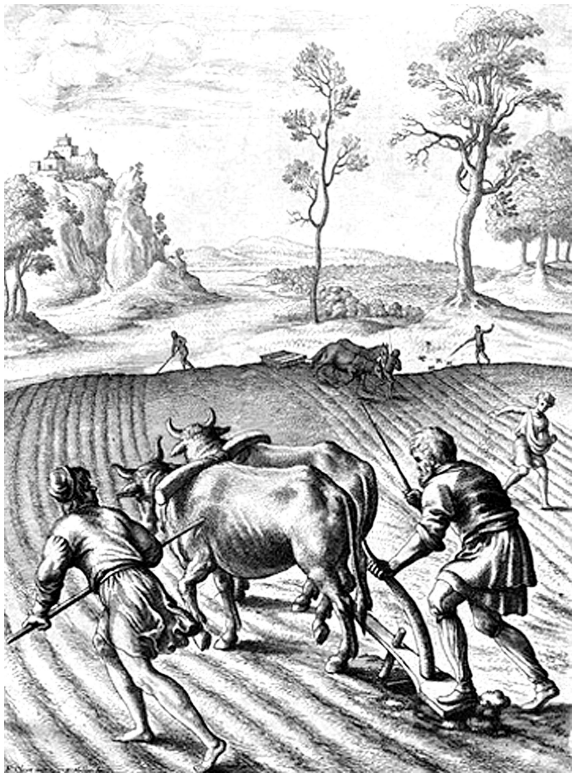
ISSN : 1812-5379 (Print)
ISSN : 1812-5417 (Online)
http://ansijournals.com/ja

JOURNAL OF AGRONOMY



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Journal of Agronomy 7 (3): 281-284, 2008
ISSN 1812-5379

Efficacy of Legume and Herbicidal Fallows in the Modification of *Imperata cylindrica* Infested Plots

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Abstract: Planted legume fallows consisting *Mucuna* sp. (var. Georgia), *Mucuna* sp. (var. Vera cruz) *Pueraria phaseoloides* and *Cajanus cajan* or initial application of imazapyr ((+) -2- [4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3-pyridine-carboxylic acid) at 0.5 kg a.i. ha^{-1} followed by a formulated mixture of paraquat + diuron at 1.0 kg a.i. ha one year after or glyphosate-trimesium at 2.4 kg ha^{-1}, were evaluated for suppression of spear grass, *Imperata cylindrica* in a fallow vegetation between 1998 and 2002 on a fallow site dominated (>90%) by *I. cylindrica* for six years before experimentation, at the Nigerian Institute for Oil Palm Research (NIFOR), Benin City, Nigeria. At commencement in 1998, plots (5×4 m) replicated four times in a randomized complete block design, were slashed back and left to re-grow and planted to the legumes or treated with imazapyr or glyphosate-triemsium in 1999. Paraquat + diuron was applied one year after in 2000. Shoot and rhizome biomass of *I. cylindrica* were significantly reduced after 4 years in herbicide treated plots or plots planted to legumes. *C. cajan* fallow was not effective in reducing *I. cylindrica* population and biomass. *Eclipta prostrata*, *Alternanthera sessilis*, *Mariscus* sp., *Cyathula prostrata*, *Commelina* sp. and *Panicum maximum* replaced *I. cylindrica* in the herbicide treated plots after 3 years. Except *P. maximum* these species also constituted the dominant species associated with the legume fallow plots. Vegetation in the untreated control and *C. cajan* fallow plots remained over 90% *I. cylindrica*.

