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Full Length Research Paper

Weed management in banana production: The use of *Nelsonia canescens* (Lam.) Spreng as a non-leguminous cover crop

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During a survey of weeds in the Tiko banana plantations, the plant *Nelsonia canescens* (Lam.) Spreng was found to have invaded large areas of the plantation with no visible adverse effects on the banana crop. The effects of this Acanthaceae on banana yield parameters, snails' population and weed species diversity and abundance were evaluated, with the intension of recommending the plant as a cover crop in weed management in banana plantations. Of the 73 weed species identified in Tiko banana plantation, only nine were found growing in association with *N. canescens.* These weed species also showed reduced abundance and vigour. The reduction in abundance ranged from 60 to 100%. The reduction in abundance was more pronounced during the dry season when cover crop growth was dense, than in the rainy season when there was reduced growth. The pseudo - stem circumference, bunch weight and hand class were significantly higher (p > /0.05) for plants grown with cover crop than for those grown without. The number of snails on and around the pseudo - stem was also significantly reduced in banana grown with *N. canescens* cover crop than in plants grown without. *N. canescens* has an added advantage in that it is prostrate and does not climb on the banana pseudo - stem. This may be a good alternative weed management tool in banana production. The techniques of mass production need to be developed.

Key words: *Nelsonia canescens*, cover crop, weed management, banana production.

INTRODUCTION

The main method of weed control is by use of herbicides (Hopkins, 1994). Herbicide residues have been shown to have a direct impact on human and animal health and may harm already endangered plant species (Jordan, 1996). Drifting and leached herbicides may also contaminate surface and ground water. The adverse effect of herbicides on people and environment necessitates the development of alternative control measures (Kanasian, 1971). The use of cover crops has been a viable alternative commonly employed in plantations.

Cover crops have been variously defined, but what is common with these is that cover crops are planted not for the purpose of harvesting, but for the purpose of benefiting the soil and other crops (SAN, 1996; Creamer et al., 1996; Lal et al., 1991). Thus a cover crop may prevent soil erosion by wind and water, conserve soil moisture, smother or suppress weeds, improve soil fertility and control pests and diseases. When planted to reduce nutrient leaching following a main crop, they are also called catch crops. The choice of a cover crop depends on some intrinsic factors including the ability of rapid establishment, reduced competition for moisture and nutrients with the main crop, good foliage cover even during non - cropping periods and efficient production of rapidly recycling biomass (SAN, 1996). Perennial herbaceous legumes such as species of *Centrosema, Mucuna* and *Pueraria* have been traditionally used as cover crops and these have the additional advantage of being able to fix atmospheric nitrogen in their nodules (Singogo et al., 1996). Cover crops have been used

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extensively in both annual and perennial crop production systems to accomplish multiple goals. Integrating cover crops into conservation tillage systems as weed management tools have been shown to provide weed control comparable to herbicides in some situations (Cruthfield et al., 1985; Smeda and Putnam, 1988; Purvis et al., 1985; Johnson et al., 1993). Ramos et al. (1983) recorded the use of some species of Commelinaceae that cover the soil extensively, of shaded coffee *(Coffea arabica* L.) plantations in Coatepec, Veracruz. The coffee farmers manage the growth of these plants and use them as green fertilizers and for weed suppression.

