International Scholars Journals

Frontiers of Agriculture and Food Technology ISSN 7295-2849 Vol. 9 (6), pp. 001-012, June, 2019. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Influence of some cover leguminous plants on the infestation degree of cotton plant major weeds

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Accepted 15 January, 2019

From phytosociological sampling carried out between 1999 and 2005 in cotton culture in the North of Ivory Coast, more than 230 weeds species were inventoried. Among those, *Euphorbia heterophylla, Ageratum conizoides, Bidens pilosa Tridax procumbens, Boerhavia diffusa* and *Chromolaena odorata* were the most abundant species causing weeding problems to farmers. A test that used herbaceous Fabaceae: *Crotalaria sericea, Mucuna pruriens, Pueraria phaseoloides* and *Vigna unguiculata* to control these weeds was carried out in some localities at Bouaké in the center of the country, Korhogo in North and Odienné in the North-West. The results showed that annual *Leguminous* species like *C. sericea, M. pruriens* and *V. unguiculata*, used in previous culture, decreased the rate of weeds on the different plots. *P. phaseoloides*, Leguminous perennial species was indicated in improved fallow.

Key words: Leguminous plants, weeds, cotton, Ivory Coast.

INTRODUCTION

Weeds have always been a major constraint for the famer. Their presence in the cultivations, leads sometimes to very considerable losses of yield products on both quantitative and qualitative plan (Regehr, 1993; Boraud, 2000). In many cases, the results expected from the application of weed control methods and current techniques proved to be not very or not satisfactory (Douti et al., 1995). Concerning the cotton plant-growing in Ivory Coast, weed control problem has taken worse with the expansion of cultivated surfaces. Weeding is tedious, sometimes difficult to carry out in due time and there are both a shortage of labour and an expensive manpower. With regards to the chemical methods, we should not ignore that, in addition to the herbicide high cost, the problems of mixture, the security precautions for the users and the environment problems connected to the use of these herbicides that can be accumulated in a unverifiable way in the nature, are to be taken account (Déat, 1981; Marmotte, 1995; Lecomte et al., 1997; Ipou Ipou, 2000). As for the mechanic method, it presents two major disadvantages: on the one hand, it does not allow cleaning the sowing rows and, on the other hand, there are risks of uprooting of seedlings when it is realized at the beginning of the cycle (Merlier and Montegut, 1982).

Then, the weed problem remains always posed, as for the research of more effective control strategies. That is why, since a few years, we turned towards the integrated weeding that call for several methods or techniques of weed management (Parry, 1982; Hintzche, 1993). As part of this integrated weeding, valuation trials of the capacity of cover plants belonging to the family of Fabaceae to control some weeds in cotton plant-growing in Ivory Coast have been carried out. These trials were about four species of leguminous plants. The present study intends to present some of the first obtained results.

MATERIALS AND METHODS

The biological material is constituted, on the one hand, by a relative numerous population of major weeds in cotton plant-growing and, on the other hand, by four species of Fabaceae: *Crotalaria sericea, Mucuna pruriens, Pueraria. phaseoloides* and *Vigna unguiculata*.

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Table 1. Weeds phytosociolocal characteristics.

Species	Densities	Absolute frequencies	Relative frequencies
Euphorbia heterophylla	950	602	81.35
Ageratum conizoides	550	452	61.08
Tridax procumbens	220	244	33.00
Boerhavia diffusa	90	230	31.08
Bidens pilosa	60	276	32.30
Chromolaena odorata	50	217	29.32

The setting up of the trials integrating the cover plants has been preceded by a phytosociological sampling realized in 2000 to 2005, which allowed to identify the main major weeds of cotton plant-growing in Ivory Coast (Ipou Ipou, 2000 ; Aman Kadio et Ipou Ipou, 2003 ; Aman Kadio et al., 2004) . In each inventoried locality, absolute and relative frequencies of all the species met, were noted, to do likewise, the density of some species among the most representatives was measured (Ipou Ipou, 2000; Aman Kadio and Ipou, 2003) . The following observations consisted to measure coverage of the four studied Fabaceae and their influence on weed density. The study took place at the same time in Korhogo, Odienné and Bouaké from 2004 to 2006. The experimental design is therefore in scattered blocks. In each locality, representing a block or a replication, five plots of 25 × 25 m each, were used. In the different cases, a plot serving as a witness is lied in fallow while the four others receive one of the four tested species of Fabaceae. The total plot number is estimated to 15, a rate of 5 plots per locality. The sowing of the cover plants was generally realized after a rain. No specific treatment has been done in the plots apart from a pre sowing labour. The trials have been set up in the same month in june and the sowing has been done the same day on all plot in a given locality. The observations have been done in the beginning, the middle and the end of the rain season.