Key words: Fallow, glyphosate, imazapyr, oil palm re-plantings, *Cajanus cajan*

INTRODUCTION

Spear grass (*Imperata cylindrica* L. Raeuschel) is a problem perennial weed in arable crop as well as in the early years of tree crop cultivation in Nigeria. It is particularly noxious in oil palm re-plantings in the forest/savannah transitions and in plots, which had been burnt regularly. In young oil palm re-plantings, the weed often assumes a serious problem because the palm canopies are not usually developed enough to shade out the weed. *I. cylindrica* often constitutes a fire hazard in oil palm plantings in newly opened secondary forest or fallow lands or old farmlands in the rain forest-savannah transition zones of Nigeria. The problem of *I. cylindrica* is significant among smallholder farmers who intercrop oil palm with food crops. Legume covers have been widely used as a strategy in reducing *I. cylindrica* populations in croplands (Macdicken *et al*., 1997; Udensi *et al*., 1999; Akobundu *et al*., 2000; Chikoye *et al*., 2005). Management systems including introduced fallow of legume cover crops which favour shifts of the vegetation from *Imperata cylindrica* to other natural vegetation such as woody secondary growth including *Chromolaena odorata* are useful in managing spear grasss (Van Noordwijk *et al*., 1997). This study investigated the efficacy of single dose application of imazapyr or glyphosate-trimesium or legume cover in the restoration of *I. cylindrica* dominated vegetation to a non-*I. cylindrica* dominated vegetation as a strategy of managing a fallow and the weed in densely infested fallow land.

MATERIALS AND METHODS

The study was conducted between 1998 and 2002 on an abandoned fallow field dominated (>90%) by *I. cylindrica* at the Nigerian Institute for Oil Palm Research (NIFOR), Benin City, Nigeria. The plots had been under *I. cylindrica* for 6 years before experimentation. At commencement in 1998, plots (5×4 m) replicated four times in a randomized complete block design, were slashed back and planted to the legumes. Due to poor establishment in 1998, the field was slashed back and left to regrow. The legumes were replanted in September, 1999 and the herbicide treatments were applied for the first time in 1998 and at the same time 1999, 2 weeks after slashing of the vegetation. The treatments were as follows:

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- Plots planted to *Mucuna pruriens* (var. Georgia),
- Plots planted to *Mucuna pruriens* (var. Vera cruz).
- Plots planted to *Pueraria phaseoloides* (Roxb.) Benth
- Plots planted to Pigeon pea (*Cajanus cajan*),
- Plots treated with a single dose of Imazapyr at 0.5 kg a.i. ha^{-1} and subsequently (one year after) with a formulated mixture of Paraquat and diuron (as Gramuron™, Zeneca)
- Plots treated with a single dose of Glyphosate-trimesium at 2.4 kg a.i. ha^{-1} and subsequently (one year after) with a formulated mixture of Paraquat and diuron (as Gramuron™, Zeneca)
- Untreated control

The legume covers were planted soon after the plots were slashed back. Minimal maintenance of the plots planted to legumes were carried out once during the 1st year of planting. Treatments were applied once and plots were left to fallow. Total weed biomass were obtained from fixed diagonal quadrats (0.5×0.5 m) in each plot, at commencement of study, or regular intervals until termination of study in July 2002. At the last weed sampling, soil in the entire quadrat area was carefully excavated to a depth of 30 cm. The soil was sieved and the rhizomes of *I. cylindrica* contained were obtained, air dried to constant weight and their dry weights were taken. All biomass were air dried to constant weight after separating *I cylindrica* and weights taken. All data were subjected to analysis of variance and means separated.

RESULTS

Other than *C. cajan*, which is a shrub, the planted legume fallows achieved nearly 80-100% groundcover most of the time. *Pueraria phaseoloides* consistently achieved better ground cover than the 2 varieties of *Mucuna pruriens*. However, *M. pruriens* especially *M. pruriens* (var. Vera Cruz.) often died back leaving occasional gaps.

Shoot and rhizome biomass of *I. cylindrica* were significantly reduced after 144 weeks in herbicide treated plots or plots planted to legumes (Table 1). *M. pruriens* (var. Vera Cruz.) was less effective than *M. pruriens* (var. Georgia) in reducing *I. cylindrica* infestation (Table 1). *C. cajan* fallow was ineffective in reducing *I. cylindrica* shoot and rhizome population and biomass (Table 1).

