Establishment of *Stylosanthes capitata* and *Arachis pintoi* by Paper Bag Method in Native Pastures of Llanos Orientales of Colombia

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Recieved March 27, 1997

Abstract

Several methods of establishment of *Stylosanthes capitata* and *Arachis pintoi* in native pastures in the Colombian savanna were examined. Three experiments were set up. In experiments 1 and 2 the paper bag (containing seeds, fertilizer, etc.) method is as compared with the fertilizer macro-pellet (containing seeds in a small paper bag) method and broadcasting method using *S.capitata*. Experiment 3 was conducted to investigate the initial effect of the paper bag method on the establishment of *A.pintoi*, compared with the macro-pellet, broadcasting, minimum tillage and vegetative planting methods. The results obtained were as follows: 1)In experiments 1 and 2, establishment was more successful in the paper bag than the macro-pellet methods. A higher density of plants was obtained in the broadcasting method but half of the plants did not survive. Plant size was smaller in the broadcasting method. 2)In experiment 3, the germination rate of *A.pintoi* was lower in both the paper bag and the macro-pellet methods than in direct sowing into a tilled row. Belowground placement of seed was superior to aboveground placement for a plant with a large seed like *A. pintoi*. These studies demonstrated that oversowing with a paper bag method leads to more rapid establishment of pasture seed than simply broadcasting seed on the surface.

Additional key words: establishment method, paper bag, macro-pellet, broadcasting, *Stylosanthes capitata, Arachis pintoi*

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Introduction

The use of legumes has been found to improve the nutritive value of the diet of animals grazing grass pastures grown on acid infertile soils of the Llanos Orientales of Colombia[1]. However, the high cost incurred by cultivation and application of fertilizers limits the introduction of legumes into the pastures. For cost reduction, Mitamura *et al.*[2] developed the fertilizer macro-pellet method for establishing legumes in grass pastures. In this method, legume seeds of either one or more species attached to the outer surface of the pellet using gum arabic are sown to the grass pasture at the rate of 1000-3000 pellets per ha. The legume seeds are released from the pellet surface by rainwater and germinate around and under the pellet. While young plants receive a high rate of nutrients near the pellet, the actual rate of fertilizer and seed application per ha is very low.

Presently, the need for the development of oversowing methods for the savannas is not as critical as previously, because the Centro Internacional de Agricultura Tropical (CIAT) has developed a new technology for establishing pastures under crops, namely through the development of rice and other crops that are tolerant to acid soils. As a result, the cost of pasture establishment is covered by the sale of the crops. On the other hand, the use of macro-pellets or a similar method for oversowing legumes appears to be still important in hillside agriculture. However, the lack of adequate moisture during the establishment of legumes oversown may also be a constraint in hillside areas in addition to nutrient deficiency. Thus the author developed a new method of incorporating materials to preserve water designated as the paper bag method. The paper bag method can be applied more conveniently by smallholder farmers than the preparation of pellets.

This paper presents the results of the experiments carried out to compare the paper bag method with other methods.

Materials and Methods

Three experiments were set up in the savanna on light clay soil at Carimagua, Colombia (4.5° north latitude, 71° west longitude, 175m altitude).

1) Experiments 1 and 2

These experiments were conducted to compare the paper bag method with the macro-pellet method and broadcasting method using *Stylosanthes capitata* sown at different times. Experimental treatments were as follows:

(1) Paper bag

Paper bag contained several seeds of *S. capitata*, vermiculite, peat moss and zeolite in addition to fertilizer, insecticides and materials to preserve water. The size, weight and the chemical composition of the paper bag are shown in Table 1. A paper bag containing seeds was placed on the soil surface at a rate of one each in a quadrate of 1x1 m in the savanna in experiment 1, and two paper bags were placed in a quadrate with the same size in experiment 2.

(2) Macro-pellet

The size, weight and chemical composition of the macro-pellet are shown in Table 1. A macro-pellet and several seeds of *S. capitata* were put together in a small paper bag (10x5 cm). The paper bag was placed on the soil surface at the same rate as in the paper bag method.

(3) Broadcasting

Three kg of *S. capitata* seeds per ha were broadcasted without fertilizer in experiment 1 and 2 kg per ha with 20 kg phosphorus per ha in experiment 2.

