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Effect of polythene and cover crop *Mucuna pruriens* (L.) DC. in the control of weeds in pineapple (*Ananas comosus* (L.) Merr.) in Côte d'Ivoire

[1*]MANGARA Ali, [2]N'DA ADOPO Achille Aimé, [3]KOUAME N'Dri Marie-Thérèse and [4]KEHE Martin

[1]Université d'Abidjan-Cocody, UFR Biosciences Laboratoire de Botanique, 09 BP 389 Abidjan 09 / Côte d'Ivoire ; [2]Centre National de Recherche Agronomique ; 01 BP 1740 Abidjan 01 / Côte d'Ivoire ; [3]Université d'Abidjan-Cocody, UFR Biosciences Laboratoire de Botanique ; [4]Centre National de Recherche Agronomique, 01 BP 1740 Abidjan 01 / Côte d'Ivoire

***Corresponding author e-mail:** mangarali@yahoo.fr; Other authors: [2]achille_adopo@yahoo.fr; [3]ndrimaritherese@yahoo.fr; [4]martin.kehe@cnra.ci

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ABSTRACT

Objective: Difficulty to prevent weed growth in pineapple crop is one of the major problems facing farmers in Côte d'Ivoire. This study analyzed the effect of polythene and cover crop *Mucuna pruriens* on the weeds.
Methodology and results: The polythene and *M. pruriens* treatments were applied separately or in combination in a randomized Fisher block and their ability to suppress weed growth assessed every 15 days. From 30 to 45 days after *M. pruriens* sowing, control plots set up without polythene and cover crop, showed rates of coverage by weeds between 40 to 60 % whereas plots with either *M. pruriens* or polythene alone had weed coverage from 25 to 37 % and 21 to 33 %, respectively. Plots with combination of *M. pruriens* plus polythene maintained low weediness of around 13%. After 75 days, control plots were almost totally covered by weeds. Polythene leads to an immediate absence of light to the weeds and the consequence is failure of their seeds to germinate or growth interruption of those that may have already germinated. On the contrary, plots with the cover crop showed gradual coverage by weed flora partly due both to the late germination of its seed and progressive growth and also due to the relatively low sowing density. The weed suppression effect of *M. pruriens* lasts approximately three months.
Conclusion and application of findings: In this study, polythene, which is commonly used in pineapple crop, proved its efficiency against weeds, though its tendency to shred and fragmentation leads to pollution of orchards. Rational application of these two options allows reduction time spent on weeding which reduces the production cost.

Key words: Cover crop, *Mucuna pruriens*, pineapple, polythene, weediness.

INTRODUCTION

Production of pineapple is very well developed in the south-eastern region of Côte d'Ivoire, and is practised both in small scale (village plantations) and in large scale (industrial farms). With 137 000 tons of fresh pineapple produced, the country represented the second biggest supplier to the European market in 2005, behind Costa Rica (432 000 tons) but ahead of neighbouring Ghana (51

000 tons) (Anonymous, 2005). Unfortunately, production has been declining since 2005 with only 73 000 tons produced in 2007 (Anonymous, 2008). One of the major problems reported by farmers is the serious competition posed by weeds to the pineapple crop. Weeds also act as alternate hosts of pathogens like *Pratylenchus brachyurus*, the nematode responsible for pineapple slow growth (Gnonhouri & Téhé, 1997). Maintaining plots free from weeds is also necessitated by various agricultural activities, such as frequent monitoring of plant growth, treatment for floral induction, counting of plants during flowering, and regular supply of fertilizers through the leaves armpits, among others (Py *et al*. 1984; Kobénan *et al*., 2005). Difficulty of controlling weeds in the country is one of the main reasons forcing many farmers to abandon old plantations of pineapple to establish new ones. It has been often reported that one weeding is necessary every thirty to forty five days during plant growth.

