Department of
Primary Industries and
Regional Development
GOVERNMENT OF
WESTERN AUSTRALIA

Digital Library

Technical Bulletins

Natural resources

11-1977

Annual medicago ecotypes from North West Libya

M Khalil

C M. Francis

N J. Trotman

Follow this and additional works at: https://library.dpird.wa.gov.au/tech_bull

 Part of the Weed Science Commons

Recommended Citation

Khalil, M, Francis, C M, and Trotman, N J. (1977), *Annual medicago ecotypes from North West Libya*. Department of Primary Industries and Regional Development, Western Australia, Perth. Technical Bulletin 37.

This technical bulletin is brought to you for free and open access by the Natural resources at Digital Library. It has been accepted for inclusion in Technical Bulletins by an authorized administrator of Digital Library. For more information, please contact library@dpird.wa.gov.au.

No. 37

ISSN 0083–8675
AGDEX 137/00

ANNUAL MEDICAGO ECOTYPES FROM NORTH WEST LIBYA

1. Preliminary agronomic evaluation

ANNUAL MEDICAGO ECOTYPES FROM NORTH WEST LIBYA

1. Preliminary agronomic evaluation

by M. Khalil, C. M. Francis and N. J. Halse
Editor: C. H. Trotman

The authors: M. Khalil, Jefara Plains Authority, Tripoli, Libya (presently at Department of Soil Science, University of Western Australia); C. M. Francis, Research Officer, and N. J. Halse, Chief, Division of Plant Research, Department of Agriculture, Western Australia.

Manuscript received November, 1977.

ANNUAL MEDICAGO ECOTYPES FROM NORTH WEST LIBYA

1. Preliminary agronomic evaluation

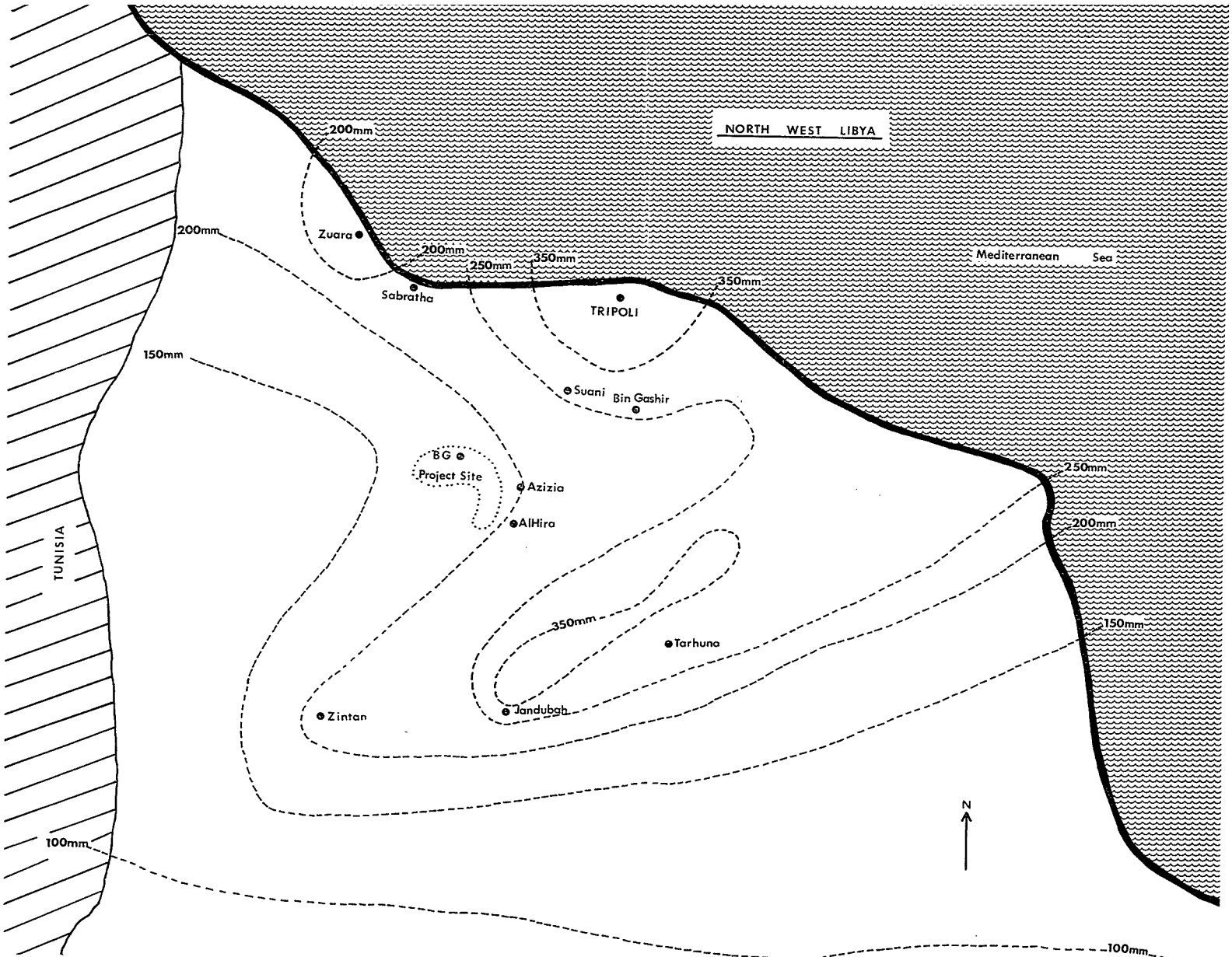
by M. Khalil, C. M. Francis and N. J Halse

