Influence of the beginning of soil preparation and the number of rows for sowing relationship on the establishment of multiple mixtures of creeping legumes associated with grasses

T. E. Ruíz, G. Febles, H. Díaz and J. Díaz
Instituto de Ciencia Animal, Apartado Postal 24, San José de las Lajas, La Habana
Email: teruizv@ica.co.cu

An experiment was conducted for studying the effect of the starting time of soil preparation and the number of the rows for sowing on the establishment of multiple mixtures of creeping legumes associated with grasses. A random block design, in factorial arrangement with four replications was applied. Factors were: time of starting soil preparation (February, March and April) and the number (2:2 and 2:3) of rows for sowing (grass-legume) and an unsown control. Trials were repeated in time. Legumes were *Centrosema pubescens* (centro), *Macroptilium atropurpureum* (siratro), *Neonotonia wightii* (glycine), *Stylosanthes guyanensis* (stylo) and *Calopogonium mucunoides* (Calopogonium), associated with *Panicum maximum* (guinea grass). They were sown in a red ferrallitic soil at the beginning of the rainy season. The time of starting soil preparation for the sowing in February showed important values for legume yield (2.2 t DM/ha) and grasses (4.3 t DM/ha). The highest weed incidence in all treatments at the end of the rainy period was present in the areas where the association was not sown (1.06 – 2.68 t DM/ha). This incidence was lower as the time of preparation was shorter. The best performance for the rows for sowing (grass-legume) was present for the 2:3 relationship, in measurements as important as higher number of legumes/m^2 and lower number of weeds/m^2. As the presence of weed plants increased, the amount of rooted points was affected. The number of legume plants/m^2 showed differences and was reflected on their yield. It was lower for March and April treatments. It is concluded that starting soil preparation in February favors the harmonic plant development, the rooted points of creeping legumes, as well as the balance of the system components and their persistency.

Key words: *soil preparation, row relationship, creeping legumes, grasses, weeds*

The poor persistency of forage legumes associated with grasses under grazing, is one of the main factors limiting their acceptance by producers (Andrade *et al*. 2004). According to Simeao *et al*. (2006), legume persistency is directly associated with the survival of their plants and the seed production for maintaining the legume in the system through natural resowing.

An analysis realized at the Institute of Animal Science of Cuba (Ruiz and Febles 2006) reviewed all the information obtained in the country regarding creeping legume persistency in grasslands. It was found that among the aspects influencing on this performance is the amount of rooted points, the sowing methods used, weed presence, as well as the beginning of the exploitation of these species without attaining a satisfactory establishment, among other factors.

Amezquita (1999) indicated that soil preparation, if required, must be directed to correct some physical limitation present in its depth where the roots grow. Once solved the physical problems, those of chemical order must be worked out, associated with amendments and to the application of lacking or deficient nutritive elements for creating a good environment of organic matter in order that beneficial microorganisms can act conveniently.

The objective of this study was to study the effect of the time of starting soil preparation and the number of rows for sowing on the establishment of multiple mixtures of creeping legumes in association with grasses.

Materials and Methods

Treatments and design. A random block design in factorial arrangement with four replications was applied. Factors were: time of starting soil preparation (February, March and April), number ofrows for sowing (grass: legume; 2:2 and 2:3) and unsown control.

Experimental procedure. The experiments were carried out in a red ferrallitic soil of fast drainage, clayey and deep on limestone (Hernández *et al*. 1999), equivalent to the subtype cambisol ferralic rodic according to FAO-UNESCO (Duran and Pérez 1994). Research was developed in the experimental area of the Department of Pastures and Forages of the Institute of Animal Science of Cuba, located at Western part of the country at 22º 53' North latitude and 82º 02' of West longitude at an altitude of 80 m.a.s.l.

Soil preparation was by ploughing, two harrow passes and rowing all the area at 0.70 m. Sowing was carried out in June when the rainy period was stabilized. Experimental plots had a net area of 7 x 6 m. Seed were inoculated with the adequate Rhizobium strain for each species. For the legume mixtures, 8 kg/ha of P.G.S. was used. Grass and legume sowing was conducted according the methodology described by Ruiz *et al.* (2000).

The mixture consisted of the associations of the legumes *Centrosema pubescens* (centro), *Macroptilium atropurpureum* (Siratro), *Neonotonia wightii* (glycine), *Calopogonium mucunoides* (Calopogonium) and *Stylosanthes guyanensis* (stylo) with the grass *Panicum*

maximum (guinea grass).

For studying the performance of the association, three observations from each treatment were taken in 0.25 m^2 fixed frames for the measurements plant population/m^2 (legumes-grass-weeds), number of rooted points/m^2 of the legumes, percentage of weeds and yield, t DM/ha (legumes-grasses-weeds).

