ALFALFA BREEDING PROGRAMS FOCUS ON GRAZING AND SUSTAINABLE SYSTEMS

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INTRODUCTION

Alfalfa is a perennial forage legume grown over 32 million hectares worldwide (Cash, 2009). Nowadays in Argentina about 3.7 million hectares are stablished in a wide range of environmental and soil conditions. About 60% corresponds to alfalfa sown in pure stands and the last 40% in mix with different temperate grasses. Generally alfalfa in pure stands is mainly used in dairy farms, hay or silage systems; on the other hand when it´s mixed with grasses is mostly used in beef cattle production. (Basigalup, 2017). When the system of alfalfa utilization is analyzed the data shows that 75% is used in direct grazing by animals and the 25% rest (nearly 900.000 hectares) are under cutting system.

Alfalfa provides herbage of consistently high nutritive value (Gierus, 2012). These characteristics result in higher quality and stability of herbage production compared to other perennial species (Mills,2015). Lucerne crops also support a series of additional agroecosystem services. They provide significant nitrogen (N) inputs via biological N2 fixation. At a rate of 20–25 kg N t DM, depending on soil fertility (Lüscher, 2000), Alfalfa crops can fix up to 500 kg N ha yr1 (Berenji & Moot, 2015). The alfalfa root system is also known to increase soil organic carbon content and the size and stability of soil aggregates (Angers, 1992).

Since the alfalfa introduction in the region, there has been important advances in breeding programs and local selections of cultivars with better environmental adaptations and outstanding disease profile, being the last characteristic the most important one that was able to achieve better dry matter productions and good persistence. However traditional breeding programs are focus on targets related to higher yields and good disease profile under cutting systems. In this case alfalfa is harvested with machinery under a frequency (depending on the season) of 10% flowering or 5 cm basal regrowth from the crowns in order to achieve good balance between dry matter production, and quality; and to not compromised root reserves (Carbon and nitrogen). In such situations the alfalfa plants are always in comfort (energy balance and optimal photo assimilates partition to all plant´s structures) reason why persistence is not been challenge.

The current situation of Argentinian dairy systems that graze alfalfa in the country tend to enter into the paddock in early stages of the crop development to maximize animal product and avoid higher cost due to mowing residuals after grazing. Something similar happens in the beef cattle production, perhaps in lesser degree when animals graze the same paddocks for long periods of time (more than 7 days) so a reduction of persistence and productivity can be expected (Basigalup et al., 2007), particularly in subtropical regions where the growing rates are high. This is because regrowth from the crown (new growth) can be removed by the animal, forcing

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the mobilization process to restart and depleting root reserves (Moot et al., 2003). Another important example of animal´s negative interaction is plants looses due to animal traffic and the damage done by hooves. These specific field conditions results in lower alfalfa´s persistence and the paddock is usually used during 2 years and over sown in the third year with alternative grasses as bromus sp to maintain productivity. An important solution to this problem can be approach by implementing adequate management practices: (frequent grazing during spring and summer to optimized live gain weight and proper rest in autumn to replenish crown and root reserves to guarantee stand persistence). However, this management should be supported from breeding programs to maximized global result of genetics interactions between environmental conditions and used conditions to achieve productive and sustainable alfalfa stands (or pastures). (We need to consider that management practices are not always easy or practical to implement for all the farmers due to specific conditions (scale, knowledge, climate conditions, etc). In the light of the aforementiones reasons, Argentinian´s breeding programs should be focused on developing grazing tolerant alfalfas.

MATERIALS AND METHODS

In our research and breeding stations placed in three contrast environmental condition of Argentina (Pergramino (PE), Pozo del Molle (PM) and Trenque Lauquen (TQ) alfalfa´s population are sown in dense swards plots and in a spaced plant block nursery . After 4 years of frequent and heavy grazing (8-10 nodes development stage in the main stem after regrowth and no residuals left during the hole year around) survival plants are collected under a selection pressure of 1,2% (i.e. 60 plants of an initial number of 5000 spaced plant block). These recurrent phenotypic selections are also based in data recorded during the years (% of persistence, total forage yield KgDM/ha, environmental adaptation and disease profile) that allows to synthetize new cultivars with improved agronomic traits. Selected genotypes are included in the polycross cage (Syn 0) and harvested seed are proportional bulk to participate in agronomics trails or to be part of another selection cycle (i.e. to roguing out of type, phytosanitary selections or improve forage yield in a specific season of the year).

Two main projects currently working:

- Grazing tolerant Non dormant Varieties: mainly focused to develop cultivars in central region ofArgentina (Santa Fe, Cordoba, San Luis and north of Buenos Aires provinces)
- Grazing tolerant Dormant Alfalfa varieties: mainly focused to develop cultivars in Central andsouthern regions of Argentina (Buenos Aires, La Pampa, San Luis and Rio Negro provinces). In this case wehave to highlight the importance of selecting genotypes that grow and persist well in competition withdifferent grasses (tall fescue, phalaris, orchadgrass, etc).

