YIELD AND DEVELOPMENT OF KENAF (*HIBISCUS CANNABINUS* L.) CROP IN RELATION TO GENOTYPE, SOWING TIME AND PLANT POPULATION IN MEDITERRANEAN ENVIRONMENT*

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ABSTRACT: In the framework of a Project supported by the European Commission, QLK5 CT2002-01729 'Biomass Production Chain and Growth Simulation Model for Kenaf' a research was conducted to study yield and development of kenaf crop in relation to genotypes ('Tainung 2' and 'Everglades 41'), sowing time (June the 12th and July the 4th) and plant population (20 plants m^{-2} and 40 plants m^{-2}), in a typical hill area of Sicily, in Mediterranean environment. A good yield performance was demonstrated both genotypes, up to 14 t ha^{-1}; small differences were find in relation to plant density, while the sowing time determined significant variations. The first sowing date has determined, in the average of the other studied factors, a higher yield (14.5 t ha^{-1}) than the second one (11.5 t ha^{-1}); a higher plant height (366 cm against 291 cm) and a higher maximum leaf area index (LAI) (5.9 against 2,9) was obtained, in the average of the other factors, in the first sowing date; 'Tainung 2' showed the highest maximum LAI respect to 'Everglades 41' (6.5 against 5.0) in the first sowing date. In the second one, there was not significant difference among varieties and plant densities.
Keywords: kenaf, arid conditions, biomass production

1 INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) is an annual herbaceous plant, cultivated for the soft bast fiber in its stem. It can be grown under a wide range of climate and soil conditions. Kenaf is a fast growing plant, cultivated as summer crop in sub-tropical and temperate areas [1].

Flowering of most kenaf varieties is under photoperiodic control. In late-maturity kenaf varieties, flowering is strongly dependent on the daylight length and the plant remains vegetative until the daylight falls below 12h and 30min [2]. Consequently, a late vegetative cycle produces significantly higher fresh and dry matter yields. Kenaf yields vary, however, widely worldwide in relation to local climate, crop management, cultivar, stand density.

In Southern Europe it has been reported production of dry stems of 20 t ha^{-1} [3] up to 26 t ha^{-1}. In Sicily, a typical Mediterranean country, the photoperiodic and thermal conditions allow the plant to produce seed [4].

Traditionally, kenaf had been used as a source of raw material for rope, canvas and sacking; recently, it has been actively cultivated for paper pulp production, but it is also characterized as multipurpose uses: fabrics, particleboard, animal feeding, bedding material, and as reinforcement fibres of the composite [5].

In the framework a Project supported by the European Commission, a research was conducted to study yield and development of kenaf crop in relation to late genotypes, sowing time and plant population in a typical hill area of Sicily, in Mediterranean environment.

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2 MATERIALS AND METHODS

The experimental field was carried out in Enna province, an area of Sicilian hill (550 m s.l., 37° 23' N Lat; 14° 21'. E Long), on a sandy clay loam soil (Typic xerorthents).

The following factors were studied:

a) two *sowing dates*: June the 12th and July the 4th 2003;
b) two *genotypes*: 'Tainung 2' and 'Everglades 41';
c) two *plant densities*: 20 plants m^{-2} (D_1) and 40 plants m^{-2} (D_2) (50 cm between rows for both densities).

A randomised block experimental design with three replicates and a single plot of 48 m^2 (6 x 8 m) was used. At sowing, 50 kg ha^{-1} of N (as ammonium sulphate) and 100 kg ha^{-1} of P_2O_5 (as mineral perphosphate) were supplied; further 50 kg ha^{-1} of N (as ammonium nitrate) were given to the crop as top dressing, on July the 25th and on September the 3rd, for the first and the second sowing, respectively.

The water was supplied by a drip irrigation system, replenishing the 100% of PET from sowing until to the first rainfalls (early September); the water irrigation volume was equal to 403,3 mm for the 1st sowing (till September 1st) and 272,8 mm for the 2nd sowing (till September 4th).

Along the crop growing season, the following data were collected:

- meteorological (maximum and minimum air temperature, rainfall, maximum and minimum air humidity and global radiation by means of a data logger (CR 21 – Campbell Scient. Inc. Logan, Utah) and water evaporation by means of a 'class A' pan;
- phenology (date of 50% plant emergence and of 50% flowering);

Every three weeks, starting when the plant was 20 cm high, a sample of plants along a meter was collected; on these plants were measured:

- fresh and dry weight of each part of plant;
- leaf area of all green leaves;

- plant height;
- number of nodes per plant;
- base diameter (at 0 cm high).

At harvest on a sample of 10 plants per plot, the following measurements were carried out: plant height, number of nodes per plant, base diameter, total fresh and dry biomass and its partitioning in the plant components (stems, flowers and capsules).

