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OFFICE DE L'ELEVAGE ET DES PATURAGES
PROJET D'AMENAGEMENT DES PARCOURS
DE LA TUNISIE CENTRALE

END OF TOUR REPORT

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OFFICE DE L'ELEVAGE ET DES PATURAGES

EN COLLABORATION AVEC
L'UNIVERSITÉ DE L'ÉTAT DE L'OREGON

GERMINATION EXPERIMENT RESULTS

December 1985

GERMINATION RATES AND PATTERNS OF SELECTED PLANTS USED
IN REVEGETATING CENTRAL TUNISIAN RANGELANDSD. E. Johnson, M. N. Ben Ali, E. Manssour, Y. Samet,

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ABSTRACT

An examination of the rate, extent and pattern of germination of plant species used for revegetating Tunisian rangelands has indicated that those species that have rapid germination rates tend to perform better under Tunisian range conditions. It also appears that species that have a percentage of hard seed or seeds that have delayed germination have an advantage. Autumn rainfall in Tunisia is erratic and a rain may be followed by a long dry period. The strategy of plants we have found to be most promising for revegetation is to rapidly germinate and use existing moisture while maintaining a reserve of seed in the soil in case there is a prolonged dry period.

INTRODUCTION

Tunisia is a country located in North Africa, bounded by Libya on the south-east and Algeria to the west. It has a long coastline on the Mediterranean sea and is the northernmost country in Africa.

Topographically the country is divided by the Dorsale, a chain of mountains which crosses from the central western part to the northeastern part of the country. South of this chain of mountains lies an area referred to as Central Tunisia. It is characterized by a Mediterranean climate with cool winters and hot, dry summers. Most of the precipitation is received during the winter months. Rainfall varies from approximately 100 mm in the south to 400 mm in the north. This precipitation is highly variable, however, both between years and within seasons.

In 1982 the governments of Tunisia and the United States initiated a rangeland development project that was directed to improve the real incomes and agricultural efficiency of farmers at specific sites in Central Tunisia.

A major focus of the Tunisian Rangeland Development Project has been to reseed abandoned croplands and severely-overgrazed rangelands in the central portion of the country. In the process of testing and selecting plant materials for use in a



reseeding effort, it became obvious that a number of ecological constraints act upon the germinating seed and seedling that can determine success or failure of the seeding. These constraints are: first, the timing of fall rains is highly erratic. The first rain in the fall may come in September while temperatures are still high (mean temperatures in the 20° to 30°C. range) or in December when it is cool (mean temperatures from 5° to 15° C). Second, the rains are not consistent once they begin. A rain may be followed by a dry spell sometimes lasting for a month or more. This variability increases with decreasing average annual precipitation. Third, competing vegetation is primarily characterized by fast-growing annual plants, mainly mustards, on former croplands and drought-resisting shrubs on rangelands. Often sheep have a low preference for these plants if they are unpalatable or poisonous. We should note that even on lands that have never been plowed we find annual mustards as competing vegetation.

In order to meet this sort of environmental challenge we felt that an ideal plant would have certain characteristics. These characteristics are: first, the ability to germinate rapidly over a wide temperature range so that it can stay abreast of the competing vegetation. Second, it should have a portion of the seed that is "hard" or resists germination in

case there is a prolonged dry period that kills the seedling. Third, it should be fast growing and temperature independent as a seedling. And fourth, seeds should be able to maintain viability for a long time while in the soil.

We decided to examine the germination patterns of a number of species that might be of use in a revegetation effort in Central Tunisia. In conjunction with field trials these results should give a better understanding of the biology of the system.

Because we are working in a developing country and the primary focus of our project is on implementation rather than research, we examined germination without the benefit of growth chambers. We placed seeds in petri dishes lined with paper tissue and wet it to saturation. The petri dishes were placed in a cabinet where they were kept dark and the temperature was monitored. The temperatures represent a moderated ambient temperature. Normally, temperatures fluctuated by 2 degrees Celsius throughout a 24-hour period. The seeds were examined daily and the number of seeds that had germinated were recorded. The experiment was continued until the germination ceased. The same group of plant species were tested repeatedly throughout the year in an effort to assess if there were time or temperature effects on the germination rate, extent or

pattern. The species that were examined are shown on the following table.