Rye (*Secale cereale* L.) is an excellent example of a plant that provides weed suppression by producing a dense canopy that is more competitive than weeds for light, moisture and nutrients. In addition, rye residues on the soil surface reduce weed germination and growth by shading, lowering soil temperatures moderating diurnal temperature fluctuation and acting as a physical barrier (Barnes and Putnam, 1986; Putnam et al., 1983; Rice, 1984). In Honduras, the most outstanding cover crops screened for their ability to reduce soil erosion on farms were nine species of *Desmodium*, two each of *Centrosema*, *Vigna* and *Cracca* and two varieties of *Glycine javanica* Willd. (SAN, 1996). None of these proved satisfactory even when established at high cost because they succumbed to shade, covering with banana trash, and foliage diseases. A natural ground cover of *Geophila repens* D. Don became established in some farms in Puerto Armuelles, Panama's Pacific Coast. The plant has become the best ground cover in the shade established banana plantations. This cover crop reduces soil erosion and is resistant to shade from banana trash. It is not attacked by any pest and it does not climb up the pseudostem. The disadvantage however, is that it must be propagated vegetatively and grows slowly, implying that the establishment of a soil cover is expensive and slow. *Geophila. repens* is among the first non - leguminous species to be evaluated for use as a cover crop in banana production systems. A good cover crop could have the additional advantage of controlling pests. In banana plantations in Cameroon, snails and slugs are common pests. The banana slug (*Vaginula olivaceous*) and snail (*Helix aspersa*) have biting and chewing mouthparts, and their feeding activities can be very damaging to the plants. They cause damage to plants by creating large irregularly shaped holes with tattered edges on the leaves. Snails normally scar the fingers of banana especially when young and these scars remain till maturity. Slugs feed at night, rasping circular holes that are deeper than those of peel feeding caterpillars and that do not scab over.

There has also been much interest in the use of cover crops to improve soil fertility. Most of these interests stem from heightened awareness of the negative environmental impacts of the synthetic fertilizers, including ground and surface water contamination, long term soil productivity and energy intensiveness of fertilizer production (Jordan, 1996). In Cameroon, cover crops are used for soil and weed management mainly in oil palm and rubber plantations. New resource management initiatives are necessary to restore the soil, increase organic matter and nutrients, improve plant production, control pests and find adequate techniques to reach a sustainable production, (Warren, 1983). It is necessary to establish programs such as the use of cover crops to improve agricultural practices that will lead to increased crop yield, better control of weeds and limited usage of harmful agrochemicals (Caamal et al., 1996). During a survey of weeds in the banana plantations at Tiko (Cameroon), the plant *N. canescens* was found to invade large areas of the plantation with no visible adverse effects on the banana crop. Other weed species were very limited in such portions of the plantation. The idea of using this plant as a cover crop for weed management then cropped up and needed to be investigated further. The effectiveness of *N. canescens* as a cover crop in banana plantations depends on how much it can suppress weeds, to what extent it affects banana yield as well as its effects on other banana pests. The objectives of this study were as follows:

i. To evaluate the potential of *N. canescens* as a cover crop for weed suppression in banana plantation.
ii. To evaluate the effect of *N. canescens* on specific growth and yield parameters of banana.
iii. To determine the effect of the *N. canescens* on infestation of banana by snails.

MATERIALS AND METHODS

Study site

The experiments were carried out in a banana field in Pungo, Tiko. The area stretches from latitudes 4° 4' and 4° 20' north and longitudes 8° 7' and 9° 25' east of the Greenwich meridian. This area is characterized by a humid equatorial climate with a mean rainfall of 350 mm per month and mean temperature of 27°C. There is a short dry season from November to March, followed by a long wet season. The soils are of rich volcanic origin, being located on an active volcano, Mt Cameroon.

The experiment was carried out from 2000 - 2002. The field was planted with the banana clone Williams at a spacing of 2.16 x 2.16 m (Hexagonal system). Thirty - six plots were mapped out; each measuring 50 x 10 m. *N. canescens* was established through stem cuttings in 18 of the plots, each alternating with a clean - weeded plot. Manual weeding was done monthly on the plots during which all weeds were pulled out from plots not planted with *Nelsonia*, while only non - *Nelsonia* weeds were pulled out from the plots planted with *Nelsonia*. The number of man - hours taken to weed each plot was noted.

Effect of cover crop on weed species and population

Before each weeding, plots were sampled for weed species diversity and population in 25 randomly selected 2 m^2 quadrats using the relevé method (Braun Blanquet, 1965). The total weed population was determined by counting the individual weeds in each quadrat while the density was determined as the number of

Table 1. Weed population in banana plots with and without *Nelsonia canescens* cover crop.

