CHANGES IN SEEDBANK SIZE AND BOTANICAL COMPOSITION OF MEDIC PASTURES GROWN IN ROTATION WITH BARLEY IN NORTH-WEST SYRIA

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SUMMARY

Changes in seedbank size and botanical composition of a mixture of seven species of medic (*Medicago* spp.) grown in rotation with barley were monitored during 1987-88 to 1991-92 at Breda, Syria (414, 195, 184, 244 and 263 mm precipitation, respectively). Both phases of the rotations were present each year. Medics sown in 1987-88 maintained seedbanks ranging from 87 to 794 kg/ha of seed throughout the experiment. Medics sown in 1988-89 produced only 25 kg/ha seed which necessitated reestablishment in 1990-91. A medic/medic/barley rotation was introduced to see if the seedbank could be built up more quickly. Seedbanks yields remained about the same in 1991-92 under 263 mm rainfall conditions on plots that were medic for a second year in a row. In successfully established medic: 1) *M. rigidula* was best adapted; 2) only *M. rigidula* and *M. polymorpha* contributed >30% of the seedbank; 3) success of *M. polymorpha* consisted of a mix of accessios and its success was mainly due to the Australian cv 'Circle Valley'; 4) *M. rotata* and *M. noeana* consistently represented 5-10% of seed present; and 5) *M. aculeata*, *M. scutellata* cv 'Snail' and *M. truncatula* cv 'Jemalong' failed to sustain seedbanks.

Key words: Ley farming, *Medicago aculeata*, *M. noeana*, *M. polymorpha*, *M. rigidula*, *M. rotata*, *M. scutellata*, *M. truncatula*, persistence, seedbanks.

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RESUME

L'évolution du stock de semences et de la composition botanique de sept espèces de luzernes annuelles cultivées en rotation avec l'orge a été suivie de 1987-88 à 1991-92 à Breda en Syrie (précipitations annuelles de 414, 195, 184, 244 et 263 respectivement). Les deux phases de la rotation ont été présentes chaque année. Les luzernes annuelles semées en 1987-88 ont maintenu des stocks de semences allant de 87 à 794 kg/ha de semences tout au long de l'expérimentation. Celles semées en 1988-89 ont produit seulement 25 kg/ha de semences, ce qui a nécessité un resemis en 1990-91. Une rotation luzerne annuelle/luzerne annuelle/orge a été introduite pour voir si les réserves en semences peuvent se reconstituer plus rapidement. Les réserves en semences ont été maintenues au même niveau en 1991-92 avec une pluviométrie de 263 mm sur les parcelles avec 2 années successives de luzernes annuelles. Pour les luzernes annuelles bien installées: 1) *M. rigidula* était la plus adaptée; 2) seules *M. rigidula* and *M. polymorpha* ont contribué avec plus de 30% aux réserves totales en semences; 3) le succès de *M. polymorpha* a été dû principalement au cultivar australian 'Circle Valley'; 4) *M. rotata* et *M. noeana* ont régulièrement représenté 5-10% des semences présentes; et 5) *M. aculeata, M. scutellata* cv 'Snail' et *M. truncatula* cv 'Jemalong' n'ont pas pu maintenir leur niveau initial de semences.

Mots clés: Ley farming, *Medicago aculeata, M. noeana, M. polymorpha, M. rigidula, M. rotata, M. scutellata, M. truncatula*, persistance, stock de semences.

INTRODUCTION

Most data on the adaptation of a ley farming system for Syria have been based on work in the wheat-growing zones receiving 300-350 mm rainfall. Native species of *Medicago rigidula, M. rotata* and *M. noeana* were selected in this zone to combine frost tolerance and adaptation to pasture/cereal rotations (Abd El Moneim and Cocks 1986; Cocks and Ehrman 1987). It is also recognized, however, that an equally important objective is to select legumes for drier zones, typified by continuous barley, and where principles similar to those in wetter zones apply for selection of medics within rotations (Cocks 1988).

