■ RESSOURCES ALIMENTAIRES

Integrated Approach to Forage Seed Production and Supplementation of Dairy Cows in the Semiarid Region of Cameroon

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Key words

Zebu – Dairy cow – Seed – Feed crop – Mixed farming – Semiarid climate – Cameroon.

Summary

Stylosanthes hamata, *Calopogonium mucunoides* and *Macroptilium lathyroides* were intercropped with maize in a randomized block design. Age of maturity, forage dry matter and seed yields were determined at the end of their cycles. In another experiment, *S. hamata* and *C. mucunoides* were planted and divided into cutting, grazing and control subplots. Lactating zebu cows were put in the grazing subplots, while cutting subplots were cut at the end of the grazing period. Intercropping had no significant effect on the age of flowering and seeding. The establishment rate was however slower in intercropped *C. mucunoides* and *S. hamata*. The forage dry matter yield was similar in pure and intercropped *C. mucunoides* and *M. lathyroides*, respectively, but significantly higher in pure *S. hamata* plots ($p < 0.01$). The seed yield was similar in the two treatments of *S. hamata* and *M. lathyroides*, but significantly higher in pure *C. mucunoides* plots ($p < 0.001$). In the establishment year, grazing and cutting reduced seed yield of *S. hamata* ($p < 0.001$) compared to control. However, the difference was largely offset by a 35% milk yield increase in cows grazing *S. hamata*. These results indicate that forage legume seed production is feasible and manageable in an integrated production system.

■ INTRODUCTION

Very little work has been reported in the area of forage seed production in Northern Cameroon. This semiarid region is characterized by two seasons of almost equal duration. The rainy season lasts for months, with average annual rainfall between 850-1000 mm (Figure 1) occurring mainly within 4-5 months (June-September). During the dry season, the vegetation is exposed to extremely high temperatures, sometimes up to 45°C, and very low humidity conditions that render the nutritive quality of natural pastures poor and unfit for animal maintenance and production.

Tropical pastures are known to contain very low levels of crude protein (CP) (2, 6). This is a limiting nutrient for livestock productivity potentials in the region. Three methods have been proposed by researchers to correct the low level of CP or nitrogen (N) in tropical forages. These consist in the application of an N fertilizer to the land, protein supplementation to livestock with agro-industrial by-products such as cottonseed meal, and the introduction of legume species to the forage mixture (13). With the rapidly growing population, this region is moreover faced with serious land degradation through overgrazing, erosion, bush fires and deforestation for fuel wood (12) and, consequently, with reduced grazing lands and poor quality pastures. Livestock farmers then depend largely on food crop residues for feed supplementation. These crop residues are mostly from cereals, low in nutritive quality and often limited in quantity. Among other alternatives, livestock farmers should be encouraged to produce

