Factors affecting cotton seedling in mulch-based cropping systems in North Cameroon

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Abstract
In mulch-based cropping systems, soil cover harbours a lot of organisms that may improve soil fertility but may also affect crop health. In the cotton systems of Cameroon, some millipedes (Diplopoda: Julidae) could become important pests by provoking important seedling damages. This study assesses the influence of mulch on the stand and health of cotton seedlings, as well as diagnoses emergence constraints.
Two different assays were carried out during the growing season, one with *Calopogonium mucunoides* (2001) and the other with *Brachiaria ruzisiensis* (2002), both as cover crop mulches. The two studied factors were (1) presence or absence of mulch and (2) seed protection (insecticide and/or fungicide). Cotton seeding in non tilled soil showed that seedling stand was globally inferior under mulch compared to nude soil. In the supposed absence of soil structure or texture differences, this constraint seemed to come from exacerbated pressure of soil pests, for which mulch provides favourable habitat. With equivalent insecticide protection, seedling stand resulted significantly greater on nude soil, with less visible symptoms of attacks. On the other hand, mulch provided better growth of seedlings, associated with greater aphid infestation but balanced by seeding precocity that permits escape from delayed arrival of aphids.
The major risk associated with seedling in mulch-based cotton is soil pests, whose species impact should be assessed to define sustainable control strategy based on the preservation of beneficial soil macrofauna.

Media summary
In North Cameroon, the presence of crop cover mulches negatively affected seedling stand of cotton, mostly by attacks of soil arthropods like millipedes.

Key words
cotton seedling, soil pests, no tillage, mulch, seed treatment,

Introduction

During sowing, the presence of cover crop mulches on the soil surface confers benefits to the cropping system in terms of decreased runoff, evaporation and erosion protection. Due to environmentally favourable conditions, this habitat structure harbours a lot of organisms (fungi, bacteria, arthropods, *etc*.) that may improve soil fertility (decomposition of organic matter, water infiltration, *etc*.) but may also affect crop health (All *et al.,*1984 ; House and Del Rosario, 1989 ; Pedersen *et al.*, 2003). Mostly detritivores, some millipedes (Diplopoda: Julidae) could become important pests after depletion of usual food, by provoking important seedling damages. This study assesses the influence of mulch on the stand and health of cotton seedlings, as well as diagnoses emergence constraints.

Methods

Experimental design
Two different assays were carried out during the growing season, one with *Calopogonium mucunoides* (2001) and the other with *Brachiaria ruzisiensis* (2002), both as cover crop mulches. The two studied factors were (1) presence or absence of mulch and (2) seed protection (Tab. I).

Table I. List of treatments.

Mulch	Seed dressing	Active matter	Dosis (g a.m./kg seeds)
without	-	-	
with	-	-	
without	fungicide	thiram	1.0
with	fungicide	thiram	
without	insectcide	carbosulfan	3.0
with	insectcide	carbosulfan	
without	fungicide + insecticide	thiram + carbosulfan	
with	fungicide + insecticide	thiram + carbosulfan	

A random design with 6 and 5 replications, in 2001 and 2002 respectively, was used to set experiment. Micro-plots were composed of 6 lines of 10 meters each containing 25 hills of 5 grains, with interline distance of 80 cm. Five days prior to seeding, herbicide application (glyphosate) was made on the entire experimental surface. Micro-plots assigned to direct seeding on nude soil were cleaned by superficial weeding.

Seed treatment
Pesticide applications were realised by powder seed dressing using a previously insecticide coated vessel (10 liters) with a lid. The hills were made with special hoes equipped with a flap to obtain homogeneous planting depth (about 2 cm).

Sampling
Hill emergence was assessed at 7, 10, 15 and 20 days after seeding (das) in the 3 central lines of each micro-plot. During each sampling, attacked seedlings and dead millipedes (major seedling pest) were counted within the 3 central interlines. At about 20 das, the height of 20 randomly selected plants per micro-plot was measured. From the onset of aphids infestation (*Aphis gossypii*), scounting was done on the 5 terminal leaves was made on 4 batches of 5 consecutive plants per micro-plot.

