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Applicability of the medic-barley system under Cyprus conditions

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SUMMARY - Adoption of the annual medic cropping system in countries of the Mediterranean region has been pursued by FAO since the early 1970s. A six-year study (1987-1993) was conducted to examine the residual effect of annual medic (*Medicago truncatula*) on subsequent barley and the regeneration of medic after barley and in continuous medic pasture. Three treatments, namely continuous barley, continuous medic and medic-barley rotation, with both phases of the rotation present every year, were tested. Establishment of medic without reseeding and barley grain yield were estimated every year. Medic pastures were established successfully in all growing seasons. Productivity of nonfertilized barley after medic was higher than continuous barley only in the last growing season of the study. Soil total N at 20 cm depth, after running the experiment for six years, was 0.105, 0.108, and 0.114 g kg^{-1} in the continuous barley, medic-barley and continuous medic plots, respectively, while soil nitrate was 12, 26, and 25 ppm, respectively. Even though agronomically it was shown that medic have an important role to play in a medic-barley system, under the existing crop and animal management, the system is not feasible in Cyprus.

Key words: Barley, medic, rotation.

RESUME *- "Applicabilité d'un système medicago-orge dans les conditions de Chypre". L'adoption de la culture des luzernes annuelles dans les pays de la région méditerranéenne a été promue par la FAO depuis le commencement des années 70. Une étude qui a duré 6 ans (1987-1993) a été effectuée dans le but d'examiner l'effet résiduel de* Medicago truncatula *sur la culture d'orge suivante et la régénération de la luzerne annuelle après l'orge et le pâturage continu. Chaque année trois traitements ont été comparés suivant l'étape en cours de la rotation : orge en continu, luzerne annuelle en continu et rotation orge-luzerne annuelle. L'estimation du rendement de la luzerne annuelle non réensemencée et du grain d'orge a été réalisée chaque année. Le pâturage de la luzerne a eut lieu avec succès durant toutes la saison de croissance. La productivité de l'orge non fertilisée était plus élevée après luzerne qu'en monoculture, seulement durant la dernière saison de croissance de l'étude. Après les six années d'expériences, l'azote total du sol à 20 cm de profondeur était de 0,105, 0,108 et à 0,114 g kg^{-1} respectivement pour l'orge en continu, la rotation luzerne-orge et la luzerne seule, alors que le nitrate au sol atteignait 12, 26 et 25 ppm respectivement. Bien que, du point de vue agronomique, il a été prouvé que les luzernes annuelles jouent un rôle important dans un système de type ley-farming, dans les conditions actuelles de gestion des cultures et des animaux, ce système est difficilement applicable.*

Mots-clés *: Orge, medicago, rotation.*

Introduction

The medic-cereal rotation system has been successfully employed on the large farms of southern Australia, (Webber *et al.*, 1976). In the early 1970s, there was an attempt to transfer the Australian experience on the medic-cereal system to countries of the Mediterranean region (Carter, 1978). Although it was realized that in each country the system should be modified to match the particular needs and factors involved in the cereal/animal production system of the country (Webber *et al.*, 1976), several factors, particularly management of the system, were not followed, which severely limited its success (Papastylianou, 1993; Riveros *et al.*, 1993).

The first noteworthy effort to introduce the annual medic as a cultivated crop in Cyprus was made by the Department of Agriculture (Extension Service) in 1978. Two 16 ha demonstration plots were sown on hilly marginal land (shallow and stony soil). The land grazing management was not controlled and no seed setting occurred. The pasture was reseeded every year for the whole period of the study (1978 to 1986).

In a second effort, also by the Department of Agriculture, marginal fields of farmers who owned flocks (sheep and goats) were sown. Grazing management was possible and seed setting was successful. However, the farmers reseeded their pasture each year, because seed was provided free of charge by the Extension Services (Papastylianou, 1993). The farmers abandoned the system as soon as provision of free seed was discontinued.

As in Cyprus there were no experimental data on medic pasture regeneration after cereals, or on the effect of medic on the yield of the subsequent barley in a barley-medic rotation system, the present study was undertaken.

Materials and methods

In 1987 an area of one hectare was sown by annual medic (*Medicago truncatula*) using two cultivars, Cyprus and Borung mixed together. The seed rate was 30 kg ha^{-1} and 200 kg ha^{-1} of triple superphosphate (0-48-0) was applied at sowing. In March when plants were at the full pod formation stage, 10 samples were taken at random from 0.5 m^2 areas to estimate dry matter yield. In summer, when all pods dropped onto the ground, the herbage was removed mechanically using hay making equipment. Following herbage removal the number of pods was recorded in 30 soil quadrats (each 30 x 30 cm).

In 1988 the area was divided into eight plots (each 10 x 100 m) to accommodate the following treatments: 1. Continuous barley 2. Continuous medic 3. Medic-barley rotation, with entry phase, so both medic and barley plots were present every year.

The treatments were replicated twice. Each barley plot was divided into two sub-plots to test two N levels (0 and 60 kg N ha^{-1} as ammonium nitrate). Phosphorus was applied to all plots every year at the rate of 100 kg ha^{-1} of 0-48-0. The experiment was continued for five growing seasons, ending with the 1992/93 growing season. In November 1993 from all plots soil samples at 0-20 cm depth were take to test for nitrate and total nitrogen. Barley was shown in plots previously being medic in the medic-barley and continuous medic systems.

Every season the number of medic plants per unit area and barley grain yield were recorded. The medic plots were grazed using sheep from the experimental unit. Animals were introduced into the pasture when medics were ready for grazing, usually in February before flowering, for a few hours every day. Grazing stopped when medic reached the full flowering stage. If there was significant dry herbage it was removed mechanically in the summer. Detailed records on animal liveweight were not kept except in the 1989/90 season.