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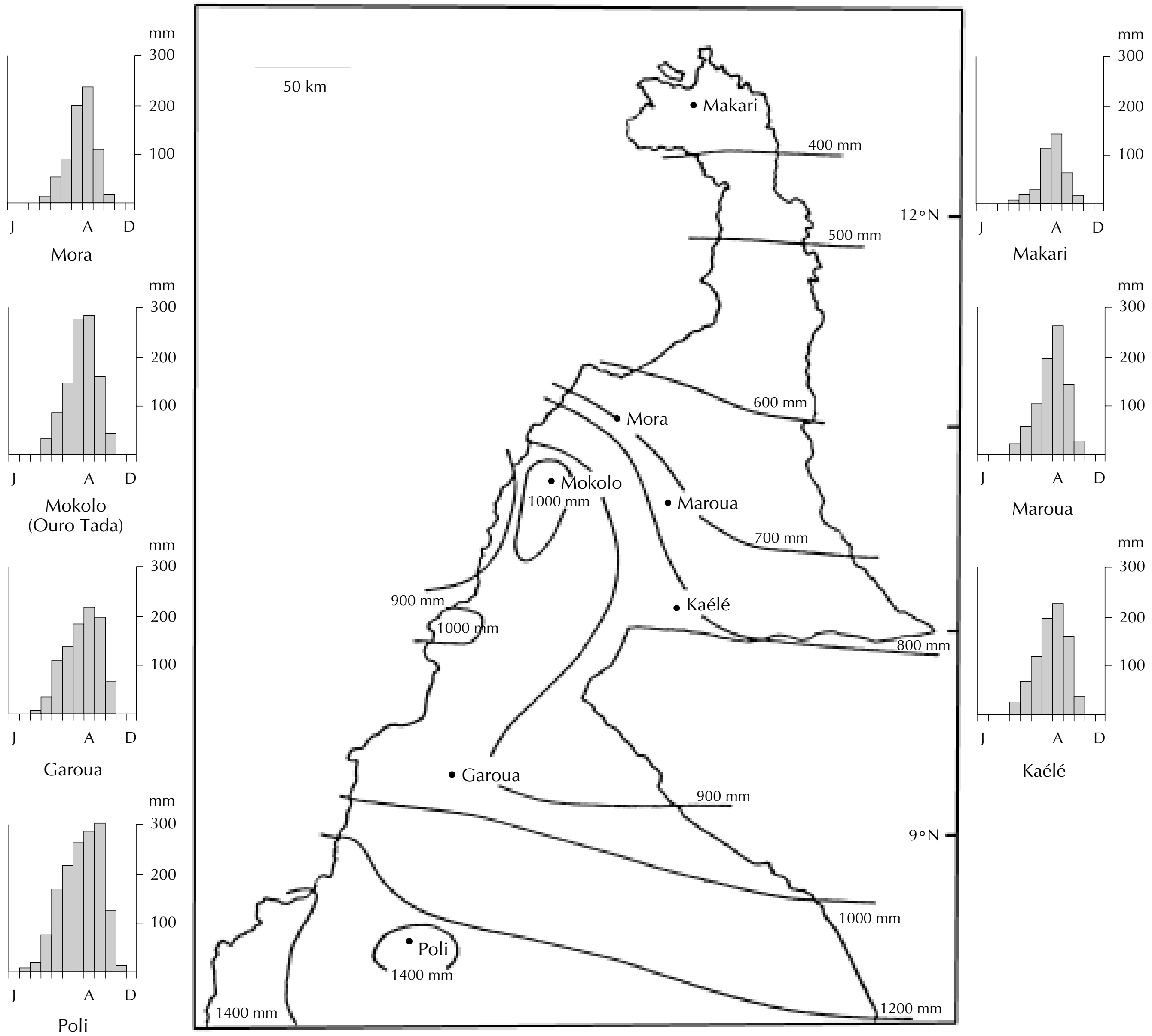

Figure 1: *rainfall isohyets in Northern Cameroon. Source: Beauvilain, 1989, North Cameroon, Crises and population 1. Map No 4, mean annual rainfall, from stations' creation to 1988.*

forage, which can be particularly useful as fodder banks during periods of shortage of natural pastures. A major constraint to this proposal concerns the lack of forage seed availability due to an inadequate seed supply system and unsuitable exploitation practices which do not ensure seed preservation from one year to the next or effective pasture regeneration. It is therefore necessary to develop low-cost seed production techniques for selected species adapted to this region, such as *Stylosanthes hamata*, *Calopogonium mucunoides* and *Macroptilium lathyroides* (7). These are legume species with high nutrient content and soil improvement capacities. Undersowing these in cereal plots is a low-cost method of establishment in cereal-based farming systems (10, 11). In this type of cropping the input and labor used for cereal crop will also benefit the establishment of the forage crop. This technique is considered to be the most feasible method for introducing legume species into crop mixtures a year before a piece of land is left to fallow. This introduction increases the nutritional value and quantity of the succeeding crop residue, while improving soil fertility faster than a natural fallow (1, 16).