The measure of the leguminous plant coverage has been done by "contact-points" method (Daget and Poissonet, 1969; Aman kadio, 1978a and b; Touré, 2001). In practice, each of the 15 reserved plots was subdivided into 25 subplots (elementary plots) of 5 × 5 m each. They are marked from 1 to 25 and 10 of them were fired at random. It is in the center of these elementary plots that the contacts were measured with a graduated ruler of 2 m established vertically in the vegetation which height doesnot exceed this limit (Touré, 2001). The contacts are noted along the graduated ruler and precisely on the projecting side of the double meter bear by the ruler. We only take account of the aerial parts of each living plant. The three realized measures were staggered as the following way: 1 month after sowing, 3 months after sowing and 5 to 6 months after sowing. For these measures, the number of plots per locality is 50 and 10 are witness plots.

To measure weed density, 5 elementary plots were fired at random between the10 reserved that have been under observation. In each subplot, 5 measured points (plot of 0.25 m^2) have been determined, one of them was always situated in the intersection of the 2 diagonals of the subplot, and the 4 others, halfway between the vertex of the square and the first control point (intersection of the diagonals). The small squares are represented by a metallic square with 50 cm of side, within which the individual species met, are counted. The measures are realized at the same previous indicated periods.

Data analyses

Mean leguminous plant coverage

In each locality and for each leguminous plant, the coverage was worked out during the three periods of observation (beginning, middle and end of season) from the following formula:

$$C_m = \frac{\sum_{1}^{n} C}{n}$$

C_m is the mean coverage and C is the coverage ; n = 5.
The mean coverage evolution of each species is expressed from the evolution curves.

Density Variation of the six weeds as a function the leguminous plant coverage

The mean weed density per plot (the 4 plots occupied by the leguminous plants and the witness plot) was worked out for each locality and observation period from the following formula:

$$D_m = \frac{\sum_{1}^{n} D}{i}$$

D_m is the mean density and D is the density; i = 5 and n = 10.

The results of the seasonal weed density variation as a function the cover plants are presented in histograms. The standard deviations between weed densities at these three periods of the year were worked out to appreciate better different variation of this parameter. The results of these calculations are presented in a synthetic table.

RESULTS

The floristic and phytosociological study realized from 740 sampling allowed counting 230 different species (Ipou Ipou, 2000). Within these taxa, 6 species considered as the most representatives because of their frequency and their significantly high density and allowing better measure of this parameter were reserved (Table 1). The Table 1 is made up, apart from the density of each species, the absolute frequency and relative (centesimal) frequency. To make easier the realisation of the different graphics, the species took account were coded (Table 2). The evolution of the cover Fabaceae coverage along the season is expressed by Figure 1, which take account collected data in the three localities. considering the evolution curves translating this paramete, for each species and each locality, we can classify the four tested cover plants in two groups : in one hand, the species

Table 2. Studied species codifification.

Species	Codes
Ageratum conyzoides	AGECO
Bidens pilosa	BIDPI
Boerhavia diffusa	BOEDI
Chromolaena odorata	CHROD
Crotalaria sericea	CROSE
Euphorbia heterophylla	EUPHE
Mucuna pruriens	MUCPR
Pueraria phaseoloides	PUEPH
Tridax procumbens	TRIPR
Vigna Unguiculata	VIGUN

which coverage evolution is translated by a curve in ring, that is, their coverage is weak at the beginning and the end of the observations and maximum at the middle of the cycle (*C. sericea, M. pruriens* and *V. unguiculata*) and in the other hand, a single species (*P. phaseoloides*) which re-coverage increases from the beginning to the end of the season. The study of the variation of the weed density in the three tested localities gives the following results in (Table 3 and Figures 2 and 6): -In cover plant absence, the density of each of the six reserved weeds remains relatively high during all the period of observation, even if a hardly perceptible fall is recorded on the histogram (Figure 2), in the middle of the season for *Euphorbia heterophylla* and *Ageratum conizoides*, however the locality; - plots with *V. unguiculata* (Figure 3), *Tridax procumbens* and *Chromolaena odorata* have always a decrease density from the beginning to the end of the observations, while in the same time, *Bidens pilosa* and *Ageratum conizoides* density increase in the contrary way; in other respect *Euphorbia heterophylla* density is very high in comparison to those of 5 others weeds, even if they evolve irregularly with a tendency to the fall in the middle of the season ; in Korhogo and Odienné, it increases in the same way (weak in the beginning of the season, very important in the midlle season and a fall to very weak amplitude at the end of the season); concerning *Boerhavia diffusa*, its density remains weak for the three localities, but, it varies very weakly in amplitude during the 3 observations periods; - the Figure 4 obtained from collected data in plots sown with of *M. pruriens* indicate that, in all the tested localities, *Tridax procumbens* has a decrease density from the beginning to the end of the observations; with the exception of *Bidens pilosa* that become more and more dense in Korhogo and Odienné, the histograms representing the others weeds have generally an evolution in « U », expressing a fall of the density in the middle of the season; - finally, on plot of *P. phaseoloides* and *C. sericea* (Figures 5 and 6), the histograms obtained from received data, indicate that, for the six weeds, the density decrease regularly from the beginning to the end of the observations, in the three studied localities.