Breda, with 280 mm annual rainfall, therefore, served to test whether medics could contribute to sustainable rotation systems in drier areas. It was

also an opportunity to include, in a mixture, the successful medic ecotypes from previous experimentation at the main ICARDA station at Tel Hadya (345 mm annual rainfall).

The chance that medics might not produce seed in a given year due to drought is high. If a medic/barley rotation could not sustain a seedbank at Breda, it was hypothesized that a medic/medic/barley rotation would be a more stable alternative. Since density is directly related to pasture dry matter production (Abd El Moneim and Cocks 1986), bigger seedbanks should improve grazing potential of pastures, especially since the seeds are also a good source of nutrition for sheep.

This paper reports on the identification of adapted medics that are capable of maintaining adequate seedbanks when grown in rotation with barley. The objective was to test whether medics could establish seedbanks that would result in medic-dominant, spontaneously regenerating pastures in dry areas in either a medic/barley or a medic/medic/barley rotation.

MATERIAL AND METHODS

The experiment was conducted at Breda (35° 56'N, 37° 10'E, altitude 300 m), 50 km southeast of Aleppo, in north Syria. It has a typical mediterranean climate, the rain falling between November and May.

A pasture/barley treatment with a 2-phased entry was compared with continuous barley, barley/fallow and barley/chickling (*Lathyrus sativus*). In 1990-91 and 1991-92 a medic/medic/barley rotation was introduced into the experiment by splitting the medic/barley rotation in two. Pasture size was 1.0 ha and there were three replicates in a randomized complete block design. Superphosphate (P_2O_5 40 kg/ha) was applied to the medic plots at the beginning of the experiment.

Mixtures of equal proportions of seven species, including several ecotypes within *M. rigidula* and *M. polymorpha* (Table 1), were sown at a rate of 30 kg/ha germinable seed on 21 Nov 1987 (first year of establishment) and 10 Nov 1988 (second establishment). The 1988-89 season was a failure for medic growth; therefore, pastures were reestablished on 17 Nov 1990. Appropriate *Rhizobium* for each accession was used to inoculate seed. In the year following medic the land was cultivated to a depth of 10 cm and sown to barley. The barley stubbles were grazed, and then pastures were allowed to regenerate.

After medic seed was set in establishment years, pastures were grazed by sheep borrowed from local farmers under supervision by technical staff. Sheep continued grazing the dried residue and seed pods in the summer, the grazing period varying in duration each year between June and October. For regenerating pastures, grazing occurred in winter, spring and summer and was terminated when either the setting of seed or maintanence of a 200 kg/ha seedbank was jeopardized.

The above- and belowground seedbank data represent the mean of 100 cores per pasture, each of 10 cm diameter, to a depth of 10 cm in both the barley and pasture phases. In June 1992 the number was doubled to 200 cores per pasture. Medic pods were separated from other residues and soil, and then classified to species and accession based on pod characteristics (Lesins and Lesins 1979). The pods were threshed by rubbing between corrugated rubber and then seed was cleaned and weighed. Data were interpreted using analysis of variance procedures.

Table 1. The species sown, their accession (Acc) and selection (Sel) numbers at ICARDA and their site of collection.

Medicago species	ICARDA Identification	Collection site
M. rigidula (L.) All.	Acc 811 Sel 716	Jisr Al Shagour, Syria
M. rigidula (L.) All.	Acc 835 Sel 1295	Kasab, Syria
M. rigidula (L.) All.	Acc 2116 Sel 1865	Hankendi, Turkey
M. rigidula (L.) All.	Acc 2713 Sel 1919	Terbol, Lebanon
M. rigidula (L.) All.	Acc 2066 Sel 1900	Kahranan Marash,Turkey
M. polymorpha L.	Acc 1172 Sel 1036	Ben Cherga, Tunisia
M. polymorpha L.	Circle Valley	Coolgardie, Australia
M. polymorpha L.	Tah	Tah, Idleb, Syria
M. aculeata Willd.	Acc 1480	Tel Amara, Lebanon
M. rotata Boiss.	Acc 2600 Sel 21213	Azaz, Syria
M. truncatula Gaertn.	Jemalong	Forbes, Australia
M. noeana Boiss.	SA 15485	Near Khorramabad, Iran
M. Scutellata (L.) Mil.	Snail	Noarlunga, Australia