■ MATERIALS AND METHODS

The study was carried out at the Institute of Agricultural Research for Development, Garoua Station (Figure 1) to investigate the performance of forage legumes in a cereal-based farming system of North Cameroon, with an emphasis on the effect of common agronomic practices on seed yield and productivity; the performance of *Stylosanthes hamata*, *Calopogonium mucunoides* and *Macroptilium lathyroides* were assessed in terms of cultivation techniques, management and utilization.

Performance of S. hamata, C. mucunoides *and* M. lathyroides *in cereal plots*

In this trial, *Stylosanthes hamata*, *Calopogonium mucunoides* and *Macroptilium lathyroides* were planted in two treatments: intercropped with maize and pure stands in a randomized block design. Each treatment had three replicates in 6 x 8 m plots. The intercropped legumes were sown into maize plots, three weeks after the maize was planted as recommended by Klein (7). During the establishment year, all plots were weeded twice at four and six weeks after planting. After germination, plant counts were performed weekly until flowering. At the onset of flowering, flower heads were counted every other week until more than 50% flowering was attained on each plot.

Effect of grazing and cutting on forage dry matter and seed yield

In another experiment, *Stylosanthes hamata* and *Calopogonium mucunoides* were planted on 2 ha and split into grazing, cutting and control subplots. For establishment, they were fertilized with 15 kg/ha of triple superphosphate and weeded twice during the growing season, 20 and 60 days after planting. At about 12 weeks after planting, just before budding, lactating zebu (White Fulani) cows were allowed access into grazing plots for a duration of five hours per day for three weeks. Twelve lactating cows were randomly allotted to three groups of four each: groups 1, 2 and 3, which grazed on *S. hamata*, *C. mucunoides* and natural pastures (control), respectively. Cows were penned separately from the calves overnight. At 5:30 a.m., calves were taken individually to their dams to incite milk flow and then withdrawn before milking as it is the practice among traditional cattle rearers. Thereafter, the calves were allowed access to their dams until the end of the day. Cutting treatment plots were cut at 10 cm above the ground 14 weeks after planting and fed to animals indoors. This coincided with the end of the grazing session on the grazing plots. All plots were then allowed to set seeds. At maturity, seed samples were collected from one-square-meter areas on five random locations per plot, cleaned and weighed. In the second year, seedlings from five one-square-meter spots per plot were counted at the onset of rains to note the rate of regeneration. Seed-head count was also noted from five one-square-meter areas until peak maturity. Harvested seeds were threshed, cleaned and weighed.

■ RESULTS

Performance of S. hamata, C. mucunoides *and* M. lathyroides *in established maize fields*

Establishment was slower in the intercropped plots for all legumes (Table I). This trend continued throughout flowering and seeding. The intercropped legumes caught up only after maize harvest and stalk removal, which eliminated the shade effect. In the early part of the season, intercropped legumes exhibited some physical differences in plant growth parameters typical of sun-adapted plants grown in the shade. These included stem elongation, reduced stem diameters and leaf discoloration. These differences, which were more evident with *Stylosanthes hamata*, did not however persist throughout the season.

There was no significant difference in the flowering date between the two treatments. However, early flowering density was higher in pure stands. Peak flowering was also attained earlier in pure stands. Stand establishment was faster in *Macroptilium lathyroides* under both treatments; flowering, seeding and maturity were 2-4 weeks ahead of the other two species (Table I).

There was a significant difference ($p < 0.01$) in *Stylosanthes hamata* yield between pure and intercropped plots (Table II). *Calopogonium mucunoides* was slowest to establish and it attained maturity very late in the season, although with a very good vegetative cover. Regeneration was good for *S. hamata* and *C. mucunoides*, but not for *M. lathyroides*, which is usually slow at self re-establishment (7).

