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Performance of alfalfa (*Medicago sativa* L.) populations to salinity stress under field condition in a semiarid environment

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The identification and evaluation of an alfalfa population with improved salinity tolerance on the field would provide some tools for dealing with salt stress. Screening populations in the field is difficult due to the high heterogeneity (spatial and temporal) of saline soils. However, some statistical techniques can analyze the results trying to reduce the error variations and increase detection of varietal differences. In addition, the use of the electromagnetic induction instrument (EM-38) can rapidly map soil properties relevant to salinity with less cost compared to the number of soil samples needed. The instrument measures the apparent soil electrical conductivity (EC_a) which could correlate with the electrical conductivity measurements in the laboratory from selected samples taken in the field. Therefore, the objective of this study was to evaluate different alfalfa populations on the field using the EM-38. The climate is semi-arid type, the average annual temperature min-max, and precipitation during the experimental period (May 2019-March 2021) were 12.3 - 28.6°C and 560 mm, respectively. The soil is classified as haplustol torriorthentic texture silty loam. As first step, a large saline area located in Santiago del Estero, Argentina (28º 01'00" S, 64º 13' 00" W) was mapped using the EM38 instrument (horizontal and vertical orientation, EC_{ah} and EC_{av}), which helped to locate the experimental site with the least heterogeneity. Then, using the EM38 readings, seven contrasting sites were selected and soil sampling (deep: 0-30, 30-60- 60-90 cm) were taken to measure the soil electrical conductivity (EC_{ex}, $dS.m^{-1}$) and pH. The pH was 7.10 and the EC_{ex} average of the soil samples (deep: 0-30, 30-60- 60-90 cm) were: 5.01, 9.40, and 19.22 on May 2019 -after rainy season. We estimated the EC (EC_{es}) for each plot using an adequate linear regression between the average EC_{ex} (0-90 cm) and EC_{ah}.Twelve alfalfa populations (including varieties, bred populations) from different origins: Ameristand801S, Salado, Sardi, Chenini, MS0036, MS0037, MSI0038, Monarca, ProINTA SuperMonarca, Salina, Salinera INTA, Kumen PV INTA were sown in May 2019, directly on the saline soil. Freshwater irrigation was applied as needed during establishment and, later on, plants were irrigated for maintenance only. Three replications of each population were planted in a Latinized Row-Column design (4x3). Fifty-five plants were kept on each plot (1 m^2) after the first cut (discarded). We studied and evaluated comparatively the performance of aerial biomass and survival. The total shoot fresh weight and dry weight (DW) per plot (TBplot, $g.m^{-2}$) were registered during 14 cuts. The total biomass per plant (TBplant, g DW) was estimated as a ratio between the shoot biomass and the number of plants of each plot at each cut, due to the decrease in the plant density over time. The relative survival (S, %) by cultivar was estimated as a ratio between the final and initial plant density. On Dec. 2020 -before rainy season-, new readings with the EM-38 were done and other seven contrasting sites were sampled to measure EC_{ex}. The average EC_{ex} for each depth was 32.44, 26.20, 22.96 dS m^{-1} respectively. New linear regression was used to estimate the EC (EC_{esh90}) for each plot using EC_{ah} readings. The data were subjected to analysis of variance using the generalized linear mixed model including population as a fixed factor while column and row as random factors, and the EC_{esh90} as a covariable. Population means were compared using the LSD Fisher test ($P<0.05$). The associations of TBplant, TBplot and S with EC_{esh90} were all significant ($P < 0.0001$, n=36) with an association degree $r = -0.65$, $r = -0.80$, $r = -0.81$, respectively. Fig.1 shows the scatter plot exploring the relationship between TBplant and EC_{esh90} with the real average data by population. The populations differed significantly ($P < 0.05$) for TBplant (g) and TBplot (g); for S differed at P=0.06. Our results showed that Chenini accumulated the lowest TBplant and per plot among all populations (also had the lowest S). MSI0037, Kumen PV INTA, Monarca and Sardi had the highest TBplant, and also were in the group which ranked at the top of TBplot among populations. The preliminary results suggest different salinity tolerance among alfalfa populations that lead to changes in total biomass over time regulated by the variance on the biomass per plant and survival. Therefore, due to the perennial character of the crop, it is desirable to continue monitoring, in long term, variables to identify populations with better performance under field conditions.

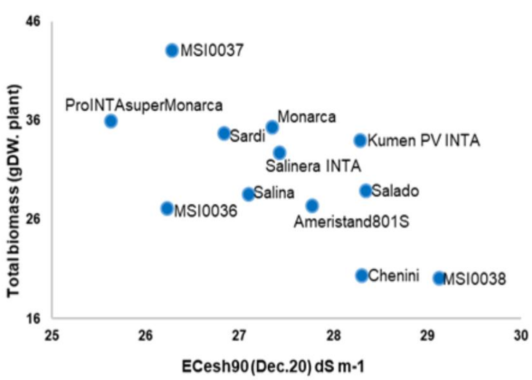

Figura 1. Scatter plot exploring the relationship between variables.