	Weed population (Number of weeds)		
	2000	**2001**	**2002**
Cover crop	59	61	59
No cover crop	718	645	661
S.E ±	0.11	0.73	0.84
LSD $_{(0.05)}$	18.68	18.94	18.07

S.D. = Standard deviation, LSD = Least significant difference.

Table 2. Diversity of weed species in banana plots with and without *Nelsonia canescens* cover crop.

	Diversity (Number of species)		
	2000	**2001**	**2002**
Cover crop	5	5	5
No cover crop	13	13	13
S.E ±	0.44	0.53	0.62
LSD $_{(0.05)}$	1.61	1.68	1.49

species per quadrat. The relative abundance of each species was estimated as the ratio of the population in the quadrat. The frequency of each species was estimated as the number of times this species occurred in the 25 quadrats sampled. All data were subjected to analysis of variance and the means were compared using orthogonal contrasts (SAS Inst, 1985).

Effect of cover crop on banana yield

At flowering, the circumferences of banana pseudostems were measured. At maturity when each banana was harvested, the second hand calibration was done using calipers. The hand class was determined by counting the numbers of hands per bunch and then the bunch weight was measured with a spring balance. The data were subjected to analysis of variance using the number of plants per plot as co - variable. Orthogonal contrasts were used to compare means.

Effect of cover crop on snail infestation of banana

The number of snails at the base of each banana plant was counted in five randomly selected 5 x 5 m quadrats per treatment, twice during the rainy season and twice during the dry season. Results were then subjected to the analysis of variance to elucidate the effects of the cover crop on the snail population within these plots.

RESULTS

Identification of the cover crop

The cover crop was identified as *N. canescens* (Lam.) Sprengel which is an Acanthaceae. The plant is a creeping herb; with hairy stem. Leaf arrangement is opposite. The lower leaves are long and petiolate while the upper leaves become sub sessile. The lamina is elliptic to ovate, with a mean length of 4 cm, with an entire margin. Leaf surface is pubescent or often wooly. The Inflorescence is a terminal, cylindrical villous spike up to 10 cm long with bracts. The bracts are imbricate, broadly ovate, about 6 mm long. Calyx lobes are 4, lanceolate in shape and unequal. The largest calyx lobe is often shortly and bilobed. Corolla is pink. The fruits are capsules and a bit longer than bracts. There are more than four seeds per capsule.

Effect of treatments on weed population

Table 1 shows the effect of cropping pattern on weed population, over a two - year period. Results showed a significant difference ($P > 0.05$) between cover crop and non cover crop plots. Weed population was much higher in plots without cover crops than in plots with cover crop.

Effect of treatment on weed diversity

A similar trend was noticed on the weed diversity across the years. Table 2 shows the results of treatment effect on the number of weed species. *N. canescens* was found to reduce the diversity of the different weed species than non cover crop treatment. There was a significant difference between the different treatments across the years of study. Diversity did not change over the years.

Interaction effects between treatments and months on weed population

Table 3 shows a significant interaction between cropping treatment in Pungo during early and peak months of the seasons. Highest values of weed population were obtained in plots without cover crop when rainfall was highest (June and August). In cover cropped plots, though weed population were high compared to other months in June and August, values were far less than what was obtained in the non-cover cropped plots. There was a significant difference ($P > 0.05$) within the month between cover crop and non cover crop treatments. Dry months of October, December, February and April had less population of the weed species (Table 3).

Comparison of weed diversity in banana plots with and without *N. canescens* cover crop at Pungo, Tiko, during the dry and rainy seasons.

Table 4 shows the weed diversity in banana plot with and without the cover crop. The general trend was a higher weed population in the plots without cover crop. However there was absence of some weed species in the plots which indicated that climate had an effect on the growth of some species.

Table 3. Weed population in banana plots with or without *Nelsonia canescens* cover crop in Pungo during early and peak months of the seasons.