SUMMARY

Nine *Medicago* species were represented in collections from 10 sites in North West Libya. This report outlines species distribution, maturity characteristics and coumestrol content of the ecotypes collected. *Medicago laciniata* was the most common species collected but there appeared to be a relationship to soil type amongst other species. *M. truncatula* predominated on heavier textured soils but *M. tornata* and *M. littoralis* were more frequent on sandy soils.

The Libyan ecotypes were typically early flowering with a rapid rate of burr maturation. They contained low to moderate levels of the plant oestrogen coumestrol in dry stems. Evaluation work was carried out at Medina Research Station, 20 km south of Perth, Western Australia.

TECHNICAL BULLETIN No. 37, DECEMBER, 1977.
DEPARTMENT OF AGRICULTURE OF WESTERN AUSTRALIA



Rainfall isohyets relevant to burr medic collection sites in North West Libya.

INTRODUCTION

In order to develop self sufficiency in cereal production, agricultural development in the Jefara Plain area of Libya will need to be based largely on frequent wheat cropping. Rainfall in the area is low, generally less than 300 mm falling almost entirely during winter and the soils are calcareous and subject to erosion by wind. The erosion situation is aggravated by stocking rates too high for the natural, unfertilised pastures to reliably maintain. In such situations *Medicago* species could play a major role in improving soil fertility, in terms of both its nitrogen and organic matter status. The soil nitrogen contribution by the legumes would also cause herbs and grasses to be regenerated and allow at least existing animal numbers to be carried without denudation by overgrazing, an obvious benefit in the control of soil erosion.

Medics occur naturally in Libya, and are well adapted to the high soil pH and existing physical soil characteristics. Also, of the Australian medics commercially available, on a maturity basis only Cyprus barrel medic (*M. truncatula*) and Harbinger strand medic (*M. littoralis*) have any prospects of real success in the erratic short growing seasons.

However, it is also unlikely that the naturally occurring medics are the best possible adapted types to Libyan conditions. At least 16 *Medicago* species are endemic in Northern Africa (Heyn 1963) and the present study embodies a comparison of some of their known important characteristics with characteristics of 'Australian' cultivars, to assist in the definition and selection of a type better suited to Libyan conditions.

Besides fast maturity and rate of burr maturation, a high proportion of hard (impermeable) seed is vital in environments where seed set is likely to be substantial only during relatively infrequent 'good years'. A high hard seed bank is thus likely to be essential for persistence. Although medics generally have a high content of hard seeds (Quinlivan 1961), it may be that the harsh environment of Libya with its frequent dry spring weather together with extreme summer temperatures demands hard seed levels higher than necessary in Australia. The characters of time to flowering, seed maturation rate and hard seed were therefore the main subjects of this initial study. Levels of coumestan coumestrol were also recorded as the major plant oestrogen known to occur in the species (Francis and Millington 1965).

