THE YIELDING POTENTIAL OF KENAF IN EUROPE

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Kenaf
Hibiscus cannabinus L.(Malvaceae)

- Kenaf is a short-day annual herbaceous crop cultivated mainly for its fibrous stem.
- It has been cultivated long, as early as 4000 BC in western Africa.
- Its area of cultivation is estimated to about 200,000 ha (FAO) and the main producers are Thailand, China, India and Mexico.
- Recent research has demonstrated numerous potential uses for each of the two stem materials (bark or core), which often must been separated.

Reasons for considering kenaf as a high productivity multi-purpose non-food crop for Europe:

- It can provide raw material for both industrial and energy applications.
- The high biomass potential (up to 26 t/ha) and the low inputs of the crop.
- It offers alternative land use and can be used in a crop rotation.
- It is an annual non-food crop with quite similar cultivation and harvest to other conventional field crops.
- It has high farmers perception as an annual crop.

Uses of the crop

- **Core uses** (paper pulp, oil/chemical absorbents, insulation panels, horticultural mixes, bedding materials for animals, etc.). Apart from the industrial uses the core material can be used for thermochemical process (combustion, gasification and pyrolysis).
- **Bark uses** (paper pulp production)
- The **whole plant** has high protein and good digestibility and may be pelletized).

State-of-the-art of the crop in Europe

- The sustainable yielding potential of the crop as well as the limitations that certain cultivation techniques (irrigation, fertilization, sowing date and planting density) place of the crop growth have not been defined.
- In the framework of the two previous EU projects the using for kenaf and pulp have been tested by several industries. Hardly any publication has been published to report the results and the exploitation plans of these projects.

Methods and Materials

- ✓ In the view of BIOKENAF project a total number of 50 kenaf field trials were established in Europe for a period of three subsequent years.
- ✓ All these trials were established in 12 sites in Europe (Greece, Italy, Spain, Portugal and France).

Field trials in the view of BIOKENAF

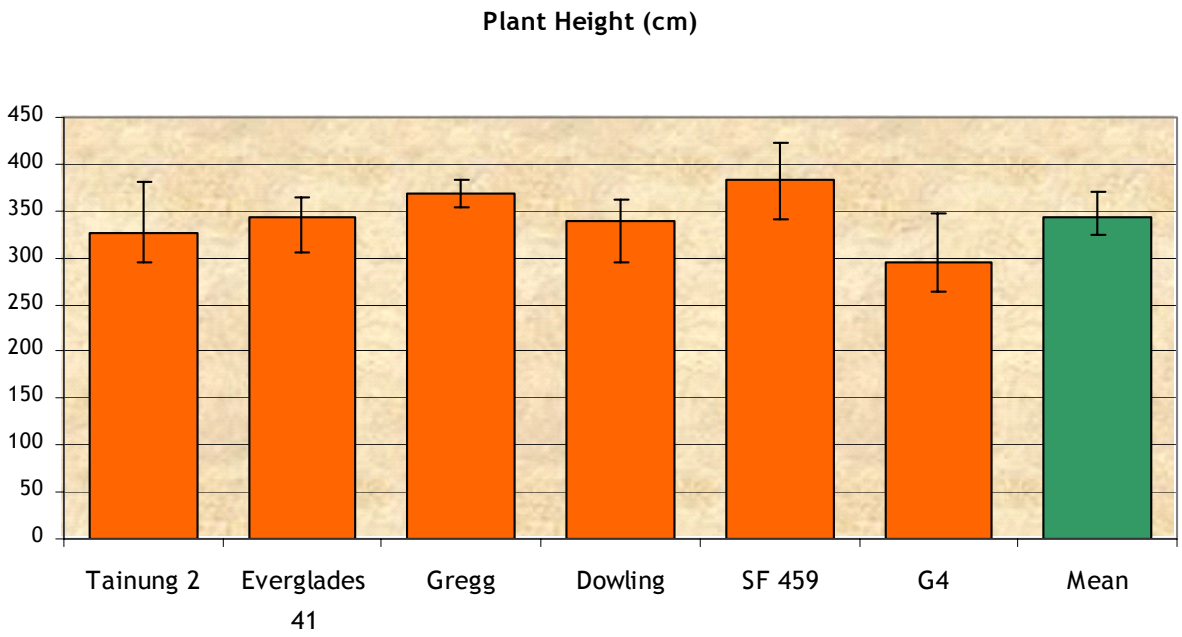
Trials	Tested factors	Sites	Years
Task 2.1 Screening trial	Six varieties	Aliartos Greece	2003-5
Task 2.2 Sowing dates	Two sowing dates Two plant populations Two varieties	Aliartos, Palamas, Catania, Bologna, Madrid, Lisbon, Paris	2003-5
Task 2.3 Irrigation and fertilization	Four irrigation rates Three nitrogen rates	Aliartos, Palamas, Catania, Bologna, Madrid, Lisbon, Paris	2003-5
Task 2.4 2 ha field trial	One variety with uniform plant density, irrigation and fertilization and sowing dates	Trieste, Thessaloniki, Komotini and Madrid	2003-5

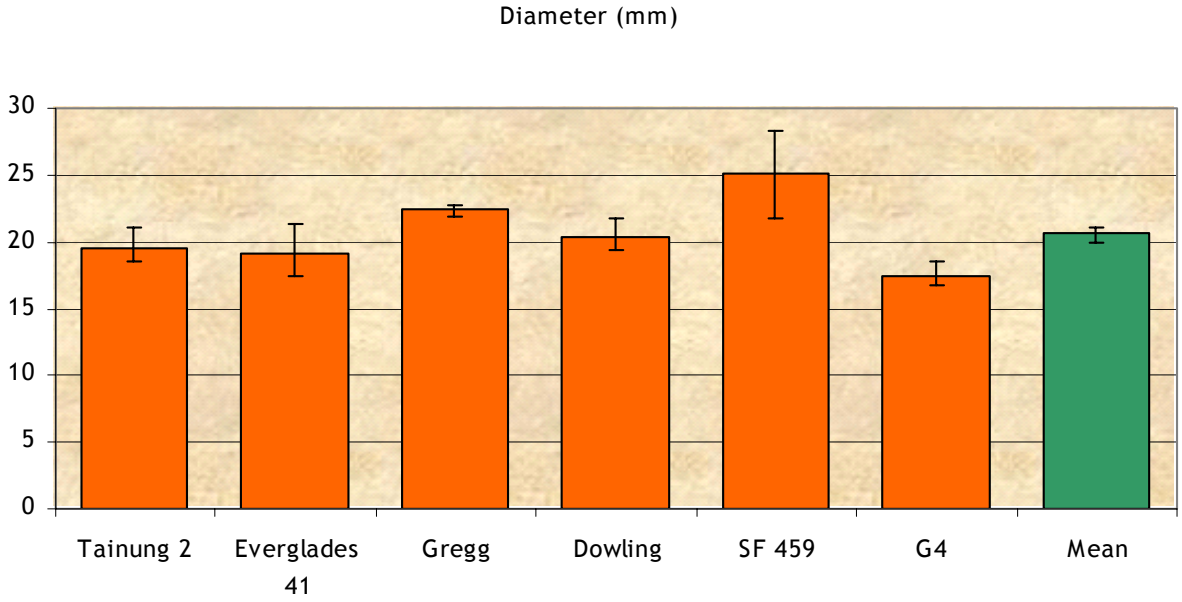
Measurements

- Plant height every two weeks (on five marked plants per plot)
- Stem diameter every four weeks (on five marked plants per plot)
- Leaf area meter (LAI) measurements every three weeks
- Harvests (2 m row) every three weeks from end of July to December
- Estimation of fresh and dry matter yields of total plant and per plant fraction (leaves, bark and core)

Results from the nursery trial

Growth characteristics (plant height and stem diameter)