From these measurements, the two formers were transformed according to √x and for the botanical composition, arc sin √x was used. For determining biomass production of legumes and guinea grass, cutting was at 20 and 10 cm height, respectively. All measurements were performed 80 days after the germination of the species sown. An analysis of variance was made and Duncan's (1955) test was applied in the necessary cases.

All treatments received the same number of field labors for soil preparation (ploughing- harrow-harrow).

Results and Discussion

There was no interaction between factors for the measurements under study (table 1). When the effect of the time of starting soil preparation for sowing, was evaluated with preparation times shorter than three months (table 1), it was found that when preparationstarted in February there were important values for legume and grass yield. The same occurred for other measurements under assessment. The best performance of the number of rows for sowing (grass-legume) at the time of establishment was shown in the relationship 2:3, in measurements as important as higher number of legumes/m^2 and lower number of weeds/m^2.

In table 1 is shown that as the numerical value of weed plants increased, the amount of rooted points was affected as it took place in March. Meanwhile, the number of legume plants/m^2 presented differences and thus, was reflected in its yield when it was lower as it occurred in the treatments of March and April. The above mentioned indicates that the weed factor markedly influenced on the sowing and initial development of the legume-grass plants.

There was interaction for the weeds regarding weight (t DM/ha). It must be highlighted (table 2) that the highest incidence, measured in all treatments at the end of the rainy period, was evident in areas where the association was not sown. This became lower as the preparation time was shorter (April, March and February). This performance can be associated with the fact that the preparation was realized in a phase with some level of rainfall (April) that favors weed germination and thus, their elimination in the process of soil preparation. In that regard, Kolmans and Vásquez (1999) indicated that for a correct land tilling it must be realized in the season where the conditions of humidity, temperature and solar radiation are most favorable.

There were no differences regarding weed presence in sowings realized at the different times for starting soil preparation. Weed incidence is not desirable for starting the exploitation of an association, since they influence negatively on the future stability of the grassland. It must be borne in mind that weed incidence in areas exploited by the animals could provoke differences between them, as an indicator of pasture stability.

In a study carried out by Ruiz and Febles (2008) for determining the performance of different combinations of grass legumes against two times of soil preparation, it was found that sowing of more than one legume presented superior performance for all indicators when compared to the sowing of only one

Table 1. Effect of the time of starting soil preparation and the row relationship on the establishment indicators

Time of starting soil preparation	Number of rooted points/m^2	Number of plants/m^2			Yield t DM/ha	
		Legumes[1]	Grasses	Weeds	Legumes	Guinea grass
February	6.0^{a} (37.2)	9.4^{a} (90)	1.4 (1.9)	3.9 (16)	2.2^{a}	4.3^{a}
March	4.9^{b} (26.4)	7.9^{b} (74)	1.4 (2.0)	4.8 (25)	1.5^{b}	4.6^{a}
April	5.7^{ab} (33.5)	8.1^{b} (68)	1.6 (2.5)	3.4 (13)	1.8^{b}	7.7^{b}
SE±	0.3*	0.5**	0.1	0.4	0.1**	0.5**
Number of row Grass-legumes						
2:2	5.8 (34.7)	8.8 (81)	1.5 (2.2)	4.1^{ab} (18)	2.4	5.9
2:3	5.7 (34.6)	10.1 (103)	1.5 (2.1)	3.5^{a} (15)	2.1	5.1
Control	-	-	-	4.5^{b} (22)	-	-
SE±	0.3	0.4***	0.1	0.4*	0.3	0.5

^{ab}Means with different superindices differ at $P < 0.05$ (Duncan 1955)

*$P < 0.05$ ** $P < 0.01$ ***$P < 0.001$

( ) Real values

[1]Calopogonium – Siratro – Stylosanthes – Centrosema –Glycine

Table 2. Weed performance, t DM/ha

Number of rows sown		Time of starting soil preparation			
		February	March	April	SE±
Grass	Legume[1]				
2	2.0	0.25[a]	0.14[a]	0.03[a]	0.24*
2	3.0	0.29[a]	0.10[a]	0.01[a]	
Unsown control		2.68[c]	1.56[b]	1.06[b]	

[abc]Means with different superindices differ at P < 0.05 (Duncan 1955)
[1]Calopogonium – Siratro – Stylosanthes – Centrosema - Glycine
*P < 0.05

species. Soil preparation by time period longer than three months before sowing does not show marked influence on indicators as important as higher weed presence, lower population values and rooted points of legumes, aspects of great importance for attaining good establishments. The preparation time lower than three months presented more satisfactory values, since lower weed incidence and higher amount of plants and rooted points per area (rooted points) were obtained.

Data analysis confirms what was reported by Amézquita (2002) on indicating the need that researchers working in the edaphological field should develop indicators and critical levels that can be used as indicators of the improvement or degradation, in function of the soil utilization time.