IMPORTANT TRAITS UNDER GRAZING SELECTIONS

Long term persistence: Important genes that codified for survival under heavy animal grazing. Large and deep crowns with adequate reserves partition to root.

Long term yield: data analyses must show excellent forage potential yield when is compared in the first and second year since establishment compared to top cultivar on the market, regardless the selection genotypes maintain yield through the remaining years of the pasture.

Plant structure: short and many grown up points that guarantee constant photosynthesis under frequent and heavy grazing to depend less on constant carbo hydrates metabolism coming from the root and crown. Leafy plants from the bottom of stem and fast recovery after grazing.

Grazing phenotype: compact strata, shorter internode length to improve leaf/steam ratio. Higher number of stem per plant to maximize dry matter production in a shorter and dense canopy. Genotypes with this plant structure could improve dry matter intake when grazing management is not adequate (i.e. 10% flowering development stage to enter in the paddock or more than 3 ton dry matter availability).

RESULTS AND DISCUSSION

To evaluate the new selection in non-dormant alfalfa's varieties agronomic trials were sown in 2018 and 2019 in two different sites in Argentina, with 3 replicates each in a Randomized complete Block Design. Frequent defoliation management was applied at all sites (grazing starting at 8-10 nodes per stem year-round); PE site was defoliated with sheep and Pozo del Molle (PM) with dairy cows. Soil Cover (%), Dry matter production (Kg/ha), and plant height (cm) were registered. ANOVAs was used to analyze differences in dry matter production (yearly and total production) and soil cover percentage. Tukey tests were used to determine the extent of variation between different levels of a factor when the ANOVA was significant ($\alpha = 0.10$).

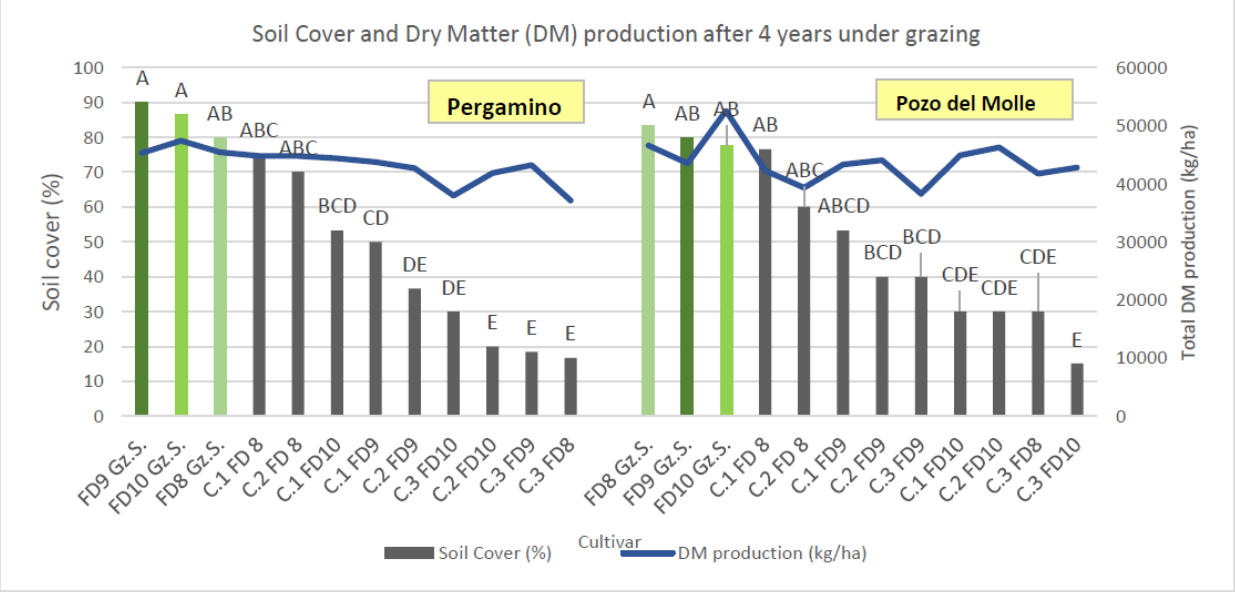

Figure 1. Soil cover () after 4 years in two localities in Argentina and total dry matter production (), 38 cuts in each site. Different letter means significant differences between varieties. Gz.S: Grazing selections. C: commercial checks. Fall dormancy (FD) 8, 9 and 10.

CONCLUSION

High differences in persistence under frequent and direct grazing were observed on the Gz.S, maintaining or increasing forage yield. After four years of experimental data, alfalfa lines which had been selected under frequent and direct grazing had higher persistence (85%) than those without grazing selection. This highlights the importance of breeding programs conducted under grazing when that is the ultimate use that will be given to such cultivars. For Argentinian´s grazing system is more relevant to reach a productive fourth or fifth year rather than a small increases of forage yield in the first or second year (economically, productively and environmentally). Combining breeding programs and proper management practices is a way to increase productivity and utilization of grazed alfalfa farms that may offer an opportunity for more sustainable, productive and financially resilient beef and dairy farms.