	Weed population[a]					
	February	**April**	**June**	**August**	**October**	**December**
Cover crop	42	36	107	121	22	18
No cover crop	421	499	936	1040	562	450
$LSD_{(0.05)}$	0.11	0.84	1.73	1.98	0.67	1.88

[a]Values are averages of a three year period, LSD = Least significant difference.

Table 4. Comparison of weed diversity in banana plots with and without *Nelsonia canescens* cover crop at Pungo, Tiko, during the dry and rainy seasons.

	Cover crop		No cover crop	
	Rainy season	**Dry season**	**Rainy season**	**Dry season**
Phyllanthus amarus Schum and Thonn	9	8	38	12
Cleome rutidisperma DC	8	4	-	-
Mariscus alternifolius Vahl	5	3	27	7
Fleurya aestuans (Linn.) ex Miq	12	4	45	18
Cyathula prostrata (L.) Blume	4	2	63	16
Mariscus flabeliformis Kunth	5	-	-	-
Solenostomon monostachyus (P.Beauv.) Brig	8	-	30	23
Euphorbia hirta L	-	-	42	17
Althernanthera sessalis (L.) DC	-	-	25	6
Eleusine indica (L.) Gaertner	-	-	8	6
Cyperus esculentus Linn	-	-	29	-
Euphorbia prostrata L	-	-	-	-
Oldenlandia corymbosa Linn.	7	-	89	19
Portulaca oleraceae Linn.	-	-	27	18
Perperomia pellucida (L.) Kunth	8	-	71	24
Asystasia gangetica (Linn)T.Anderson	-	-	27	23

Effect of treatment on four yield parameters of banana

There was a significant difference ($P > 0.05$) between the treatments on the yield parameters of banana. Pseudo-stem circumference of plants in plots with cover crop was higher than those of plants with no cover crop. This same effect was obtained in bunch weight, second hand calibration and hand class (Table 5). However, the difference in calibration between cover crop and non cover crop plots was not significant ($P > 0.05$).

Treatment effect on snail population

Tables 6 and 7 show the results on the incidence of snails in banana plots with or without *N. canescens.* It was observed that the population of snails in the upper canopy of banana plants was significantly lower than in plots with no cover crop. This same trend was observed on the soil surface. There were more snails observed in the rainy season than the dry season.

Effect of treatments on labour input

The labour input in manually weeding the banana plots with or without *N. canescens*. It was observed that the time taken in weeding plots with cover crop was about a third of the time used in weeding the plots with no cover crop. In some cases just eight minutes was used to weed a 500 m^2 plot with cover crop. The general trend was an appreciable reduction of the time spent on weeding in all cover crop plots.

DISCUSSION

The results show that *N. canescens* was very effective in weed control. Out of the seventy – three weed species

Table 5. Yield parameters of banana from plots with or without *Nelsonia canescens* cover crop at Pungo Farm (Tiko).

	Yield parameter			
	Pseudostem circumference (cm)	**Bunch weight (kg)**	**Second hand calibration (mm)**	**Hand class**
Cover crop	63.2	27.2	44.1	8.8
No cover crop	62.3	26.6	44.0	8.6
LSD $_{(0.05)}$	0.11	0.07	0.01	0.05

Table 6. Incidence of snails in banana plots with or without *Nelsonia canescens* cover crop at Mondoni and Pungo, Tiko (Rainy season).

	Snails population	
	Upper plant	**Plant base**
	Mondoni	
Cover crop	6	78
No cover crop	23	93
LSD $_{(0.05)}$	2.12	1.34
	Pungo	
Cover crop	5	91
No cover crop	8	96
LSD $_{(0.05)}$	0.44	0.93

Table 7. Incidence of snails in banana plots with or without *Nelsonia canescens* cover crop at Mondoni and Pungo, Tiko (Dry season).