Rainfall during of the study was 316, 801, 210, 133, 321 and 297 mm for the years 1987/88 to 1992/93, respectively.

Results

The herbage production at the full pod formation stage of the pasture during the establishment year, ranged from 4 to 6 t ha^{-1} dry matter. The composition of the herbage was 60% medic and 40% weeds. At full maturity, when pods and most of the leaves had dropped onto the ground, 2 t ha^{-1} herbage was removed from the paddock. Pod production, which was left on the ground, was 1.2 t ha^{-1}.

In the year following the year of establishment, the dry matter yield of the pasture plots was 2.6 t ha^{-1} with only 20% medic, and this was due to the effect of the very low temperatures on the growth of medic.

In the third year of the study, at the beginning of the growing season the population of medics was 890 plants m^{-2} in the permanent pasture and 840 plants m^{-2} after barley. Grazing started in the middle of March having, 3 sheep in each plot for 7 hours daily, and continued for 44 days. During this period the mean animal liveweight dropped from 65.7 kg $animal^{-1}$ to 60.1 kg $animal^{-1}$.

In the fourth year of the study a serious drought affected the production of both medic and barley. Emergence of medic plants occurred in late February and medic density was initially 800 plants m^{-2}, dropping to 200 plants m^{-2} due to the drought, without significant differences in plant density between permanent pastures and pastures after barley. Grazing was not applied in the pasture because of the limited growth.

In the fifth year, medic establishment was around 350 and 500 plants m^{-2} in pastures after barley and permanent pastures, respectively. Grazing of the pasture plots was done from the middle of March till the beginning of April. Each plot was grazed by 120 sheep for three days, 2 to 3 hours daily.

During the sixth (last) year of the study the dry matter production of the pasture plots was 1 t ha^{-1} and 1.5 t ha^{-1} of medic and weeds, respectively.

In 1988/89 the barley grain yield increased 30% following the nitrogen fertilization. In the subsequent two growing seasons (1988/90) production was very low and the previous year's treatment and nitrogen fertilizer did not influence barley grain yield. In 1991/92 yields of barley were high and mean production increased 30% following nitrogen fertilization, both after pasture and in continuous barley. In 1992/93 crop yields were high. Nitrogen fertilization increased production of grain by 30% and 70% in the two replications of the continuous system and zero and 13% in the two replications of barley following pastures. Production was similar in the fertilized plots of the continuous barley and barley after pastures. The highest grain yield was obtained after medic pasture without any nitrogen fertilization.

In the 1993-94 growing season barley after medic, in the medic-barley system, produced 2.3 t ha^{-1} grain while barley after continuous medic pastures produced 2.8 t ha^{-1} grain. Soil total N at 20 cm depth, after running the experiment for six years, was 0.105, 0.108, and 0.114 g kg^{-1} in the continuous barley, medic-barley and continuous medic plots, respectively, while soil nitrate was 12, 26, and 25 ppm, respectively.

Discussion

The promotion/adoption of the medic-cereal rotation under rainfed conditions in Cyprus will be discussed from two angles: first the functional point of view which examines the effect of medic pastures on subsequent cereal crops and the regeneration of medic after the cereal crop, two aspects which were not tested in Cyprus in the past. The second angle is the applicability of the system under the local socioeconomic conditions and the prevailing farming system.

Dormancy of the medic seed ensures regeneration when drought interrupts seed production or when the pasture phase is interrupted by a cereal crop phase. The critical aspect of the medic-cereal system is the initial enrichment and subsequent maintenance of the seed-bank reserves (Kirchner and Andrews, 1971; McComb and Andrews, 1974). With the present study it is shown that regeneration of medic can be practised successfully in both the medic-cereal system and continuous medic pastures as long as the grazing management of the pasture phase allows the maintenance of the seed-bank reserves.

The positive contribution of medic pastures to subsequent cereals cropping is also well demonstrated in southern Australia (e.g. Puckridge and French, 1983). The present study showed that barley following medic does not always perform better than barley after barley and additional N fertilizer is required. This was shown in the 1988/89 and 1991/92 growing seasons. However, it should be pointed out that the 1988/89 season followed two years of very poor pastures. In the 1989/90 and 1990/91 seasons barley production was very low and influence of the previous crops could not be expected. In contrast to the other seasons, in 1992/93 it was shown that non-fertilized barley after medic pastures performs better than barley after barley, but the productivity of the two systems is similar when adequate nitrogen fertilizer is applied. It should be noted that in the 1992/93 season the production was high and followed a good growing season for medic.

Although the functioning of the system was shown to be possible the applicability poses problems under the socioeconomic and farming conditions of many countries typical of the West Asian and North African region (Riveros *et al.*, 1993). For Cyprus, the applicability of systems involving medic pasture is also not possible at present. In addition to reasons such as bio-environmental technical, socioeconomic

and technological constraints, which were reviewed by Riveros *et al.* (1993), the farming system and the small size of the farms are additional constraints in the case of Cyprus.

The farming system, and particularly animal production in Cyprus, differs fundamentally from that of Australia. Sheep and goats are milk producing animals and are kept under an intensive management system. Grazing takes place rarely and not far away from the folds. Stock-keepers usually are not land holders or have or rent limited areas near their sheds. Stocking rate and management of pastures can not be controlled under such conditions. Due to the small land ownership farmers prefer the crops which give more dry matter yield and these are barley and common vetch. Dry matter yield of medic is far less than barley and common vetch, and, as long as the grazing characteristics of medic are not important, medic cannot substitute hay-making crops. The reasons which restrict the application of medic pastures in Cyprus were discussed on other occasions in more detail (Papastylianou, 1993).

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