To reduce weediness from the early stages of growth and throughout the crop cycle, it is necessary to develop efficient and inexpensive strategies. Polythene application on ridges is a common practice to restrict weed growth and germination of their seeds. It also reduces soil water loss, and the leaching of its constituents such as fertilizers, and also protects its structure (Py, 1965; Combres, 1976; Combres, 1979).
Cover crops are used both to control weeds and improve soil fertility through nutrient contribution. Gliesseman *et al*. (1981), Ayeni *et al*. (1984) and Unamma *et al*. (1986) recognized the effect of legumes to reduce weeds and used them successfully.

According to Galiba *et al.* (1994), in Ouémé area in Benin, some farmers have succeeded to control weeds in palm tree crop by applying *M. pruriens*, which has permitted reduction of time devoted to weeding activities. The cover crop *Pueraria phaseoloides* was described by Skerman (1982) as one of the tropical legumes, which successfully suppresses weeds, and has been used in Tanzania in sisal crop (Hopkinson, 1969). Application of both polythene and cover crops helps to reduce cost of crop management and ensures environmental quality through low use of herbicides. This study was undertaken to quantify evolution of weediness in pineapple crop as affected by polythene and *M. pruriens.*

MATERIALS AND METHODS

Materials: Pineapple variety *Smooth Cayenne*, black polythene and cover crop *Mucuna pruriens* (L.) DC.were used.

Study site: Two tests were conducted in 2007 and 2008, at the Anguédédou station of The National Agricultural Research Center (CNRA) located 4°08' W, 5°25' N and 25 km from Abidjan in south eastern Côte d'Ivoire.

Experimental set up: Experimental plots consisted of identical blocks 1.5 meters apart. Plot dimensions were 10 m length and 6.4 m width (area of 64 m²). In each plot, four observations were carried out in four distinct areas of 16 m², including a ridge and an inter ridge. In each ridge, pineapple plants were placed 30 cm apart along the plot length and 60 cm apart in along the width. Each plot included 264 pineapple plants. Planting density was approximately 47 142 plants ha^{-1}. The plots were arranged in Fisher blocks with 4 treatments and 4 replications representing the following treatments:
(1) control (without any protection against weeds) (tr1); (2) cover crop only applied between the ridges (tr2); (3) polythene only applied on the ridges (tr3); (4) polythene and cover crop combination (tr4).

The experimental farm was an old pineapple plantation in fallow for two years. Soil was tilled to soften and remove weeds. To prevent possible infestation by nematodes, the nematicide Rugby 10 G, containing Cadusaphos as the active substance was applied. Tricalcium phosphate (350 kg ha^{-1}) and dolomite (350 kg ha^{-1}) were applied as fertilizer mixed into soil. Ridges of about 25 cm height were built up manually. Polythene films were arranged to cover the ridges completely. Pineapple plants had been treated with insecticide (Dursban 480 g l^{-1}) containing Chlorpyrifos ethyl as the active substance, by soaking in diluted solution of 0.125 %. Dursban treatment was intended to fight against floury cochineal that causes wilt disease of pineapples. No fungicide treatment was applied because of the high acidity of soil, which is unfavourable for development of the fungus *Phytophthora nicotianae* var. *parasitica*. Two months after pineapple planting and manual weeding of plots, *M. pruriens* seeds were sown in pairs in each hole, at 1 m intervals apart in inter ridges. Monthly fertilization was done with a mixture composed of urea and potassium sulphate in granular form, administrated in the basal leaves (Py *et al*., 1984).

Data recording and analysis: Weed coverage rate in the plots was estimated starting two months after pineapple planting then carried out every 15 days until full coverage of the most vulnerable plot. Coverage assessment was done using the rating scale (table 1) established by the Commission on Bioassays (Marnotte, 1984).

Data were analyzed using XLSTAT software version 7.5.3, by analysis of variance (ANOVA) determination of significance at the P <0.05 threshold by Newman-Keuls' test.

Table 1: Weed coverage rating scale established by the Commission on Bioassays (Marnotte, 1984).