Table II

Effect of intercropping on seed and forage dry matter yield

Species and treatment	Forage DM (tons/ha)	Seed yield (kg/ha)
S. hamata		
Pure	8.54 ± 0.96*	490 ± 18
Intercrop	4.98 ± 0.5	380 ± 23
C. mucunoides		
Pure	7.21 ± 0.89	277 ± 3**
Intercrop	5.91 ± 0.84	225 ± 5
M. lathyroides		
Pure	5.82 ± 0.73	190 ± 5
Intercrop	4.31 ± 0.55	175 ± 6

* Pure and intercropped yields significantly different ($p < 0.01$)
** Pure and intercropped yields significantly different ($p < 0.001$)

Table I

Performance of *Stylosanthes hamata*, *Calopogonium mucunoides* and *Macroptilium lathyroides* in cereal-based farming systems

Species and treatment	Age at flowering (weeks)	Age at seeding (weeks)	Age at ripening (weeks)	Establishment rate	Degree of regeneration
S. hamata					
Pure	7	10	14	S	E
Intercrop	8	12	14	VS	G
C. mucunoides					
Pure	12	13	16	S	F
Intercrop	12	13	16	VS	F
M. lathyroides					
Pure	6	8	12	G	F
Intercrop	6	9	12	G	F

S = slow; E = excellent; VS = very slow; G = good; F = fair

Effect of grazing and cutting on seed yield and forage DM

In the second experiment, results in the first year showed a significant decrease in seed yield for the grazed and cut plots (Table III). However, this decrease was highly compensated for by the increase in milk yield from the grazing cows (Fig 2). Milk production was significantly higher in cows that grazed *S. hamata* plots than in those that grazed *C. mucunoides* and control plots. Starting at an average daily production of 0.85 l, the *S. hamata* group rose to about 1.3 l at the end of the grazing period, producing a 35% increase, while a low intake of *C. mucunoides* at the beginning of the trial induced a decrease in production which remained below 1.0 l. (Figure 2). This low intake was still manifest even after several days of adaptive feeding. Average milk yield in the cows grazing natural pastures was also lower, averaging 0.95 l per cow per day even though this trial was carried out during the rainy season when natural pastures in this region are presumably at their best in terms of forage availability and quality. Intratreatment variation was highest in the *S. hamata* group and least in the control group (Table IV).

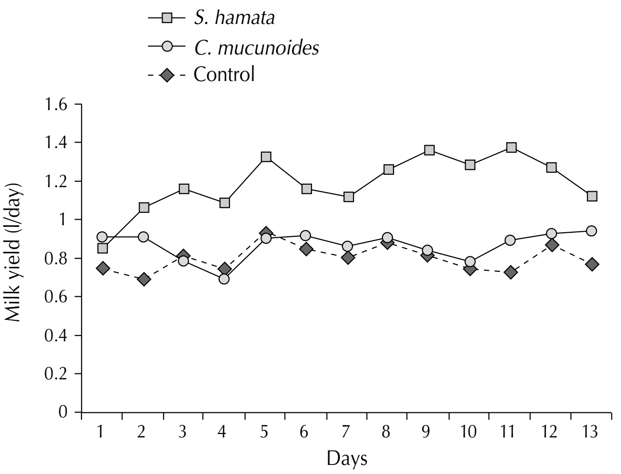

Figure 2: *milk yield of zebu cows grazing* Stylosanthes hamata *and* Calopogonium mucunoides.

Table III

Effect of grazing and cutting on the performance of *Stylosanthes hamata* and *Calopogonium mucunoides*

Species and treatment	Seed head count	Seed yield (kg/ha)		Forage DM (tons/ha)
	Year 2	Year 1	Year 2	Year 2
S. hamata grazed	60.9[a]	490[a]	520	3.67
S. hamata cut	58.5[a]	403[a]	480	3.8
S. hamata control	54.3[a]	847[b]	460	3.86
C. mucunoides grazed	48.3[a]	277[a]	170	3.5
C. mucunoides cut	44.5[a]	247[a]	150	4.21
C. mucunoides control	30.3[b]	560[b]	230	4.23

[a, b] Column means with different superscripts for the same species are significantly different ($p < 0.001$)

Table IV

Variations in average daily milk production in different treatments

Treatment	Mean (l)	Standard deviation
S. hamata	1.21	0.54
C. mucunoides	0.87	0.34
Control	0.85	0.12

■ DISCUSSION

Traditionally after harvest, livestock is put in to graze crop residues left on the farmland. These residues are mostly cereal stalks left standing after harvest and they are low in nutrient content. Incorporation of forage legumes in a farming system where livestock depends largely on crop residues would provide quality forage and also rebuild the structure and nutrient content of the soil through their nitrogen fixing capacity (1, 3, 11, 15).