These experiments were arranged in a 10x10 m plot size for each method without replication. Before sowing, the experimental plot in the savanna was burnt in experiment 1 and cut in experiment 2. Sowing dates in experiment 1 and experiment 2 were 3 September 1992 and 3 May 1993, respectively. Sowing rates for the paper bag method,macro-pellet method and broadcasting method were 0.2kg, 0.2kg and 3kg per ha in experiment 1, and 0.4kg, 0.4kg and 2kg per ha in experiment 2, respectively. After sowing, cattle

Table 1. Size, weight and chemical composition of paper bag and macro-pellet mixture

	Size (cm)	Weight (g)	chemical composition (g/paper-bag or pellet) N	P	K	Mg	Ca	S	Mn	B	Fe	Zn
Paper bag	12x16	59.4	0.38	0.47	0.25	–	1.32	–	0.11	0.05	0.04	0.002
Macro-pellet	3x3	8.8	0.02	0.69	0.36	0.18	1.22	0.35	–	–	–	–

had free access to the experimental sites.

Survival and plant height of *S. capitata* sown were determined in experiment 1, and seedling emergence and seedling density per m^2 were determined in experiment 2.

2) Experiment 3

The experiment was carried out to compare the five different methods of establishment of *Arachis pintoi*, one of the promising legumes adapted to native pastures in South America. The methods of establishment (treatments) were as follows:

(1)Paper bag

The size of the paper bag and the chemical composition of the nutrients in the paper bag were the same as in experiments 1 and 2. Two paper bags per m^2 containing three seeds of *A. pintoi* each were placed on the soil surface.

(2)Macro-pellet

The size and chemical composition of a macro-pellet are same as experiment 1 and 2. After a macro-pellet and three seeds of *A. pintoi* were put together in a same size of small paper bag as used in experiment 1 and 2, the two paper bags per m^2 were placed on the soil surface.

(3)Broadcasting

Ten kg of *A. pintoi* seeds per ha were broadcasted with 20 kg phosphorus per ha.

(4)Minimum tillage

Strips of soil were tilled by manpower to a depth of about 3 cm and width of 5 cm at intervals of 1 m. This treatment consisted of 10 ridges 1 m wide, each. Ten kg of *A. pintoi* seeds were sown with the same amount of phosphorus as in the broadcasting treatment.

(5)Vegetative planting

After tillage was performed in the same manner as in the minimum tillage treatment, 20 stolons of *A. pintoi* per ridge were planted at intervals of 50 cm.

This experiment was laid out in a randomized complete block design with two replications. The plot size of each treatments was 10x10 m. After the savanna vegetation was cut, sowing or planting was performed on 3 May 1993. The sowing rate in all the treatments except for vegetative planting was 10 kg per ha.

Seedling emergence and plant height were determined.

Results and Discussion

1) Experiments 1 and 2

Comparison of the establishment of *S. capitata* among different methods of introduction into the savanna

Table 2 shows the results of the first sowing of *S. capitata* (Experiment 1).

The establishment was more succesful in the paper bag than the macro-pellet method. There was also a good persistence of legumes at locations where there had been an initial successful establishment with both the macro-pellet and paper bag methods. A higher density of plants was obtained in the broadcasting method but half of the plants did not survive. Plant size was smaller and more variable in the broadcasting method due to the absence of fertilizer. The plant size in the paper bag method was the longest of all methods. Figures 1 and 2 illustrate plant establishment under different methods and the appearance of the plants 6 months later. Table 3 shows the preliminary results of the second sowing (Experiment 2). Again the establishment in the paper bag method was succesful both in terms of number of sites at which germination occurred and

Table 2. Survival and plant height of *Stylosanthes capitata* sown into narive savanna using different methods of establishment

Method of establishment	Date of Observation							
	16 Dec. 1992		16 April 1993		7 May 1993		10 June 1993	
	Survival (%)	Plant height (cm)	Survival (%)	Plant height (cm)	Survival (%)	Plant height (cm)	Survival (%)	Plant height (cm)
Paper bag	74*	4.8	74*	5.7	74*	9.9	74*	17.0
Macro-pellet	38*	5.3	38*	5.3	38*	8.0	38*	14.6
Broadcasting	166**	3.2	87**	3.6	80**	6.0	77**	10.0

Sowing date: 3 Sept. 1992.
Sowing rate: 0.2 kg/ha for paper-bag and macro-pellet, 3 kg/ha for broadcasting.
*Percentage of locations with viable *S. capitata* seedlings (one paper-bag or macro-pellet placed per m^2).
**Plant density (Number of S. capitata seedlings per m^2).

Paper bag

Macro-pellet

Broadcasting

Fig. 1. Initial establishment *S. capitata* seedlings using paper bag, macro-pellet and broadcasting methods (one month after sowing)

Paper bag

Macro-pellet

Broadcasting

Fig. 2. Growth of *S. capitata* seedlings after six months, using paper bag, macro-pellet and broadcasting methods for establishment

in the number of seeds that germinated.