Table 2. Total seed (kg/ha) above and below the soil surface for seven Medicago species. Codes: ME1= 1st attempt for medic establishment; ME2= 2nd attempt at medic establishment; ME3= 3rd attempt at medic establishment: BME= barley after ME (1,2 or 3): MB= medic after barley in a 2-phase rotation; BM= barley after medic in a 2-phase rotation; 2M1B= 1st medic in a medic/medic/barley rotation; 2M2B= 2nd medic in a medic/medic/barley rotation, and B2M= barley after two years of medic.
Repeat samplings on the same treatment in the same year have solid underlines, sampling before and after setting of new medic seed.

	Sampling date and treatment code												
Species					6/89 ME1B	2/90 BME1	2/91 ME2	6/91 ME2		2/92 BME2	2/92 2M2B	6/92 2M2B	2/93 B2M	2/93 ME3
M. rigidula					19^{a1}	16^{a}	7^{a}	54^{a}		17^{a}	17^{a}	53^{a}	12^{a}	10^{a}
M. polymorpha					$<1^{b}$	$<1^{b}$	$<1^{bc}$	31^{b}		6^{b}	5^{b}	21^{b}	2^{b}	2^{b}
M. rotata					1^{b}	1^{b}	$<1^{bc}$	10^{bc}		1^{c}	2^{bc}	6^{b}	1^{b}	$<1^{bc}$
M. noeana					3^{b}	2^{b}	1^{b}	3^{c}		2^{c}	1^{bc}	2^{b}	$<1^{b}$	$<1^{bc}$
M. aculeata					$<1^{b}$	$<1^{b}$	$<1^{bc}$	1^{c}		2^{c}	0^{c}	$<1^{b}$	$<1^{b}$	$<1^{bc}$
M. truncatula					$<1^{b}$	$<1^{b}$	$<1^{bc}$	2^{c}		$<1^{c}$	$<1^{c}$	1^{b}	$<1^{b}$	$<1^{c}$
M. scutellata					0^{b}	0^{b}	0^{c}	1^{c}		0^{c}	$<1^{c}$	$<1^{b}$	$<1^{b}$	0^{c}
Total					25	21	9	102		28	27	84	17	13
± SE					6	5	1	41		4	6	42	5	<1
Sown:	8/88	9/88	10/88	2/89		2/90	2/91	6/91	10/91	2/92	2/92	6/92	2/93	2/93
1987/88	ME1	ME1	ME1	BME1		2M1B	2M2B	2M2B	2M2B	B2M	MB	MB	BM	2M1B
M. rigidula	217^{b}	175^{b}	136^{b}	157^{b}		105^{a}	73^{a}	469^{a}	318^{a}	134^{a}	37^{a}	100^{a}	38^{a}	82^{a}
M. polymorpha	315^{a}	312^{a}	223^{a}	244^{a}		135^{a}	80^{a}	216^{b}	232^{a}	105^{a}	35^{a}	64^{ab}	19^{ab}	39^{b}
M. rotata	45^{c}	40^{c}	28^{c}	36^{c}		26^{b}	13^{b}	33^{b}	30^{b}	14^{b}	6^{b}	27^{bc}	4^{b}	7^{b}
M. noeana	18^{c}	17^{c}	14^{c}	17^{c}		12^{b}	10^{b}	50^{b}	54^{b}	23^{b}	3^{b}	5^{c}	1^{b}	13^{b}
M. aculeata	35^{c}	28^{c}	16^{c}	15^{c}		7^{b}	2^{b}	8^{b}	6^{b}	1^{b}	2^{b}	3^{c}	$<1^{b}$	$<1^{b}$
M. truncatula	16^{c}	14^{c}	9^{c}	12^{c}		8^{b}	5^{b}	15^{b}	13^{b}	5^{b}	4^{b}	5^{c}	1^{b}	4^{b}
M. scutellata	26^{c}	22^{c}	13^{c}	14^{c}		6^{b}	1^{b}	3^{b}	3^{b}	$<1^{b}$	$<1^{b}$	$<1^{c}$	1^{b}	$<1^{b}$
Total	672	608	439	495		299	184	794	656	283	87	205	65	146
± SE	44	42	49	50		48	36	197	99	35	20	64	19	28