Stylosanthes hamata, *Calopogonium mucunoides* and *Macroptilium lathyroides* are among legume species introduced and found adapted to this region, each of them with its own specific attributes. The fast maturing characteristic of *M. lathyroides* makes this species suitable for multiplication and use in areas with very short growing periods as it will escape the onset of the dry season. On the other hand, the very slow rate of establishment of *S. hamata* and *C. mucunoides* in the intercropped plots makes them quite promising for use in cereal-based cropping systems, where their negative effect on crop yield is minimal (3, 9). In addition, these species have been shown to improve the yield of cereals on plots sown with the former in the previous year (3, 17, 18).

Calopogonium mucunoides proved to be better adapted in the cereal mixture, hence a more suitable choice for undersowing. However, the time for undersowing should be chosen in a manner to avoid competition with the cereal crop (7, 17). Klein (7) gave undersowing dates for these forage legumes in this region as 15-30 days after sowing cereal crop around Garoua, 15-30 days before sowing cereal crop in the upper belt/Far North province, and at the same time as cereal crop in the southern fringe of this region (Touboro). These specifications are due to differences in annual precipitations which decrease from south to north (Figure 1).

The drop in milk production by cows grazing *C. mucunoides* in the first few days resulted from its low palatability (7, 14). Palatability is said to be the first determinant of what a moderately hungry animal will eat, when food supplies are abundant, and it depends on the taste, smell, flavor and texture of the given feed (4). *C. mucunoides* is densely covered with brownish hair. This aspect, which is more evident when the plant is at its fresh state, may have greatly contributed to its low palatability at that stage. Recent studies on feeding donkeys with this species in the dry season (unpubl. data) gave more promising results in terms of intake and performance. More studies are therefore needed to determine the best state at which this important species is best accepted by animals given that its CP content of 24.31% ranks very high among selected green plants available for livestock in this region during the dry season (5). The increase in milk production by the *S. hamata* group is in line with the fact that legumes provide higher CP than natural pastures and hence would increase the performance and productivity of livestock (2, 13).

Apart from improving livestock performance, grazing of legume plots leads to an early regeneration of pastures from fallen seeds at the onset of rains especially for species with heavy mulch cover (6, 7). *C. mucunoides* reportedly regenerated two months earlier in a grazed paddock with the onset of rains (8). Grazing or cutting seed plots just before budding permits the use of high quality forage just before seeding and increases the number of times for exploitation as well as provides forage for housed animals such as small ruminants, which are often confined during the farming season. A second grazing after seed harvest favors seed dissemination through fecal droppings.

■ CONCLUSION

These results indicate that forage DM yield and, more importantly, seed yield is not in most cases affected by intercropping, and land use can therefore be maximized. Milk production of lactating cows partially grazing on *S. hamata* is greatly improved. Forage seed production is therefore feasible in an integrated production system where land is a limiting factor. There is also the added advantage of reducing the fallow period through its nitrogen fixing capacity and hence increasing its agricultural potentials. The final choice of what management and exploitation system to use will therefore depend on the chosen forage species.

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REFERENCES

1. BAYER W., WATERS-BAYER A., 1998. Forage husbandry. The tropical agriculturist series. London, UK / Wageningen, The Netherlands, Macmillan/CTA, 198 p.

2. BUTTERWORTH M.H., 1988. Beef cattle nutrition and tropical pastures. New York, NY, USA, Longman, 500 p.

3. DOGBE W., 1998. Green manure crops for sustainable agriculture in the inland valleys of northern Ghana. In: Buckles D., Eteka A., Osiname O., Galiba M., Galiano G. Eds, Cover crops in West Africa; Contributing to sustainable agriculture. Ottawa, Canada, IDRC, p. 213-215.