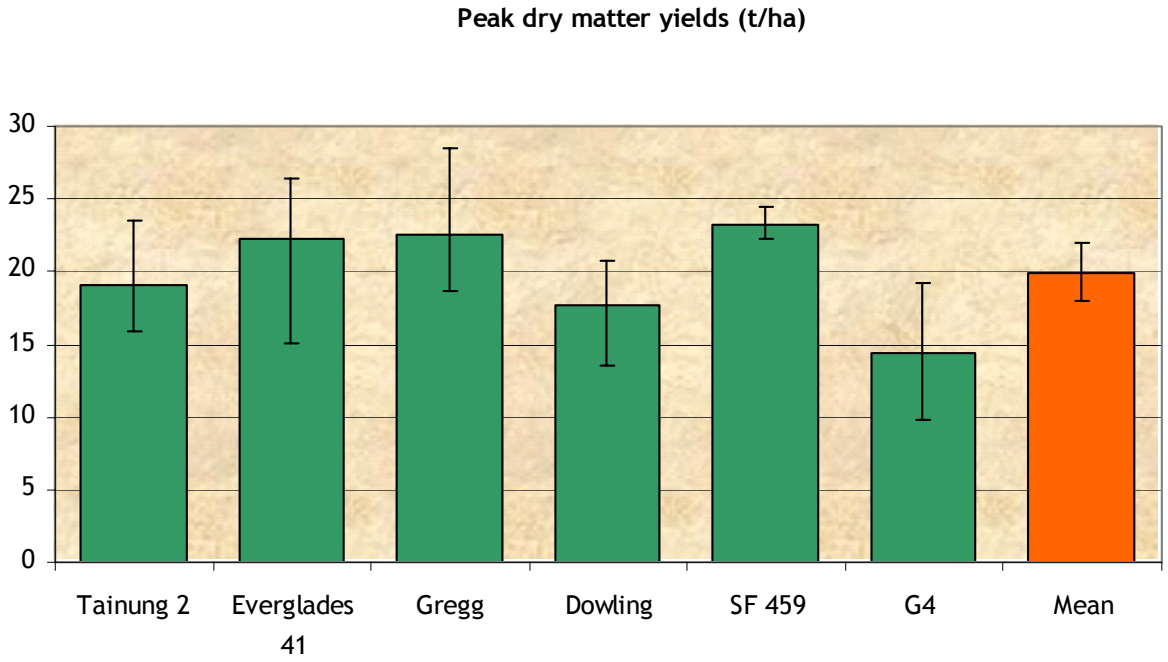


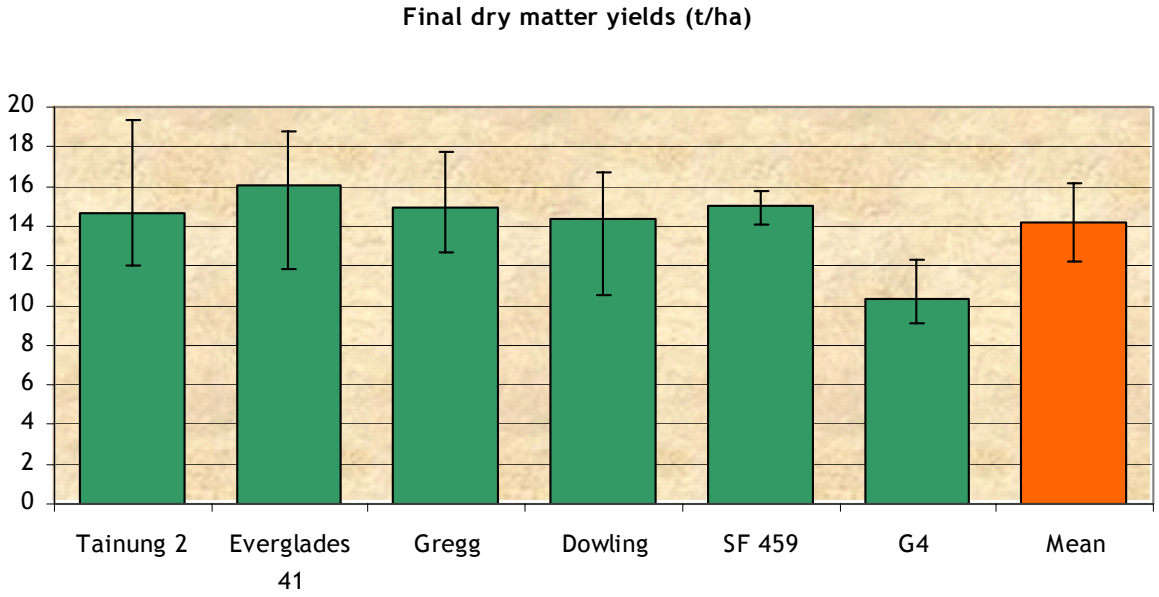


- The mean plant height (2003-5) ranged from 296 cm (G4) to 384 cm (SF 459).
- The mean stem diameter (2003-5) varied from 17.5 mm (G4) to 25.1 mm (SF 459).
- For both growth characteristics (plant height and stem diameter) the same late maturity kenaf variety gave the highest plants with the largest stems. On the other hand the shortest plants with the smallest stems were developed from the early variety SF 459.

Results from the nursery trial

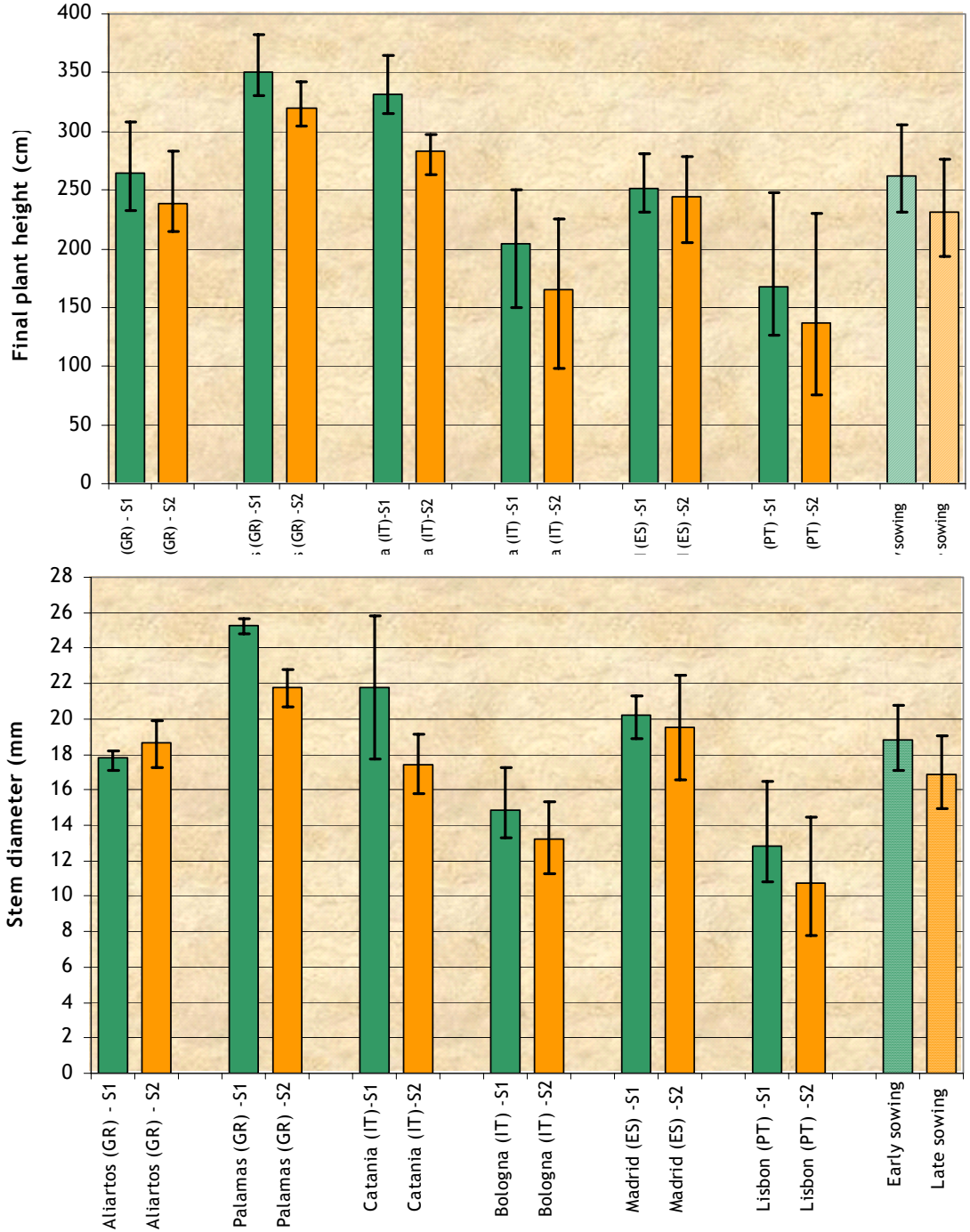
Yields





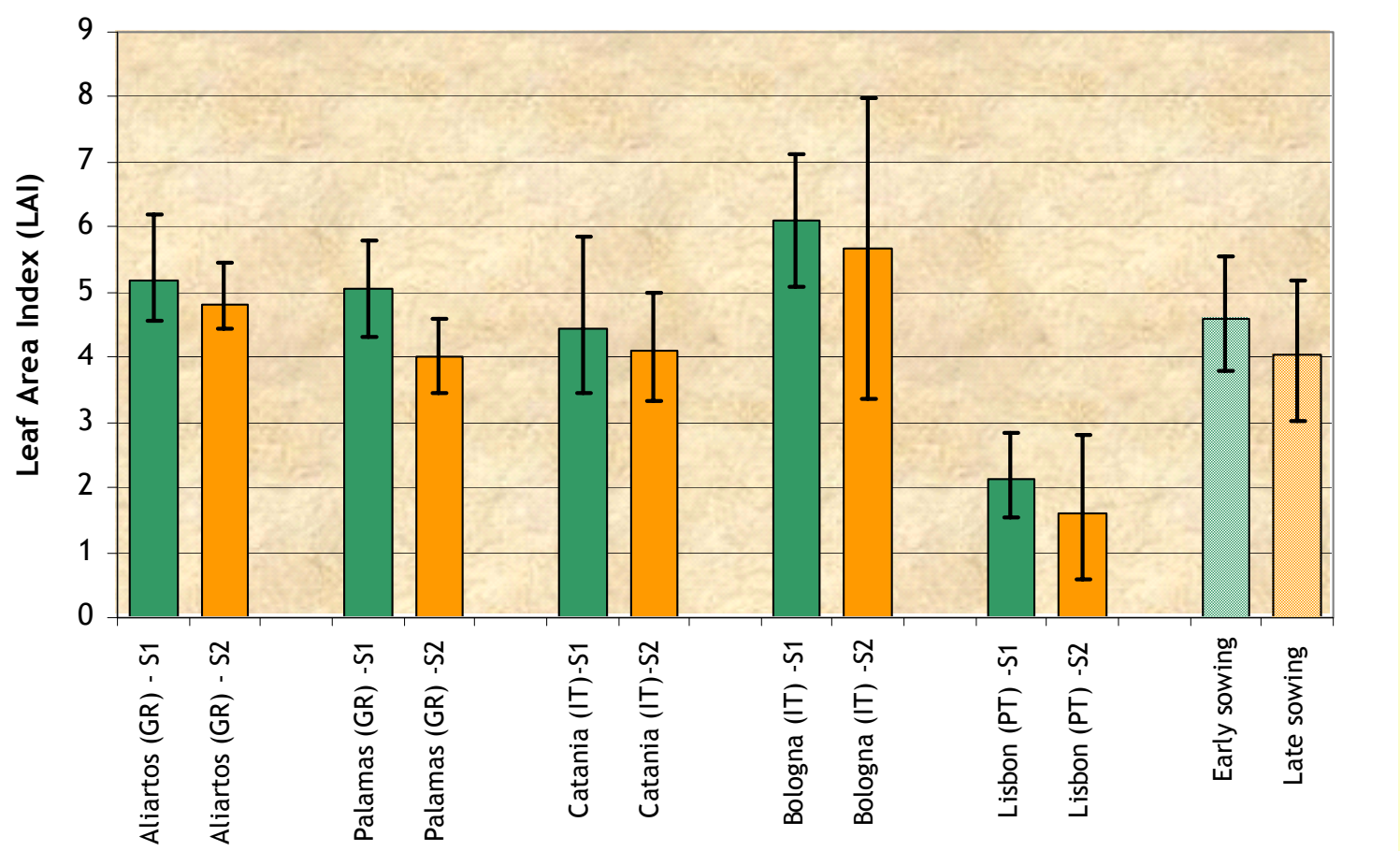
- The maximum dry matter yields (t/ha) were recorded each year at the end of October (50-100% of the flowering). Only the early variety G4 reached the peak yields earlier at the end of September.
- The mean maximum yields ranged from 14.4 t/ha (G4) to 23.2 t/ha (SF 459).
- At the and of December the stems were defoliated and the moisture content was quite low. At that time the mean dry matter yields ranged from 10,4 t/ha (G4) to 15 t/ha (SF 459).