2) Experiment 3

Table 4 shows the initial results of establishment of *A. pintoi* in a native savanna pasture. Germination rate of *A. pintoi* was lower in both the paper bag and the macro-pellet methods than in direct sowing into a tilled row. Germination was poorerin the paper bag than the macro-pellet method because the paper material used for the paper bag method was less resistant than that used for the macro-pellet method. It disintegrated with the first heavy rain and seeds were washed away from the site of application. Establishment was poor in the case of vegetative planting because the temperature during two days immediately after planting of the material was very high. It was obvious that for a plant with a large seed like A. pintoi belowground placement was superior to aboveground placement. However, it should be emphasized that the ger minating A. pintoi seedlings benefited from the nature and proximity of the fertilizer contained in the macro-pellet or paper bag compared with the application of phosphorus along the row in the minimum tillage method.

These studies have demonstrated that oversowing by applying either the paper bag or macro-pellet method leads to a more rapid establishment of pasture than simple broadcasting of the seeds on the surface in the absence of close contact with fertilizer. The paper bag method especially seems to be an effective method of establishment at hilly sites where machinery may not be easily applied.

Table 3. Seedling emergence and seedling density of *Stylosanthes capitata* sown into native savanna using different methods of establishment (sampling on 9 June 1993)

Method of establishment	Seedling emergence (%)	Seedling density per m^2
Paper bag	95*	9**
Macro-pellet	64*	3**
Broadcasting	–	14**

Sowing date: 5 May 1993.
Sowing rate: 0.4 kg/ha for paper-bag and macro-pellet, 2 kg/ha for broadcasting.
* Percentage of locations with viable *S. capitata* seedlings (one paper bag or macro-pellet placed per m^2).
** Plant density (Number of *S. capitata* seedlings per m^2).

Table 4. Seedling emergence, location emergence and plant height of *Arachis pintoi* sown into a native pasture using different methods of establishment (sampling on 9 June 1993)

Method of establishment	Seedling emergence* (%)	Location emergence** (%)	Height of plants (cm)
Paper bag	5.4	10.3	7.6
Macro-pellet	8.3	21.3	6.5
Broadcasting	0	–	–
Minimum tillage	23.8	–	3.8
Vegetative planting	3.8	–	4.3

Sowing date: 6 May 1993.
Sowing rate: 10 kg/ha for all sown tretments, 5/m^2 for vegetative planting.
* Percentage of total seeds/cuttings planted.
** Percentage of locations with viable *A. pintoi* seedlings (two paper bags or macro-pellets placed per m^2).

Acknowledgement

The author thanks Dr.Peter C Kerridge, Leader, Tropical Forages Program, CIAT for his useful comments and suggestions.

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コロンビア東部ジャノス地方の放牧草地における ペーパーバッグ法による *Stylosanthes capitata* と *Arachis pintoi* の定着

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摘　要

コロンビアのサバンナ放牧地に*Stylosanthes capitata* 及び*Arachis pintoi* を導入する数種の方法を検討した。３試験を実施した。試験１及び２ではS.capitataを用い，種子，肥料，保水材等を含むペーパーバッグを散布する方法（ペーパーバッグ法），小さい紙袋に種子と肥料を固めたマクロペレットを入れ散布するマクロペレット法及び種子を散布する散播法（試験１では無肥料，試験２ではリン酸２kg/ha施用）を，試験３では*A.pintoi* を用い前記の３導入法に深さ約３cm，畝幅５cmに播種するミニマムティレッジ法と*A.pintoi* のストロンを植え付ける移植法を加えた５方法でそれぞれの定着性について比較検討した。

結果の概要は，以下のとおりである。１）試験１及び２では，ペーパーバッグ法がマクロペレット法より*S.capitata* の定着性の高いことが認められた。散播法は高い出芽密度が得られたが，５ヶ月後には半減し，個体のサイズも小さかった。２）試験３では，ペーパーバッグ法及びマクロペレット法における*A.pintoi* の出芽はミニマムティレッジ法に比べ劣った。*A.pintoi* のような大きい種子では土壌による種子の被覆が出芽を高めるのに必要であることが認められた。

これらの結果から，ペーパーバッグ法は牧草の早期の定着に有効である可能性を認めた。

キーワード：導入方法，ペーパーバッグ法，マクロペレット法，散播法，*Stylosanthes capitata*，*Arachis pintoi*

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