4. GROVUM W.L., 1988. Appetite, palatability and control of feed intake. In: Church D.C. Ed., The ruminant animal - Digestion, physiology and nutrition. Englewood Cliffs, NJ, USA, Prentice Hall, p. 202-216.

5. IKHIMIOYA I., OLAGUNJU B.O., 1996. Chemical composition of selected green plants available to small ruminants in the dry season in humid Nigeria. *Tropicultura*, **14**: 115-117.

6. JUTZI S., 1985. Herbage seed production in Sub-saharan Africa; its integration in national pasture research and industry development and prospects for regional supporting activities. In: Proc. Workshop Potentials of forage legumes in farming systems, Addis Ababa, Ethiopia, 16-19 Sept. 1985. Addis Ababa, Ethiopia, ILCA, p. 505-522.

7. KLEIN H.D., 1995. Introduction des légumineuses dans la rotation céréale-cotonnier au Nord Cameroun : gestion et utilisations. Maisons-Alfort, France, Cirad-emvt, 179 p.

8. KLEIN H.D., 1991. Agropastoralism. Annual report. Garoua, Cameroon, IRZV, 62 p.

9. MOHAMMED-SALEEM M.A., 1986. Integration of forage legumes into the cropping systems of Nigeria's sub-humid zone. In: Proc. Livestock systems research in Nigeria's sub-humid zone, 2nd ILCA/NAPRI Symposium, Kaduna, Nigeria, 29 Oct. - 2 Nov. 1984. Addis Ababa, Ethiopia, ILCA, p. 304-325.

10. MOHAMMED-SALEEM M.A., OTSYINA R., VON-KAUFMAN R., 1985. Some methods of improving fodder by incoporating forage legumes in cereal cropping systems in the Nigerian sub-humid zone. In: Proc. Workshop Potentials of forage legumes in farming systems, Addis Ababa, Ethiopia, 16-19 Sept. 1985. Addis Ababa, Ethiopia, ILCA, p. 363-378.

11. MUNTHALI J.T.K., MSISKA H.D.C., ZIMBA A.W.C., DZOWELA D.H., 1990. Towards an integrated cereal crop-forage production for improved cattle productivity: the Malawi experience. In: 1st joint workshop Utilisation of research results on forage and agricultural by-product materials as animal feed resources in Africa, Lilongwe, Malawi, 5-9 Dec. 1998, p. 234-248.

12. NJITI C., SHARPE D.M., 1994. A goal-programming approach to the management of competition and conflict among land uses in the tropics: The Cameroon example. *Ambio*, **23**: 112.

13. NJOYA A., 1992. Effects of cottonseed meal supplementation on the performance and pasture utilisation by zebu steers. PhD Dissertation, Iowa State University, Ames, IA, USA, 115 p.

14. ROTAR P.P., KRETSCHMER JR, 1985. Tropical and sub-tropical forages. In: Heath M.E., Barnes R.F., Metclaff D.S. Eds, Forages, 4th Edn. Ames, IA, USA, Iowa State University Press, p. 154-165.

15. SALEZ P., 1988. Compréhension et amélioration des systèmes de cultures associées céréale-légumineuses au Cameroun. Thèse Doct. Ing. Insam. Nogent-sur-Marne, France, Cirad-irat, 190 p.

16. SANGINGA N., OKOGUN J.A., AKOBUNDU I.O., KANG B.T., 1996. Phosphorus requirement and nodulation of herbaceous and shrub legumes in low P soils of the Guinean savanna. *Appl. Soil Ecol.*, **3**: 247-255.

17. TARAWALI G., DEMBELE E., N'GUESSAN B., YOURI A., 1998. Small holder use of *Stylosanthes* for sustainable food production in Sub humid West Africa. In: Cover crops in West Africa; Contributing to sustainable agriculture. Ottawa, Canada, IDRC, p. 107-170.