Table 1. Species Tested for Germination Characteristics

<u>Argyrolobium uniflorum</u>	
<u>Atriplex semibacata</u>	
<u>Atriplex annicola</u>	
<u>Atriplex canescens</u>	"NM-155"
<u>Atriplex canescens</u>	
<u>Atriplex confertifolia</u>	
<u>Atriplex glauca</u>	
<u>Atriplex halimus</u>	
<u>Atriplex lentiformis</u>	
<u>Atriplex nummularia</u>	
<u>Atriplex undulata</u>	
<u>Cenchrus ciliaris</u>	
<u>Dactylis glomerata</u>	(Hajeb)
<u>Dactylis glomerata</u>	(Gafsa)
<u>Hedysarum carnosum</u>	
<u>Hedysarum coronarium</u>	
<u>Hedysarum spinosissimum</u>	
<u>Helianthemum lippii</u>	(El Grine)
<u>Helianthemum lippii</u>	(Gafsa)
<u>Oryzopsis miliacea</u>	(M'said)
<u>Oryzopsis miliacea</u>	(Gabes)
<u>Oryzopsis miliacea</u>	(Tunis)
<u>Plantago albicans</u>	
<u>Stipa lagascae</u>	(Medenine)
<u>Stipa lagascae</u>	(Ben Guerdene)
<u>Vicia monantha</u>	

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<u>Argyrobolium uniflorum</u>
<u>Atriplex semibacata</u>
<u>Atriplex annicola</u>
<u>Atriplex canescens</u> "MH-155"
<u>Atriplex canescens</u>
<u>Atriplex confertifolia</u>
<u>Atriplex glauca</u>
<u>Atriplex halimus</u>
<u>Atriplex lentiformis</u>
<u>Atriplex nummularia</u>
<u>Atriplex undulata</u>
<u>Cenchrus ciliaris</u>
<u>Dactylis glomerata</u> (Hajeb)
<u>Dactylis glomerata</u> (Gafsa)
<u>Hedysarum carnosum</u>
<u>Hedysarum coronarium</u>
<u>Hedysarum spinosissimum</u>
<u>Helianthemum lippii</u> (El Grine)
<u>Helianthemum lippii</u> (Gafsa)
<u>Oryzopsis miliacea</u> (M'said)
<u>Oryzopsis miliacea</u> (Gabes)
<u>Oryzopsis miliacea</u> (Tunis)
<u>Plantago albicans</u>
<u>Stipa lagascae</u> (Medenine)
<u>Stipa lagascae</u> (Ben Guerdene)
<u>Vicia monantha</u>

<u>Lolium rigidum</u>
<u>Medicago ciliaris</u>
<u>Medicago polymorpha</u> (Kasserine)
<u>Medicago truncatula</u> "Jemalong"
<u>Avena sativa</u>
<u>Agropyron intermedium</u>
<u>Bromus mollis</u>
<u>Medicago littoralis</u> "Harbinger"
<u>Eragrostis tricaldes</u>
<u>Agropyron desertorum</u> "Nordan"
<u>Agropyron elongatum</u>
<u>Dactylis glomerata</u> "Berber"
<u>Dactylis glomerata</u> "Palestine"
<u>Agropyron cristatum</u>
<u>Agropyron sibericum</u>
<u>Medicago polymorpha</u> (Kairouan)
<u>Medicago italica</u>

* Medics were tested without the burr.

RESULTS and DISCUSSION

Four observations can be made from the data generated by this experiment. First, the time required for a seed to germinate varies markedly between the species tested. Second, the pattern of germination, that is, the variability from an average time is different with different species. With some of our collections all of the seeds germinated at about the same time while with others the response is quite broad. Third, the viability of local collections varies between species and in one case between accessions of the same species. And fourth, seed viability changes with storage time (as would be expected) and some of the collected species maintain their viability for longer periods under ambient temperatures. We will now discuss each of these observations and their management implications.

The time required for seeds to germinate varies from species to species. Table 3 lists the day of the trial on which the greatest number of seeds germinated and also the first day a seed of that species was observed to germinate. We have chosen to use this measure (the mode) rather than another measure of central tendency because the data intrinsically deviates from the normal curve.

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Table 3. Plants that had the highest daily germination rate on the first or second day of the trial at a mean temperature of 19°C.

SPECIES	DAY OF MODAL GERMINATION	DAY OF FIRST GERMINATION
<u>Medicago polymorpha</u> (Kass.)	1	1
<u>Plantago albicans</u>	1 & 2	1
<u>Hedysarum spinosissimum</u>	2	1
<u>Medicago italica</u>	2	1
<u>Argyrolobium uniflorum</u>	2	2
<u>Atriplex glauca</u>	2	2

Table 4. Plants that had the highest daily germination rate on the third day of the trial at a mean temperature of 19°C.