Rating	Coverage %	Meaning of note
1	1	Presence of species but rare
2	7	Less than one individual per m²
3	15	At least one individual per m²
4	30	30 % covered
5	50	50 % covered
6	70	70 % covered
7	85	High coverage
8	93	Very little apparent soil
9	100	Total coverage

RESULTS

Fifteen days after *M. pruriens* sowing, the control plots (tr1-no treatment) and those with cover crop only (tr2) showed similar rates of invasion by weeds, about 10%, whereas plots with polythene alone (tr3) or in combination with cover crop (tr4) were around 5% covered by weeds. From 30 to 45 days, control plots were covered by weeds at 40 to 60 % whereas coverage rates from 25 to 37 % and 21 to 33 % were noted in plots containing only the cover crop and only polythene, respectively. After 75 days, control plots were nearly totally covered by weeds. Plots combined *M. pruriens* and polythene maintained weediness at no more than 13 %. Figures 1 and 2 express evolution of weediness during tests in 2007 and 2008.

The state of weediness in each treatment after 45 days is presented in figure 3 (A-D). Although showing relatively similar levels of weed coverage in 2007 and 2008, plots containing only polythene were less covered than those with only *M. pruriens,* at 55.62 and 53.47 % for the former against 67.81 and 68.75 % for the latter (table 2). Despite their apparent similarity, coverage levels with these two treatments were statistically different according to Newman Keuls test. All treatments in this study are different from each other. Comparison of weed levels from one year to another showed that means were almost identical (table 2).

Table 2: Mean weed coverage levels after 75 days.

Treatment	Mean weed coverage levels (%)	
	2007	2008
tr1 : control (without any protection against weeds)	97,16 a	97,97 a
tr2 : cover crop only	67,81 b	68,75 b
tr3 : polythene only	55,62 c	53,47 c
tr4 : polythene and cover crop in combination	13,06 d	12,59 d

In the same column, means assigned different letters are significantly different at the *P* <0.05 threshold according to the Newman-Keuls'test.

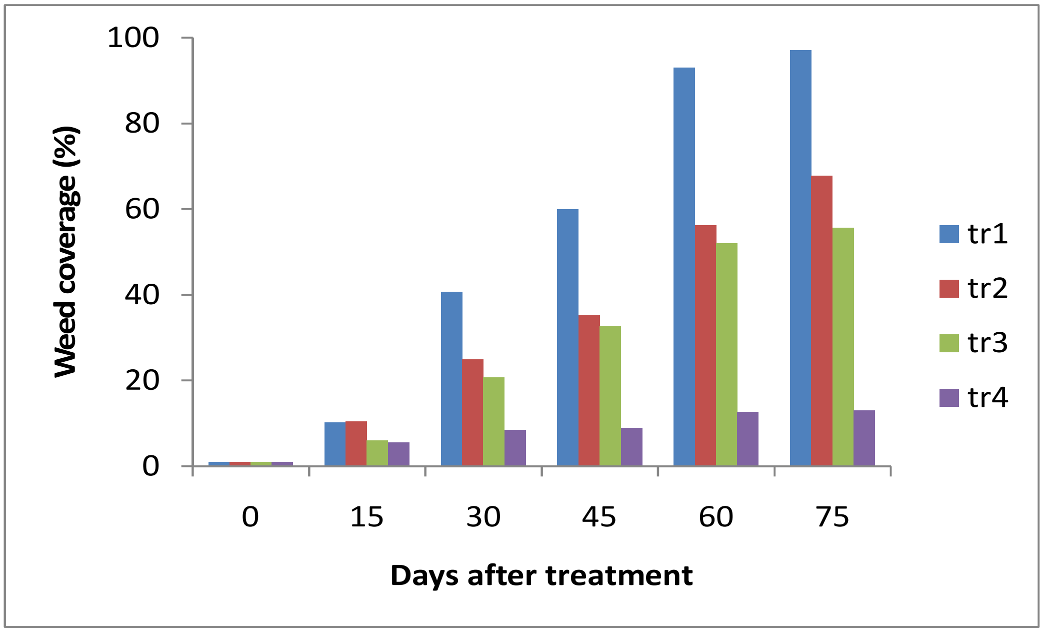

Figure 1: Evolution of the recovering rate of plots by weeds in 2007. (tr 1 - control (without any protection against weeds; tr 2 - cover crop only; tr 3 - polythene only; tr 4 - polythene and cover crop in combination).