Task 2.2 Effect of sowing dates on kenaf growth



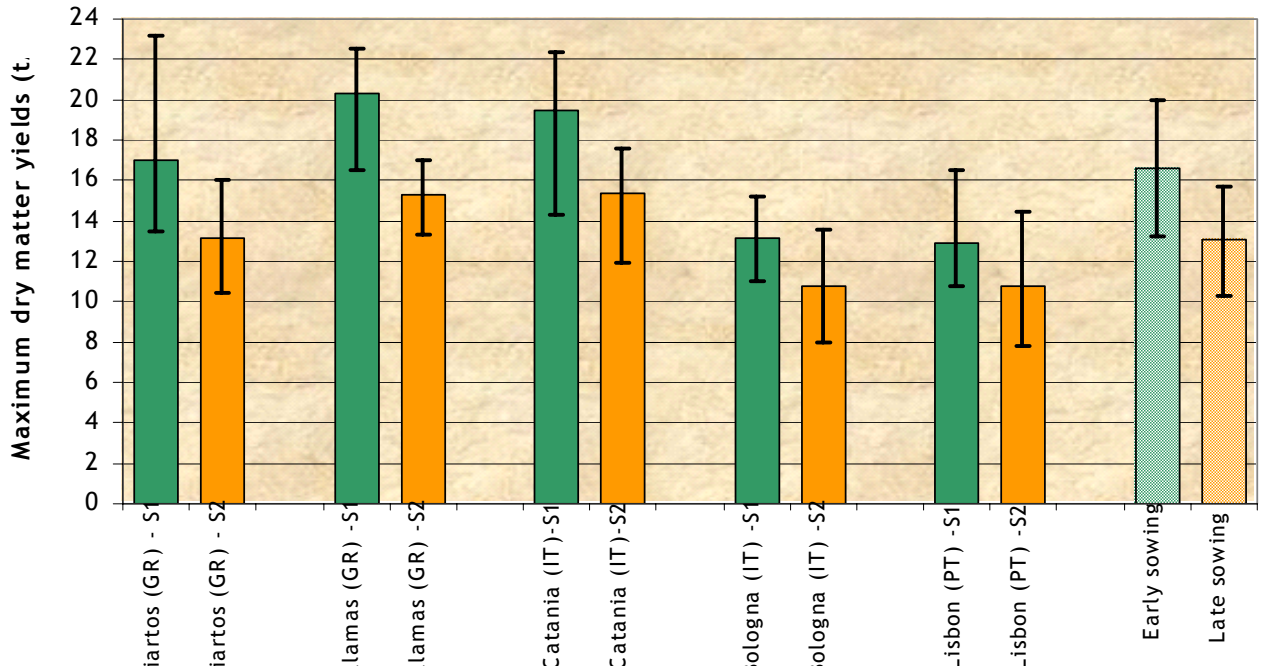
- In all sites the plants of the early sowing had higher stems compared to the ones of the late sowing. Averaged overall sites and years the plant of the early sowing had a mean height of 262 cm, while of the early 231 cm.
- Similar findings were also recorded for the stem diameter, except for Aliartos that the opposite findings were recorded. The mean stem diameter, averaged overall sites and years, was 18.8 mm for the early sowing and 16.6 mm for the late.
- The superiority of the early over the low for both growth characteristics was in most of the cases statistical significant.

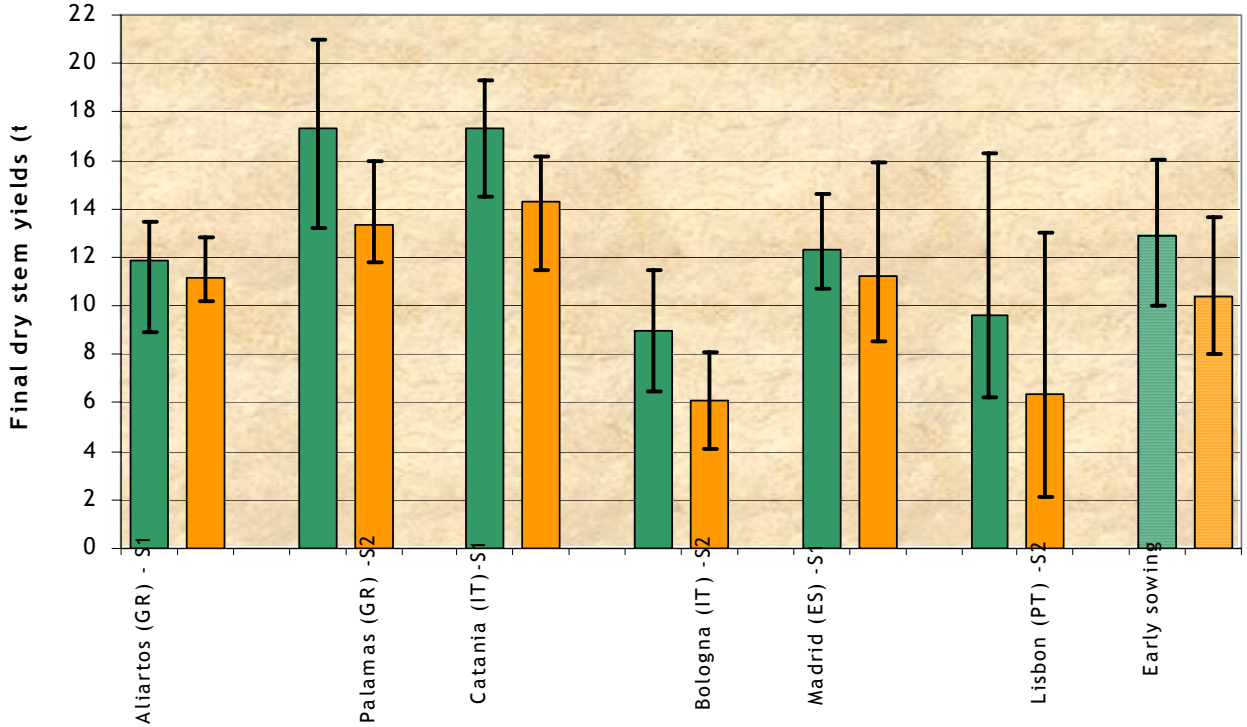
Task 2.2 Effect of sowing dates on kenaf growth



- In all sites the LAI reached higher peak values in the plots of the early sowing. The peak LAI values for the early variety ranged from 6.1 (Bologna) to 5.2 (Aliartos), for the late varied from 5.7 (Bologna) to 4.8 (Aliartos).
- In most cases the differences between the two sowing dates differ statistical significant.

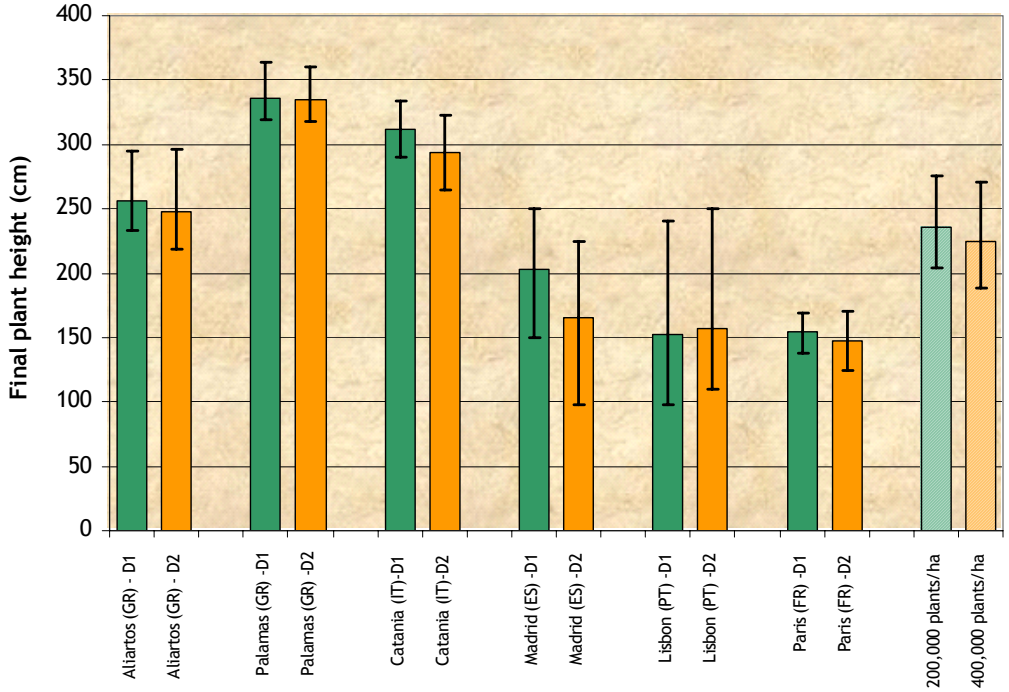
Task 2.2 Effect of sowing dates on kenaf yields

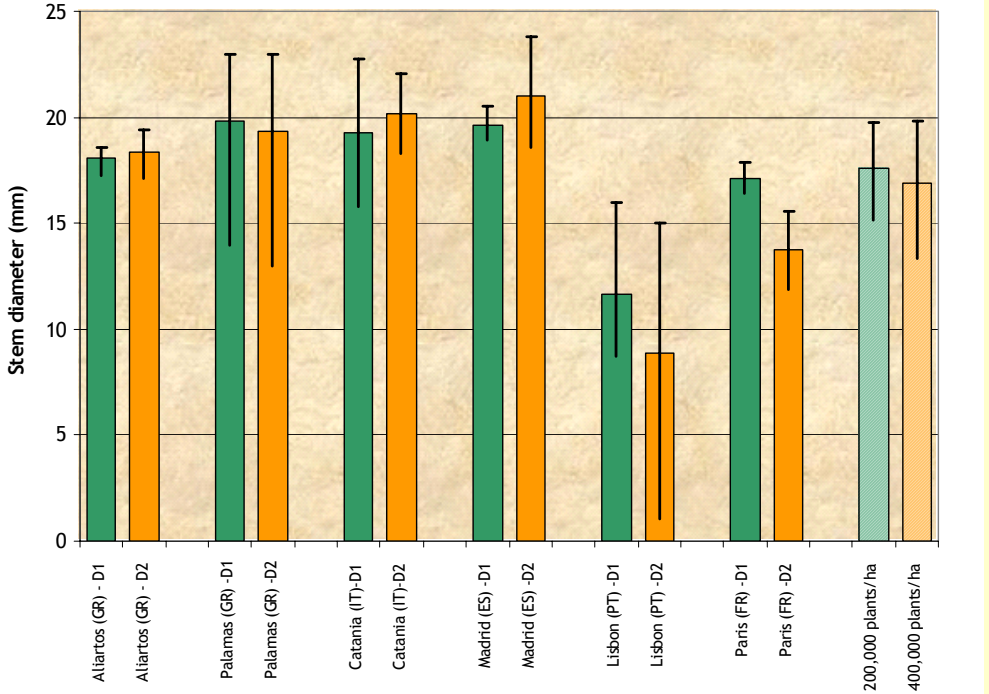


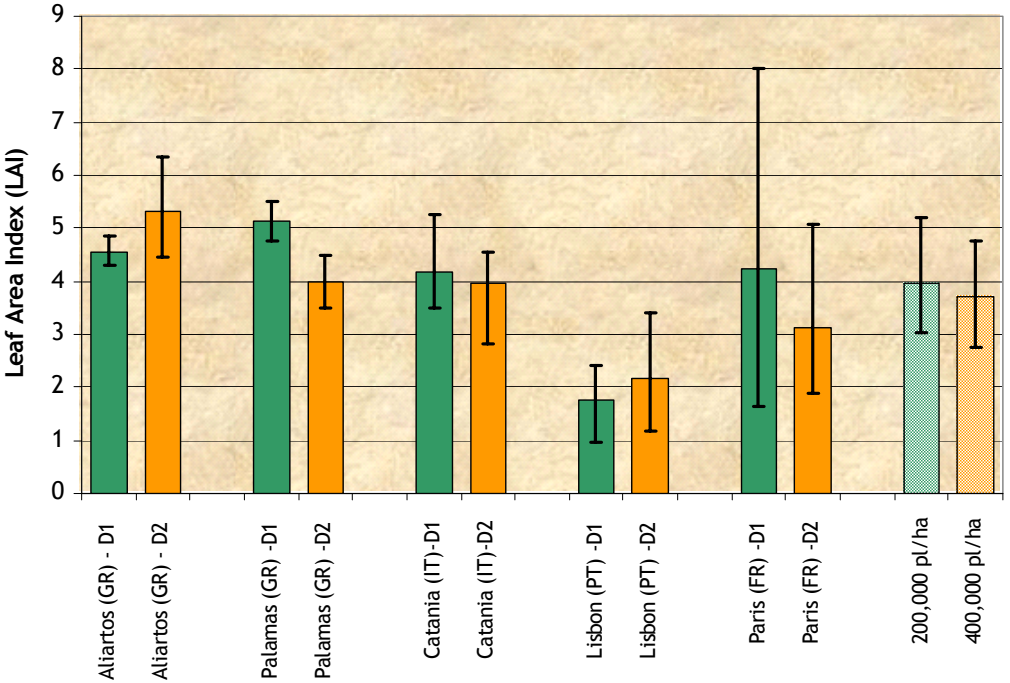


- In all sites the early sowing resulted in significant higher dry matter yields. The peak dry matter yields (end of October – early November) varied from 12.9 t/ha (Lisbon) to 20.4 (Palamas), while for the late sowing varied from 10.8 t/ha (Bologna) to 15.4 t/ha (Catania).
- At the final harvest of the crop (both yields and moisture reduced) the yields from early sowing varied from 9 t/ha (Bologna) to 17.3 t/ha (Palamas, Catania) and for the late sowing ranged from 6 (Bologna) to 14.3 t/ha (Catania).