SPECIES	DAY OF MODAL GERMINATION	DAY OF FIRST GERMINATION
<u>Atriplex canescens</u> (NM-155)	3	1
<u>Hedysarum carnosum</u>	3	1
<u>Avena sativa</u>	3	2
<u>Agropyron intermedium</u>	3	2
<u>Medicago ciliaris</u>	3	2
<u>Medicago truncatula</u>	3	2
<u>Medicago polymorpha</u> (Kair.)	3	2
<u>Atriplex canescens</u>	3	3
<u>Atriplex semibacata</u>	3	3
<u>Bromus mollis</u>	3	3
<u>Lolium rigidum</u>	3	3
<u>Stipa lagascae</u>	3	3

Table 5. Plants that had the highest daily germination rate on the fourth and fifth days of the trial at a mean temperature of 19°C.

SPECIES	DAY OF MODAL GERMINATION	DAY OF FIRST GERMINATION
<u>Medicago littoralis</u>	4	1
<u>Xedysarum coronarium</u>	4	2
<u>Eragrostis tricooides</u>	4	4
<u>Agropyron desertorum</u>	4 & 5	3
<u>Atriplex halimus</u>	5	3
<u>Agropyron elongatum</u>	5	4

Table 6. Plants that had the highest daily germination rate on the sixth day or greater of the trial at a mean temperature of 19°C.

SPECIES	DAY OF MODAL GERMINATION	DAY OF FIRST GERMINATION
<u>Atriplex lentiformis</u>	6	3
<u>Cenchrus ciliaris</u>	6	4
<u>Dactylis glomerata</u> "Berber"	6	4
<u>Dactylis glomerata</u> (Hajeb)	6	4
<u>Dactylis glomerata</u> (Gafsa)	6	6
<u>Agropyron cristatum</u>	7	4
<u>Agropyron sibericum</u>	7	4
<u>Dactylis glomerata</u> "Pal."	7	4
<u>Oryzopsis miliacea</u> (M'Said)	10	7
<u>Vicia monantha</u>	16	3
<u>Atriplex amnicola</u>	16	7

We find that many of the most promising plants for revegetation of rangelands and abandoned croplands are found in the upper half of this list. From field trials it has been determined that the annual grasses Lolium rigidum and Bromus mollis have the broadest adaptability and that the perennial Stipa lanascae also has been successful generally across test sites in Central Tunisia. Dryzopsis miliacea and Dactylis glomerata have done well on the relatively cool moist sites. Of the legumes, both the Medics and the Hedysarums are generally adapted but Medicago polymorpha and Hedysarum spinosissimum do the best on the drier sites.

Also near the top of the list is Plantago albicans, a common plant throughout Central Tunisia. This plant is a perennial that spreads from seed or vegetatively by sprouting from the roots.

