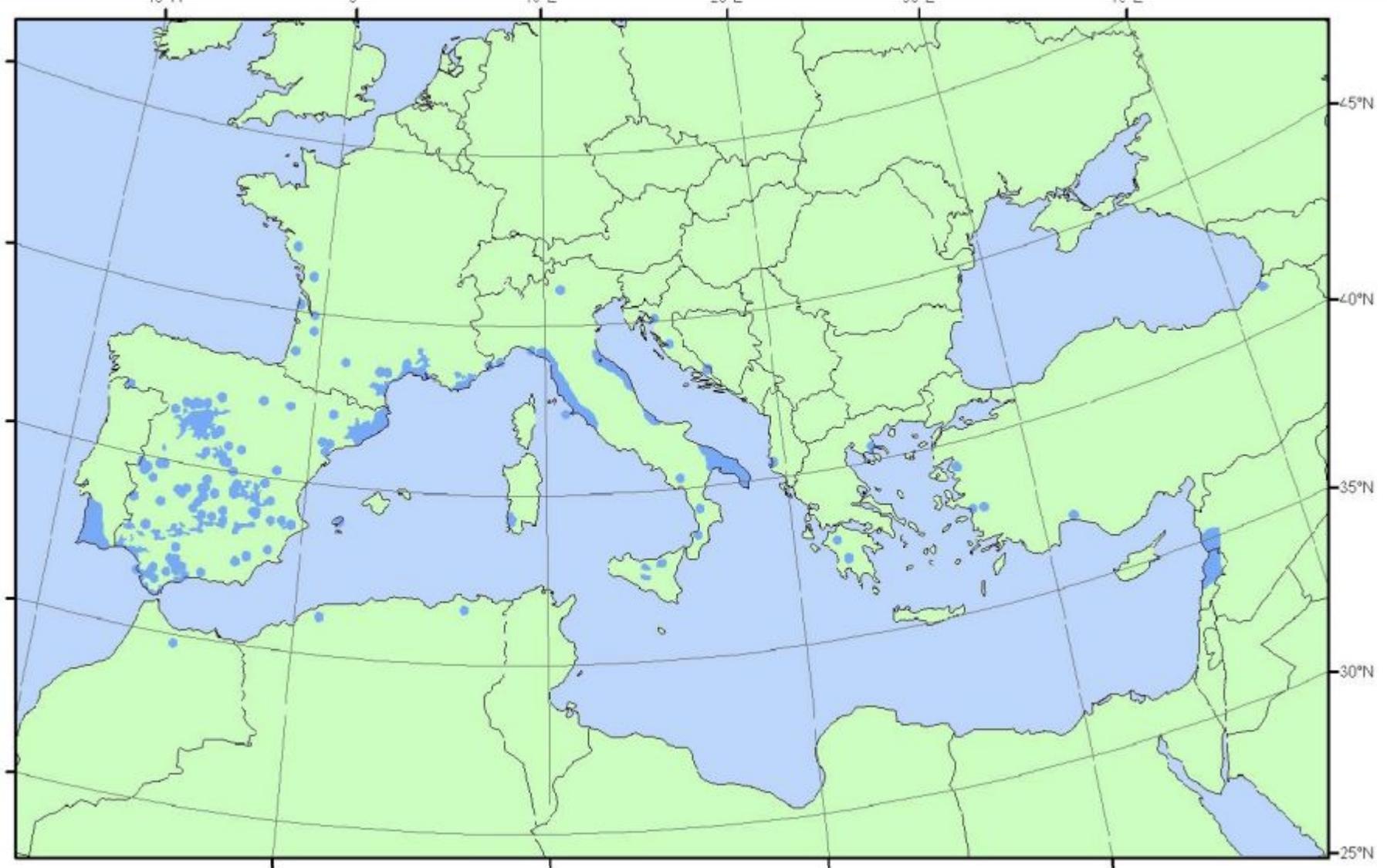


*Influence of stand structure and silviculture practices
on cone and seed production in planted forest
of Pinus pinea in north of Tunisia*