DISCUSSION

The setting up of a plot of cotton plant-growing requires an initial preparation which consists to clear the concerned land of all the disturbed plants from the original vegetation (Hala *et al.*, 1998): it is the clearing stage. Such environment become propitious to emergence of a substitution vegetation dominated, in first stage by heliophile therophytes, plant category of the 6 weeds involved in the present study (Aman Kadio, 1973). Among these plants, 4 belong to Asteraceae Family (*Tridax procumbens*, *Ageratum conizoides*, *Bidens pilosa* and *Chromolaena odorata*) which most representatives are known for their very high ability of seed production. The two others species have the same biological characteristics, although they do not belong to the taxonomic family; *Euphorbia heterophylla* is an Euphorbiaceae and, *Boerhavia diffusa*, a very nitrophile Nyctaginaceae (Ipou Ipou, 2000; Aman Kadio and Ipou Ipou, 2003). Then, it is about 6 species with a high ability of competition for the available space occupation, notably when the surroundings conditions are favourable. But the middle and the end of the farming season also correspond to a period when cotton plants became branchy (Hala et al., 1998), a stage that creates an environment more and more unfavourable against weed emergence, in general way.This tendency has been well proved for *Euphorbia heterophylla* species for which Ipou Ipou (2000), after counting 1500 plants / m^2 at the beginning of cotton cycle, met only 50 / m^2 at the end of the observations.

If the 6 weeds have around the same behaviour during the farming season and in each the 3 tested localities (high density at the beginning and decrease up to the endof the season) in absence of cover plants, they donot always present the same development in the presence of cover plants. Thus, in plots sown with *V. unguiculata*, 3 species (*Euphorbia heterophylla*, *Ageratum conizoides* et

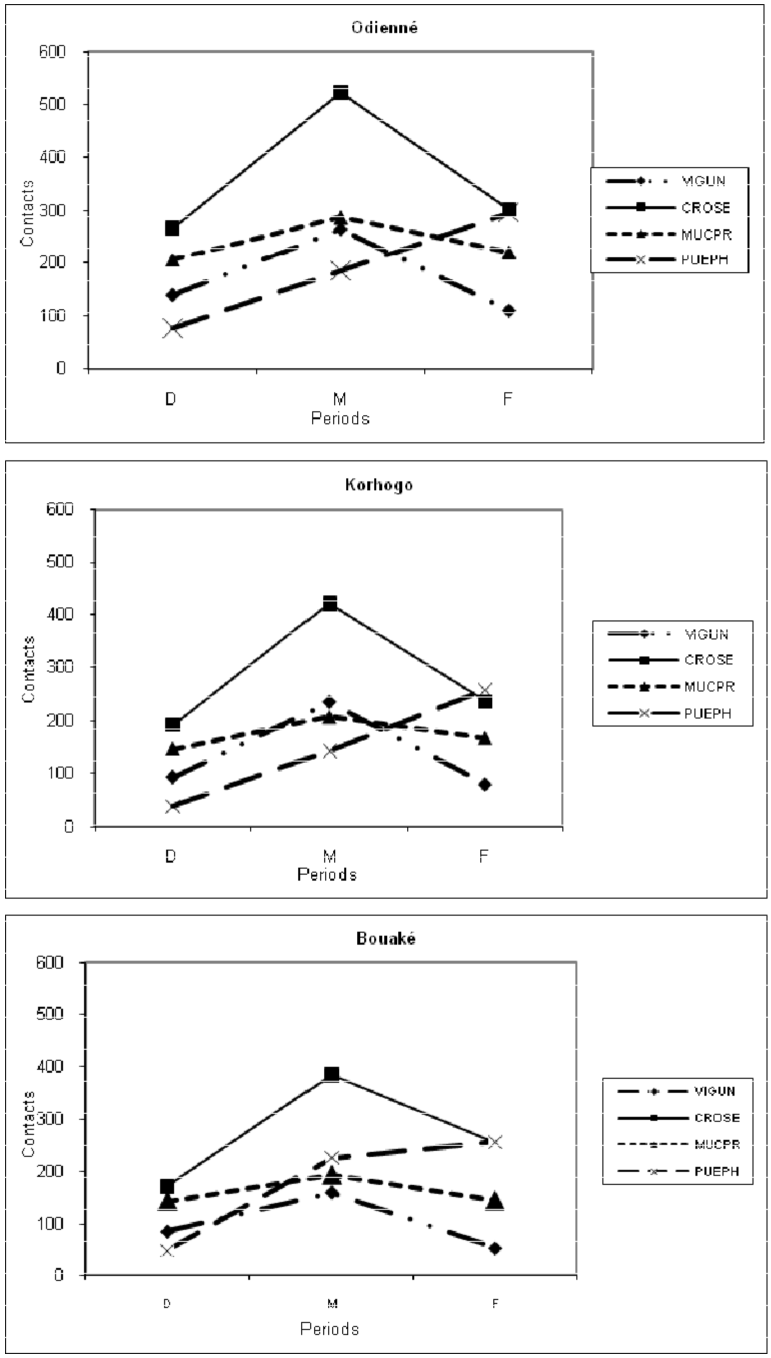

Figure 1. Seasonal variation of cover plant Coverage D = beginning; M = Middle; F = End (of season).

