MICROFICHE N°

00308

République Tunisienne

MINISTERE DE L'AGRICULTURE

CENTRE NATIONAL DE

DOCUMENTATION AGRICOLE

TUNIS

الجمهورية التونسية

وزارة الفلاحة

المركز القومي

للتوثيق الفلاحي

تونس

F 1

PROCEEDINGS

THIRD REGIONAL WHEAT WORKSHOP

- Durum Wheat Improvement
- Weed Control
- Crop Rotation with Annual Forage Legumes
- Seed

Tunis, Tunisia

APRIL 28 - MAY 2, 1975

CONTENTS

Contents (Cont.)

Contents (cont).

Part VII. NON-SCHEDULED CONTRIBUTIONS

Part VIII. SPECIAL SESSIONS

Part IX. CONFERENCE CLOSING

Part X. LIST OF PARTICIPANTS

23

THE ELEMENTS OF ESTABLISHING A CROP ROTATION PROGRAMME USING ANNUAL FORAGE LEGUMES

J.M. Doolette

The concept, important principles, benefits and the feasibility of the land-use system developed in southern Australia in which a free-seeding, self-regenerating, annual forage legume is grown in rotation with cereal crops has been described previously (1, 2).

This paper discusses some important considerations for the introduction of the system to a country where it is intended to replace the existing rotation.

Choosing a new crop rotation

Experiments designed to compare possible crop rotations are long-term and complicated. In comparing a simple 2-year rotation with a 3-year rotation and assuming each to have been established in 3 successive years to minimise the effect of climate in the year of establishment and to speed up comparisons, the useful wheat yield data would be generated in the 9th, 10th and 11th years of the experiment. It is not unusual to have analyses deferred until 25-30 years after commencement in more complicated comparisons. The disadvantages of these time delays are obvious when there is need to find a superior rotation to replace a lowly productive or damaging system.

Often the "best bet" approach is preferable. This entails a careful appraisal of the environment, the constraints imposed by the environment and management facilities, and the production goals, and then looking to another region of the world of similar environment, constraints and goals and where improved systems have been established.

In these respects Tunisia and other parts of North Africa resemble southern (temperate) Australia so that a land-use system based on wheat in rotation with an annual forage legume is likely to be suitable.

The levels of soil nitrogen are low as evidenced by the yield responses obtained to added nitrogen. Wilhelmi (3) reported 82 experiments over four years and stated that responses have been very pronounced in most of the trials even in dry years.

Year	Mean Yield Increases from Added Nitrogen	%age Increase
1969-70	7.1 qls/ha	26%
1970-71	10.3 qls/ha	37%
1971-72	11.3 qls/ha	33%

In the same report Wilhelmi states that organic matter values taken from soil samples in the wheat areas normally range between 1-2 percent. It should be expected that soils of these types in regular cropping patterns would have values in the order of 2-3 percent.

The wheat growing region of Tunisia has soils variable in respect to type, depth and texture and rarely have the capacity to sustain continuous cropping.

Tunisia has a rainfall pattern the main feature of which is its variability -- variable not only in respect to the annual incidence but also in respect to the onset and length of the growing season and the occurrence of stress periods.

In all these constraints the Tunisian wheat regions resemble those of temperate Australia. More importantly, the production goals of cereal grain and livestock products which are the prime income sources are the same.

Whereas the broad principles of a crop rotation programme are dictated by technical considerations and directed towards maintaining soil productivity, the final decisions are invariably based on financial considerations. The land-use system in which cereal crops are interspersed with periods of pasture composed predominately of annual forage legumes is capable of maintaining soil productivity for the cereal crops and supporting livestock enterprises in a flexible manner.

All these considerations made it reasonable to assume that the system could be economically sound for Tunisia as well as being technically feasible.

Variety of legume and its interaction with the location

The key factor in the system is the legume -- the free-seeding, self-regenerating, annual forage legume.

