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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.
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 (ECa) which could correlate with the electrical conductivity measurements in the laboratory from selected samples taken in the field.

Materials and Methods

Environmental condition

- Saline area in Santiago del Estero, Argentina
- (28º 01’00” S, 64º 13’ 00” W)
- Climate: semi-arid type,
- Temperature min-max: 12.3 - 28.6°C
- Precipitation (May 2019-March 2021): 560 mm
- Soil: haplustol torriorthentic texture silty loam.

Initial mapping- after the rainy season, May 2019

① a large saline area was mapped using the EM38 instrument (fig.1, 2), which helped to locate the experimental site with the least heterogeneity.

② using the EM38 readings, seven contrasting sites were selected to take soil samples; the average was pH: **7.10** and soil electric conductivity (Ecex): **5.01, 9.40, and 19.22 dS m^{-1}** (deep 0-30, 30-60- 60-90 cm).

Fig.1. EM-38 instrument

③ the EC was estimated (ECes) for each plot using an adequate linear regression between the average ECex (0-90 cm) and ECa from horizontal readings (fig.3).

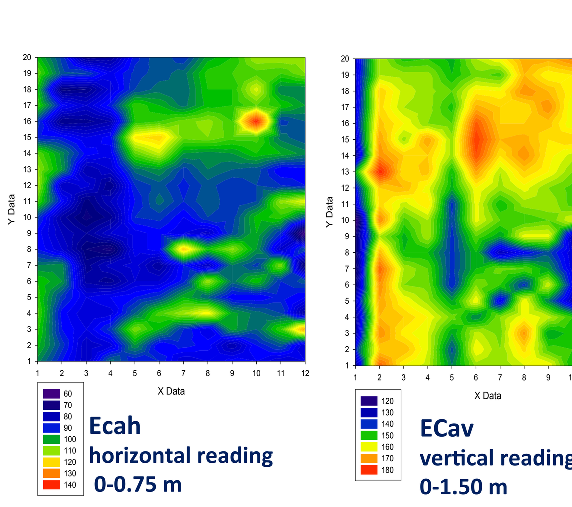

Fig.2. Maps of apparent EC

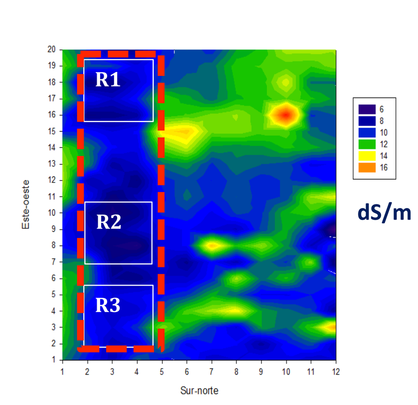

Fig.3. Map of estimated EC with the location of the experimental site selected with three repetitions.

Experimental design

Latinized Row-Column design (4x3), three replications

Populations

Twelve populations from different origins:
Ameristand801S, Salado, Sardi, Chenini, MS0036, MS0037, MSI003, Monarca, ProINTA SuperMonarca, Salina, Salinera INTA, Kumen PV INTA .

Sowing (May 2019)

Fig.4: The seeds were sown directly on the saline soil.

Fig.5: Initial density. Thinning to keep 55 plants per plot (1m^2) before the first cut.

Freshwater irrigation was applied as needed during establishment and for maintenance only.

Evaluations

✓ Total shoot fresh weight and dry weight (DW) per plot (**TBplot, g.m^{-2}**).

✓ Total biomass per plant (**TBplant, g DW**): 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.

✓ Relative survival **(S, %)** by population: estimated as a ratio between the final and initial plant density.

Later mapping- before the rainy season, Dec.2020-

④ new readings with the EM-38 were done and other seven contrasting sites were sampled to measure ECex. The average ECex for each depth was **32.44, 26.20, 22.96 dS m^{-1}** respectively.

⑤ New linear regression was used to estimate the EC (ECesh90) for each plot using ECah readings and ECex (0-90 cm).

Statistical analysis

Analysis of variance using the GLM model including population as a fixed factor while column and row as random factors, and the ECesh90 as a covariable. Population means were compared using the LSD Fisher test (P<0.05).

Results

✓ *Fourteen cuts were done from nov.2019 until march2021.*

✓ The associations of **TBplant**, **TBplot** and **S** with ECesh90 were all significant (P < 0.0001, n=36) with an association degree ***r* = -0.65, *r* = -0.80, *r* = -0.81**, respectively.