Task 2.2 Effect of plant populations on kenaf growth

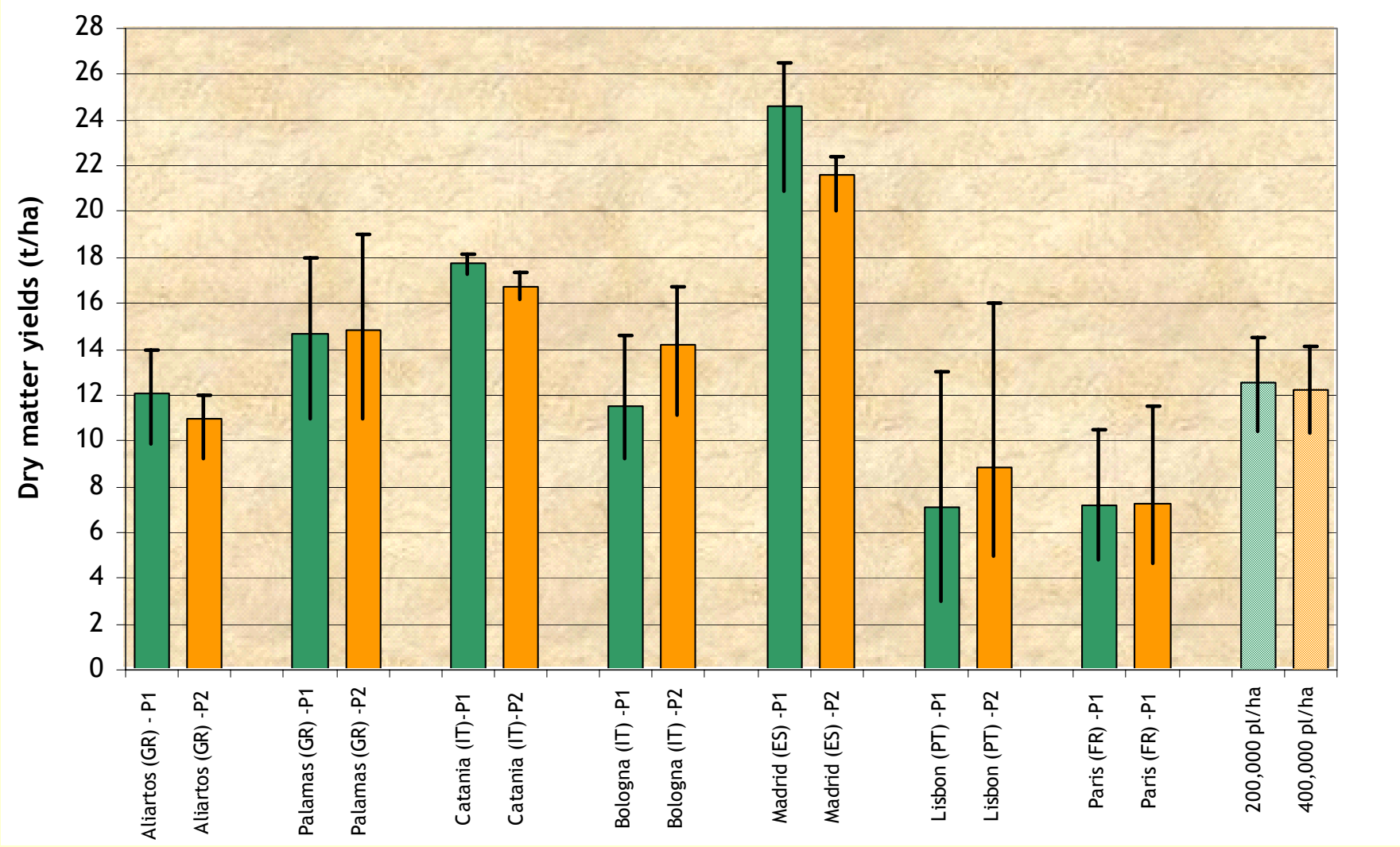






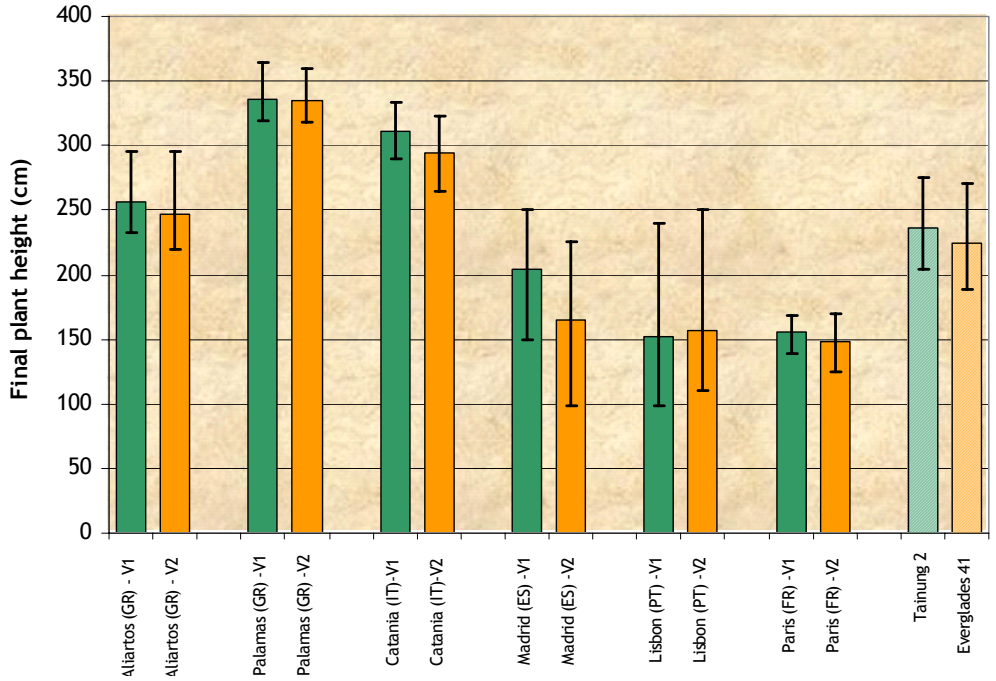
A mix picture was recorded regarding the effect of plant density on growth characteristics (plant density, stem diameter and LAI). Based on the mean values, averaged overall sites and years it can be said that the low density (200,000 plants/ha) resulted in higher plants with larger stem diameter and higher LAI compared to the high density (400,000 plants/ha).

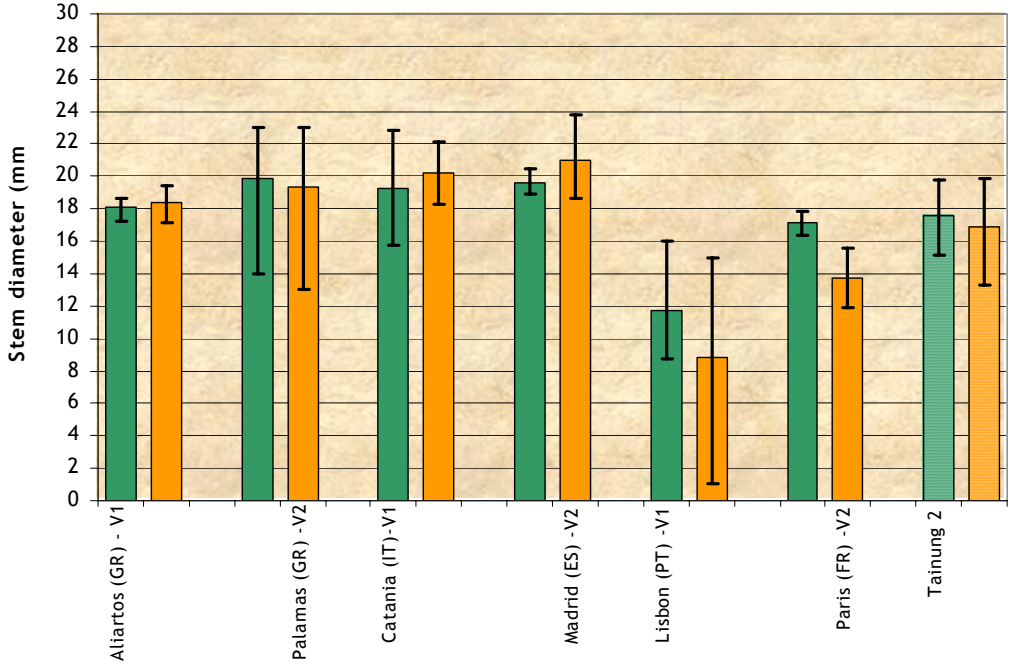
Task 2.2 Effect of plant populations on kenaf yields