Bidens pilosa) have an evolution in inverse direction (weak density at the departure and high density at the end of the season) while the three others keep practically their initial movement, in contrary to the 3 species mentioned above. This is perhaps connected to the fact that *V. unguiculata* is a species with a short cycle, from 80 to 90 days (Dugué et al., 1994), and recovering less the soil below. In these conditions, it will prove to be less competitive next to heliophile weeds that will take advantage, very early, on the clearing hole left by the cover plant to settle. The weak density of *Euphorbia heterophylla* and *Ageratum conizoides* observed at the beginning of the season in Korhogo and Odienné can respond to a period when the environment conditions were favourable to *V. unguiculata* which rapid development has inhibited the development of the 2 mentioned

Table 3. Standard deviations between weed densities at the three observation periods.

Species	Cover plants	Localities		
		Bouake	**Korhogo**	**Odienne**
	JACHERE	120.67035	83,1043521	108,656953
	VIGUN	37,469988	159,95416	159,95416
EUPHE	MUCPR	214,441911	178,298439	240.806977
	PUEPH	270.385527	200.933654	227,381471
	CROSE	279,90415	190.549206	245,88073
	JACHERE	30.5013661	53,4072405	74,8086448
	VIGUN	72,700298	79,8582077	79,8582077
AGECO	MUCPR	53,5070089	16,5025251	23,1588716
	PUEPH	79,8999374	114,503275	128,136646
	CROSE	92,8726727	124,857252	161,898116
	JACHERE	16,2890556	2	10.3923048
	VIGUN	7,76745347	13,0128142	13,0128142
BIDPI	MUCPR	6,244998	14,571662	5,56776436
	PUEPH	26,6520793	9,07377173	23,515952
	CROSE	30.5122926	7,02376917	17,2433562
	JACHERE	26,0256284	6,11010093	13,3166562
	VIGUN	50.5008251	37,5099987	37,5099987
TRIPR	MUCPR	59,0931468	41,7891533	48,0867272
	PUEPH	45,3982379	36,9368831	36,7559519
	CROSE	39,8789836	36,1155553	44,9703606
	JACHERE	3	1,73205081	0.57735027
	VIGUN	5,85946528	4,04145188	4,04145188
CHROD	MUCPR	3,51188458	2,51661148	3,60555128
	PUEPH	9,29157324		8,50490055
	CROSE	7,3711148	5,50757055	6,80685929
	JACHERE	2,64575131	2,51661148	4,163332
	VIGUN	3,60555128	3,21455025	3,21455025
BOEDI	MUCPR	1,52752523	3,05505046	3,51188458
	PUEPH	6,80685929		7,21110255
	CROSE	6,65832812	3,60555128	9,45163125

weeds to which we can also add *Bidens pilosa*. That also means that we must well choose the period of setting up the cover plant so that it will be able to act perfectly on the weeds. By increasing the sowing density of *V. unguiculata*, it could be also possible to have the same result because of the high phytomass density this cover plant could develop at the beginning of the season. Sown in the same conditions, the important phytomass that *V. unguiculata* could produce, could equally serve as mulching that by reducing considerably light on the soil, could limit significantly weed germination, notably when it is about recognized heliophile species.

The behaviour of the 6 tested weeds through their density evolution in the presence of *M. pruriens* is characterized by histograms with disturbed look on appearance, except *Tridax procumbens* which keep the same sort of movement in the three studied localities, but also in the three considered seasonal period. The observed disorder is probably connected to the nature of this cover plant. In fact, as she has well indicated Touré (2001) and before this author, Botton (1957), and Skerman (1982), *M. pruriens* is a leguminous plant which starts slowly, and very quickly, produces oppressive vegetation that that permit to reduce considerably the