The system has been developed in mediterranean climates and the subterranean clover and medicago varieties used are typical mediterranean annuals. They germinate with the autumn rains, grow under favourable conditions until seed is set in the spring or early summer and survive the dry summer months as seed. The success of a variety depends not only on the vigour of the winter/spring growth but also on its ability to produce a large quantity of seed so that in regeneration dense seedling populations exert competitive pressures. The seed must have a protective mechanism against germination until growing conditions are favourable. Some sort of dormancy mechanism will allow the species to survive adverse conditions and germinate at the correct time. In the neutral to alkaline soils of Tunisia's wheat growing regions (pH 7.5-8.0) the annual species of the genus Medicago grow strongly and the development of the system is based on this material. The system can be constructed, under different soil conditions, using varieties of Trifolium subterraneum or indeed other annual forage legumes, but this discussion will are the consideration relating to Medicago.

An important issue is the necessity of establishing the system using a variety which responds best to the environment. As well as varieties commercialized elsewhere there is a wide range of indigenous material occurring in Tunisia. Heyn (4) reviewed the world distribution of the genus Medicago which occurs from Europe to Central Asia, in North Africa and in Asia Minor. It is suggested that the annual species are mostly confined to areas bordering the Mediterranean Sea and nearby regions. Much of the material in North Africa has been collected and in some instances some of them have already been chosen for multiplication for commercial purposes. There is little doubt that suitable native material is available for most of the micro-environments where the system is envisaged. A good deal of work is necessary however to establish how a newly developed strain is going to react to an environment. Early selection based on agronomic characters and yield performance in rows or micro-swards can sometimes be misleading. The effects of such factors as seed size, seedling populations, drought tolerance or competition in mixed swards have received little attention from agronomists mainly because in the areas where most study has been done and at the time when study was most active there was an absence of a suitable range of material. In North Africa there is a wide range of material and it is widely distributed, so that new plantings will have to compete from the beginning.

Development of commercial varieties from indigenous material should be a strong part of a country programme and should be encouraged, but because of the length of time needed to establish the true performance of potential lines particularly from an ecological standpoint, an alternative approach should be sought initially.

Taking these considerations into account it is strongly recommended that programmes be launched using commercial varieties of known performance and wide adaptation, or, if a dense population of natural material exists in situ, managing this.

It is not always possible to predict what influence the native material will have on the sown sward. In the year of establishment it has been noted in Tunisia that the sown material readily dominates the legume fraction of the pasture. In the sward that regenerates after the first wheat crop there is a likelihood of it being invaded by a large population of native material which has been encouraged by the shallow cultivation, superphosphate and other management treatments. Broadly the goal is to ensure a dense population of plants which fix nitrogen and meet the requirements for success described above.

The Tunisian programme was launched using two introduced varieties whose performance is well known and whose wide adaptation is established.

The variety Jemalong belongs to the group of barrel medics (Medicago truncatula) of which there are four well known commercial varieties, viz., Hannaford, Jemalong, Cyprus and Borung. Jemalong variety is adapted to a Mediterranean-type climate with greater than 250 mm annual rainfall of predominantly winter incidence. Flowering occurs approximately 3½ months after germination. It is best suited to medium - textured, neutral to alkaline soils with a high lime content and of medium fertility. It is unsuitable for heavy textured soils. It cannot withstand waterlogging but is moderately tolerant of high salinity. It displays good tolerance to drought stress. Seed yields in lower rainfall areas in good seasons may be in the order of 500 kg/ha.

The variety Harbinger is a strand medic belonging to the species Medicago littoralis. It is winter growing with the same general adaptation as the barrel medics. It is earlier flowering than Jemalong with the seed ripening some 15-20 days earlier. It has considerably higher herbage yields in the winter. It grows well on soils suitable for barrel medics and in addition grows well on sandy alkaline soils where barrel medics do not perform well. It is extremely sensitive to waterlogging. Harbinger's high winter production, early maturation and ability to set seed satisfactorily make it suitable for low rainfall districts with short growing seasons.

The two varieties of known wide adaptation were chosen as the basis of the commercial establishment programme in Tunisia and the results to the present have justified the choice.