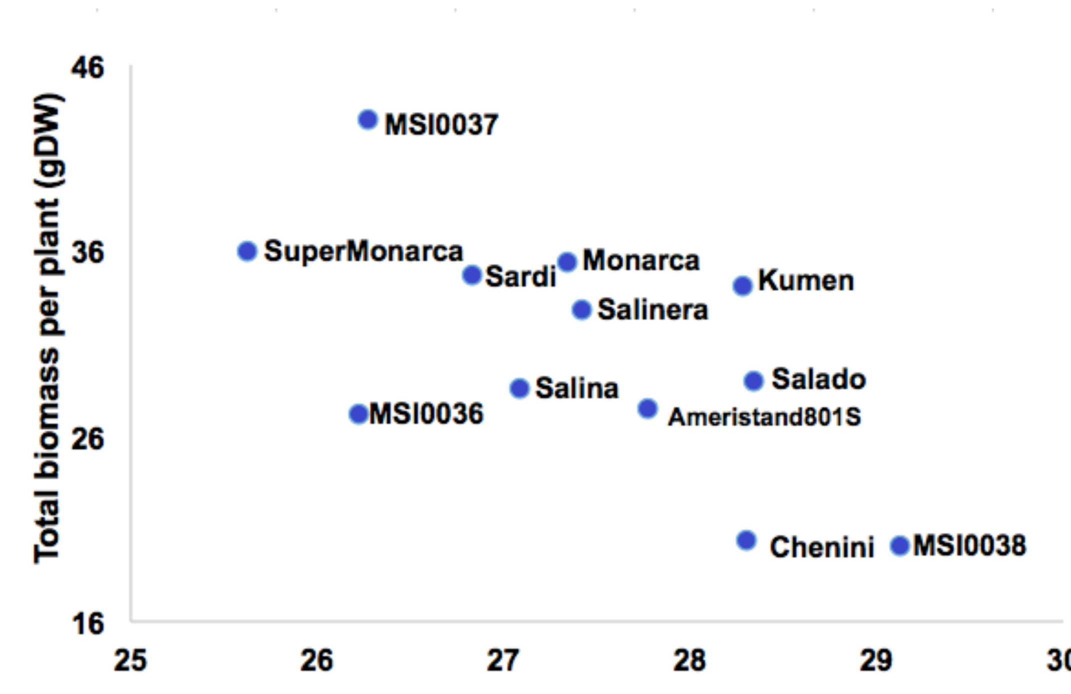

Fig.6 . The scatter plot exploring the relationship between biomass per plant -real average data- and ECesh90 of the plots by population.

✓ The populations differed significantly (P < 0.05) for TBplant (g) and TBplot (g) ; for S differed at P=0.06 (table 1).

Table 1. Tbplant, Tbplot and S for each population.

Population	g. plant*	g. plot	S%
MS0037	41.39 a	1649 a	41
Kumen	35.31 ab	1308 abcd	43
Monarca	35.18 ab	1446 abc	63
Sardi	34.13 ab	1579 ab	65
SuperMonarca	33.49 bc	1267 abcd	37
Salinera	32.94 bc	1494 abc	59
Salado	30.55 bc	1440 abc	69
Salina	28.17 bcd	1095 cd	34
Ameristand801S	27.65 bcd	1137 cd	58
MSI0036	25.67 cd	1133 cd	51
MSI0038	22.55 d	1185 bcd	57
Chenini	21.55 d	925 d	29

*data arranged by biomass per plant from larger to smallest

Chenini accumulated the lowest biomass per plant and per plot among all populations (and also had the lowest survival).

MSI0037, Kumen, Monarca and Sardi had the highest biomass per plant, and also were in the group which ranked at the top of biomass per plot among populations, being MS0037 the population that stand out until now .

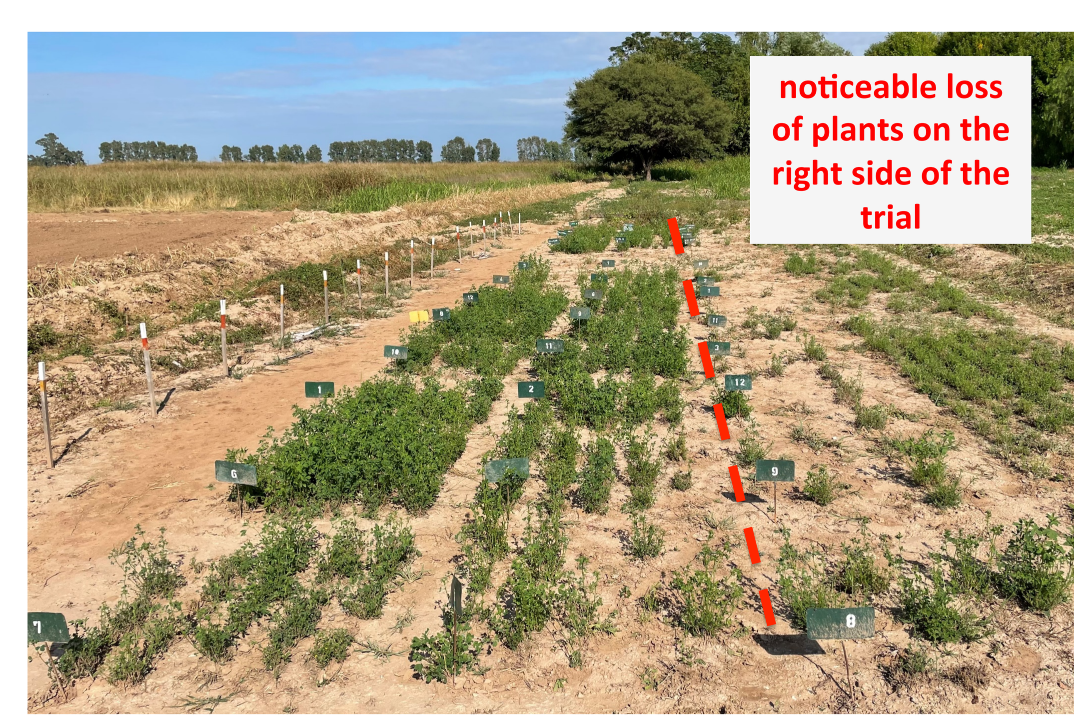

Fig.7 View of the trial after 10 days of the 14 cut. March2021

Conclusions

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.

Due to the perennial character of the crop, and the temporal and spatial variability of the salinity , it is desirable to continue evaluating the variables longer, to identify populations with better performance under field conditions