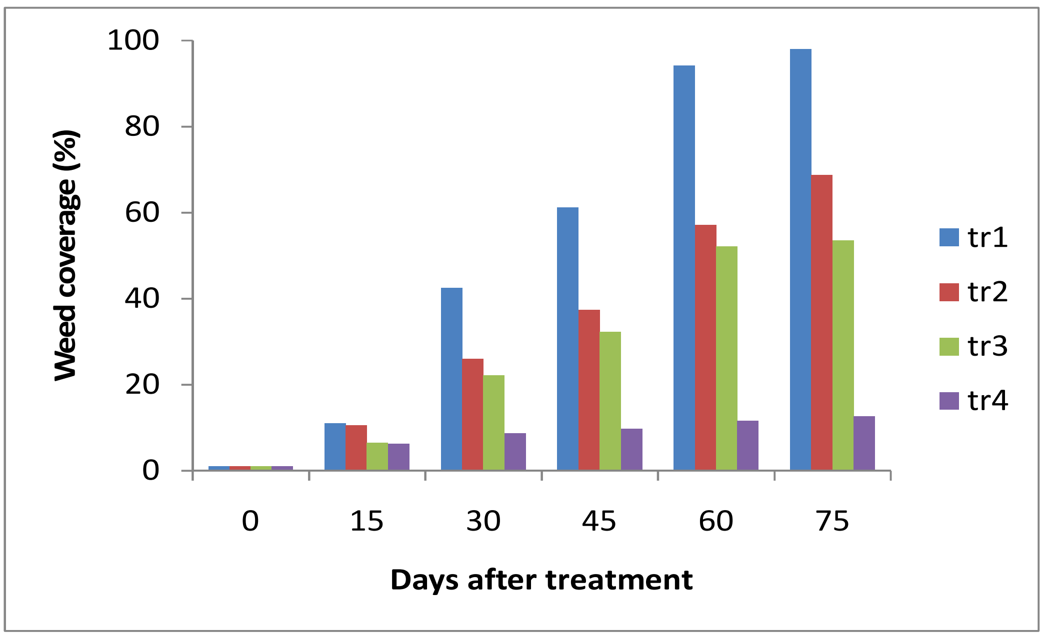

Figure 2: Evolution of the recovering rate of plots by weeds in 2008 (tr 1 - control (without any protection against weeds; tr 2 - cover crop only; tr 3 - polythene only; tr 4 - polythene and cover crop in combination).

Combination of *M. pruriens* and polythene improves protection by reducing weediness to values below 15%, i.e. to the equivalent of less than an individual weed per m² according to Marnotte (table 1). During the experiment, weediness in plots with combined treatment increased only from around 5 to 13%, as compared to the substantial increase from 5 to 55% in the next least invaded plot. Analysis of variance indicated that means of all treatments were significantly different ($P \leq 0.0001$). The coefficients of variation (53.46 in 2007 and 54.71% in 2008) observed also reflect a difference between the treatments. The probabilities in the variable of block (0.793 and 0.456) show no significant difference between the means from one block to another (table 3).

Figure 3: A-Extensive weed coverage in control plot (with no treatment).; B- weed coverage in pineapple plots planted with *Mucuna pruriens* as a weed management measure. Mucuna plants with broad leaves are visible between the pineapple plants. Weeds are growing freely on the ridges; C- weed coverage in pineapple plot where polythene sheets were placed as a weed control measure. See *Ageratum conyzoides* as major weeds growing only between the ridges ; D – Reduced weed coverage in pineapple plots where *Mucuna pruriens* was planted between the ridges and polythene sheets applied as weed control measures.