The importance of seed coat impermeability

In the description of a successful variety reference is made to the need to have some sort of dormancy mechanism to allow the species to survive adverse conditions and germinate at the correct time. It is required that once established the legume regenerate spontaneously either in successive years or after cropping. This requires that the seed produced survive the long, hot, dry summer periods and the cropping phases and that the irregular recurrence of the opening of the winter season and out of season rains does not induce germination that cannot be sustained and hence causes pasture failure.

Both embryo dormancy and impermeability of the seed coat are listed as characteristics of importance, but Quinlivan (1) establishes that the latter is the principle mechanism regulating germination of annual legumes over a number of years.

Impermeability prevents water movement through the seed coat. The mechanism is referred to as 'hardseededness' and the seeds concerned are referred to as 'impermeable seeds' or more commonly 'hard seeds'.

Seed coat impermeability, which is due to the development of a continuous suberin deposition in the seed coat, develops as seeds ripen and lose moisture in equilibrium with the relative humidity of the ambient air. It has been shown that the actual proportion of hard seeds depends on the stage of development of the seed when drying starts. Seeds maturing under moisture stress display less hard seeds than those maturing under conditions of adequate moisture. Hence there is an important influence of seasonal conditions in the spring. There is no evidence associating hardseededness with plant nutrition.

In field situations the daily alternating temperature cycle is the major cause of softening.

Annual medics are capable of carrying through a much higher proportion of impermeable seeds than other annual legumes and this ability to retain a relatively high proportion of the total seed crop as hard seed for one year at least is important in climates such as these and in fitting a situation of alternate year cropping.

Early study of the hard seed function is essential.

In Tunisia the pattern of hard seed percentage has been different from that anticipated. Whereas it would be anticipated that hard seed percentages should range from 85-95% for first year seed, in fact the limited data so far collected ranges between 55 and 70% for Harbinger at the lower rainfall sites and 65-85% for Jemalong at wetter sites. These levels remain satisfactory and regenerations after cropping have generally been satisfactory.

The subject warrants urgent study in Tunisia and should be an important early activity in any country programme perhaps in variety x location studies as well as commercial demonstrations.

Nitrogen and Nodules

The legume has the ability to fix atmospheric nitrogen through its symbiotic relationship with rhizobia bacteria, and the nitrogen fixation assumes that inoculation and nodulation with rhizobia is satisfactory.

The scientific appreciation of this symbiosis began in 1889 with the observations of two German scientists, Hellriegel and Wilfarth that the legumes' nodules made the host independent of other nitrogen. A year later Beijerinck isolated the bacterium Rhizobium. In the 81 years since then there has been a slow but steady increase in the understanding of how the nodule develops, the barriers to this development and subsequent function and how much nitrogen can be fixed.

From the practical standpoint it was important in Tunisia at the beginning of the programme to evaluate the situation. Firstly, it was assumed from visual examination that adequate rhizobia of one or more strains was present because the indigenous medics appeared to be effectively nodulated. Secondly, the soil conditions which affect inoculation and function such as low pH and mineral deficiencies such as molybdenum, cobalt, calcium were not apparent.

Early variety trials with Jemalong, Harbinger and Cyprus which have low rhizobia specifity, Paraggio which has a narrow specificity and Clare variety of subterranean clover were planted with and without inoculum. These and many subsequent commercial plantings led to the conclusion that Jemalong, Harbinger and Cyprus could be planted with safety wherever native material could be found in the near vicinity.

It is keenly appreciated that the local strains may be less effective than specially developed strains, but it is also keenly appreciated that the varieties Jemalong and Harbinger for which a suitable strain is available commercially may not remain the dominant varieties, that developing strains for new cultivars takes time, the introduced strains will have to compete with existing bacteria in the same way as introduced varieties will have strong competition from existing varieties.

Thus in the long term detailed rhizobial research and development could prove lucrative and it ought to be initiated relatively early in the programme, but in launching a programme the subject may best be treated as early as the local situation will allow.

