ALFALFA SEEDING PATTERNS AND THEIR RELATIONS WITH VEGETATIVE AND REPRODUCTIVE DEVELOPMENT

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ABSTRACT

This study was conducted to understand how plant density (17, 61 and 89 plants m^{-2}) and row spacing (30 and 90 cm) affect plant development and the consequences on potential seed yield (PSY) and agricultural realized seed potential (ARSP) of alfalfa (*Medicago sativa* L.) in south Brazil. Both variables were not affected by row spacing but were negatively correlated to plant population. This was a consequence of a higher allocation of assimilates to reproductive structures at low plant competition, denoted by a positive correlation between these two variables and reproductive parts growth rate. Despite the benefits of the low plant population on the PSY, uncontrolled factors limited LAI development, and consequently vegetative and reproductive plant growth periods, affecting ARSP. The phyllochron was not affected and leaf duration limited LAI probably due to high relative humidity and temperature.

KEYWORDS

Alfalfa, plant population, row spacing, dry matter, LAI, phyllochron, seed potential, seed yield

INTRODUCTION

Alfalfa is the main forage legume grown economically for hay in Rio Grande do Sul (RS), Brazil, but the lack of a continual supply of seeds limits the improvement of the actual cultivated area. Local alfalfa seed yield has always been low (around 100 kg/ha), unreliable, varying between sites and seasons. Since seed yield is a function of seed yield per plant and plant number, then different row spacing and plant densities are factors governing seed production by altering microenvironment and light competition.

This research was designed to determine the effects of row spacing and plant density on the vegetative and reproductive development and their consequences on the potential seed yield (PSY) and agricultural realized seed potential (ARSP) of alfalfa cv. Crioula.

METHODS

The experiment was carried out at the Estação Experimental AgronÙmica, Universidade Federal do RS, located in Eldorado do Sul (30oS, 51oW), Brazil, from September 7, 1992 (seeding), to January 18, 1993 (seed harvest). Climate is humid subtropical with hot summers (Cfa -Köeppen), annual rainfall of 1400 mm, but short-term droughts in spring-summer can occur. The soil is a lateritic hydromorphic, Plinthaqualt (Plinthosols) type, with a sandy texture. Soil deficiencies were corrected by adding limestone and fertilizers according to soil analysis. A split plot experimental design was used with four replicates per treatment, 30 and 90 cm between rows in the main plots and 17, 61 and 89 plants m^{-2} in the sub-plots.

Samples were taken weekly to evaluate evolution of dry matter (DM), floral organ dry matter growth rate (FGR) and leaf area index (LAI). Also ten plants were sampled to measure the number of nodes (NN) on the primary stem to provide an estimate of the phyllochron (PHY). At seed harvest ten stems were chosen at random from each sub-plot to determine number of racemes $stem^{-1}$ and number of flowers $raceme^{-1}$ (Medeiros, 1995) in order to estimate PSY. Agricultural realized seed potential was obtained by harvesting 4 m of two and four rows in the center of the sub-plots, for the 30 and 90 cm row spacings, respectively.

RESULTS AND DISCUSSION

There was no effect (P>0.05) of row spacing on either PSY or ARSP. Response of these variables to plant density (NP) were expressed by negative linear relationships: PSY = 6404-31.456NP (R^2=0.98) and ARSP = 180.5-1.3376NP (R^2=0.98). The PSY and ARSP were linear and positively related to the FGR (PSY = 2328 + 2498FGR and ARSP = -1.1313 + 115.1FGR with FGR expressed in g/m2/day). This suggests that plants subjected to a lower competition level allocate more assimilates to reproductive structures than other parts of the plant as reported by Weiner (1988). In spite of the benefits of low plant densities on seed yield, the realized yield represented only 1.7 to 2.8% of the potential yield, which was lower than the rate (4%) presented by Lorenzetti (1993). The maximum ARSP (168 kg/ha) was not different from the 178 kg/ha registered by Franke (1993) at the same site with the same cultivar with no limiting soil water and phosphorous availability.

Number of pods per raceme and number of seeds per pod have been reported to be determining factors of low ARSP (Medeiros *et al*., 1996). The low LAI recorded was possibly the primary cause of low DM (Figure 1a) and ARSP, by limiting intercepted radiation mainly in the reproductive phase and consequently carbon allocation to pod and seed development. Several authors demonstrated that maximum light interception in well developed canopies is reached at LAI=3. Analysis of LAI dynamics (Figure 1b) seems that maximum value of 2 was attained only at near 1200 GDD in the narrow row spacing and the maximum LAI at 90 cm was 1.6. Kaithy and Lemaire (1992) observed these values between 400 and 600 GDD and a maximum LAI near 5 at 1000 GDD. These low values were not a consequence of a reduction in the rate of leaf appearance. Figure 2 suggests that up to full bloom stage (1000 GDD) organogenesis was not affected (i. e., the rate of node formation was expressed, for both row spacing, by a unique linear model). Based on this equation (NN=0.00224GDD, Figure 2) the phyllochron (1b) was 45.5 GDD which was near the value mentioned by Nabinger & Fleury (1990). However, the reduction in the phyllochron and the growth rate (Figure 1a) observed in the reproductive period was more pronounced than referred to in the literature and was more noticeable in the narrow row spacing.

Leaf duration was not measured but if we consider that morphogenesis was not affected, the main factor affecting ARSP was precocious leaf senescence. Factors affecting leaf life span during vegetative and reproductive phases, such as temperature, water uptake, N nutrition and disease need further study to provide a better understanding of the controlling mechanisms of alfalfa crop development in this particular environment.

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Figure 1

Acumulated dry matter yield (DM) (**a**) and leaf area index (LAI) evolution (**b**) of alfalfa c.v. Crioula as function of growing degree-days GDD).

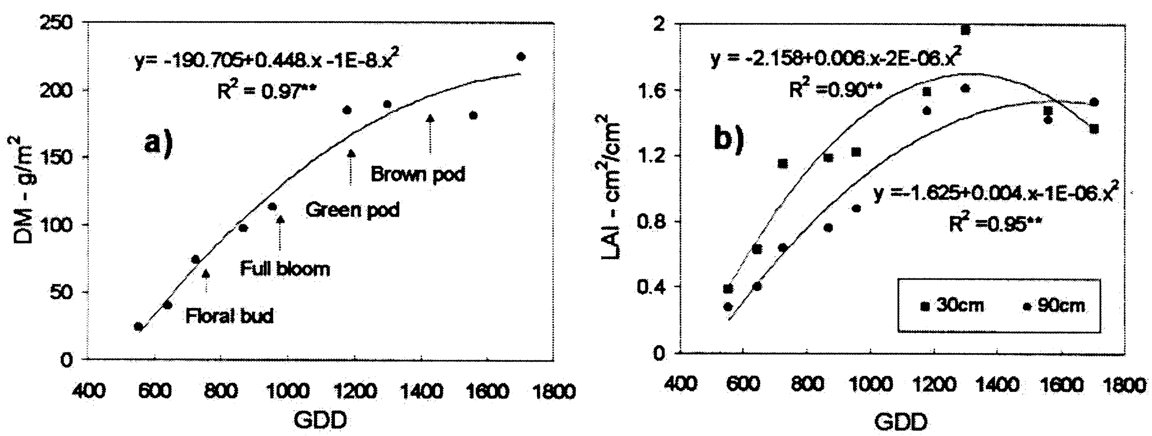

Figure 2

Number of nodes of the primary stem of alfalfa cv. Crioula during vegetative and reproductive phases.