Although other weed species mainly annual species had emerged in the plots, biomass of weed species other than *I. cylindrica* was highly variable among the plots and not significantly different between the treatments (Table 2). Resurgence of weeds at the end of the 1st year necessitated application of paraquat + diuron in the imazapyr and Glyphosate treated plots. *I. cylindrica* remained the dominant species 144 weeks after in plots planted to *C. cajan*. *Eclipta prostrate* (L.) L., *Alternanthera sessilis* (L.) R. Br. Ex Roth, *Mariscus* sp, *Cyathula prostrate* (L.) Blume, *Commelina* sp. and *Panicum maximum* Jacq. replaced *I. cylindrica* in the herbicide treated plots after three years (Table 3). Except *P. maximum* these species also constituted the dominant

Table 1: Effect of legume fallow and herbicide application on shoot and rhizome biomass of *Imperata cylindrica*, weeks after planting or treatment application

	Time (weeks) after treatment			
	Shoot dry matter (g m^{-2})			Rhizome dry matter (g/0.3 m^3)
Treatments	0	96	144	144
Mucuna pruriens (var. Georgia)	493.0	105.0	21.3	76.0
Mucuna pruriens (var. Vera Cruz.)	351.0	90.0	207.0	248.0
Pueraria phaseoloides	503.0	145.0	12.0	77.0
Cajanus cajan	614.0	222.0	559.0	296.0
Imazapyr 0.5 kg a.i. ha^{-1} fb# paraquat + diuron 1.0 kg a.i. ha^{-1}	303.0	150.0	77.3	42.6
Glyphosate-trimesium 2.4 kg a.i. ha^{-1} fb# paraquat + diuron 1.0 kg a.i. ha^{-1}	496.0	74.0	44.0	85.0
Untreated control	220.0	226.0	857.0	392.6
SE±	65.4^{NS}	16.2^{NS}	76.2***	38.8**

fb = followed by; NS: Non Significantly; **,***Significant and highly significant

Table 2: Biomass of other species in plots 144 WAT# of fallow

Treatments	Weed biomass (g m^{-2})
Mucuna pruriens (Georgia)	181.0
Mucuna pruriens (Vera Cruz.)	417.0
Pueraria phaseoloides	194.0
Cajanus cajan	239.0
Imazapyr 0.5 kg a.i. ha^{-1} fb paraquat + diuron 1.0 kg a.i. ha^{-1}	242.0
Glyphosate-trimesium 2.4 kg a.i. ha^{-1} fb paraquat + diuron 1.0 kg a.i. ha^{-1}	290.0
Untreated	320.0
SE±	121.4^{NS}

WAT`weeks after planting legume or herbicide treatments; NS: Non Significantly

Table 3: Species composition of plots following fallow period

Treatments	At commencement	144 WAT
	Dominant weed species	Dominant weed species
Mucuna (Georgia)	*Imperata cylindrica*	*Eclipta prostrata*, *Mariscus* sp., *Cyathula prostrata*, *Commelina* sp.
Mucuna sp.	*Imperata cylindrica*	*Eclipta prostrata*, *Mariscus* sp., *Cyathula prostrata*, *Commelina* sp.
Pueraria phaseoloides	*Imperata cylindrica*	*Mariscus* sp., *Cyathula prostrata*, *Commelina* sp.
Cajanus cajan	*Imperata cylindrica*	*Imperata cylindrical*, *P. maximum*
Imazapyr 0.5 kg a.i. ha^{-1} fb# paraquat + diuron 1.0 kg a.i. ha^{-1}	*Imperata cylindrica*	*Alternanthera sessilis*, *Mariscus* sp., *Cyathula prostrata*, *Commelina* sp. and *Panicum maximum*
Glyphosate 2.4 kg a.i. ha^{-1} fb# paraquat + diuron 1.0 kg a.i. ha^{-1}	*Imperata cylindrica*	*Alternanthera sessilis*, *Mariscus* sp., *Cyathula prostrata*, *Commelina* sp. and *Panicum maximum*
Untreated	*Imperata cylindrica*	*Imperata cylindrica*, *Alternanthera sessilis*, *Mariscus* sp., *Cyathula prostrata*, *Commelina* sp. and *Panicum maximum*

#fb = followed by

species associated with the legume fallow plots. Vegetation in the untreated control and *C. cajan* fallow plots remained over 90% *I. cylindrica*.

