	41.8
Sunnhemp mono	37.7	37.3	34.5	34.5	56.4	46.8	41.4
F value	0.33	0.03	1.22	0.03	1.04	4.7	0.10

*Repeated measure analysis for trial.
**$P < 0.05$; df (2,46)

Table 3. Percentage of harvested groundnut pods with scarification and/or borer damage at ICRISAT Center, Sept. 1988 (N = 24)

Treatment	Scarification	Borer	Total*
Groundnut mono	8.4	3.8	11.3
Groundnut/sunnhemp	10.5	3.7	13.1
T value⁺	2.18**	0.22	1.51

*Total pods with damage.
⁺From square root transformed values.
**$P < 0.05$; df (23).

significantly, more scarification in the intercrop than monoculture (Table 3). Borer damage was equal in the two systems.

DISCUSSION

Intercropping groundnut with sunnhemp did not affect termite attack on bamboo baits, groundnut plants or drying pods. These results contrast with Colombian intercropping trials in which sunnhemp reduced burrowing bug attack on cassav by 95%. The present study raises questions concerning the use of multiple cropping as a cultural control against termites and the potential use of sunnhemp against other soil arthropods.

Absence of cropping system effects in experimental trials may reflect the insect species involved, the choice of intercrop (including cultivar) and weather/crop/soil interactions specific to both the site and crop cycle (Parkhurst and Francis, 1986; Gold et al., 1989a). Variable response to cropping systems have been demonstrated by congeneric insects at one site, by specific insects to different crop combinations, and by specific insects to similar systems, but for different seasons, sites or varieties (Risch, 1980; Andow, 1983; Gold et al., 1989b).

Termite biology differs from that of most herbivores studied in intercropping/insect studies. Their presence in agricultural fields prior to planting eliminates a step involved in host location; therefore, termites and other soil insects may circumvent one important mechanism (reduced immigration rates) by which diversified systems reduce herbivore load.

Sunnhemp induced reduction of burrowing bugs in cassava systems is believed to result from phenolic exudates which act as repellents (Vargas et al., 1987). Reductions occurred only in systems containing a high density of sunnhemp, suggesting either a limited sphere of root influence or that extended contact with the root exudates was required to repel burrowing bugs. However, burrowing bugs live primarily within the crop root zone, thereby increasing their encounters with the sunnhemp roots.

In contrast, termites are social insects. With nests below the root zone, foraging termites may be exposed to sunnhemp exudates for only short periods. At the same time, vertical movement from nest level towards the soil surface may reduce contact with sunnhemp roots. Additionally, location of food sources by foraging termites is often followed by recruitment through pheromone trails and construction of runways protected by sheeting composed of soil/saliva mixtures (Waller and Lafage, 1987). Therefore, even if intercrop presence did interfere with termite host-seeking capacity, arrival at food sources by a limited number of individuals might still lead to the same level of attack as occurs in monocultures.

The potential use of multiple cropping to protect crops against termite damage remains largely unexplored. Differences in sunnhemp effects on cassava burrowing bugs in Colombia and groundnut termites in India, suggest differences in herbivore biology and call attention to the site specificity of cropping system work.

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