	Snails population	
	Upper plant	**Plant base**
	Mondoni	
Cover crop	2	66
No cover crop	21	43
LSD $_{(0.05)}$	2	1
	Pungo	
Cover crop	3	71
No cover crop	8	36
LSD $_{(0.05)}$	1	1

that were identified in the Tiko plantation, only nine were found growing together with *N. canescens* indicating an 86.24% reduction in the number of weed species (Table 2). There was also a significant reduction of the weed population. Results showed 60 -100% reduction in weed population when quadrats were used (Table 1). Even in the cases where the nine species were found growing with *N. canescens*, the number of weeds was relatively low. This is a clear indication that this cover crop has a very significant effect on the number of weed species and weed population growing in the plantation.

The following weeds were found growing with *N. canescens*: *Phyllanthus__amarus* Schumet Thonn*, Solenostemon monostachyus* P. Beauv. Brig*, Euphorbia hirta, Cleome rutidiosperma* DC, *Fleurya aestuans* (Linn) ex Miq. *Cyathula prostrata* (L.)Blume*, Althernanthera sessalis* (L.)DC., *Mariscus alternifolius* Vahl. *Peperomia pellucida* (L.) Kunth. *N. canescens* (Lam.) Spreng is a non - leguminous cover crop. It has some advantages of a good cover crop. These include, provision of a rapid high percentage of ground coverage. *N. canescens* grows from stem cutting as well as from seeds and takes about four weeks to form ground cover. It also protects the bare soil and has the potential to suppress weeds. It

does not climb up the banana stems, which confer an excellent advantage as a cover crop. Some growers resort to dry banana leaves and ground covers such as *Commelina* spp. or *Zebrina pendula* Schizl and *Glycine javanica* L. (Rhodesia kodzy) or creepers to discourage weeds but these tend to climb the banana stems and become a nuisance. Some weed exclusion was found in the cover crop plots. There was significant suppression of weeds that in turn minimized the detrimental effect of weeds within the plantation. Weeds such as *Acanthus montanus, Amaranthus spinosus* and *Ficus exasperata*, which were considered useless, unwanted and undesirable due to uninteresting morphological structures such as thorns and prickles, were suppressed. The cover crop caused a definite shift in weed flora over time. Weeds flourish on bare soil, but with the presence of cover crops, there is great reduction of the opportunity for these weeds to establish themselves. During the dry months (September to March) *N. canescens* thrived very well and had good ground cover and contained fewer weeds. Table 4 displays an example of the comparative weed species in banana plots with or without *N. canescens* cover crop at Pungo during the dry and rainy season. Species population and diversity reveals some interesting results. There was a higher number of species and population of weeds in the rainy season. The lower numbers in the dry season was probably as a result of the luxuriant growth of the cover crop an indication that the cover crop had an effect on the growth of other weeds.

Mariscus alternifolius, *Althernanthera sessalis, Stachytapheta cayenensis*, *Portulaca oleraceae*, *Asystasia gangetica* were considered as the most serious weeds. The cover crop plots contained much less or none of these weeds. This was the same observation made by Schonbeck et al., (1998) reported similar observations in rye grass and Sudan grass in reducing *Erigeron strigosus* and *Lychnis alba*, which the farmers considered their most serious weeds at Belchertown in Massachusetts, United States of America. Observation in the field also showed that there was less proliferation of the cover crop during the rainy months (May – September) resulting in relatively higher numbers of weeds. The number of species however did not change. The result suggests that using *N. canescens* as a cover crop had a very positive role in reducing weed pressure in the plantation. Weed densities were low and variable in cover crop plots. Weed densities of 0 - 76 plants in 2 m^2 quadrat were present during the years of the study with the prominent weed being *Phyllanthus amarus* in these plots. In non cover crop plots, densities of all weed species ranged from 60 - 1300 plants in 2 m^2 by late October. The predominant weeds were *Solenostemon monostachyus*, *Mitracarpus villosus*, *Euphorbia hirta, Fleurya aestuans, Cyperus esculentus, Mariscus alternifolius, Eleusine indica.* In the case of number of species the number ranged from 10 -17 species while for the cover crop number of species ranged from 0 - 7 species. The cover crop, *N. canescens* could be an effective low cost and environmentally sensitive means of controlling weeds in banana. The degree of weed suppression depends on soil coverage, residue characteristics, residue management, amount of disturbance at planting and possible soil type. An important observation was made where cover crop plots had higher weed densities that had been disturbed either by movements of workers within these plots or some possible destruction of the crop than those that had experienced less disturbance. A vigorous cover crop does the best job by suppressing weeds. Cover crops decrease evaporation from the soil surface.