Table 3: Analysis of variance for weed coverage levels in pineapple plantation.

Source of variation	**DF**		**Fisher's F Test**		**P value**		**Coefficient of variation (%)**	
Year	2007	2008	2007	2008	2007	2008	2007	2008
Total variable	15	15						
Treatment variable	3	3	3177,74	2099,83	10^{-4}	10^{-4}		
Variable of block	3	3	0,345	0,951	0,793	0,456		
Residual variable	9	9					53,46	54,71

DF: Degree of Freedom

DISCUSSION

The high efficiency of polyethene sheets on the ridges compared to the Mucuna cover crop between the ridges is explained by its immediate and total coverage of soil leading to absence of light that is required for weed growth. Yard (1992), Horowitz (1993) and Printz (1993) noticed the hindering of mass germination of heliophile weeds by black films due to limitation of their access to sunlight. In plots with polythene only, spaces available for development of weeds are reduced to inter ridge only, and around perforations made while manufacturing to facilitate planting of pineapple plants or holes that occurred accidentally during management of the crop. Covering of inter ridges by *M. pruriens* progresses gradually as the plants grow. Gorski (1975) indicated that generally on the soil surface, seeds of weed under dense vegetation don't germinate. In this study the density of sowing of the cover crop seems relatively low to permit sufficient coverage of inter ridges and better reduction of weediness.

M. pruriens growth capacity was studied by Sedga *et al*. (1998) while evaluating legume performance in fallow. They established that *M. pruriens* and *M. cochinchinensis* have a faster initial development and soil coverage than another cover crop *Pueraria phaseoloides.* In competition against weeds that grow rapidly, these *Mucuna* sp. are more effective in the first weeks of growth. However *M. pruriens* has a short growth cycle (approximately three months) leading to emergence of weeds after this period.

Touré (2001) showed that *M. pruriens* ranks behind *Pueraria phaseoloides* and *Crotalaria sericea* but is better than *Vigna unguiculata* in efficiency of controlling weeds. *Pueraria phaseoloides* is ranked high due in part to its long growth cycle, that classifies it as a herbaceous perennial. The effectiveness of a cover plant in reducing weediness is related to its longevity and covering density.

Hoarau and Huet (2006) have used other plant parts such as sugar cane straw crushed for weed control in pineapple crop. These biological materials applied in inter ridges proved to be more efficient than polythene, thermoplastic and biodegradable films, and permitted reduction of weeding operations by 50 %. Unfortunately this practise presents a disadvantage due to risk of diseases developing such as Phytophtora rots (Tisseau & Py, 1965).

Polythene commonly used in pineapple crop degrades very slowly and thus it contributes to pollution of land and promotion of soil heterogeneity due to gley formation. Biodegradable polythene tested as an alternative was unfortunately found to have fast degradation rate (Py *et al*., 1984). Hoarau and Huet (2006) found that thermoplastic films t (Bio Telo®) labelled as 17 µ thick disappears before pineapple harvesting while biodegradable films with thickness of 75 µ had the disadvantage of fragmenting rather than degrading and disappearing completely. In Côte d'Ivoire, the polythene currently applied is also subject to fragmentation.

In conclusion, covering ridges by polythene in pineapple crop reduces the spaces available for weeds only to the inter ridges and also prevents their seeds from germinating. The cover crop *Mucuna pruriens* applied in inter ridges also acts by covering the soil surface and twining round weeds. The combination of these two practices, in accordance with the principle of integrated weed management, would permit significant reduction of the time committed to weeding from once every thirty to forty five days to one every three months.

To improve on the observed effects, it is necessary to evaluate the effect of varying sowing density of *M. pruriens* and also to evaluate various types of cover crops. Biodegradable polythene of different thickness that better conforms to the pineapple crop cycle should also be experimented on. Whereas many farmers accept and apply polythene commonly, cover crops are still minimally used in Côte d'Ivoire because they are less known and are also considered capable of hiding reptiles under their leaves.

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