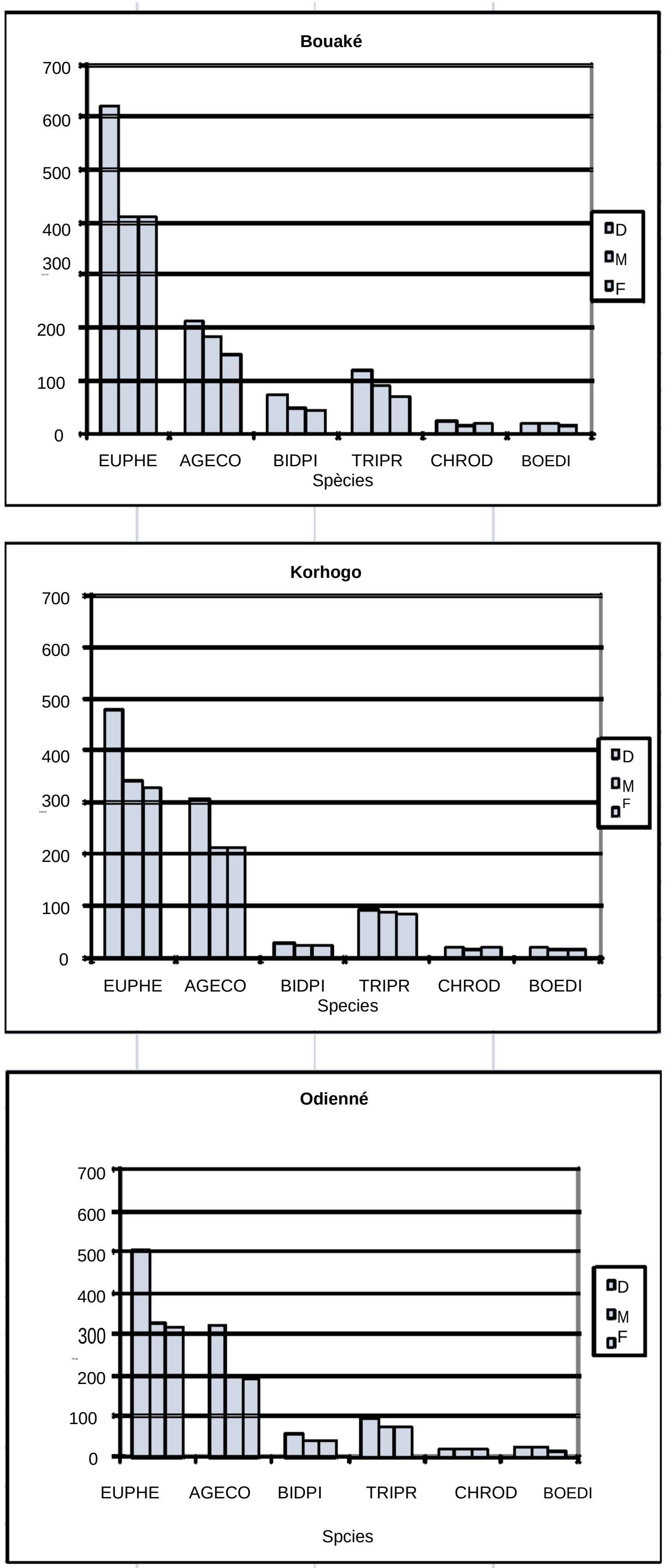

Figure 2. Seasonal variation of weed density on plot lied fallow. D = beginning; M = Middle; F = End (of season).