The results showed that *N. canescens* caused a 60% reduction in growth of weeds in banana plots. The mechanism of inhibition was not known and it occurred regardless of any fertilization. These results confirmed earlier findings.

In the semi arid tropics, weed induced yield losses may be up to 80% (Rao et al., 1987). Weed invasion has significantly increased farm labour cost due time spent on weeding. The use of *N. canescens* drastically reduced weeding time by about 60%. As concerns the labour input in manual weeding of banana plots with or without *N. canescens* cover crop, time spent on weeding was reduced by 60%, which in turn reduced labour input. A vigorously cover crop can act as a “smother” crop and can out - compete many weeds and suppress germination of weed seeds. The cover crop had an effect on banana yield. Table 5 shows yield parameters of banana from plots with or without *N. canescens* cover crop at the Pungo farm. There was an increase in the pseudostem circumference, hand class and bunch weight of banana plants. Obiefuna (1989) also reported the suppression of weeds when plantain is intercropped with “egusi” melon (*Colocynthis citrallus*).

A four - year study in Maryland by Teasdale et al., (1993) suggested that, under no - till management, hairy vetch (*Vicia villosa*) was particularly effective at reducing the densities of the following weeds: goose grass (*Eleusine indica*), stinkgrass (*Eragrostis cilianensis*), and carpetweed (*Mollugo verticillata*). Under conventional tillage, hairy vetch appeared during one year to increase the densities of large crabgrass (*Digitaria sanguinalis*) above those observed without a cover crop or with cereal rye (cv 'Abruzzi'). In some years, cereal rye grown as a no - till cover crop significantly reduced the densities of the goose grass and carpetweed. Moore et al., (1989) also found in pot experiments in Australia, that subterranean clover can suppress the seedlings of the perennial weed St. John's Wort (*Hypericum perforatum*) by overtopping the seedlings and shading them out. This study confirmed earlier findings that subterranean clover could suppress the weed if sown into native pastures, particularly if phosphate fertilizers had been applied. This was in line with what was found in the field. Some weeds

were shaded out completely especially during the dry months of the year. Tables 6 and 7 show the incidence of snails in plots planted with and without *N. canescens* snails were found more in the plots without cover crop, an indication that this cover crop helped in keeping the snails at the base of the banana plant. This of course is an advantage as the aesthetic values of the banana fruits are maintained. The relatively non - performing nature of the cover crop during the rainy season could be appreciated as an advantage in the plantation. The cover crop helps in preventing erosion as well as retaining water. If it becomes very performant in the rainy season, there could be a tendency of water stress. The bare soil is susceptible to wind and water erosion especially at the beginning of the rainy season in South Western Cameroon. *N. canescens* was found to protect the soil surface from rain drops impact, run - off and erosion. Young (1989) also made this observation and added that cover crops are also capable of providing nutrients to the soil. Budelman (1989) reported that cover crops also maintain low soil temperature needed for soil biological activity.

Conclusion

There is no evidence that the practice of the use of cover crops is being adopted. Some farmers expressed interest in growing *N. canescens* as a cover crop to protect the soil and reduce weed population and some of them said they would be willing to adopt it if it is shown to be cost effective.

The study indicates the possibility of using *N. canescens* to suppress weeds in banana plantations. In managing cover crops, many issues must be considered. Knowledge on cover crop ecology is still fragmentary, yet it is progressing rapidly.

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