Importance of Phosphorus

The annual legumes subterranean clover and medicago species are sensitive to phosphorus deficiency and appear more responsive to application of phosphorus than wheat, probably because of their freedom from dependence on an outside nitrogen supply. A great deal more work has been carried out on the effect of phosphorus on subterranean clover than medics, but the general principles can be assumed to apply.

Apart from the question of correcting a deficiency of phosphorus to produce healthy plants, there are several important issues. Nitrogen accretion is related to phosphate supply. The production of the legume in the sward is affected by a number of factors, but an estimated mean value of annual build-up is 60-70 kgs N/ha which represents in the order of 3-4 kgs N/kg P_2O_5. Many workers have tried to separate the response to currently applied phosphate from the response to residual phosphate. In summarizing some of these it seems that the reaction products of water-soluble phosphate are available to the plants on neutral to alkaline soils at least in the short term.

There is quite frequently a response to the initial application of phosphate which is lasting and may be due to the competitive effect of a denser initial stand and better yield of seed. These factors can have a long-term effect.

A third point relates to the effect of time of application of phosphate on botanical composition and this is particularly important in the legume which is regenerating spontaneously. There is a difference between phosphate applied before the germinating rain than after. When applied before, the legume is stimulated ahead of the grass and this is important in maintaining legume dominance and competing with grassy weeds.

Early Programme Goals

Based on the assumption that in Tunisia the system would work from a technical standpoint, that it was socially possible and that it supported the main production goals at least in the 350-500 mm rainfall region, certain programme objectives were established.

(1) The first was to adapt the Australian model to fit the Tunisian situation. To do this several simple and important questions had to be answered. These largely centre around points discussed above. The important additional point concerned the frequency of cropping particularly in the initial stages. Whilst it is clear that the system functions best on a 1:1 medic, crop basis and after seed supplies in the soil and soil fertility build-up more intensive cropping can occur, often in establishment it is wise to have an initial period of 2 or 3 years pasture. This in fact can allow the build-up of seed reserves and soil fertility quickly. Here in Tunisia it appeared to be prudent to maintain the 1:1 frequency from the beginning. This frequency of cropping was the established pattern and a lessening would reduce income and make acceptance more difficult. Also, there did not appear to exist the facility for

heavy grazing or cutting in years subsequent to establishment and it was likely that the [illegible] weed populations particularly grassy weeds would use up accumulated nitrogen and affect the next crop.

Therefore, the aim became one of re-grazing after one year of [illegible], however successful it might have been, and if necessary adding some fertiliser nitrogen.

(2) The second objective was to give some understanding of the principles and practical considerations to scientists and technicians of the country and convince the farmers to the possibilities and implications of this system. Although the plants which are the mainstays of the [illegible] system come from this region and have undoubtedly contributed to its agricultural production in the past, the major scientific and production development has occurred elsewhere. Hence it was not unreasonable that there was a very limited understanding before the programme began.

(3) It was important to establish the likelihood of success as early as possible in respect to two main considerations. In the first of these, the question was simply to determine whether within a relatively few cycles of the rotation the yields of cereal could match those obtained in the fallow system using all the recommended production practices of seedbed preparation and fertiliser. Equally as tangible is the need to measure the stability of the system. Would the legume regenerate after the crop? This is not only a question of seed quantity and hardseededness but also a managerial issue of whether it would be allowed to regenerate and establish.

(4) The fourth objective of the early programme was to point up and address as many of the management and technical problems which may limit adoption or function. The areas in which they lay but not the actual problems could be [illegible]. These areas concerned things such as likely insect attack, grazing management or cutting strategy to limit weed growth and facilitate subsequent seed-bed preparation, and phosphate fertiliser placement.

(5) Develop the bases for more detailed agronomic and economic research within the appropriate institutions.

To achieve these objectives, a series of experiments were laid down at several sites and a large number of demonstrations were established. At the same time, 100 hectares of medicago was established in various size commercial areas in each of two successive years.