DISCUSSION

The legume covers of *M. pruriens* and *P. phaseoloides*, effectively shaded out *I. cylindrica* and reduced its rhizome in the soil, thereby reducing the its regenerative capacity. Thus the infestation of *I. cylindrica* in the fallow was effectively reduced by the legume covers.

I. cylindrica owes its aggressive growth and success as a weed to its capacity to regenerate from rhizomes. The rhizomes of *I. cylindrica* are extensive and concentrated in the upper 20 cm of soil (Soerjani, 1970). Therefore, effective strategies of its control aim to reduce its capacity to regenerate from rhizomes and form new aerial shoots (Brook, 1989; MacDicken *et al*., 1997). Although shading out the weed has been shown to reduce its level of infestation (Soerjani, 1970; Eussen, 1980), reduction of its rhizome do not seem to be effectively achieved by short-term shading as shown by Akobundu *et al.* (2000). Akobundu *et al.* (2000) reported that the shade from legume covers did not eliminate the problem of *I. cylindrica* due to the limited effects on rhizomes. Thus for effective control of the weed, shading or smothering it using legume covers should last longer than at least one year as in a short or long term fallow. As the legume fallows achieved ground cover over the relatively long period of this study, they effectively achieved the objective of shading out *I. cylindrica* thus reducing its level of infestation as well as its rhizomes. Chikoye and Ekeleme (2003) achieved reduction in rhizomes of *I. cylindrica* using *Mucuna conchinchinensis* and *Pueraria phaseoloides*. Being a shrub, *C. cajan* did not achieve sufficient shading of the weed as the creeping *M. pruriens* or *P. phaseoloides*. Thus it was not able to reduce the infestation level of *I. cylindrica*. Udensi *et al.* (1999) showed that regrowth of *I. cylindrica* was as effectively reduced by *Mucuna pruriens* as glyphosate at 1.8 kg ha^{-1}, 1 year after treatment and was better reduced by imazapyr at 0.5 kg ha^{-1}. Being strongly translocated herbicides, single doses of glyphosate-trimesium and imazapyr, appeared to have achieved effective initial kill of the rhizomes of *I. cylindrica* and consequently also reduced their regenerative capacity, as achieved by the legume covers. Subsequent application of paraquat + diuron effectively reduced the resurgence of the weed in imazapyr and glyphosate treated plots. Given that the herbicides were applied two months before the dry season of the year (September), the regenerative capacity of the weed could have been further reduced by the ensuing dry spell. As herbicides were applied in the late season, further studies would be needed to elucidate the importance of the time of application in control reducing *I. cylindrica* infestation in fallows. The herbicide treatments were as effective as four-year fallow of *Mucuna* or *Pueraria* in the restoration and shift of *I. cylindrica* to manageable vegetation. Generally herbicides have been shown to achieve suppression of *I. cylindrica* as shown by Chikoye *et al.* (2005).

While legume covers and shading have demonstrably reduced infestation of *I. cylindrica*, in cropping cycles, in short term studies (Versteeg and Koudokpon, 1990; Udensi *et al*., 1999; Akobundu *et al*., 2000; Chikoye and Ekeleme, 2003), it would be necessary to over come practical problems which could arise in maintaining the covers over a long time to achieve reasonable reduction of its infestation. As short fallows are increasingly becoming features of agriculture in West Africa, these legume covers and the herbicides can be incorporated in the fallow systems to reduce infestation of *I. cylindrica* in fallows and subsequent cropping cycles.

ACKNOWLEDGMENTS

We are grateful to Director, NIFOR for permission to carry out this study and publish the research. We thank Messrs. D. Ikubese and Monday Ogbole for technical assistance.

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