Growth pattern and survivorship in a tree plantation trial under fog dependent enviromental conditions

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Abstract: In a test-site located in a coastal hill (760 m .a.s.l) in south Perù a set of native (*Caesalpinaea spinosa* and *Prosopis pallida*) and introduced (*Acacia saligna, Casuarina equisetifolia, Parkinsonia aculeata*) tree species were planted in order to check the rehabilitation potential of degraded "lomas" ecosystems. Past and present grazing activities affected the dynamics and structure of such vegetation communities, where fog is the only water resource. The paper deals with survival, establishment and growth of planted trees under different water-supply regimes, and induced micro-environmental modification by tree-shelters. After 18 months since observations began, survival rate is rather high for all tested species, and particularly for native ones under non-watered treatments. Introduced species show the highest growth increment rate. Tree-shelters induce both higher survial and height growth; on the contrary, diameter increment values are lower in sheltered trees. Results outline that, being water use efficiency rather different within the species, selection of tree species for future planting campaign, must be linked to the availability of water support during the early stages of seedlings life. The use of tree-shelters is reccomended in plantation trials in such environment, even if has still to be verified the effect on relatively high water-demanding species.

1. Introduction

Vegetation of the coastal hills (lomas) in the south of Perù is strongly related to the presence of the fog and to the grazing pressure. Different types of lomas vegetation have been described (Keel, 1987;. Pefaur, 1978) included "tree lomas". In the lomas of Mehia present tree vegetation consists mainly of scattered native *Caesalpinea spinosa* (*Ct*) individuals, forming low density groups or savannah-like formations in very few defined sites.

Such woodlands relics, besides showing a high rate of human disturbance (grazing related activities), have an even-age-like structure and no tree regeneration is present (Angeletti, 1997).

In the south Perù fog is present yearly from may-june to november-dicember (Cereceda, 1997): despite the very low rain amount, survival of trees is enabled by the fog water. Fog may be collected by tree crowns and dripped, and/or flowed along the stem to the ground in appreciable quantities even when no moisture is caught by standard rain gauges in open sites.

The general objective of the research programmes is to verify the possibilities of rehabilitation of the "lomas" throught the plantation of trees and shrubs. A set of native and exotic species growing in arid zones was selected and planted in a test-site aiming to verify the following hypotheses:

- young trees take advantage by water supply during the phases of establishment and early growth;
- seedligs can survive and grow under a strictly fog-dependent environment in absence of external water supply, once the seedlings are established;
- survival and growth rate are increased by the modification of micro enviroment by usig plastic tree shelter.

1.2 Materials and methods

The experimental programme was carried out in the field station of *Las Cuchillas*, in the district of Valdividida (La Curva) located at 760 m a.s.l. An area of 42000 m^2 sorrounding the test sites was fenced to avoid injuries by animals browsing. In order to favour the establishment of seedlings, the ground of the test sites was prepared by ripping.

Between June and July 1996, 1296 trees were planted according to a random blocks experimental design. 36 trees per unit plot were planted at a relative distance of 3 by 3 m. Trees species were randomly placed in the frame of the unit plot. 5 tree species were selected (tab. 1), while two cohorts of *Ct*, being respectively 6 and 12 months old were treated as different species. In order to check the response of seedlings to water supply, 3 levels of irrigation time span were selected to test along the experiment duration. The plants were supplied by 1 liter of fog-water per day using a drip irrigation system. In parallel, standard plastic tree shelters were placed to test the effect of micro environmental modification on survivorship, establishment, and

growth. Resulting 5 different treatments per four replications were settled as shown in tab. 2.

Height to the nearest cm and root collar diameter to the nearest mm of all planted trees have been montly measured. During the summer, data collection on survival has been done every 15 days.

Acacia saligna = As
Casuarina equisetifolia= Ce
Prosopis pallida = Pp
Parkinsonia aculeata = Pa
Caesalpinaea spinosa$_6$ = Ct
Caesalpinaea spinosa$_{12}$ = Ct1

Tab. 1 List of tested tree species

Treatment	N. of variants	Type of var.
Water supply duration	3	3 yrs(A)., 2 yrs.(B), control (C)
Tree-shelter	2	presence (A1,B1,C1) absence (A,B,C)

Tab. 2 Experimental design: treatments and variants

1.3 Results

1.3.1 Survivorship

After 16 months survivorship is rather high in all treatments. Is to be taken into account that two fog seasons are included. By considering all treatments as a whole, survival of different species ranges from 69% (*Ce*) to 100% (*Pp*).

In watered plots, death rate tends to zero: 1% of Ct individuals died during the dry season. In non-watered treatments, *Ce* showed the lowest survival rate (22%), while roughly the 80% of the individuals belonging to the other tested species survived.

1.3.2 Height growth

Within the species, *Ce* e and *As* show increment rates significantly different from the other ones. In watered treatments, *Ce* individuals grow more than *As* ones, while the opposite was observed in non-watered treatments (fig. 1).

During the second fog season (from june 1997), all trees show a stasys in height increment, *Ce* excluded. Only in non-watered/tree shelter treatments, growth continue for individuals of all species. The highest average relative increments are shown by Pa (388%) and Ce (285%). Nevertheless, in watered treatments the average relative increment is higher then 100% for all the species (fig. 3).