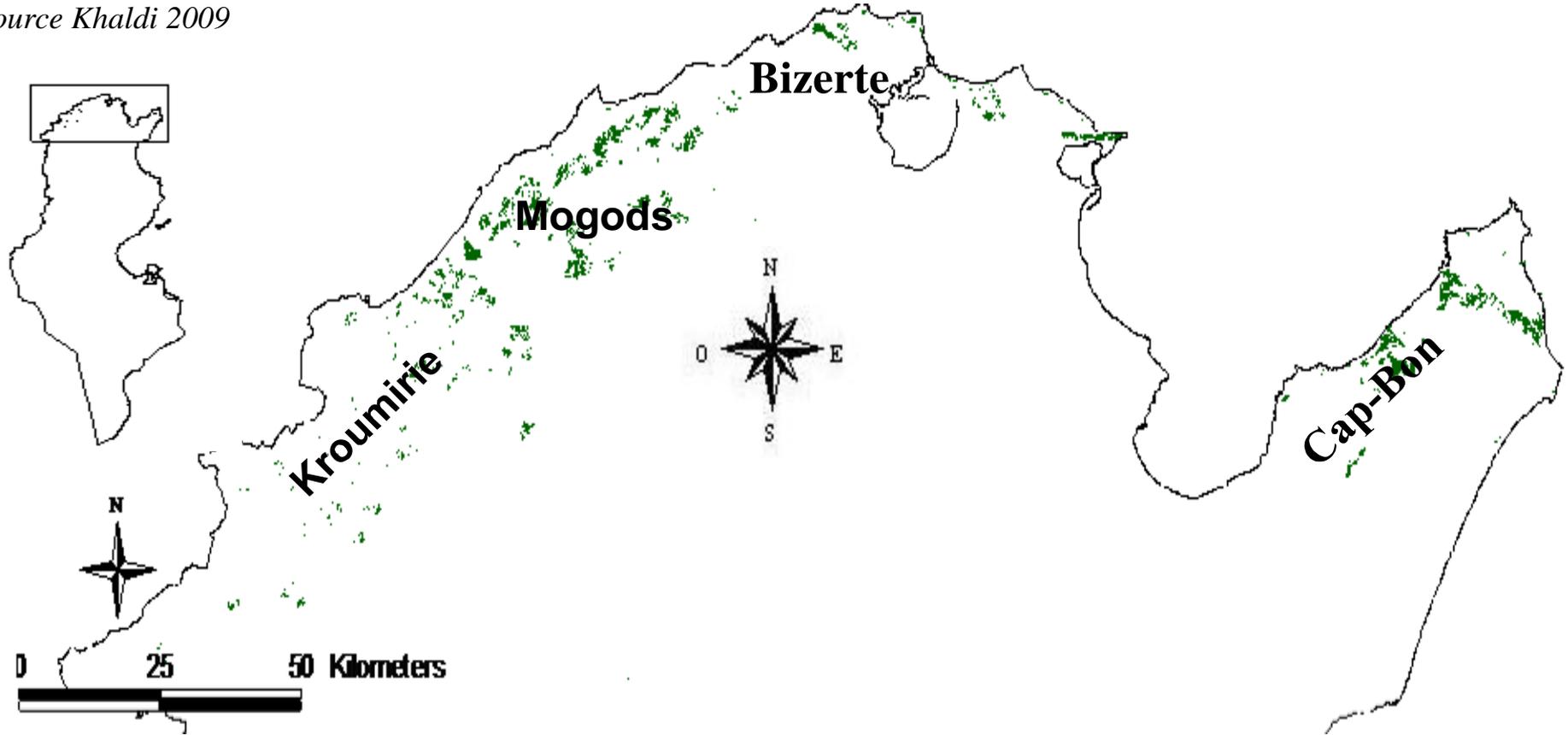
ADILI BOUTHEINA
BALANDIER PHILIPPE
EL AOUNI MOHAMED EL HEDI

Pinus pinea in the world



Pinus pinea in Tunisia

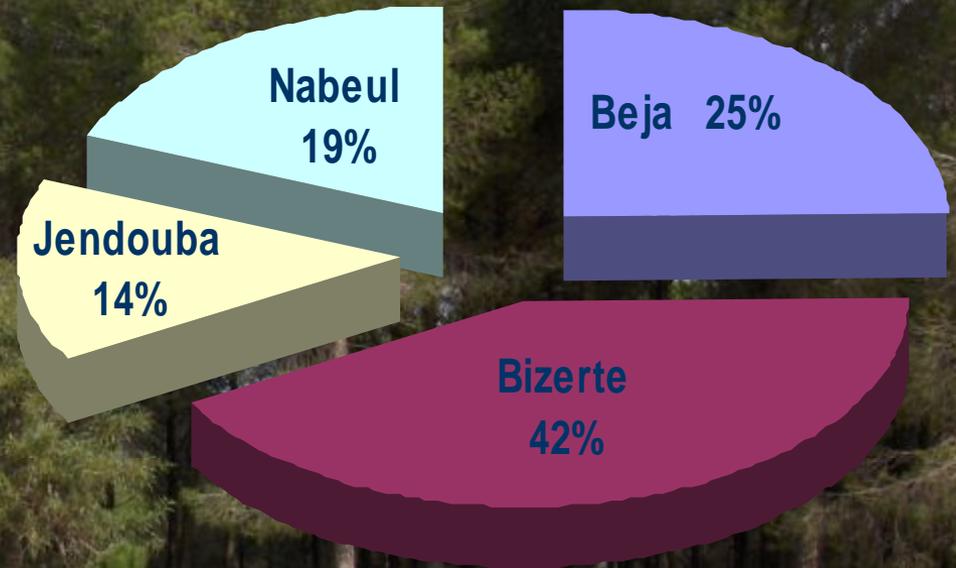
Source Khaldi 2009



**Pinus pinea* was introduced late 19th century along the mediterranean cost line

*It's one of the most valuables species in Tunisian reforestation programs for coastal dunes fixation, economic values (wood production, cone yields: pine nuts and resine).