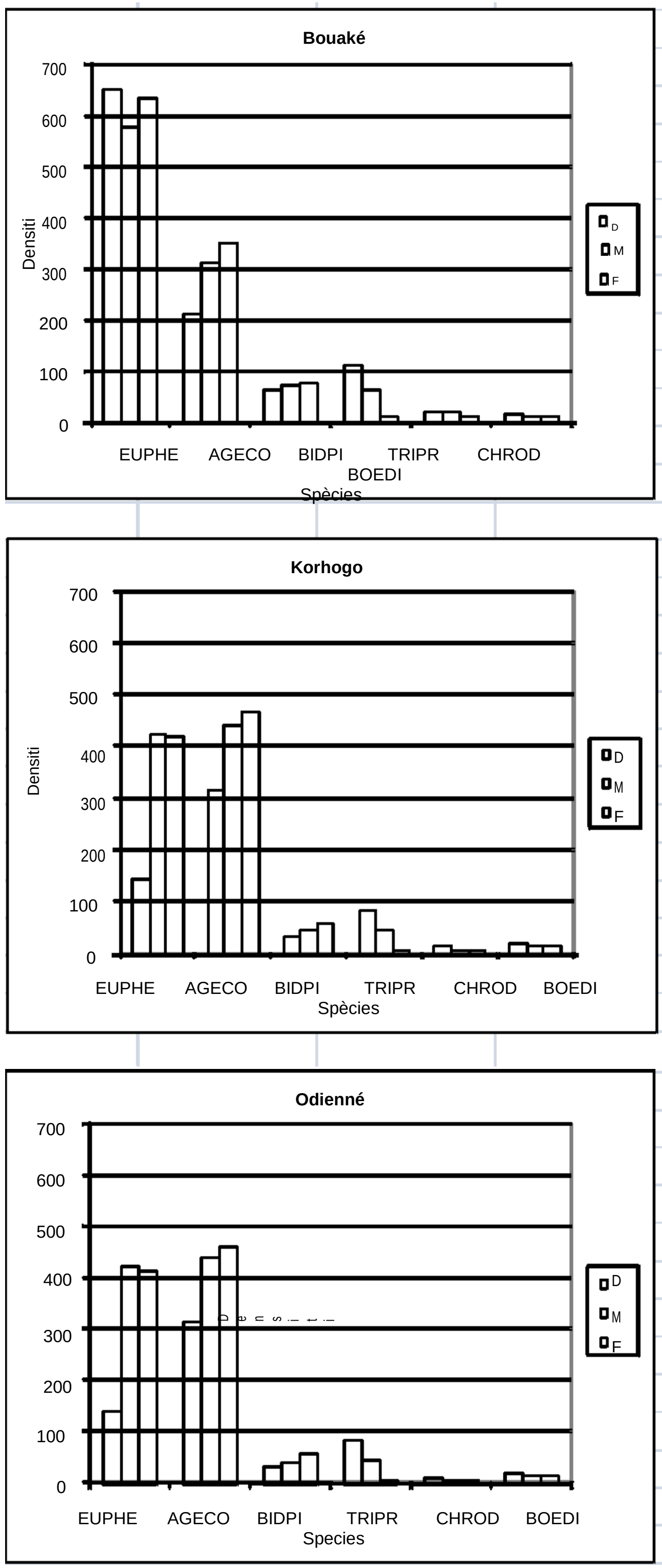

Figure 3. Weed density variation during the season on *Vigna unguculata* plots. D = beginning; M = Middle; F = End (of season).