METHODS

Dry medic burrs were collected in the summer by Mr J. Roberts of the Western Australian Department of Agriculture, and by two of us (N. J. H. and M. K.) at locations selected for wheat cultivation as part of the joint Libyan-West Australian Jefara Plain Project. Characteristics of the collection sites are recorded in Table 1 and their locations relative to rainfall isohyets on the Figure. Sampling was by no means comprehensive in all areas visited and there was some bias toward burr types with less aggressive spines.

The samples were then forwarded to Perth and sorted into their species groups, with further selection made toward burr types of low-moderate spininess without apical hooks.

Table 1.—Description of collection sites in North West Libya.

Sites	Rainfall	Soil	Land use and grazing pressure
Zintan	150–230 mm	Fine calcareous sand with low organic matter. Shallow soil, wind and water erosion.	Extensive grazing. Olive trees and barley on the flat wadis. Shifting grazing on native plants.
Sabratha	200–250 mm	Calcareous yellow brown sand, poor in organic matter.	Grazing and shifting cultivation and static farming—mainly palm trees. On sea coast.
Zuara	150–200 mm	Fine calcareous sub-desert soils	Heavy grazing goats and camels. Shifting cultivation between *Aristida pungens* sub-dunes. Area has been overgrazed.
Al Hira	150–200 mm	Brown loamy fine sand, poor in organic matter, calcareous.	Continuous cropping of wheat and barley, grazing on the stubble after harvesting in the summer.
Gabu Zaid .... (BG_1, BG_2)	150–200 mm	Loose red brown calcareous sand. Semi stable sand dunes, poor in nitrogen and organic matter.	Nomadic grazing by sheep and goats. Annual grasses and desert bush.

Table 1.—Description of collection sites in North West Libya —*continued.*

Sites	Rainfall	Soil	Land use and grazing pressure
Janduba	300–330 mm	Brown loamy fine sand, calcareous, low organic matter. Some calcrete and limestone on surface. Water erosion processes.	Continuous cropping every year and olive and almond trees. The area grazed in summer; in winter the sheep shifted to the hills.
Tarhuna	250–300 mm	Yellow brown loamy fine sand, calcareous. Poor in nitrogen and organic matter.	Continuous cropping on the wadi beds and olive trees on the slope. Barley and wheat between the trees and where the wadis flooded, grazing sheep around the hills.
Bin Gashir	250–300 mm	Red brown fine sand, calcareous. Organic matter 0·2%.	Small farms under irrigation—olive, palm trees, citrus, heavy grazing south of the Bin Gashir village.
Swani	200–250 mm	Red brown fine sand, calcareous.	Small farms under irrigation—olive trees, citrus. Heavy grazing around the farms.
Azizia	150–220 mm	Yellow brown fine sand, calcareous.	Small farms, cereals under irrigation—olive trees.

Three species, *M. truncatula*, *M. littoralis* and *M. tornata*, were predominant amongst the 165 ecotypes selected for preliminary agronomic studies.

Collections of *M. scutellata*, *M. rugosa* and *M. rigidula* comprised only one or two burrs and are recorded in Table 2, although it was assumed that their scarcity implied lack of general adaption to the conditions prevailing in the localities of interest. Along with many ecotypes of *M. polymorpha*, *M. minima*, *M. laciniata* and *M. arabica*, these were not included in the present study.

In mid-May, 1975, scarified seed from individual pods was sown in a red brown (Tuart) sand at Medina Research Station (Smith 1952), initially in 165 rows with three replications. Most promising ecotypes were then included in a further series of replicated row evaluations in 1976 and 1977. Flowering date, growth habit, and leaf and burr characteristics formed the basis of initial selection, with the rate of burr maturity of some of the more promising selections being estimated as the time difference between time to first flowers and the appearance of mature (brown) pods on half the plants in the row.