Stand type	Area (ha)
<i>P.halepensis</i>	363 367
<i>Cork oak</i>	45 461
<i>Tetraclinis</i>	32 884
<i>P.pinea</i>	21 165
Other conifer	3 930
Other	33 485



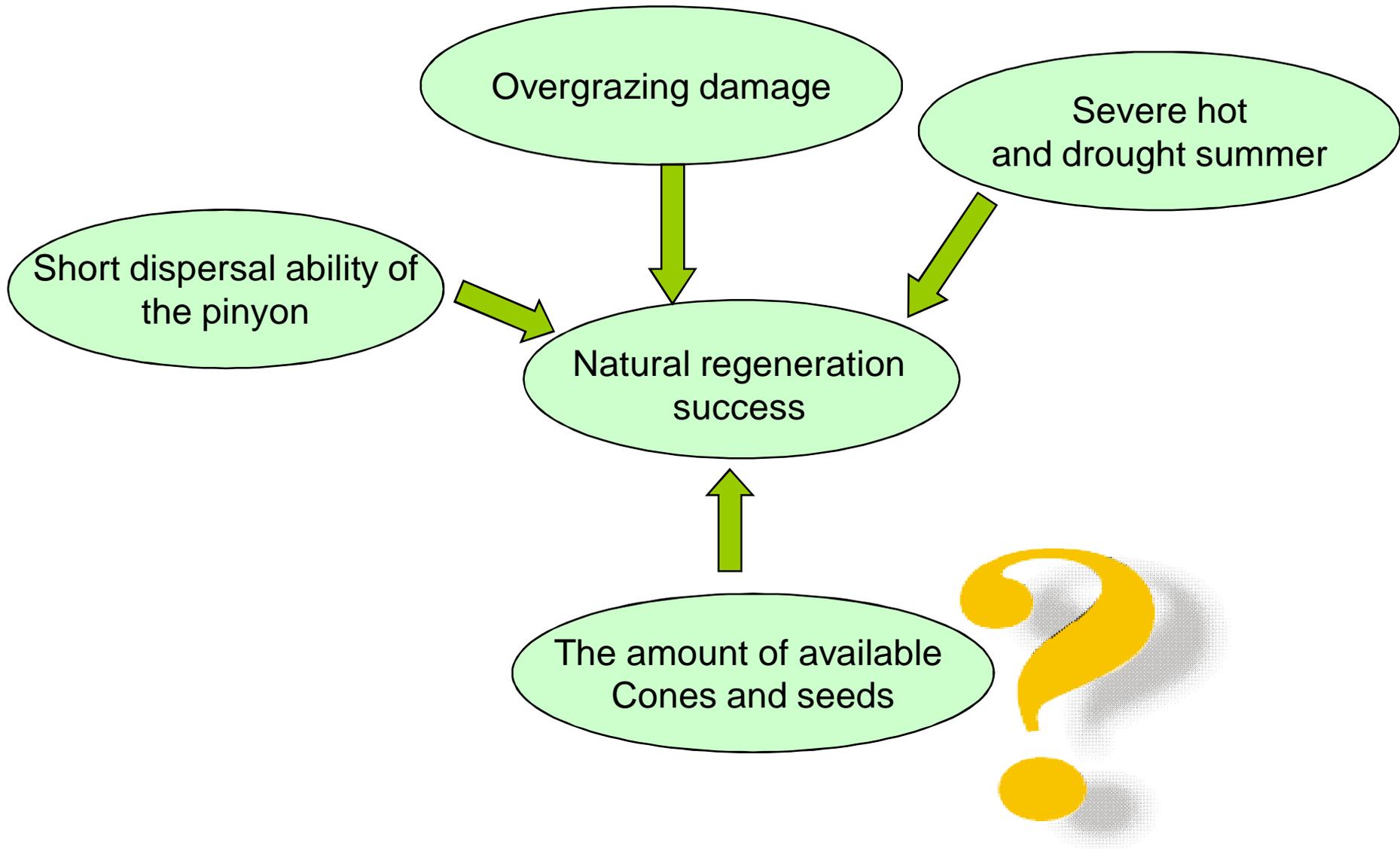
**Pinus pinea* stands are relatively young and oldest do not exceed 90 years

*The age groups most represented in Tunisia, are those 20-30 years and 30-40 years, these 2 classes represent nearly $\frac{3}{4}$ of *Pinus pinea* stand in Tunisia.