Data analysis
For each variable, analysis of variance was conducted by using SAS GENMOD procedure (binomial and negative binomial distribution, logit and log transformation) or SAS GLM (normal distribution).

Results
Seedling stand
The first criterion for determining emergence was the proportion of stand relative to the number of seeds. Over the two years of experimentation, it was noticed that the presence of mulch had a depressive effect on the stand (Tab. II). Seed treatment with insecticide significantly contributed to the stand success, with an exacerbated response on mulches (significant interaction mulch*insecticide, Tab. II and III). The use of fungicide did not reveal any effect on the stand under *Calopogonium* mulch, but showed improved emergence in 2002, in the case of nude soil in the *Brachiaria* experiment (significant interaction mulch*fungicide, Tab. II and III). Residues of *Brachiaria* may have had effect on the development of fungi.
The second criterion is the proportion of hill emergence (containing at least one seedling). The negative effect of the mulch is confirmed, as well as the benefit from insecticide seed dressing, but the absence of significant fungicide effect (Tab. II).

Table II. Seedling stand according to soil cover, insecticide or fungicide seed dressing. das: days after sowing. * P<0.05, **P<0.01.

Effect	Modalities	2001 seedling stand (%) 7 das	2001 seedling stand (%) 10 das	2001 seedling stand (%) 15 das	2001 seedling stand (%) 20 das	2001 hill emergence (%) 20 das	2002 seedling stand (%) 7 das	2002 seedling stand (%) 10 das	2002 seedling stand (%) 15 das	2002 seedling stand (%) 20 das	2002 hill emergence (%) 20 das
Mulch	with	50.3	46.7	42.8	39.7	60.6	57.0	56.8	54.0	52.8	91.1
	whithout	67.7 **	53.0 **	49.9 **	46.1 **	65.3 **	60.7 **	61.1 **	61.4 **	60.9 **	96.0 **
Insecticide	with	64.2	55.5	51.8	47.9	70.2	62.3	62.5	61.8	61.2	95.7
	whithout	53.8 **	44.2 **	41.0 **	37.9 **	60.5 **	55.4 **	55.4 **	53.6 **	52.5 **	91.3 **
Fungicide	with	58.0	50.8	47.9	44.6	66.9	61.1	60.3	59.6	59.0	94.3
	whithout	60.1	48.9	44.9	41.1	63.8	56.6 **	57.6	55.8 *	54.7 *	92.7
Interaction	insecticide * fungicide										
	mulch * insecticide			*	*				*	*	
	mulch * fungicide							*	*	*	

Table III. Seedling stand according to soil cover and seed dressing. das: days after sowing. * P<0.05, **P<0.01.

Modalities		2001 seedling stand (%) 10 das	2001 seedling stand (%) 15 das	2001 seedling stand (%) 20 das	2002 seedling stand (%) 10 das	2002 seedling stand (%) 15 das	2002 seedling stand (%) 20 das
Nude soil	with insecticide	59.8	56.4	52.1	63.8	63.8	63.7
	without insecticide	46.3 **	43.4 **	42.1 **	58.3 *	59.1 *	58.0 *
Mulch	with insecticide	51.3	47.1	43.7	61.1	59.8	58.7
	without insecticide	42.1 **	38.6 **	35.6 **	52.5 **	48.1 **	46.9 **
Nude soil	with fungicide	53.5	51.4	48.2	64.2	64.9	64.6
	without fungicide	52.6	48.5	44.1	57.9 **	58.0 **	57.1 **
Mulch	with fungicide	66.3	65.1	41.1	56.3	54.4	53.3
	without fungicide	64.7	61.5	38.2	57.3	53.6	52.3

Seedling health

The mean percentage of attacked seedlings was significantly greater in the presence of mulch on the soil surface (Tab. IV).

Table IV. Seedling health according to soil cover, insecticide or fungicide seed dressing. das: days after sowing. * P<0.05, **P<0.01.