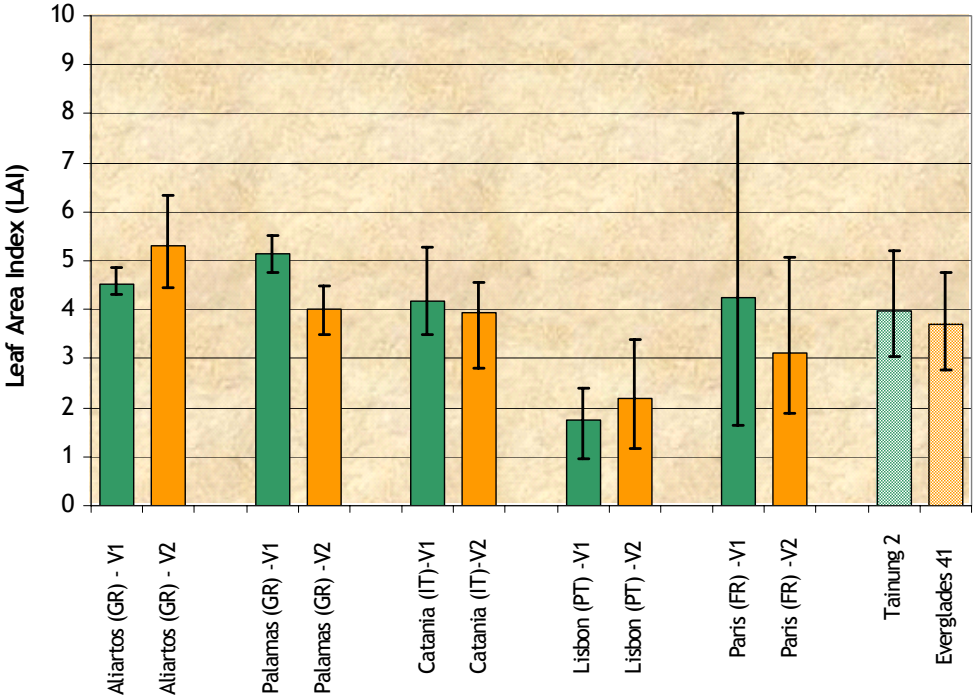


There is no clear picture regarding the effect of plant population on yields. In cases like Aliartos, Catania and Madrid a clear superiority of the low density (200,000 plants/ha) over the high one (400,000 plants/ha) was recorded, while in Bologna and Lisbon the opposite was happened. In Palamas and Paris both densities gave almost the same yields. The mean yields of low density, averaged overall sites, was 12.5 t/ha, while for the high density was 12.2 t/ha.

Task 2.2 Effect of varieties on kenaf growth

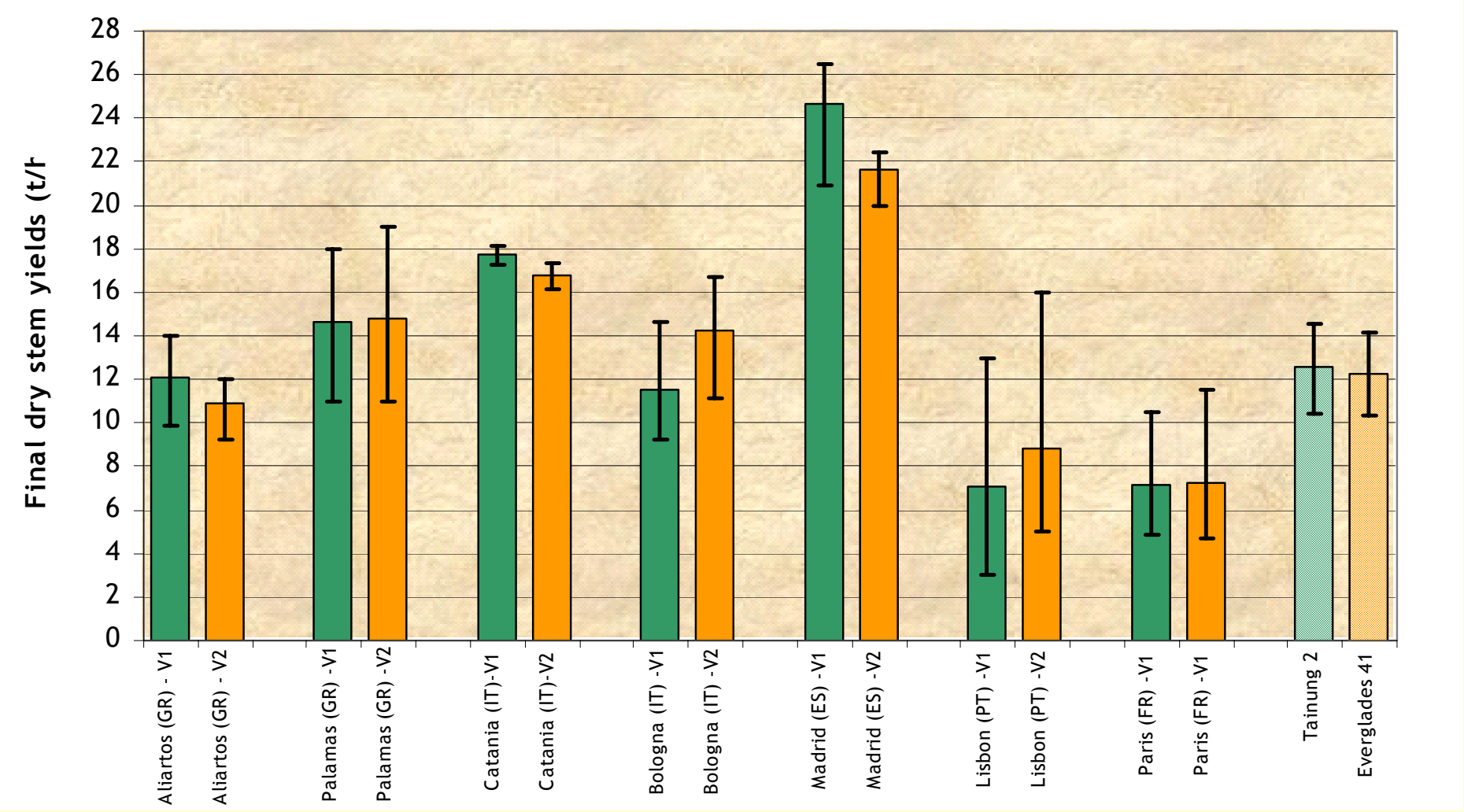






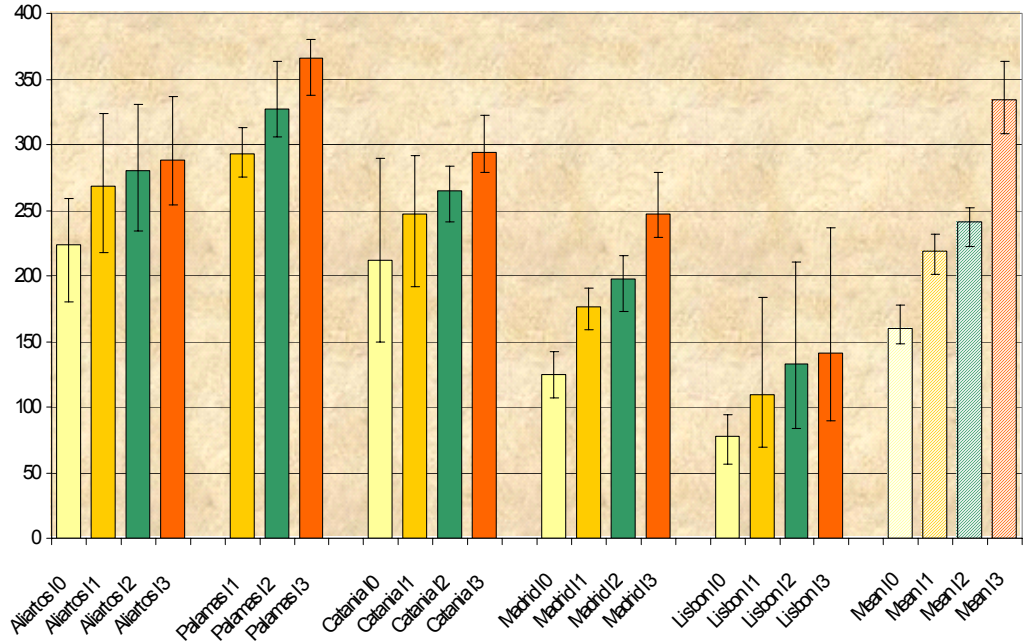
- In most sites the variety Tainung 2 produced plants with height and larger stems and gave higher LAI values.
- Averaged overall trials, Tainung 2 produced plants with a plant height of 236 cm, with stem diameter of 17.6 mm and LAI 4. The corresponding values for Everglades 41 were 224 cm, 16.9 mm and 3.7.

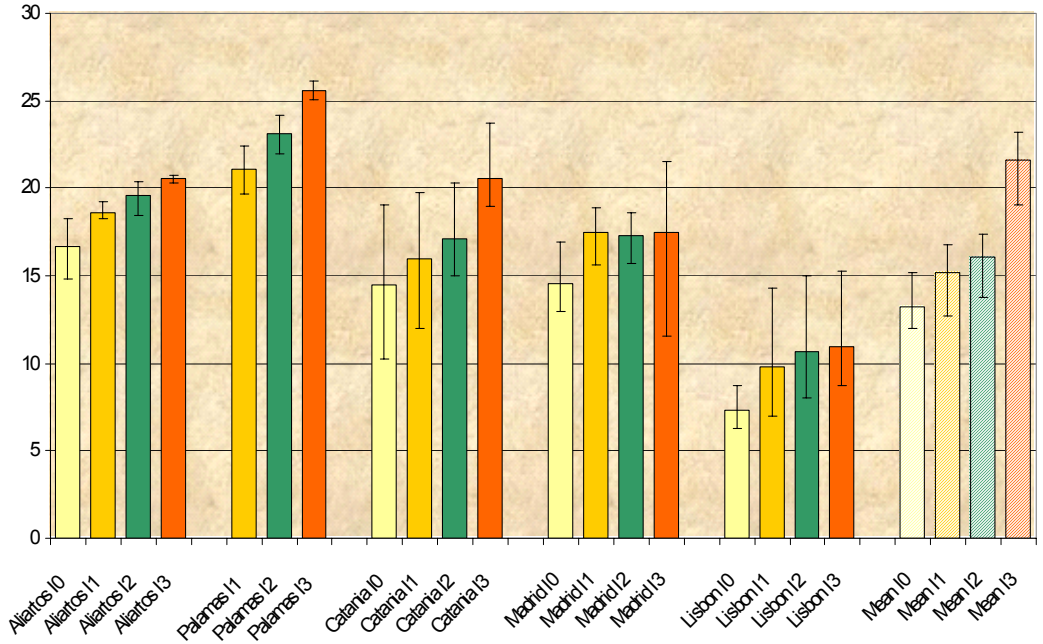
Task 2.2 Effect of varieties on kenaf yields

