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INRAE, URP3F, 866000 Lusignan, France

The fate of individual plants in a dense stand, whether mono- or multispecific, conditions the persistency and level of production of cultivated species. Growth in monoculture is not comparable to that in mixture, due to the complex interactions (complementarity, competition, facilitation) between neighbouring plants. These interactions, together with the genotype of the plant, influence the final yield of individuals and their status of dominant or subordinate plants.

The present study aimed at analyzing the morphological and genetic evolution of a phenotypically diverse lucerne population. A F1 was grown under different competition conditions: intraspecific competition (pure lucerne), and interspecific competition represented by the mixture with red clover or tall fescue. Our hypothesis was that the future of a plant in a dense stand is influenced by its early morphological traits which condition future interactions with neighbouring plants. We detected genetic markers (QTL) involved in early morphological traits and compared the allele frequency of all markers between the 30% of plants with high biomass yield and the 30% with low yield, in order to determine whether the QTL played a role in the fate of the plants.

Experimental design

Pure lucerne, lucerne-red clover, and lucerne-fescue treatments were studied from May 2020 to October 2021, in 1.2 m^2 trays with a planting density of 400 plants.m^{-2}, in two replications. Early morphological measurements were made at the beginning of the experiments, before any competition between plants was established. The initial rate of leaf emission presented by the number of leaves emitted in the first 12 days, as well as the length and width of leaf number 3 were collected. Dry biomass yield was then collected for the next two years, obtained by drying at 60 °C for 72 h the shoots of each individual plant on all treatments.

QTL detection

With GBS genotyping (genotyping by sequencing), 20 000 SNP markers were obtained, covering all chromosomes. The detection of QTL associated with early morphological traits was carried out with all plants from the three treatments. For leaf emission rate, only one QTL was identified. For leaf length, 5 QTL were detected. For leaf width, 4 QTL were detected. Several QTL are common between

length and width of leaf 3, which may indicate that both traits are controlled by the same genetic determinants.

Effect of QTL on plant fate

The frequency of each marker was compared between dominant (30% highest biomass yield) and dominated (30% lowest biomass yield) plants in the three different treatments ("pure lucerne", "lucerne-red clover" and "lucerne-fescue"). This comparison revealed 1081, 1601 and 997 markers involved in the biomass difference between the two groups of plants in the three treatments, respectively. These markers were located on all chromosomes and were close to or superimposed to the QTL controlling the three early phenotypic traits. This result is consistent with our hypothesis of the role of early growth traits in shaping the fate and size hierarchy of plants in dense stands.

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