*The density of stands is variable from one area to another and has a very great heterogeneity. This density reaches sometimes 3500 trees/ha (*El Khorchani, 2010*).

*The average national production in cones is approximately 1.5 tonnes/ha, the average seed production is $15\text{kg}\cdot\text{ha}^{-1}\cdot\text{an}^{-1}$ with 3kg of pinyons (*Belkhouja, 2001*).

Problematic and objectives

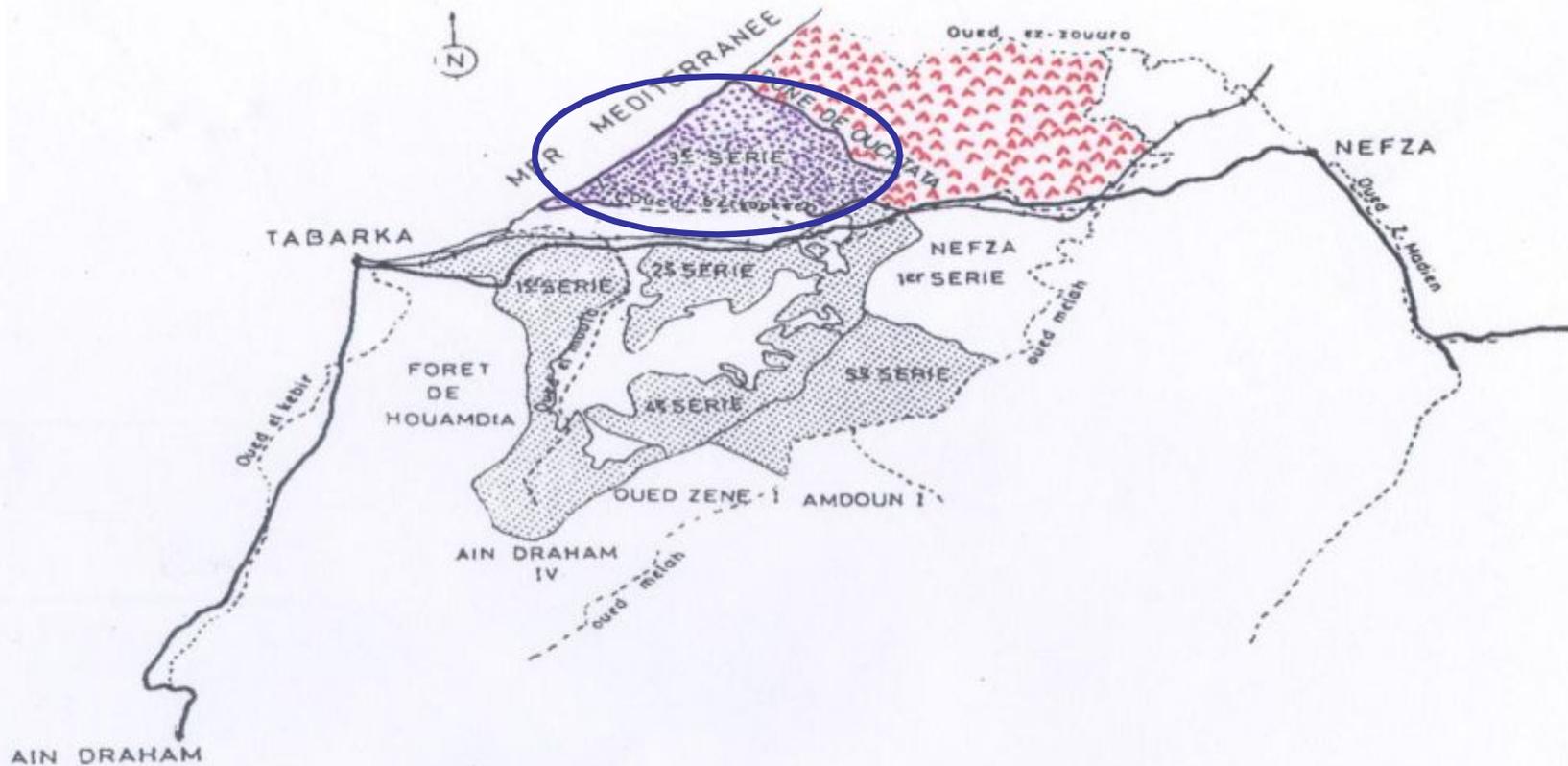


➤ Our objective is to study the effect of stand parameters (DBH, crown volume, stem age, stem density, social status of tree) on cone and seed production and their interaction.