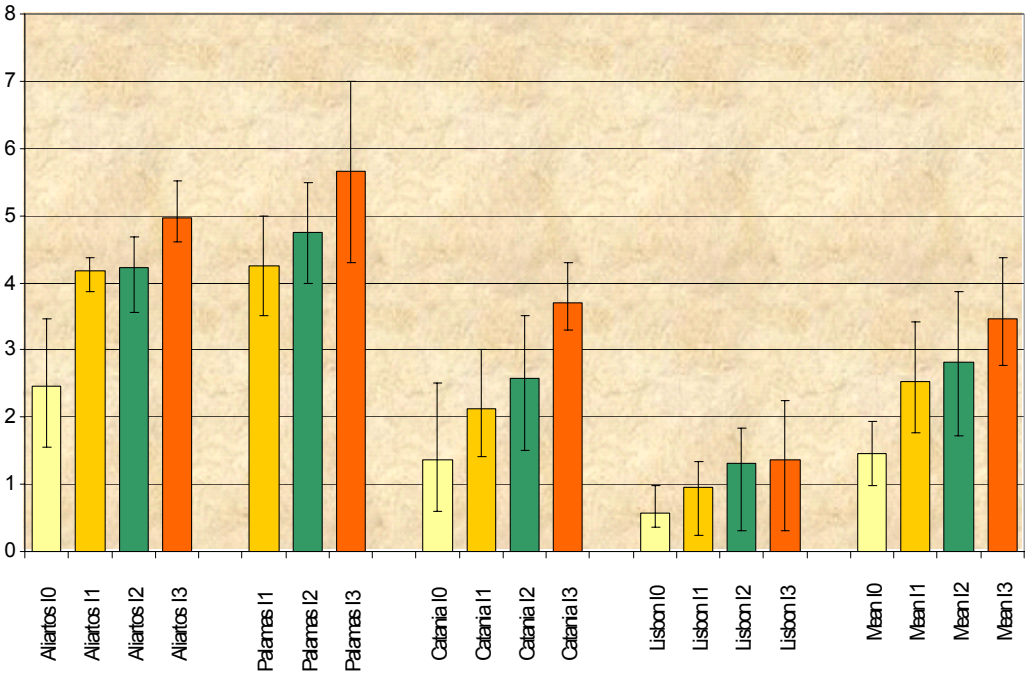


In three sites (Aliartos, Catania and Madrid) Tainung 2 was more productive compared to Everglades 41. The opposite findings were recorded in the cases of Bologna and Lisbon. In the case of Paris almost the same productivity was recorded for both varieties. Averaged overall trials, Tainung 2 gave 12.5 t/ha, while Everglades 41 gave 12.2 t/ha.

Task 2.3 Effect of irrigation on kenaf growth

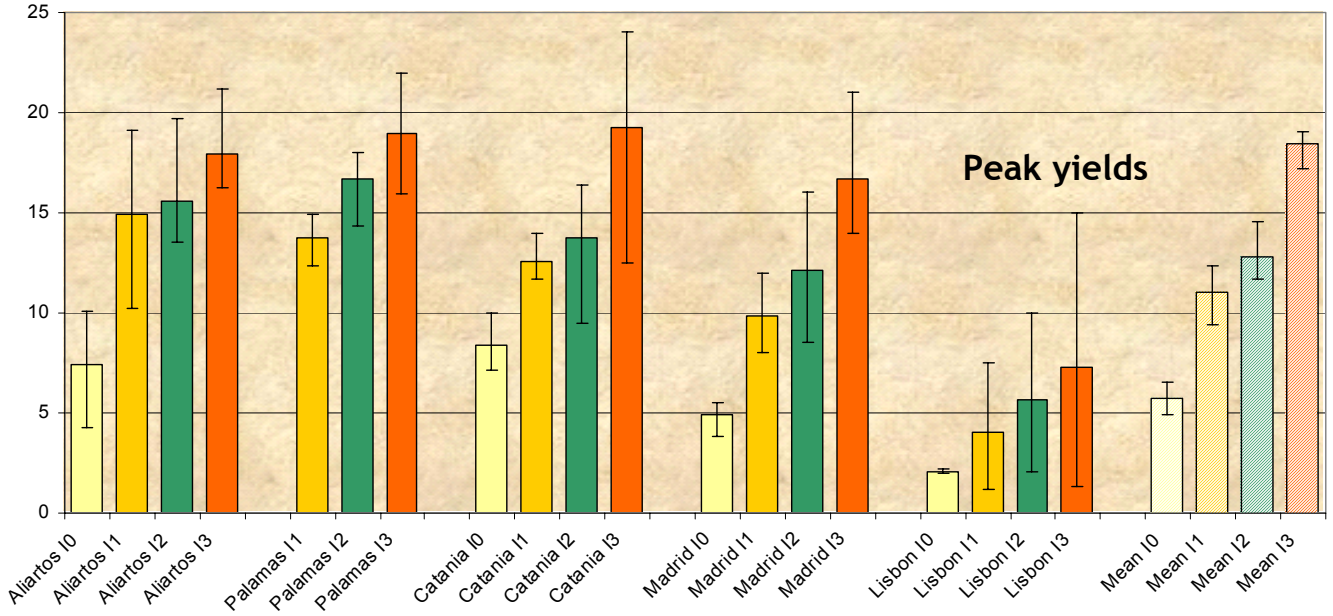


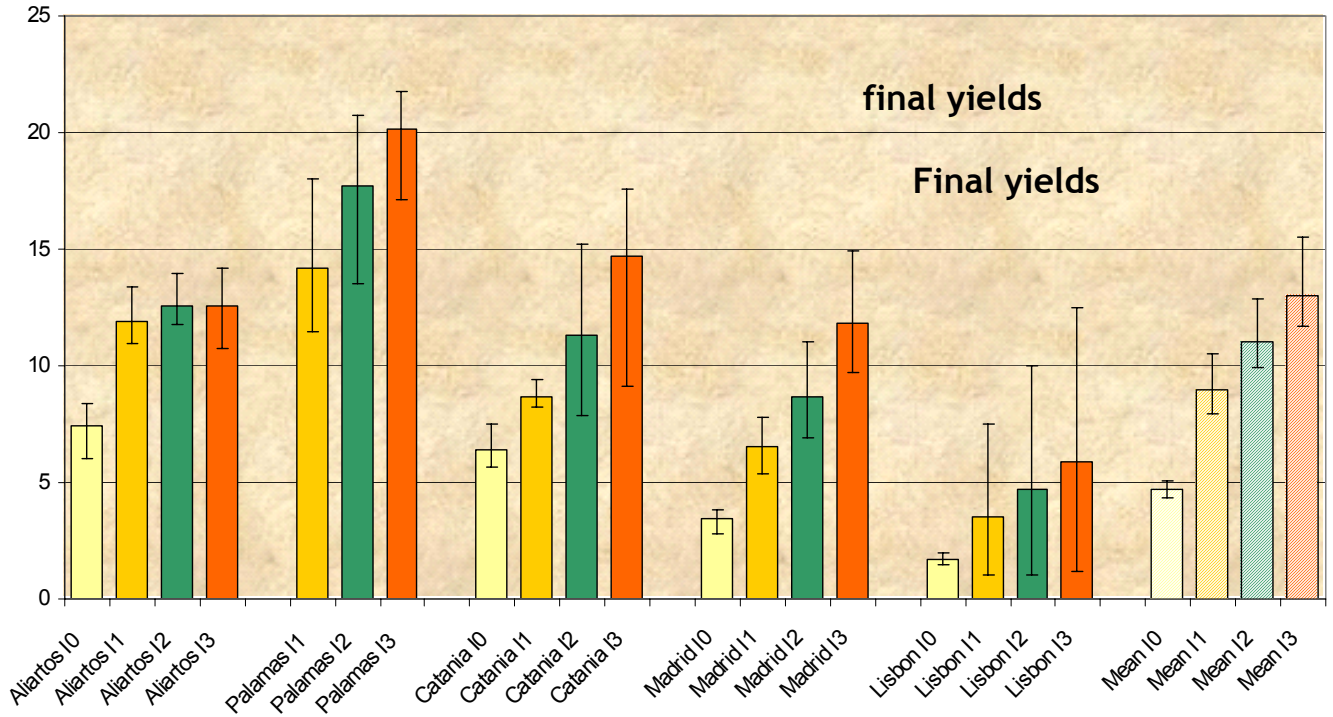




- It is very obvious that by increasing the irrigation the values for all growth characteristics were increasing.
- In most of the cases the values for the growth characteristics differ statistically significant among the applied irrigation rates.
- The mean plant height ranged from 160 to 334 cm, while for the stem diameter ranged from 13.3 to 23.6 mm and for the LAI for 1.5 to 3.5.

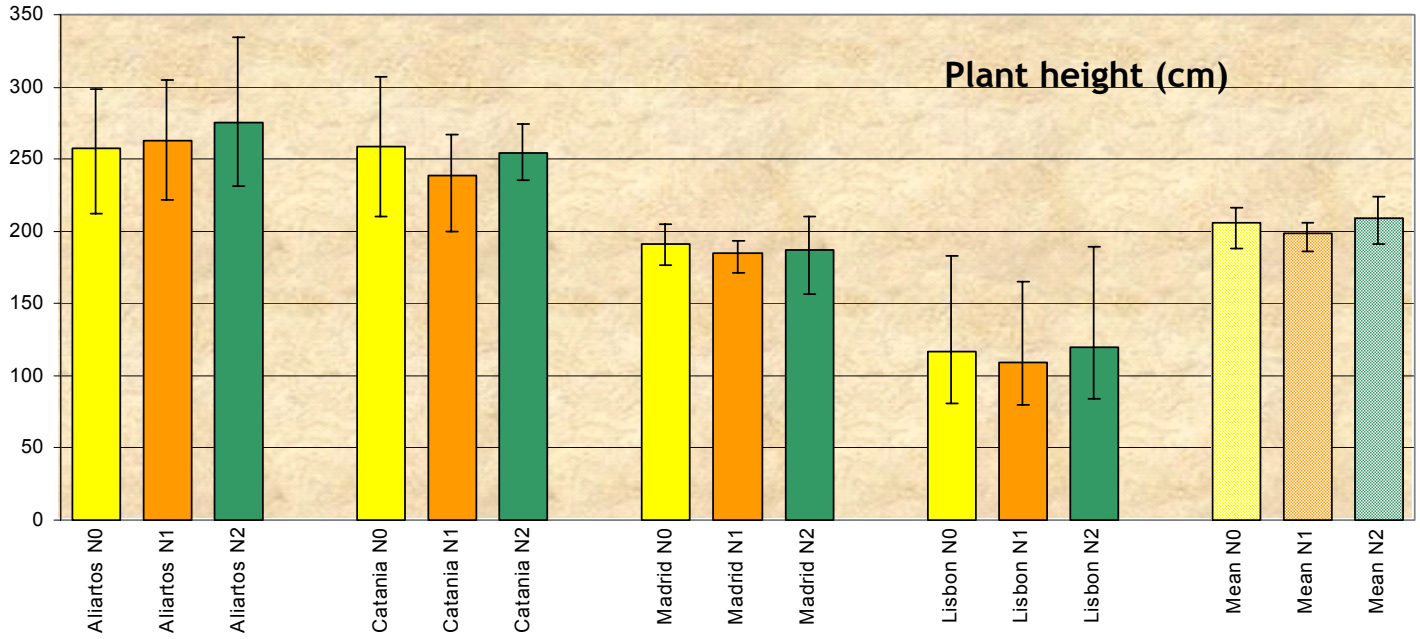
Task 2.3 Effect of irrigation on kenaf dry yields