The hard seed content of some of the more promising lines was evaluated using the method of Quinlivan (1961), and was assessed as a percentage of initial hard seed remaining after six months storage at a 15° to 60° C fluctuating daily temperature. The content of the oestrogenic coumestan coumestrol was analysed in field dried stems of most lines using thin layer chromatographic techniques (Francis and Millington, 1965).

RESULTS AND DISCUSSION

The medic species recorded in the various collections are listed in Table 2. *Medicago laciniata* (cut leaf medic) was by far the most common medic species in this series of collections, and was clearly well adapted to the arid environment. It was the species apparently best adapted to dry sites, e.g. Zintan where it comprised at least 80 per cent. of the burrs collected.

A comprehensive series of collections and their study at the beginning of an agricultural development project should have a number of

Table 2.—Species distribution at 10 collection sites in North West Libya.

Locality	*Medicago* species								
	laciniata	*littoralis*	*minima*	*polymorpha*	*rigidula*	*rugosa*	*scutellata*	*tornata*	*truncatula*
Zintan	+		+						
Sabratha	+	+		+				+	+
Zuara	+	+						+	+
Al Hira	+	+		+				+	+
Abu Zaid (BG_1)	+	+						+	
Janduba	+		+	+		+	+		+
Tarhuna	+		+	+	+		+		+
Bin Gashir	+	+		+				+	
Swani		+		+				+	
Azizia	+		+	+					+

important benefits. It defines the range of species best adapted to the locality and indicates those characteristics of the natural populations in terms of flowering time, growth habit and burr form that should provide a useful guide to defining the pasture plant best selected for the area.

Sampling for some localities in the present study was limited so that only generalisations are possible at this stage. Even so, some interesting observations can be made. In the first instance, the common occurrence of *M. littoralis* and *M. tornata* is quite likely a reflection of the sandy nature of most Libyan soils and the known adaptation of these species to them (Heyn 1963). At sandy sites like BG_1 and Bin Gashir it seems apparent from available ecological evidence that these species are better adapted than the barrel medics (*M. truncatula*). The reverse appears to be true on the heavier soil types at Janduba, Tarhuna and Al Hira where barrel medics were far more common and *M. littoralis* and *M. tornata*, though recorded at Al Hira, comprised only a minor proportion of the current collections. However, more comprehensive study in terms of species frequency at other sites where both species are recorded should be an important future aim to assist in more accurate definition of species requirements. It would also serve to identify contaminant species which may compete with sown pastures in subsequent development programmes.

Janduba and Tarhuna, two of the relatively better rainfall sites, recorded the widest range of species, each recording six of the seven species found in the present survey. Of the 16 species recorded in Northern Africa (Heyn 1963), nine occur in neighbouring Tunisia of which only *M. soleirii* was not recorded. However there appears every prospect to add to the Libyan range from further collections in the region.

Flowering and maturity data

As might have been expected from the available climatic data, early maturity was the rule amongst Libyan ecotypes. Most were as early or earlier than cv. Cyprus (*M. truncatula)* and were invariably earlier than cv. Harbinger (*M. littoralis*) or Tornafield (*M. tornata*), the earliest of the commercial 'Australian' cultivars

Table 3.—Maturity data, coumestrol and hard seed content of some Libyan ecotypes at Perth.

	Days to 1st flower	Days from 1st flower to 1st mature pods	Coumestrol (ppm)	Hard seed* content %
M. truncatula				
Zuara 1	83	39	75	81
Zuara 3	83	39	65	78
South Alhira B F_{22}	80	37	100	75
South Alhira D_9	81	40	105	88
Janduba A_3	74	36	70	92
Janduba A_{22}	76	41	75	61
Tarhuna A_{27}	80	37	55	82
Tarhuna A_{30}	77	35	55	75
W. Azizia 8	79	38	75	89
M. littoralis				
Sabratha 1	78	44	130	90
South Alhira F_{25}	70	33	125	87
Bin Gashir GB_4	77	31	105	85
M. tornata				
Swani	76	42	25	77
BG_1, A_{16}	76	36	40	82
BG_1, B_{16}	77	36	20	89
Controls				
M. truncatula				
cv. Cyprus	81	45	75	80
cv. Ghor	75	52	80	86
cv. Jemalong	98	42	80	75
M. littoralis				
cv. Harbinger	86	48	175	77
M. tornata				
cv. Tornafield	94	40	25	76

* percent hard seed remaining after 6 months storage at 15°–60°C daily fluctuating temperature expressed as percent of initial hard seed.