Thus, can help managers to take an appropriate silvicultural practices in order to conserve this important species habitat

Study site



- ✓ Bioclimate: humid (mild winter)
- ✓ Mean annual precipitation: 934mm
- ✓ Mean annual temperature: (Max=23.7°C, Min=13.9°C)
- ✓ Soil: very low organic matter with small quantities of sandstone

Collected data

➤ Diameter at breast height



Stand characteristics

	Mean	Min	Max
Tree diameter (cm)	23.8	6	61
Tree height (m)	12.8	6.2	21
Stand density (n/ha)	462	140	1820
Tree age (years)	37	17	57

➤ Crown diameter



➤ Crown height



➤ Age

➤ The social status of the trees

Collection of the cones

➤ **Healthy cones from each tree are counted and weighed**



*The cones are oven-dried



opened



*seeds are extracted counted and weighed (healthy and empty)

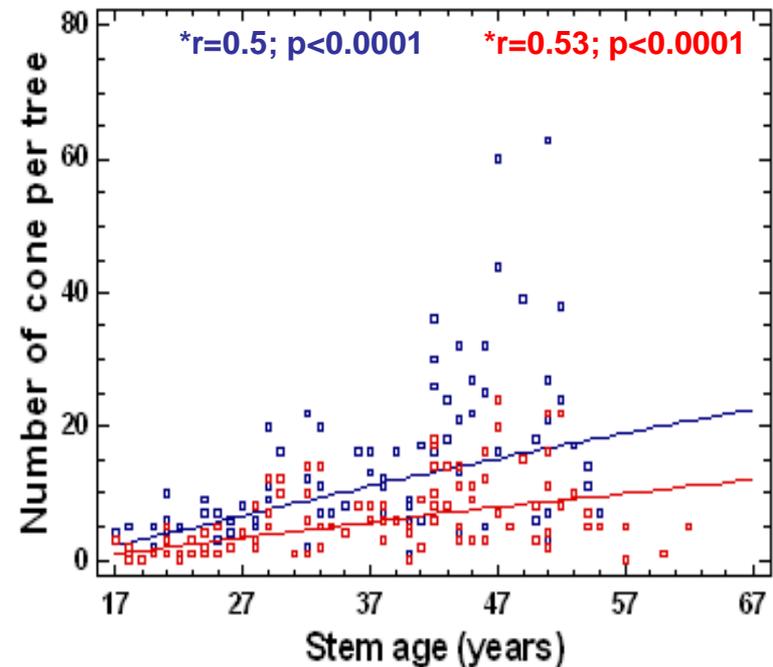
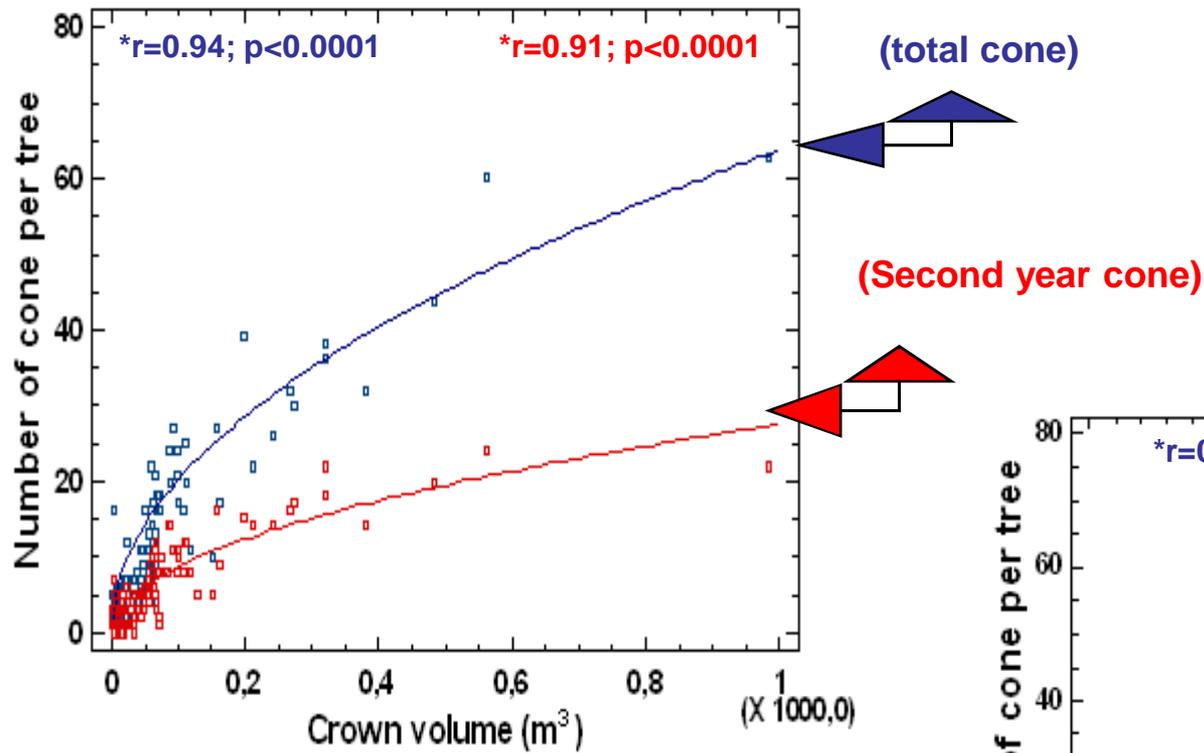