The early data and observations referred to in the Tunisian programme were derived from these experiments, demonstrations and commercial areas.

REFERENCES

1. Doolette, J.B. ([illegible]). Alternative Land-Use Systems for Wheat Growing in Semi-Arid Areas. Proceedings, First Regional Wheat Workshop, Beirut.

2. Doolette, J.B. ([illegible]). Wheat in Rotation with Forage Legumes. Proceedings Fourth FAO Wheat Seminar, Teheran.

3. Wilhelmi, K.D. (1972). Summary of Soil Fertility Studies on Wheat in Tunisia. Report to CIMMYT.

4. Heyn, C.C. (1963). The Annual Species of Medicago. Scripta Hierosolymitana, Publication of the Hebrew Univ., Jerusalem, Vol. II.

5. Quinlivan, B.J. (1971). Seed Coat Impermeability in Legumes. Journ. Aust. Inst. Agric. Science, 37, 283.

L'INITIATION DE PROGRAMMES D'ASSOLEMENTS A BASE DE LEGUMINEUSES FOURRAGERES ANNUELLES

J.H. Doolette

RESUME

L'expérimentation dans le domaine des assolements est une entreprise de longue haleine, et les décisions finales sont inévitablement fortement influencées par une situation économique en constante mutation. Il est préférable par conséquent de choisir un assolement à peu près valable, que de s'obstiner à trouver un assolement parfait, ce qui signifie choisir un assolement qui a déjà fait ses preuves dans une région présentant plus ou moins les mêmes conditions de milieu, limitations et objectifs en ce qui concerne la production agricole. A ce niveau il y a de fortes ressemblances entre la Tunisie et certaines autres régions en Afrique du Nord, d'une part, et le Sud de l'Australie de l'autre; il est donc fort possible que l'établissement d'un système d'utilisation du sol basé sur la culture du blé en rotation avec des prairies de légumineuses fourragères annuelles serait praticable.

Les données existantes indiquent que les réserves limitées d'azote dans le sol et l'insuffisance de matières organiques ainsi que certains problèmes ayant trait à la structure du sol qui ont été observés en Tunisie peuvent être imputés en partie à la pratique qui consiste à laisser les champs en jachère dans le but de minéraliser l'azote à partir de matières organiques, pratique qui ne réussit que rarement à assurer la constitution de réserves d'humidité. Les principales activités sont de loin la culture du blé et l'élevage, et au moins dans la zone pluviométrique de 350 à 500 mm, il n'existe guère d'autres alternatives. Des variétés de légumineuses fourragères adéquates sont disponibles, et un grand nombre de variétés locales spontanées garantit la possibilité de mettre au point des variétés qui seront adaptées à la plupart des micro-environnements. Les difficultés qui se présentent quant à la culture de ces variétés sont minimes.

Il est nécessaire d'avoir une idée assez précise du modèle englobant l'ensemble des activités, et à cet effet il faut dès les premiers temps procéder à une évaluation de la performance de différentes variétés et des relations qui pourraient exister entre cette performance et la localité, ainsi qu'une étude des problèmes de levée, de l'accumulation d'éléments nutritifs, des relations avec les rhizobia, des caractéristiques du tégument de la graine et de l'amélioration de la fertilité du sol.

Les objectifs visés par un programme au stade du démarrage sont multiples: il faut simultanément trouver les réponses à certaines questions de façon à rendre possible l'adaptation du modèle, sensibiliser aussi bien les agriculteurs que les chercheurs à un système tout à fait nouveau et leur apprendre les techniques d'exploitation, estimer quelles sont les chances de réussite, préparer le terrain pour des recherches tant sur le plan scientifique qu'économique et développer certains aspects commerciaux tels que la production de semences.

Les difficultés qui se posent dans les premiers temps sont plutôt dans le domaine de l'exploitation qu'un manque de données et dans la nécessité d'assurer une continuité dans les sites d'expérimentation et dans le personnel.

Original: Anglais

FIN

16

VUES