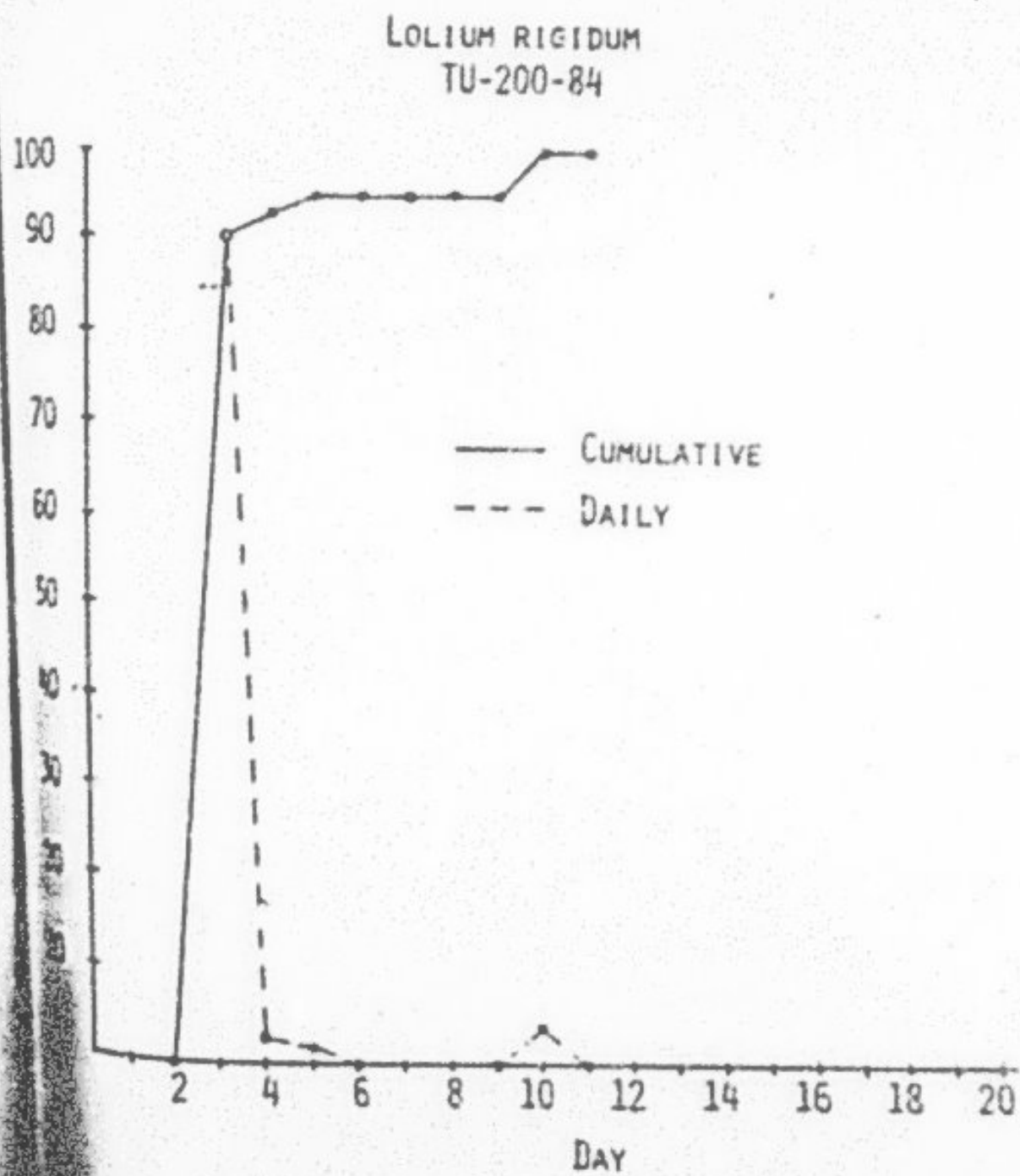
It is interesting that one of the slowest plants tested, Vicia monantha is found generally throughout Central Tunisia although not as ubiquitously as Plantago albicans. This species has a very large seed (there are about 25,000 per kilogram). This could mean that although it germinates more slowly than the competing vegetation it has seed reserves enough for the seedling to overcome the disadvantage. Among the species tested, shrubs were generally slower to germinate than were local forbs and annual grasses.

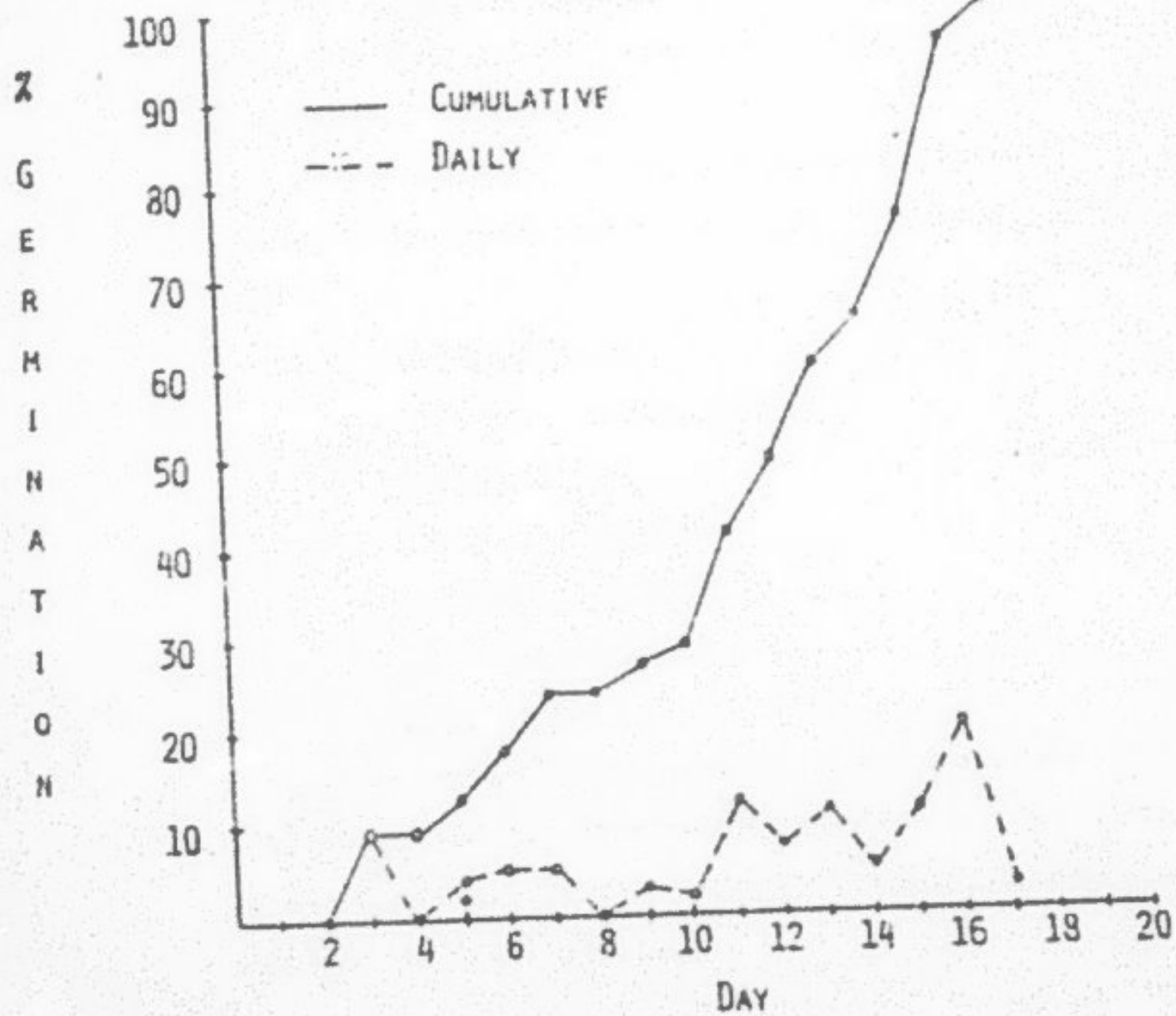
We realize that there are many factors that contribute to success or failure of a seeding but it appears that seeds that germinate more rapidly generally have an advantage over the slower species in our area.