GERMINATION TEST

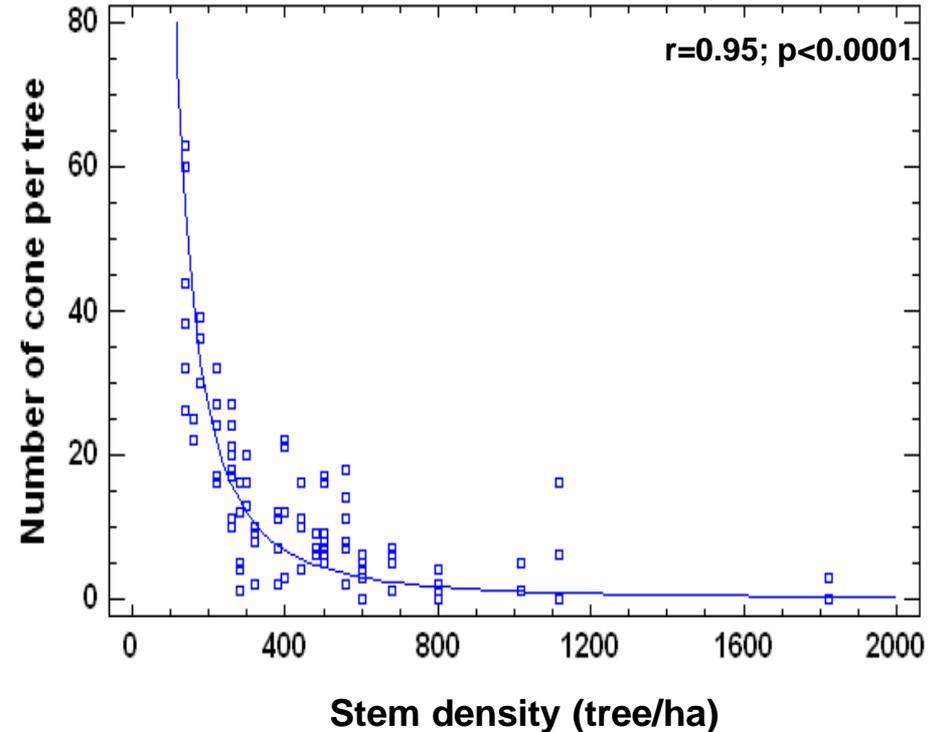
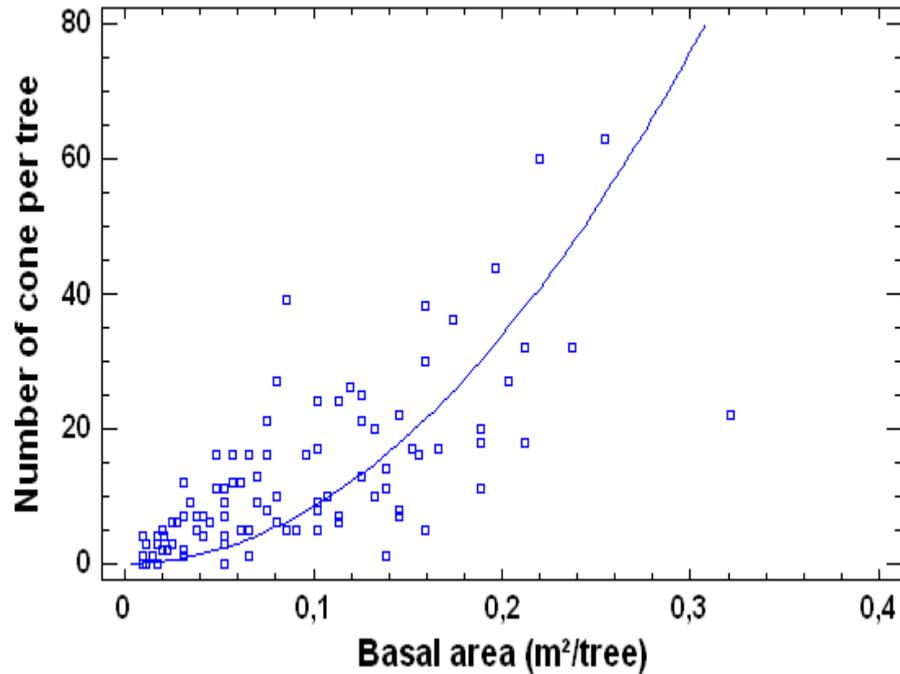
growth chamber