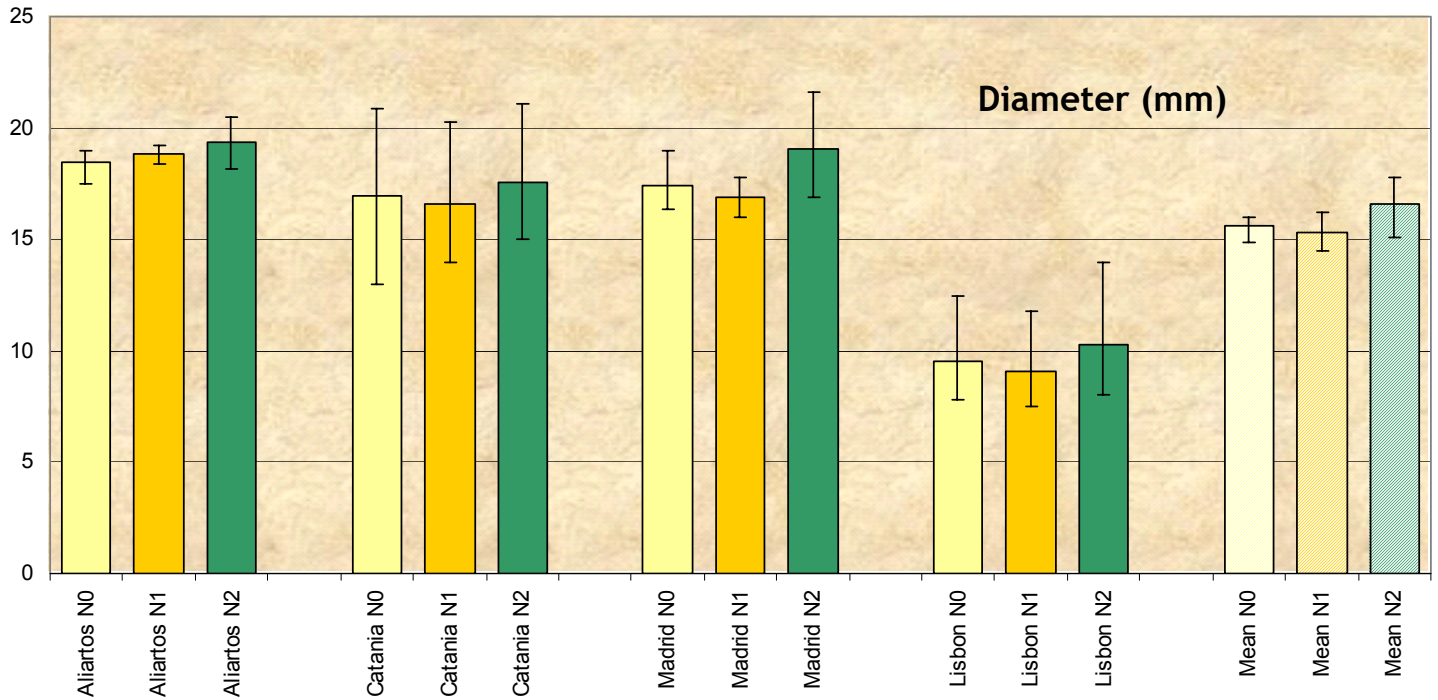




- The mean peak yields were 5.7 t/ha (no irrigation), 11 t/ha (25% of PET), 12.8 (50% of PET) and 18 t/ha (100% of PET). The corresponding values for the final dry yields were 4.7, 9, 11 and 13.
- The achieved dry yields (peak and final) were increasing when the applied irrigation rate was increasing.
- It should be pointed out that the most clear effect of irrigation on yields was recorded in the case of Madrid.

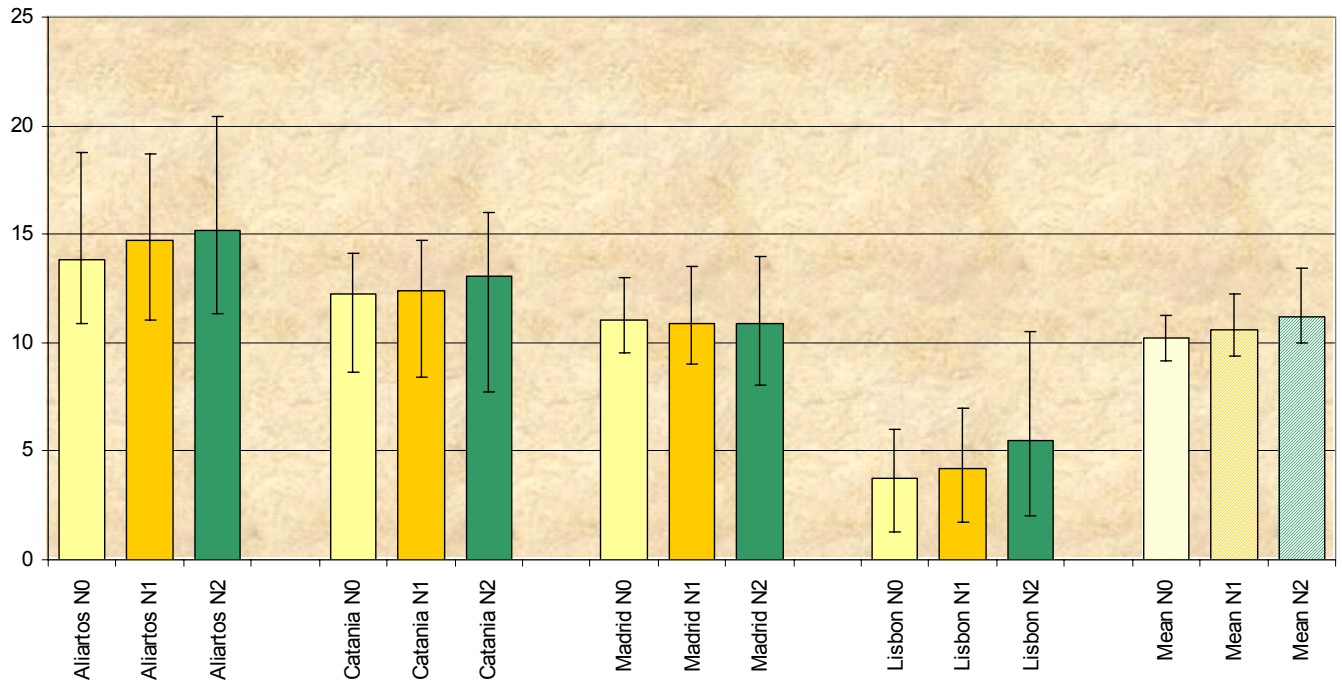
Task 2.3 Effect of nitrogen on kenaf growth

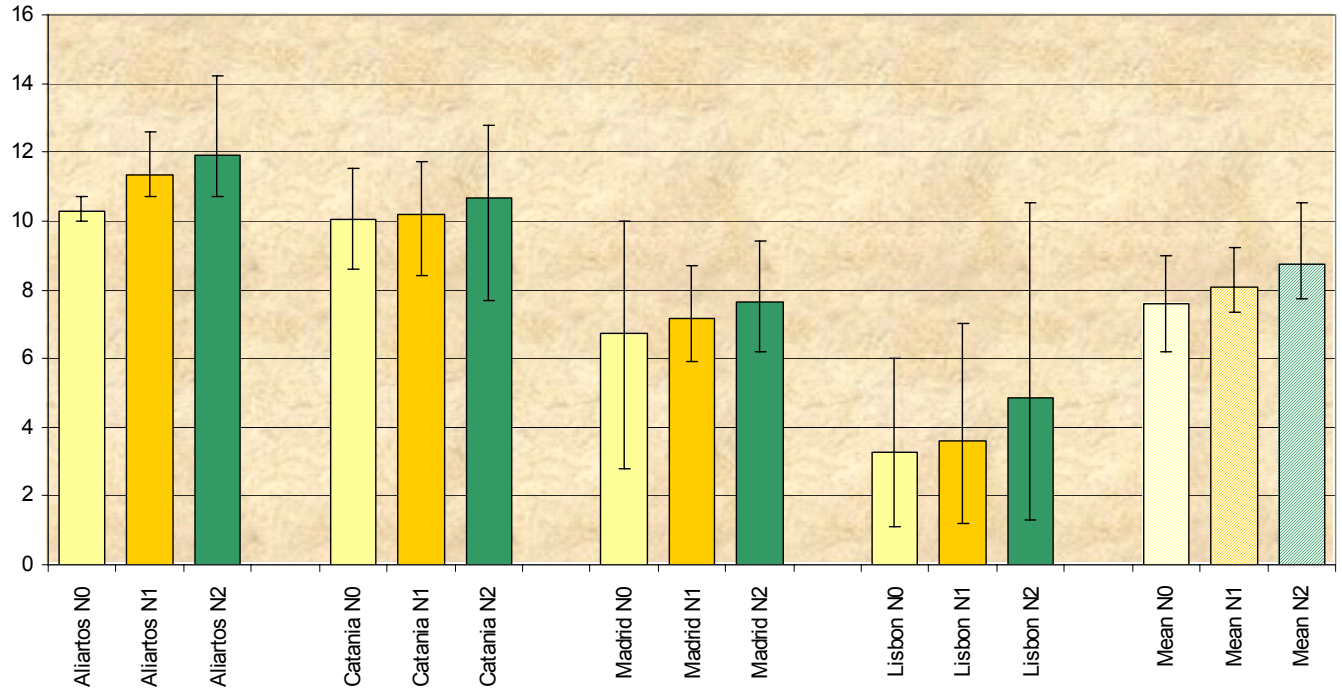




- In all sites the increase of the nitrogen application did not result in increasing of plant height and stem diameter. Only in the case of Aliartos when the nitrogen application increasing the plant height and diameter was slightly increased.
- The mean plant height was 206 (0 kg N/ha), 199 (75 kg N/ha) and 209 (150 kg N/ha). The corresponding values for the diameter were 15.6, 15.4 and 16.6 mm.