18. YOURI A., 1998. Système de culture avec légumineuses au Cameroun. In: Cover crops in West Africa; Contributing to sustainable agriculture. Ottawa, Canada, IDRC, p. 225-227.

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Résumé

Asongwed-Awa A., Njoya A. Approche intégrée pour la production de semences fourragères et la complémentation de vaches laitières dans la région semi-aride du Cameroun

Stylosanthes hamata, *Calopogonium mucunoides* et *Macroptilium lathyroides* ont été semés en association avec du maïs dans un dispositif en blocs randomisés. L'âge à la maturité, le rendement en matière sèche du fourrage et le rendement semencier ont été déterminés à la fin de leurs cycles. Dans un autre essai, *S. hamata* et *C. mucunoides* ont été semés et divisés en sous-parcelles destinées à la coupe, à la pâture ou conservés comme témoin. Les vaches en lactation ont été introduites dans les parcelles destinées à la pâture, alors que les parcelles destinées à la coupe ont été coupées à la fin de la période de pâture. L'association de cultures n'a pas eu d'effet significatif sur l'âge à la floraison ni sur la production de semences. La mise en place a cependant été plus lente pour *C. mucunoides* et *S. hamata* en association. Le rendement en matière sèche de *C. mucunoides* et de *M. lathyroides*, respectivement en culture pure et en culture associée, a été similaire, mais il a été significativement plus élevé dans les parcelles pures de *S. hamata* ($p < 0, 01$). Le rendement semencier a été similaire dans les deux traitements de *S. hamata* et *M. lathyroides*, mais il a été significativement plus élevé dans les parcelles pures de *C. mucunoides* ($p < 0, 001$). Au cours de l'année de mise en place, la pâture et la coupe ont réduit le rendement en semences de *S. hamata* ($p < 0, 001$) par rapport au témoin. Cependant, cette différence a été largement compensée par une augmentation de 35 p. 100 de la production laitière des vaches pâturant *S. hamata*. Ces résultats montrent que la production de semences de légumineuses fourragères est possible et gérable dans un système de production intégré.

Mots-clés : Zébu – Vache laitière – Semence – Plante fourragère – Polyculture élevage – Climat semi-aride – Cameroun.

Resumen

Asongwed-Awa A., Njoya A. Enfoque integrado del suplemento y de la producción de semillas de forraje en vacas de leche en una región semi árida de Camerún

Se cruzó maíz con *Stylosanthes hamata*, *Calopogonium mucunoides* y *Macroptilium lathyroides*, en un diseño en bloque al azar. Se determinó la edad de maduración, la materia seca en el forraje y el rendimiento de semillas al final de los ciclos. En otro experimento, se plantaron *S. hamata* y *C. mucunoides* y se dividieron en sub lotes control, de poda y de pastoreo. En los lotes de pastoreo, se instalaron vacas cebú en lactación, mientras que los lotes de poda se cortaron al final del periodo de pastoreo. Los cruces entre cultivos no presentaron un efecto significativo sobre la edad de florecimiento y de producción de semillas. La tasa de establecimiento fue, sin embargo, más baja en los cruces *C. mucunoides* y *S. hamata*. El rendimiento de materia seca del forraje fue significativamente más alto en lotes de *S. hamata* puros ($p < 0, 01$). El rendimiento de semillas fue similar en los dos procedimientos con *S. hamata* y *M. lathyroides*, pero significativamente más alto en los lotes puros de *C. mucunoides* ($p < 0, 001$). En el año de establecimiento, el pastoreo y la poda redujeron el rendimiento de semillas de poda y de *S. hamata* ($p < 0, 001$) en comparación al control. Sin embargo, la diferencia fue considerablemente opacada por un aumento de la producción de leche de 35% en las vacas pastoreando *S. hamata*. Los resultados indican que la producción de semillas de forraje es factible y controlable en un sistema integrado de producción.

Palabras clave: Cebú – Vaca lechera – Semilla – Planta forrajera – Explotación agricola combinada – Clima semiárido – Camerún.