- *Seeds were immersed in water and any floating were removed _
- *a Petri dish with 60 filed seeds was used
- *Temperature and relative humidity were kept constant at 18 °C and 90%

Results

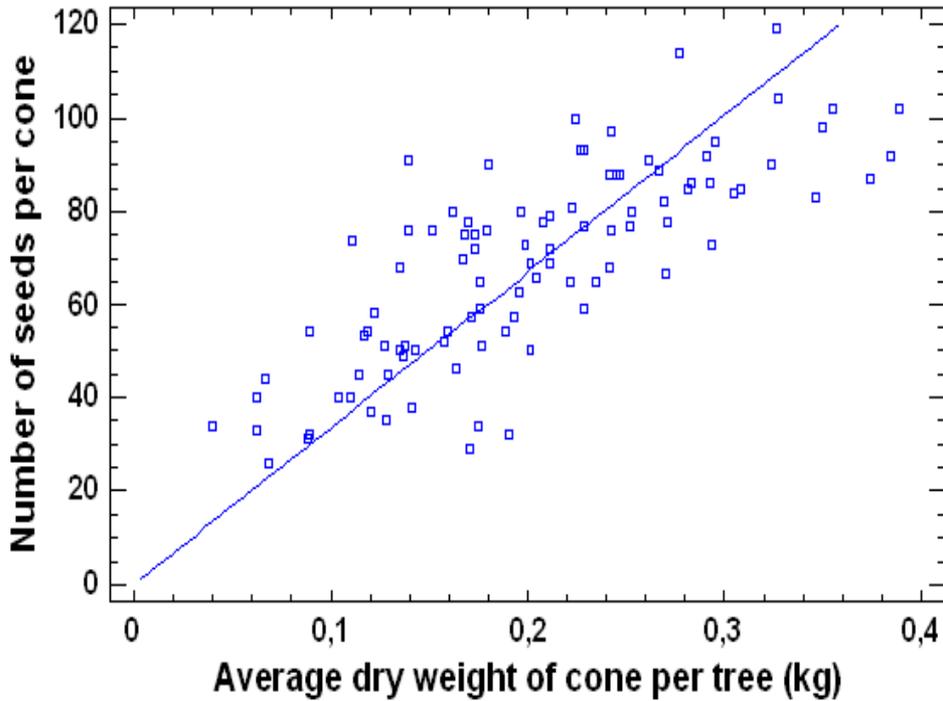


$r=0.91$; $p<0.0001$

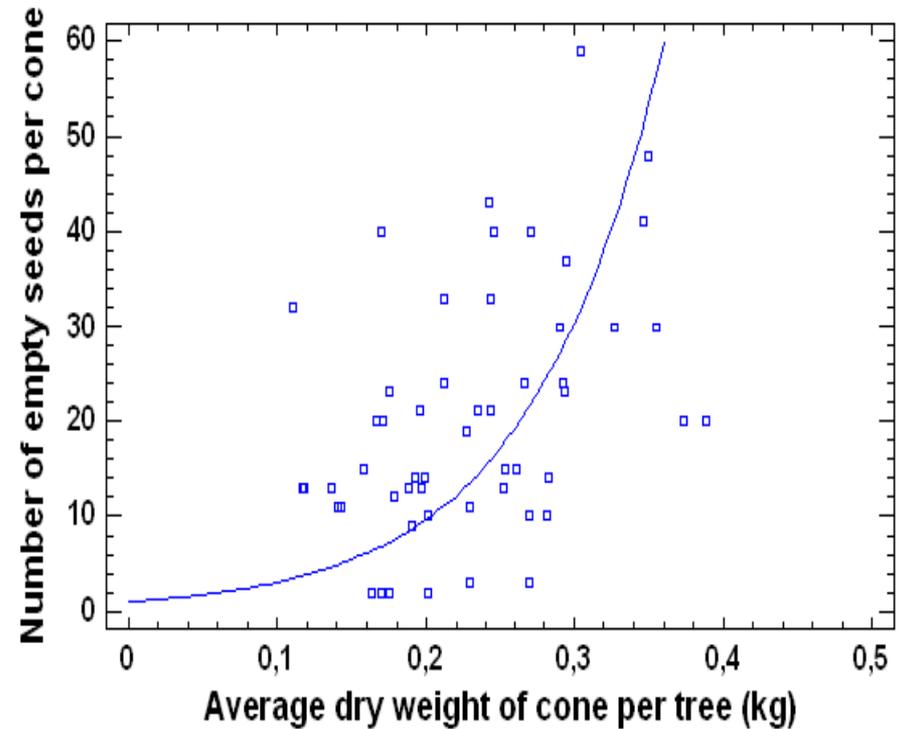


- ✓ Studing Interaction between these factors (crown volme, stem age, basal area, stem density and numbe of cone) show that crow volume is a limiting factor for cone production.
- ✓ Social status of tree (dominant, co-dominant or dominated) is a factor could reducing cone production