Reyes *et al.* (1995) stated that the conventional method of soil preparation may be more productive that direct sowing or tilling reduction, but the latter allow an establishment that although slow, its cost is low. These authors recommends using plough + two harrow passes and suggest further studies under different conditions. Similar conclusions were referred by Bernal *et al.* (2003).

Ruiz *et al.* (2000) and Padilla *et al.* (2005) coincide in that better results are attained in pasture establishment when soil preparations are realized during short periods (three months).

In addition, the literature information in the last years is scarce and mainly centered on the use of zero soil tilling in cultures as maize, sorghum and not in pastures and forages. Similar conclusions were cited by Lok *et al.* (2011) on pointing out the need of studying further soil and pastures indicators that reflect better the stability of legume systems.

It is concluded that the beginning of soil preparation in February favors the harmonic plant and rooted points of creeping legume development. This is displayed in the balance and persistency between the system components.

Acknowledgements

Thanks are due to Dr. Verena Torres and to the technician Lucía Sarduy from the Department of Biomathematics of the Institute of Animal Science for the statistical analysis of the data.

References

Amézquita, E. 1999. Problemas de degradación de suelos en los llanos orientales y enfoque de la investigación para entenderlos y controlarlos. CIAT. Colombia

Amézquita, E. 2002.Hacia la sostenibilidad de los suelos en los llanos orientales de Colombia. CIAT. Colombia

Andrade, R.P., Karia, C.T. & Ramos, A.K.B. 2004. Stylosanthes as a forage legume at its centre of diversity. In: Chakraborty, S. (Ed) High- yielding anthracnose-resistant Stylosanthes of agricultural Systems. Canberra: Aciar. p. 39

Bernal, N., Montealegre, G., Nolan, S. & Ramírez, L.M. 2003. Efecto de cuatro métodos de labranza sobre las propiedades físicas y la pérdida de suelo en la rotación papa-pastos en un ecosistema húmedo alto andino de Colombia. Universidad Nacional de Colombia. Sede Palmira, Colombia

Duncan, D. B. 1955. Multiple range and multiple F. tests Biometrics 11:1

Duran, J.L. & Pérez, J.M. 1994.Correlación de la clasificación genética con otros sistemas de clasificación. Primera Conferencia de Clasificación de los Suelos. La Habana. Cuba. p. 21

Hernández, A., Pérez, J.M. & Bosch, O. 1999. Nueva versión de clasificación genética de los suelos de Cuba. Instituto de Suelos. AGRINFOR- MINAG. Cuba. p. 64

Kolmans, E. & Vásquez, D. 1999. Manual de agricultura ecológica. Nueva Ed. SIMAS- CICUTEC. Managua, Nicaragua. p. 19

Lok, S., Crespo, G., Torres, V., Ruiz, T.E, Fraga, S. & Noda, A. 2011. Determination and selection of indicators in a grassland based on a multiple mixture of creeping legumes with fattening cattle. Cuban J. Agric. Sci. 45:59

Padilla, C., Sardiñas,Y., Cino, D.M. & Curbelo, F. 2005. Initiation moment of the soil preparation and its economical repercussion on the establishment of *Pennisetum purpureum* Schum (elephant grass Cuba CT- 115) and the control of *Sporolobus indicus* L.R. Br (wiregrass). Cuban J. Agric. Sci. 39:623

Reyes, F., Hernández, D. & Carballo, M. 1995. Efecto del laboreo mínimo en el establecimiento de asociaciones múltiples. Pastos y Forrajes 19: 39

Ruiz, T. E. & Febles, G. 2006. Principios agronómicos para la producción de pastos. Parte 1. Agrotecnia para el fomento de sistemas con leguminosas. In: Recursos Forrajes. Herbáceas y Arbóreas. Editorial Universitaria. Universidad de San Carlos de Guatemala. p. 103

Ruiz, T.E. & Febles , G. 2008. Establecimiento de leguminosas rastreras en cultivo puro. Modulo II: Pastos tropicales,

principios generales, agrotecnia y producción de biomasa. In: Diplomado "Manejo y alimentación de bovinos en el trópico".Tantakin. FIRA. México. p.185

Ruiz, T.E., Febles, G., Castillo, E. & Elías, A. 2000. Leguminosas herbáceas en la producción pecuaria. Reflexiones y Posibilidades. In: Estrategias de alimentación con recursos locales para la ganadería de doble propósito en épocas críticas. Universidad de Colima. México. p. 46

Simeao, R., Resende, M., Valle,C., Jank, L., Laura,V. & Chiari, L.2006. Analise genetica do carater sobrevivencia em *Stylosanthes guianensis* e implicacoes na selecao para produtividade. 43 Reuniao Anual da Sociedade Brasileira de Zootecnia.Joao Pesson-PB

Received: July 15, 2014