Tree-shelters induce higher average increase in height: as relative increment, differences are larger in watered treatments. In control plots (non-watered at all), only *Ce* individuals without tree-shelters show a

continuous height increase: increase in height was not observed in seedlings of all the other species(fig. 2).
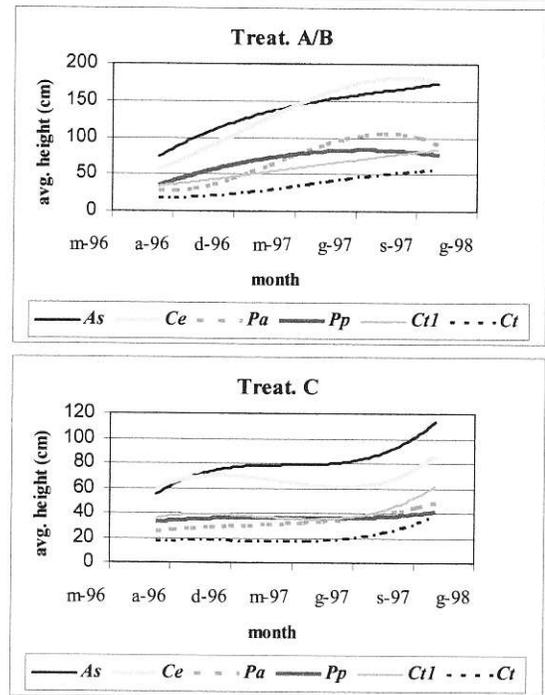

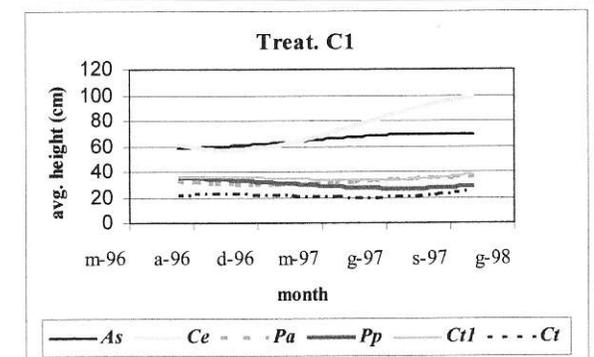Fig. 1 Height growth trends A/B = Watered; C= Control

Fig. 2 Height growth trends in sheltered control treatments

3.3 Diameter growth

The observed growth pattern in height, as resulting from the previous chapter, did not occurred so evidently concerning diameter growth pattern.

Only *Ce* and *As* seedlings show appreciable differences in watered plots, rating in average from 1:2 to 1:4. As sequence of relative average diameter increment (in %), *As* shows the highest one, *Ce* and *Pp* following. *Ct* and *Pa* do not

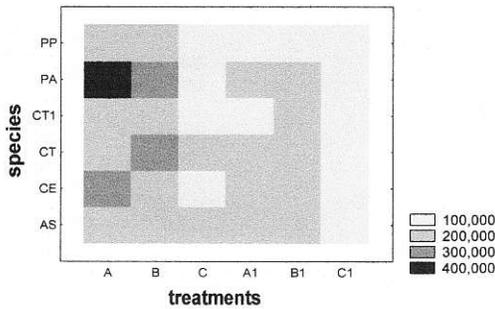show any significant difference between watered and

Fig. 3 Relative height increment (in %)

non-watered treatments (Fig. 4)
As general feature, all species show higher diameter increments in watered/no-sheltered treatments. No significant differneces appeared between sheltered and non-shelterd tratments, *As* excluded.
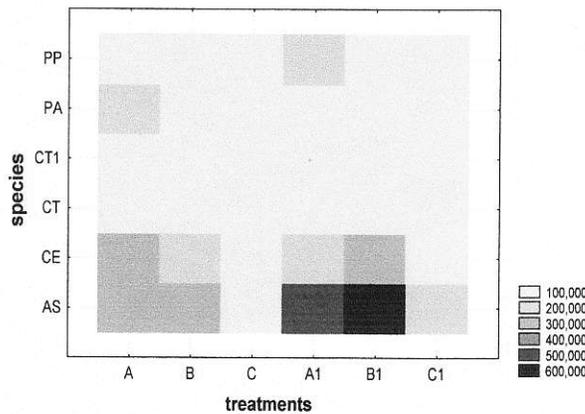

Fig. 4 Relative diameter increment (in %)

1.4 Conclusion and Reccomendation

All the species take advantage from watering in term of survival and growth, but water use efficiency was rather different within the species, and seems to be strongly influenced by the presence of tree-shelters, i.e. by the modification of crown micro-environment.
Death rate was rather low for all species in all treatments *Ce* exclusive , confirming to be the highest water-demanding species within the selected ones.
Referring to hypothesis n. 2, native species, and particularly *Ct*, seem to be able to better cope (and establish and grow) the severe environment even without any water supply.
Within the selected species, *As* and *Ce* gained the

maximum advantage in term of growth from watering: while water supply was stopped in june 1997 and rains due to *El Niño* phenomenon changed the meteorological pattern in the following season, it is still to early to confirm if such advantage will have positive or negative effects in future space occupation and survival.
The presence of treeshelters influences both survival and height growth of seedlings: average height values are higher for all selected species in plots treated by treeshelters, while, on the contrary, root collar dimeter average values are lower.
As general remark, on one hand can be outlined that the bigger the height (by maximising crown parameters), the bigger the fogwater collection ability; on the other hand as the root collar diameter (i.e. root-system growth indicator) doesn't seem to increase proportionally, the derived unbalanced root system/stem ratio could be unfavourable in term of water budget.

1.5 Acknowledgements

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