[1] Means within a column with the same letter are not different using Fisher's Protected LSD (P=0.05). Consider upper and lower halves of table separately.

RESULTS AND DISCUSSION

Medic established well in 1987-88 because of the 415 mm of rainfall received. The 195 and 184 mm received in the following two years were well below average (280 mm) and very little medic seed was produced in either the establishment of medic in 1988-89, or in the regenerating medic of 1989-90. Indeed, the summer seedbank sampling of 1990 was canceled due to the absence of medic pods.

The 244 mm rainfall in 1990-91 was 40 mm below average but it was very well distributed; therefore, 102 kg/ha of seed were measured in June 1991 (Table 2) for medic that was re-established for a second time. *M. rigidula*, *M. polymorpha* and *M. rotata* contributed one-half, one-third and one-tenth of the seed, respectively, regardless of phase.

Medic sown in 1987-88 yielded 672 kg/ha of seed, which was grazed down to 439 kg/ha by the end of the summer (Table 2). Once the medic was established, the main difference between phases was one of seedbank size. *M. rotata* and *M. noeana* were not failures, but they did not contribute more than 10% of the seed to the seedbank at any time. Apparently, the late maturation of *M. noeana* imparts a disadvantaged to its persistence in a dry zone. *M. aculeata*, Jemalong and Snail medic all failed to sustain seedbanks.

A medic/medic/barley rotation was initiated in 1990-91 and an additional 610 kg/ha of seed was produced on the plots that were medic for the second year in a row. Seed pods were grazed throughout the summer, leaving a total seedbank of 656 kg/ha in Oct 1991 (Table 2). *M. rigidula* and *M. polymorpha* actually represented a mix of accessions within each species (Table 1). *M. rigidula* entries listed in Table 1 produced similar proportions of the total seed formed. For *M. polymorpha*, the Australian cv Circle Valley produced copious quantities of seed during the medic establishment year of 1987-88: it contributed about half the seed set from all species of medic (by weight) in the summer of 1988 and was by far the most successful *M. polymorpha* entry. Circle Valley maintained its performance relative to the other *M. polymorpha* entries throughout the experiment and in June 1992 it still had a seedbank of 58 kg/ha from a total seedbank of all species of 205 kg/ha. Circle Valley is susceptible to frost (Cocks 1988); however, it is clear that it is also capable of copious seed production. The pods of Circle Valley are spineless and relatively small so it is more difficult to deplete the seed stock by grazing.

The results show that medics survived some very dry years and can persist for several seasons without major new inputs of seeds if a good growing season builds up the seedbank periodically. Management should concentrate on maximizing seed production when conditions permit. Little can be done to build up seedbanks in dry years. It is interesting however, that although the seedbank set in 1987-88 was depleted to one-third the original level by two successive dry years, full recovery in June 1991 was possible in a less than average rainfall year.

The experiment was located 35 km from ICARDA headquarters, and because of the lower degree of control, medic plots were pastured using mob grazing over short periods of time by local flocks of sheep. This management is the rule rather than the exception in West Asia. It will be difficult for medics to set seed and persist unless farmers can be convinced that aboveground pods serve a valuable purpose as an emergency feed and that belowground pods are a necessity for regeneration of pastures.

This experiment will be continued until 1994-95 to give the medic/medic/barley and medic/barley rotations time to express their effects on seedbanks. Seedbanks for these two treatments will be directly compared in 1995 when medic/medic/barley and medic/barley plots come in synchronony in the same phase under the same weather conditions.

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