Effect	Modalities	2001 attacked seedling (%) 7 das	2001 attacked seedling (%) 10 das	2001 attacked seedling (%) 15 das	2001 Mean number of millipedes per plot	2002 attacked seedling (%) 7 das	2002 attacked seedling (%) 10 das	2002 attacked seedling (%) 15 das	2002 Mean number of millipedes per plot
Mulch	with	8.6	9.9	7.0	0.9	5.8	6.5	2.4	4.2
	whithout	2.9 **	5.8 **	4.4 **	0.6	1.0 **	2.0 **	0.2 **	1.3 **
Insecticide	with	5.0	7.4	5.0	1.5	2.6	3.4	0.9	5.1
	whithout	6.5	8.4	6.4	0.0 **	4.1	5.2	1.6	0.4 **
Fungicide	with	5.2	7.5	5.2	0.7	3.8	4.6	1.1	2.6
	whithout	6.3	8.3	6.3	0.8	3.0	4.0	1.5	2.9
Interaction	insecticide * fungicide								
	mulch * insecticide								**
	mulch * fungicide								

Despite difficulties in detecting millipedes in mulches, the mean number of dead millipedes was significantly greater in micro-plots harbouring *Brachiaria* mulch or insecticide seed dressing, highlighting the rapid action of carbosulfan. Moreover, the insecticide action was exacerbated (significant interaction mulch*insecticide, Tab. IV) in *Brachiaria* mulch.

Table V. Seedling height and population density of *Aphis gossypii*. das: days after sowing. * P<0.05, **P<0.01.

Effect	Modalities	2001 seedling height (cm) 20 das	2001 Aphids per leave 38 das	2002 seedling height (cm) 24 das	2002 Aphids per leave 55 das
Mulch	with	9.2	12.6	16.3	3.6
	whithout	7.2 **	6.8 **	13.1 **	4.0
Insecticide	with	9.0	9.8	14.7	3.7
	whithout	7.4 **	9.5	14.7	3.9
Fungicide	with	8.4	10.4	14.1	4.2
	whithout	8.1	8.9	15.3	3.4
Interaction	insecticide * fungicide	**			
	mulch * insecticide	*			
	mulch * fungicide	**			

The vigour of seedlings, measured by their height, revealed a positive effect of mulch in both experiments and insecticide seed dressing in the case of *Calopogonium* mulch. On the contrary, neither mulch nor insecticide seed dressing induced significant difference in aphids per seedling leave in 2002, whereas mulch seemed to favour aphids in 2001.

Conclusion

Cotton seeding in non tilled soil showed that seedling stand was globally inferior under mulch (dead vegetal cover composed of *Calopogonium* or *Brachiaria*) compared to nude soil. In the supposed absence of soil structure or texture differences, this constraint seemed to come from exacerbated pressure of soil pests, for which mulch provides favourable habitat, as shown by Carpenter *et al.* (1978). With equivalent insecticide protection, seedling stand resulted significantly greater on nude soil, with less visible symptoms of attacks. Nevertheless, single effect of fungi or other non controlled pathogens or pests could not be excluded.

The major risk associated with seedling in mulch-based cotton is soil pests, whose importance is difficult to control by recommended seed treatment. The experiment was conducted on small and recently covered surfaces with mulch probably serving as refuge for major seedling pests such as millipedes and disequilibrium between phytophagous and predator communities (House, 1989). The frequently observed pest outbreaks, especially soil-associated pest populations in the transition period, could discourage farmers from adopting mulches (Brown *et al.*, 2001). On the other hand, mulch provided better growth of seedlings originating from beneficial elements, superficial humidity or physical protection. This major risk of aphid infestation conferred by greater seedling attractiveness and/or appetence is balanced by seeding precocity that permits escape from delayed arrival of aphids.

From these results, it would be interesting to carry out these experiments on larger farming plots to evaluate the effect of parameters like mulch type and biomass, previous crop and age of cropping system. Attention should focus on sampling and measuring relative impact of soil pests to define sustainable control strategy based on the preservation of beneficial soil macrofauna (Lal, 1988; Reddy, 1999).

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