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WORKSHOP

THE NITROGEN CHALLENGE: BUILDING A BLUEPRINT FOR NITROGEN USE EFFICIENCY AND FOOD SECURITY

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GROWTH AND NITROGEN RECOVERY IN THE ABOVE-GROUND BIOMASS OF ELEVEN SELF-RESEEDING ANNUAL LEGUMES GROWN IN A RAINFED OLIVE ORCHARD

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Most of the traditional dry-farmed olive orchards of the NE of Portugal are planted in shallow soils on sloping terrain. The olive yields obtained are usually low, due to the severe environmental constraints under which these orchards are grown. Growing olive trees in such hard conditions, may recommend the management of the orchards as organic, a low-input farming system from which the farmer profit can arise from the appreciation of the price of the olive oil. The natural soil fertility of these orchards is usually very low, being nitrogen the most limiting nutrient to the growth of the trees (Rodrigues et al., 2011). Objectively, to manage these orchards as organic and to maintain the soil fertility and the tree nutritional status in an acceptable level, there is a single option: the introduction of legume species as cover crops. Legumes can access atmospheric N_2, due to the symbiotic relationship that they can establish with nitrogen-fixing bacteria (Russelle, 2008). In this work eleven self-reseeding annual legumes were introduced in a rainfed olive orchard in order to test their suitability to be used as cover crops. The legume species/varieties were grown as pure stand and managed without grazing, since currently the farmers of the region are not raising animals. Data on dry matter yield, nitrogen recovery and persistence of the sown species are presented.

Materials and Methods

The field trial took place in Mirandela (NE Portugal) in an olive orchard of ~20 years old. The olive orchard is installed in a Leptosol loamy textured, pH acid and low organic matter content. The climate is of Mediterranean type. In the autumn of 2009 were sown the following eleven species/varieties: *Ornithophus compressus* L. cv. Charano, *O. sativus* Brot. cvs. Erica and Margurita, *Trifolium subterraneum* L. ssp *subterraneum* Katzn. and Morly cvs. Dalkeith, Seaton Park, Denmark and Nungarin, *T. resupinatum* L. ssp *resupinatum* Gib and Belli cv. Prolific, *T. incarnatum* L. cv. Contea, *T. michelianum* Savi cv. Frontier and *Biserrula pelecinus* L. cv. Mauro. Seed rates varied according to that recommended for each species/varieties. The area of the individual plots was 49 m^2 (3 replications per treatment). Dry matter yield was determined in May, by cutting the biomass of a grid of a 0.25 m^2. The samples were oven-dried at 70 °C and ground. Nitrogen concentration in the dried samples was determined by a Kjeldahl procedure. Nitrogen recoveries were estimated from tissue nitrogen concentrations and dry matter yields.

Results and Discussion

B. pelecinus cv. Mauro showed very low nitrogen recoveries since the first year due to a very low rate of seed germination. Nitrogen recovery by *T. incarnatum* cv. Contea exceeded 450 kg N ha^{-1} in the four growing seasons. The cvs. of *T. subterraneum* yielded nitrogen recoveries close to 200 kg N ha^{-1} (cvs. of short growing cycle, Nungarin and Dalkeith) and close to 300 kg N ha^{-1} (the longer growing cycle cultivars, Denmark and Seaton Park). The cvs. of *O. sativus* produced higher nitrogen recovery values (~300 kg N ha-1) than *O. compressus* cv. Charano (264 kg ha^{-1}). *T. michelianum* exceeded 300 kg N ha^{-1}, whereas *T. resupinatum* just surpassed 200 kg N ha^{-1}. Most species/varieties reached the higher nitrogen recoveries in the first growing season (spring of 2010). The fourth growing season was also good for several species/varieties whereas the third was the worst for all of them.

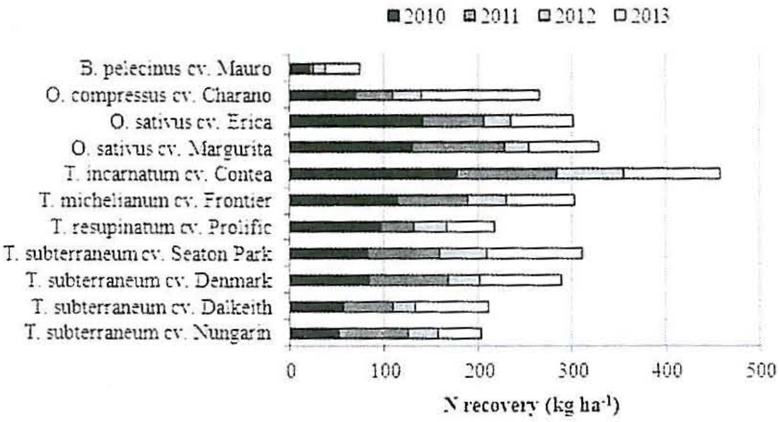

Figure 1. Nitrogen recovery in the above-ground biomass of eleven legume species/varieties grown in pure stands in a rainfed olive orchard during four consecutive growing seasons.

The first growing season was highly favorable to the establishment and growth of the sowed legumes species. Also the absence of grazing allowed the formation of a great seed bank from the first year, leading to a good establishment of the swards in the second growing season. The climate conditions in the second year were not so favorable, with less rain during spring. In the third year, the first big problem occurred. It was observed a false break (germination-inducing a rainfall event late in August followed by death from severe drought during September). The false break associated to the increase in soil fertility, as a result of two consecutive seasons of the growth of the legume species, has created an opportunity for weeds. In the third year the sward appeared dominated by Rattail Fescue (*Vulpia myuros*). At the end of the third year it was feared the end of the sown legumes. The autumn of the fourth year was again very favorable for legume seeds germination and plant growth. In spring 2013, the dominance of most of the sown legume species/varieties was restored. In summary, most species/varieties are able to persist for long-term in this environment. Farmers should chose the most appropriate for rainfed or irrigated orchards taken into account their N fixing capability and the length of their growing cycles.

Rodrigues MA, et al. 2011. Commun. Soil Sci. Plant Anal. 42, 803-814.

Russelle MP 2008. In: Nitrogen in agricultural systems. Schepers JS, Raun WR (Eds.). Agronomy monograph n° 49. ASA, CSSA, SSSA, Madison, Wis., USA. pp. 281-359.