$r=0.99$; $p<0.0001$



$r=0.96$; $p<0.0001$



➤ The average percentage of empty seeds per cone is 15%

<i>Stand</i>	<i>Average cone production per tree</i>	<i>Average cone yield per tree (kg)</i>	<i>Average number of filled seeds per cone</i>
<i>Pinus pinea</i> (Mekna)	13	4.2	58

✓ The data shows that the available amount of cone and seeds is very low and it seems unable to secure species regeneration.

➤ The final seed germination percentage was 48.5% , meaning that Mekna forest produce seeds of not high germination capacity (seed germination of *Pinus pinea* in Strofylia Forest is 87.2%).

Damaged cones

✓ Brown color



✓ Small and larger Circular wholes



Alain Roques (INRA Orléans)



Damaged cones are attacked by:

1-*Dioryctria mendacella*



2-*Pissodes validirostris* (pine cone weevil)

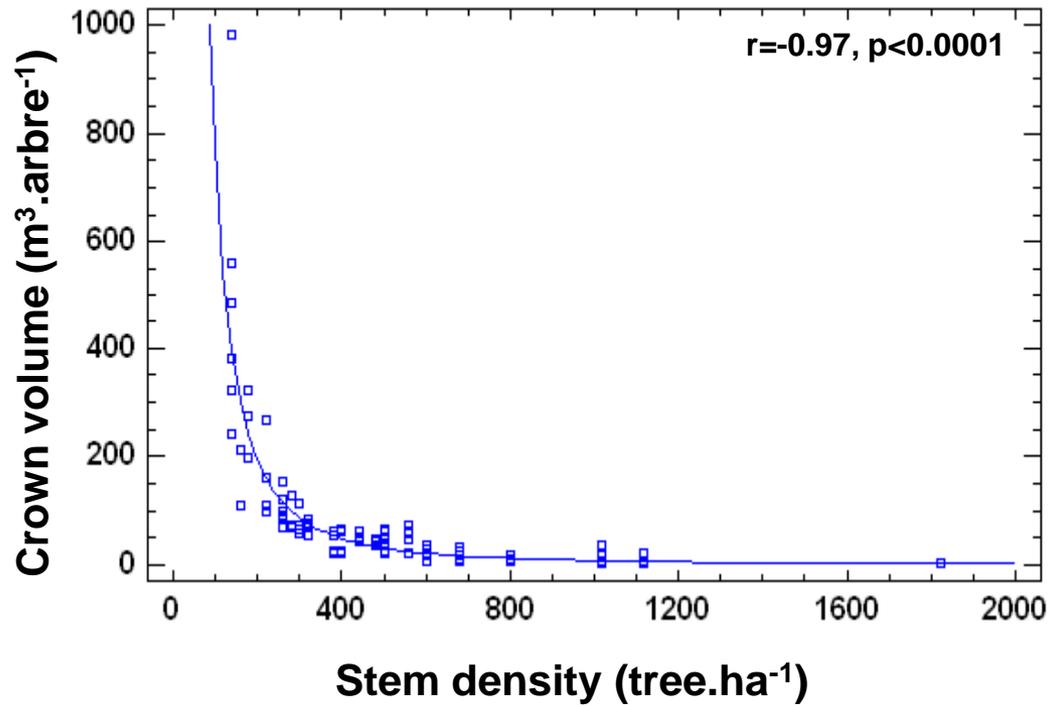


3- Coleopter (*Anobiidae*, genus *Ernobius*)



Conclusions

- Cone and seed production show great year to year variability (long intervals between good seed crops) and are also conditioned by the size of mother tree (age, crown volume and social status of tree) and its health (pests).
- The amount of available seeds depends on the number and size of the cones and the number of viable pinyons within the cones
- Seed production and quality is a limiting factor for regeneration, thus estimate adequately the total number of viable seeds is necessary to ensure regeneration.



✓ appropriate silvicultural practices are needed to ameliorate crown development in order to enhance seed cone production, such as thinning (stands could be maintained at low densities), pruning.

✓ Predicting the total amount of cones and viable pinyons could help the forest managers to identify an adequate year, to permit commercial cone collection with limitation.



Thanks for your attention