As we mentioned before the pattern of germination is also important. We plotted the germination rates standardized by considering only those seeds that germinated during the trial (which means we ignored hard seeds and seeds that were dead).

Figure 2 shows the pattern for Lolium rigidum. Seeds of this plant germinate quickly and completely. By the sixth day almost all the seeds had germinated. The vetch Vicia monantha (Fig. 3) by contrast is much slower and much more variable. We classified species into three groups -- broad, intermediate and narrow in their range of germination times. Table 3 shows this breakdown.

It seems reasonable to assume that this variability in germination response is the plant's insurance against having all its seed germinate at one time causing it to run the risk of dying from desiccation. Short-term variability as well as "hard seed" which resists germination over long periods becomes increasingly important as the variability of precipitation increases. Even though we could not measure "hard seed" with this experiment we know that



VICIA MONANTHA
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the medics and the sweetvetchs (Hedysarum spp.) do produce a significant percentage of hard seed. As range managers we would like to "hedge our bet" by planting seeds that have a good probability of carryover if we do not have a good rainfall year. We observed this with a seeding of Hedysarum carnosum in the fall of 1983. It did not germinate appreciably that fall; however, the following year this area had a good stand and very good production.

Our management strategy should be in Central Tunisia to "charge" the soil with seeds of beneficial annual or biennial plants that will germinate over a period of years. This increases the probability of seeding success and stand maintenance which translates to an improvement in the return on investment dollars.

This project is helping to develop a range seed industry in Tunisia. It is therefore important to know which species of plants produce a high proportion of viable seed and what types of seeds maintain viability. Through this experiment we found that some species obtained from native collections had good germination rates. These included three grasses:

Lolium rigidum (86%)

Stipa lagascae (76%)

Oryzopsis miliacea (one accession only) (64%)

Six forbs had good germination rates:

Hedysarum carnosum (56%)

Hedysarum spinosissimum (88%)

Plantago albicans (100%)

Medicago polymorpha (63%)

Medicago ciliaris (50%)

Vicia monantha (56%)

The shrubs Atriplex glauca (90%) and Atriplex holimus (72%) had germination rates that we believe are acceptable.

After one year of storage under ambient temperatures, seeds with the highest germination rates were:

Lolium rigidum

Hedysarum spinosissimum

Hedysarum carnosum

Plantago albicans

Medicago polymorpha

Medicago ciliaris

Vicia monantha

We believe that the species just mentioned have a high potential for development in Central Tunisia and we are currently in the process of expanding the seed supplies of these plants.

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VUES