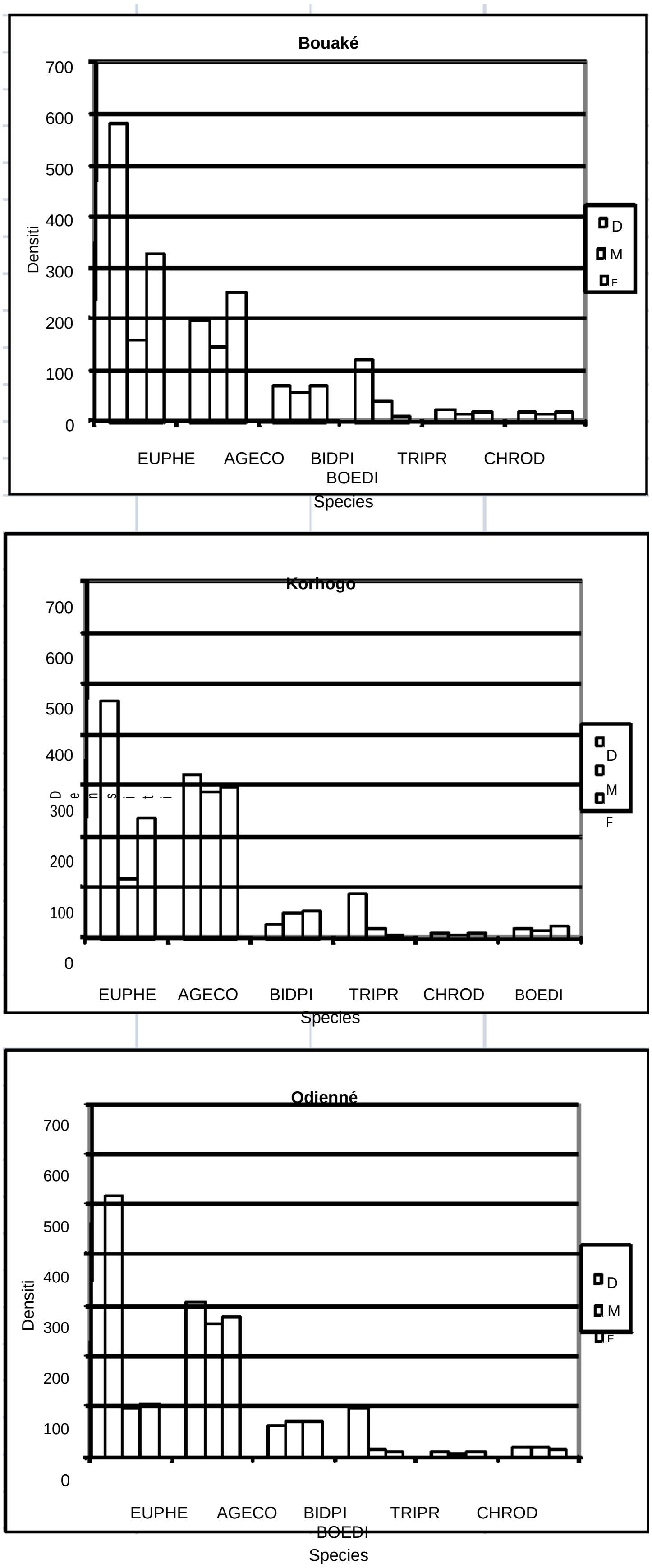

Figure 4. Weed density variation during the season on *M. pruriens* plots

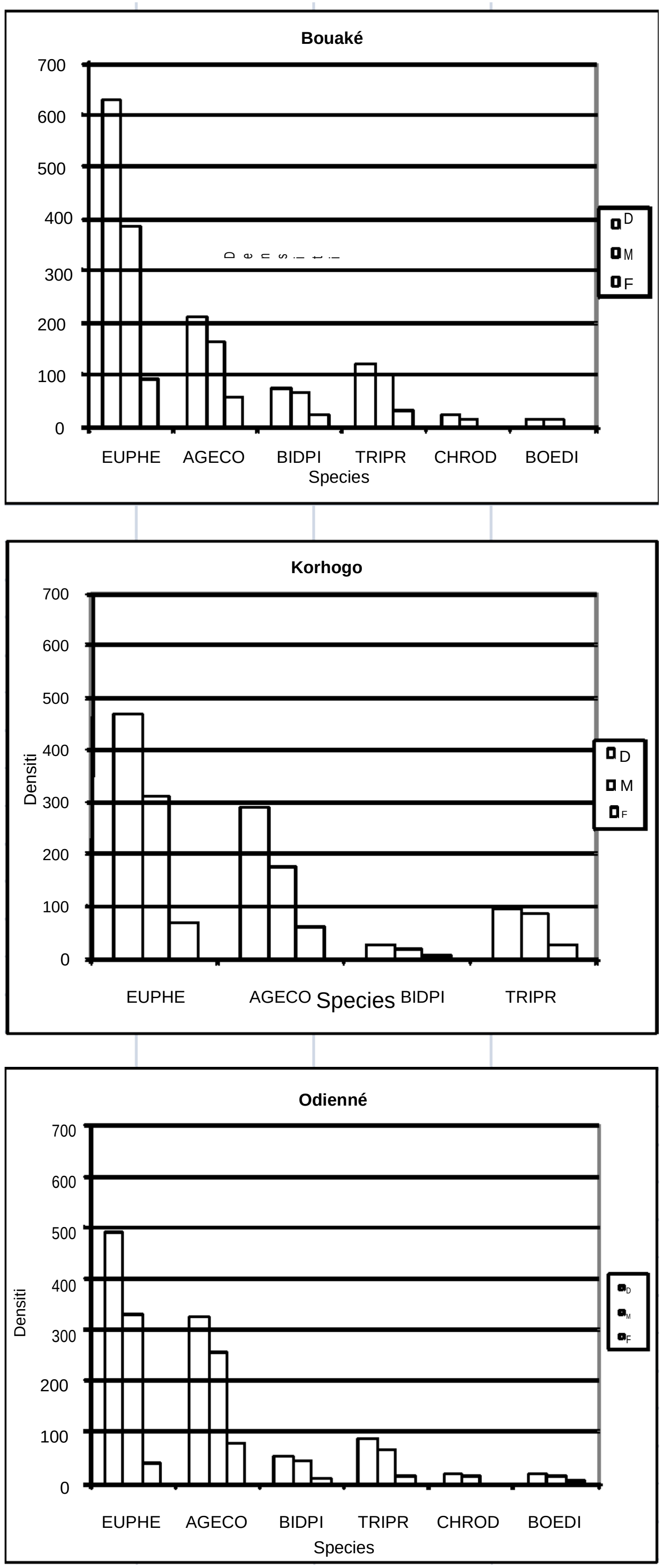

Figure 5. Weed density variation during the season on *P. phaseoloides* plots. D = beginning; M = Middle; F = End (of season).