(Table 3). It may be unwise to extrapolate this data to the Libyan environment's cold winter but the suggestion from the data is that cv. Harbinger in particular may have later than optimum maturity for Libya. This is despite the fact that Harbinger should otherwise be well adapted to many of the sandy alkaline soils.

Libyan medics in general showed a relatively rapid burr maturation phase, perhaps a response to the often short periods of available moisture at flowering time in Libya. Clarkson and Russell (1976), however, after a detailed study, suggested that water stress itself accelerates phasic development, and that this varies with species and cultivars. An analogous study using the Libyan ecotypes would thus be worth investigating to find if their adaptation to a dry climate depends solely on early flowering coupled with relatively rapid burr development, or whether, additionally, they have the ability to accelerate burr production more rapidly than less adapted types in drought situations.

Coumestrol content and hard seed data

All the Libyan medics tested contained coumestrol in the dry stems with the highest values of 250 ppm being recorded in a sample of *M. polymorpha* from Sabratha. Such levels give cause for caution, because coumestans in medics may inhibit oestrous in ewes, as well as produce follicular abnormalities (Kelly, Adams and Lindsay 1976). As a safe guard against possible deleterious effects on ewe fertility and because low to moderate coumestrol varieties were common, the group of promising selections chosen were all lower in coumestrol than cv. Harbinger, a cultivar not hitherto associated with sheep infertility despite its moderate to high coumestrol levels (Table 3).

Hard seed content is an important characteristic which enables medic species to persist despite seasonal failures in one or more years. The Libyan selections were no exception although one might have expected even more extreme levels in ecotypes from such an erratic climate. There was no clear indication of this amongst the *M. truncatula*, *M. tornata* and *M. littoralis* ecotypes but the only two *M. laciniata* tested were significantly harder than the others, perhaps an additional reason for its almost ubiquitous occurrence and its apparently greater success in the more extreme environments in this study.

The use of promising Libyan ecotypes

Table 3 documents some of the more promising lines from our initial collections in the area. Although studies are far from complete, it may be expected that ecotypes will generally persist better than introduced lines, as well as probably being in a better balance with the soil rhizobial population. Both Sabratha I (*M. littoralis* and Swani *(M. tornata)* appear outstanding on the sandier soils and show promise of fulfilling a useful role both in Libya and under Western Australian conditions.

ACKNOWLEDGMENTS

We wish to express our thanks to Mr J. R. Mack for his competent technical assistance, Dr. B. J. Quinlivan and staff for the hard seed evaluation, and Mr M. Brown, Institute of Agriculture, for the coumestrol analyses.

We also wish to express our gratitute to Mr. Bashir El Wahashi, Director of the Cereals Project, Tripoli, for his interest and assistance.

REFERENCES

Clarkson, N. M. and J. S. Russell (1976). The effect of water stress on the phasic development of annual *Medicago* species. *Aust. J. Agric. Res.* **27** : 227.

Francis, C. M. and A. J. Millington (1965). Wether bioassay of annual pasture legumes. The oestrogenic activity of annual medic pastures. *Aust. J. Agric. Res.* **15** : 565.

Heyn, C. C. (1963). The annual species of *Medicago*. Hebrew University of Jerusalem press.

Kelly, R. W., Adams, N. R. and D. R. Lindsay (1976). Effect of coumestans on the reproduction in the ewe. *Aust. J. Agric. Res.* **27** : 253.

Quinlivan, B. J. (1961). The effect of constant and fluctuating temperatures on the permeability of the hard seeds of some legume species. *Aust. J. Agric. Res.* **12** : 1009.

Smith, R. (1952). The soil associations of part of the Swan coastal plain. CSIRO Div. of Soils Report 1/52.

71565/11/77—400 WILLIAM C. BROWN, Government Printer, Western Australia