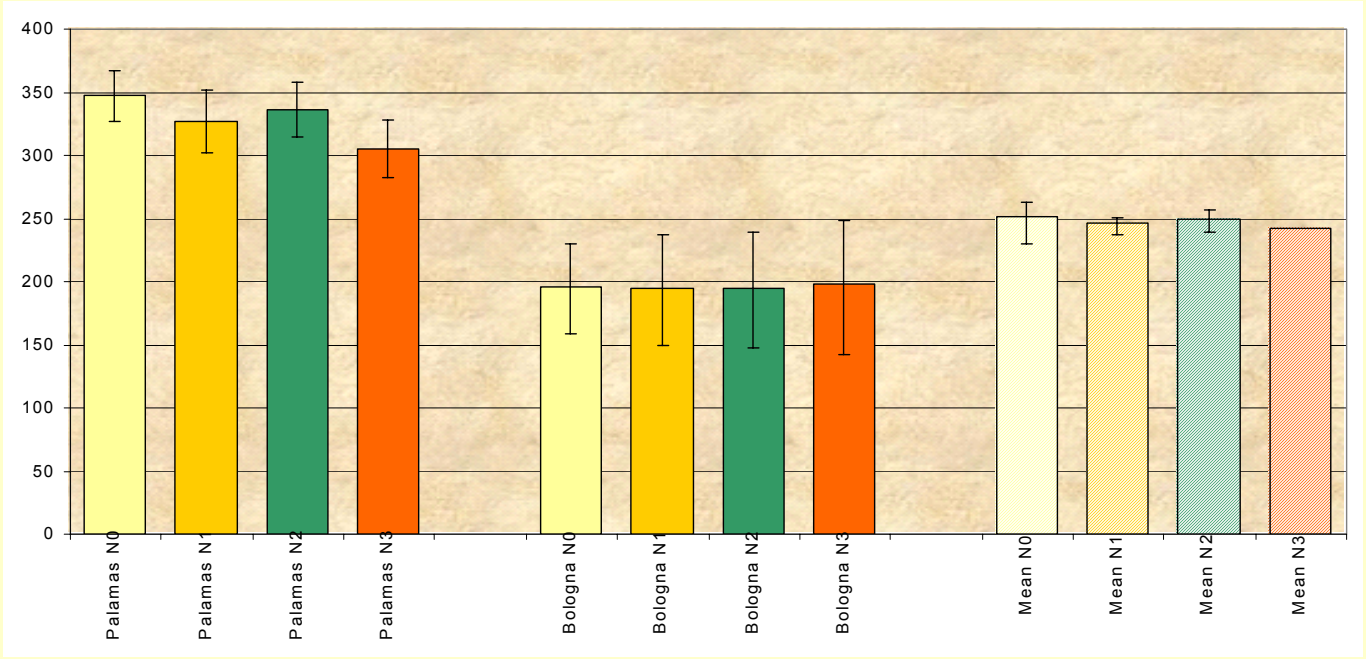
Task 2.3 Effect of nitrogen on kenaf yields

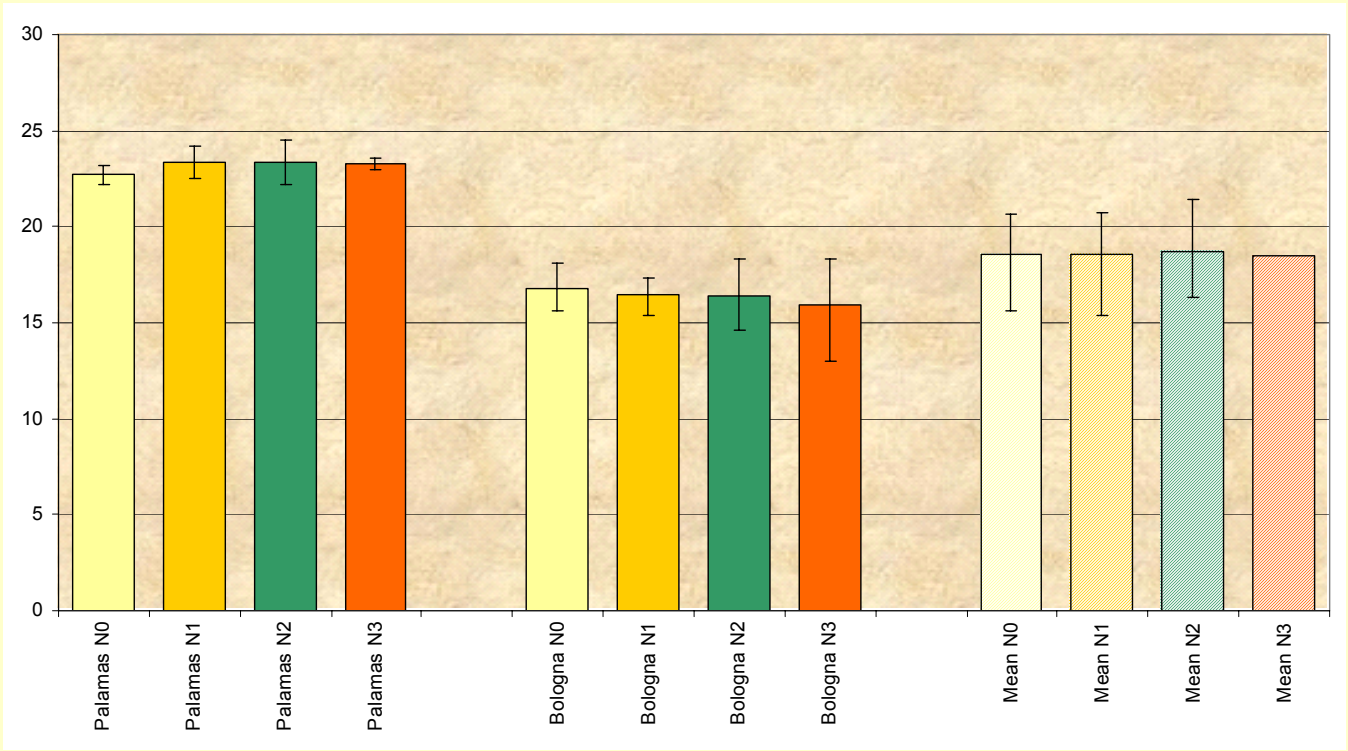




- In most sites it was found that when the nitrogen application was increasing the dry yields were also slightly increased.
- It should be pointed out that only in very few cases the differences among the nitrogen rates were differ statistically significant.
- Averaged all trials, it was found that the peak dry yields were 10.2 t/ha (0 kg N/ha), 10.6 t/ha (75 kg N/ha) and 11.2 t/ha (150 kg N/ha). The corresponding values for the final dry yields were 7.6, 8.1 and 8.8 t/ha.

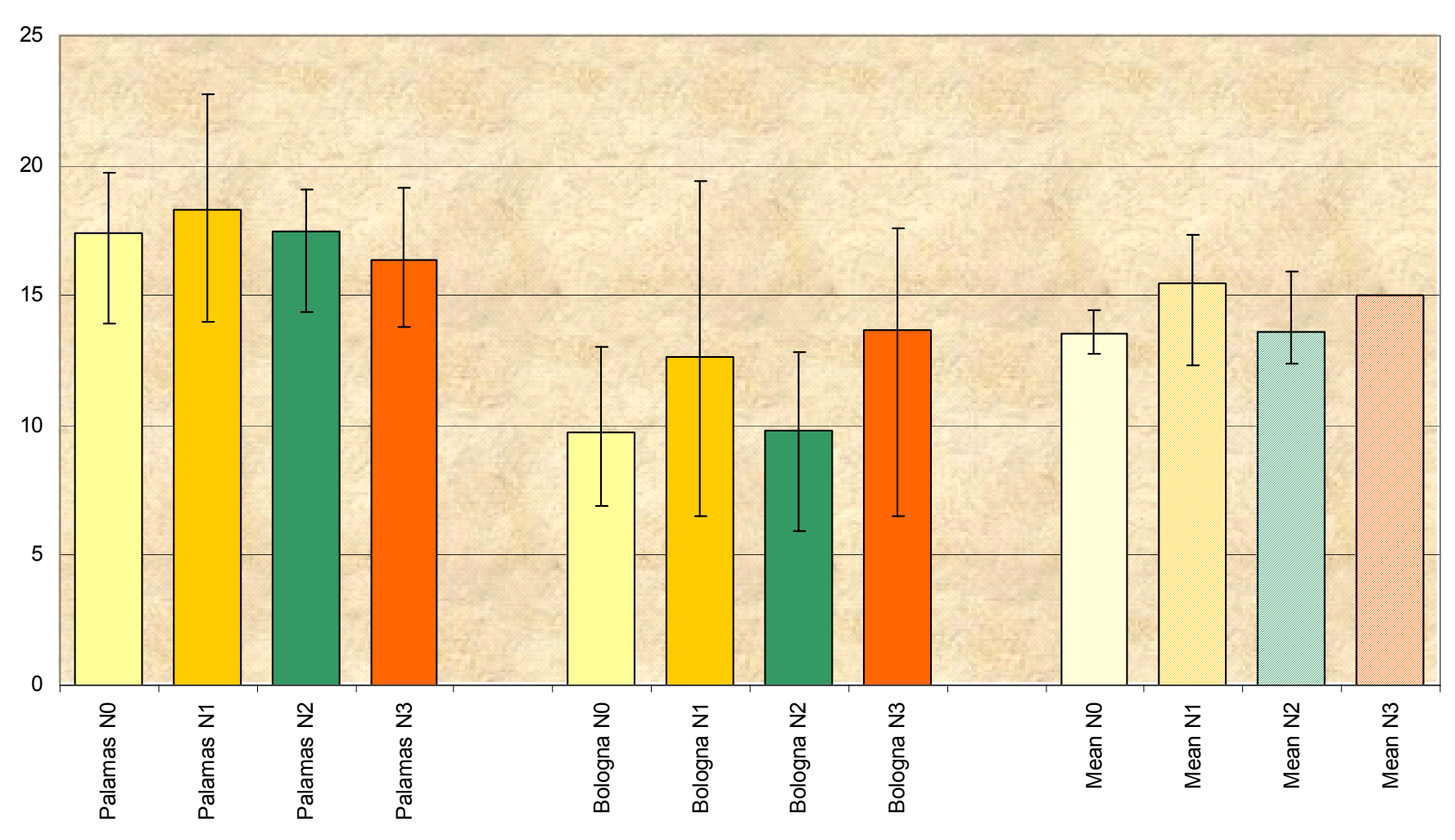
Task 2.3 Effect of nitrogen on kenaf growth





- In sites Palamas (Greece) and Bologna (Italy) the plant height and the stem diameter did not found to affect by the increasing of the applied nitrogen fertilization.
- The mean plant height was 252 (0 kg N/ha), 246 (50 kg N/ha), 249 (100 kg N/ha) and 242 (150 kg N/ha).
- The corresponding values for the diameter were 18.6, 18.6, 18.7 and 18.5 t/ha.

Task 2.3 Effect of nitrogen on kenaf final dry yields



The increasing of the applied nitrogen fertilization (from 0-150 kg N/ha) did not result in increasing of dry yields in the cases of Palamas and Bologna. The mean dry yields were 13.6 t/ha (0 kg N/ha), 15.5 t/ha (50 kg N/ha), 13.6 t/ha (100 kg N/ha) and 15 t/ha (150 kg N/ha).

Conclusions

- The **late maturity varieties** more productive compared to the early.
- The **new variety SF 459 is very productive** with yields higher than the yields of the two traditional varieties Tainung 2 and Everglades 41.
- **The yields were increased when the sowing time was between the early to the middle of May**. When the sowing time was delayed until the middle of the end of June a serious decline of the yields were recorded.
- A mixture picture was recorded regarding the effect of plant density on the yields. **Both densities (200,000 and 400,000 pl/ha), averaged overall trials, gave almost the same mean yields.**
- Similar findings with plant densities were also recorded for the two varieties. **It was found that their yielding capacity was almost the same with a slight superiority of Tainung 2 over Everglades 41, when grown in South Europe.**

Conclusions

- **It was found that by increasing the applied water in the kenaf fields their productivity was increased** and in most cases the yields that were recorded for the applied irrigation rates were differ statistically ($P<0.05$). This trend was quite strong and clear in all years in the case of Madrid
- **On the contrary the dry yields did not or slight increased by the increase of the applied nitrogen.**

Thank you very much for your attention

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