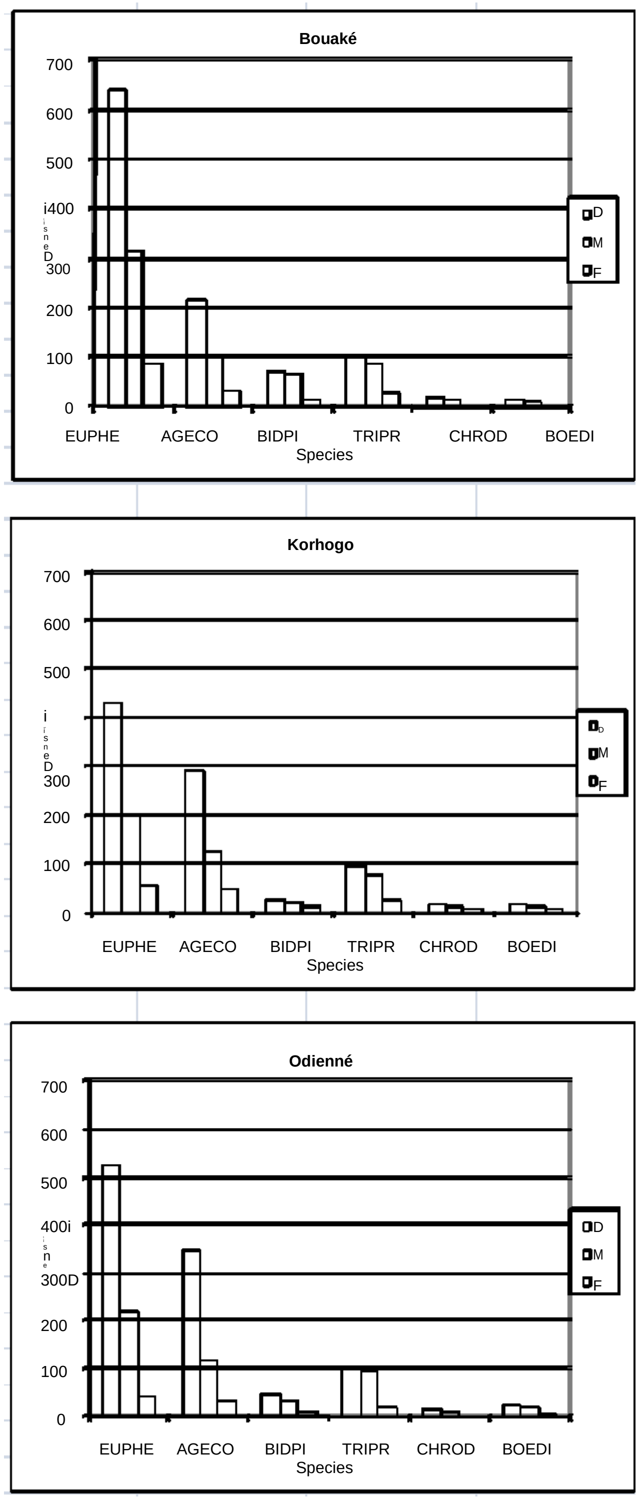

Figure 6. Weed density variation during the season on *C. sericea* plots. D = beginning; M = Middle; F = End (of season).

growth of some weeds. Like this, for most of the 6 tested weeds, the density is high at the beginning of the season and more or less low according the species and studied locality, before a recovery at the end of the season. This last attitude is connected to the fact that, in reality, *M. pruriens* is an annual species with a short cycle that lost very early their leaves. Then, this is favourable to heliophile weeds that grow again. However, the weigh of the vegetal material produced is an obstacle light penetration in the soil level, that can be a limited factor to weed germination and emergence such the histograms indicate in the middle of the season. As *V. unguiculata*, the use of *M. pruriens* can only be advised before cotton plant-growing while the mulch created by the leaves fall delayed the weed seed germination for the benefit of cotton plant seeds if they are sown in clear row. The histograms of figures 5 and 6 show that *C. sericea* and *P. phaseoloides* act at the same manner on weeds (weed density decreases regularly from the start to the end of the season). However, these two cover plants donot have the same morphology. *C. sericea* is an annual species with a long cycle which emergence and development are speed, that permit this taxon, an important phytomass productions in a period relatively short and a great aptitude to control weeds, such as the 6 weeds we are interested in this study. But these characteristics, although researched in others circumstances donot like to be profitable to cotton plant if we grow them at the same time. However, sown at the beginning of a setting up of the plot in fallow, *C. sericea* could be well indicated to control the expansion of the weeds which growth and development could be stopped. This very competitive leguminous plant next to weeds could be used in the same time to restore rapidly the fallow potentialities, notably by reducing of the number and the density of the infesting species.

Concerning *P. phaseoloides* , a perennial Leguminous, with relatively emergence and development, it could not be indicate as a cover plant before cotton plant sowing or others annual species. However, it could intervene in an operation aiming to fallow improvement and also in weed control of some perennial farming (palm tree, coconut palm, hevea …).

Definitively, it appears distinctly clear from this study that among the four tested leguminous plants, only *P. phaseoloides* could not be indicated in a cultural association based on cotton plant. Their role in weed control and fallow soil improvement remain undeniable because of their biological and ecological individual particularity. In fact, all of the four are good phytomass producer in important quantities that can stop massive weed emergence because of the lackness of light on the soil surface. As leguminous plants, they can transform mineral nitrogen in organic nitrogen favourable to good disturbed soil improvement. .

Conclusion

The present study has shown that the use of some leguminous plant in integrated farming weed control is possible. However, the behaviour of these leguminous plants next to these weeds can vary according to the situation. Thus, species with short cycle and rapid development (*V. unguiculata* and *M. pruriens*) could be effective to control weeds in annual farmings such cotton plants, when they are used before farming. In fact, they can produce an important phytomass able to limit and even interfere with the emergence and the perfect development of most of the weeds among which figure the 6 tested species. The cotton plants sowed in the mulch of the organic material left on the plot can take advantage of the limited completion ability that the leguminous plants that cover the soil offer them.

C. sericea, an annual leguminous plant with a long cycle, can produce in a short time an abundant phytomass, which by spreading on the plot surface, can constituted a large plot mulch that protect the soil surface which pedologic quality can be improved with a very significantly enrichment in organic material. This plant could therefore be effectively used to improve the fallows in a short period. Concerning *P. phaseoloides*, a perennial Leguminous, its use in integrated weed control has already been proved. In fact, because of it emergence and slow growth, it can install sustainably in a fallow where it will have at the same time a very good action on weeds that it can shoke rapidly and the soil on which it contribute to improve the pedologic qualities with a good contribution in organic material and available nitrate

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