3 RESULTS

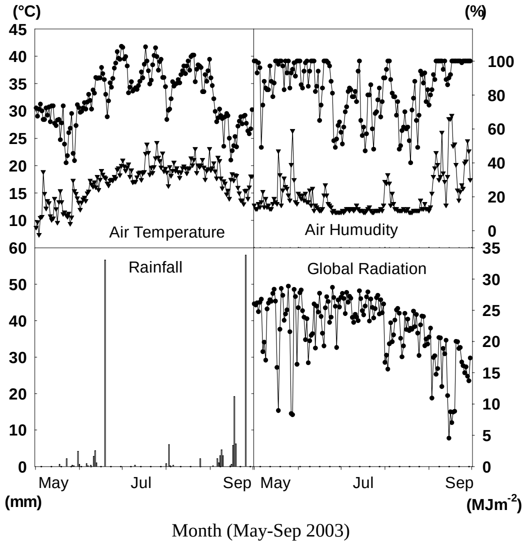


Figure 1: Meteorological data

During the growing period, maximum air temperature ranged from 21°C (May and September) to 42°C (July and August) and minimum air temperature ranged from 8° to 23°C (Fig. 1). Few rainfalls occurred: one on June and the other ones at the end of September (more than 50 mm), therefore, irrigation was necessary during cropping cycle with a volume of 403.3 mm for the 1st sowing and 272.8 mm for the 2nd sowing. Emergence occurred on June the 16th and on July the 8th for the first and the second sowing date, respectively, while flowering occurred on October the 2nd and the 18th, in the average of the other studied factors. The crop was harvested on 4th December 2003.

Neither variety, nor plant density affected significantly plant height, in the average of all factors, attained to 366 cm in the first sowing date and 291 cm, in the second sowing date (Fig. 2).

The number of nodes per plant was affected by the sowing date, as well (87.2 in the first one, and 65.5 in the second one, in the average of all studied factors) (Fig. 3).

The maximum leaf area index (LAI) was higher in 'Tainung 2' than in 'Everglades 41' (6.5 against 5.0) in the first sowing date. In the second one, LAI was lower than in the first sowing (3.8-4.0), without no significant difference among varieties and plant densities.

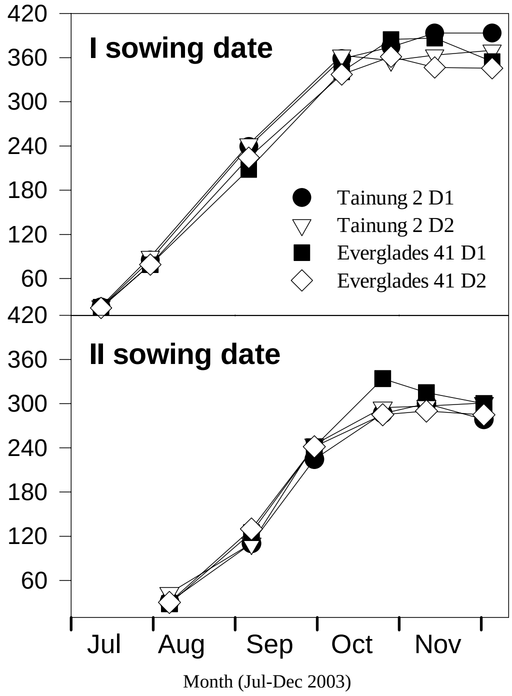


Figure 2: Plant height in the first and in the second sowing date.

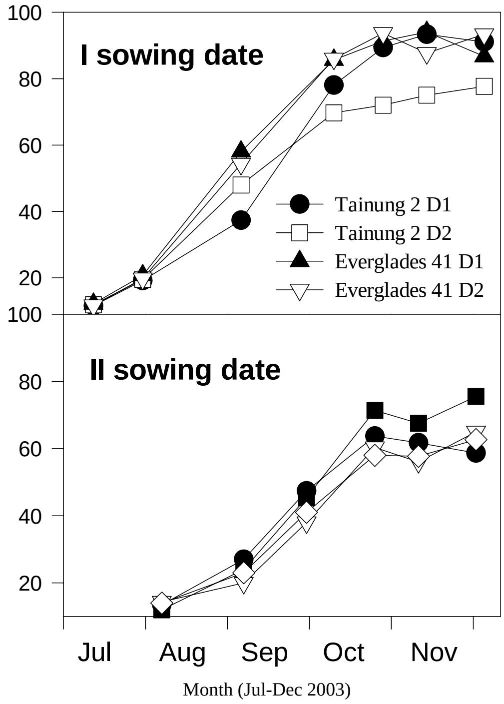
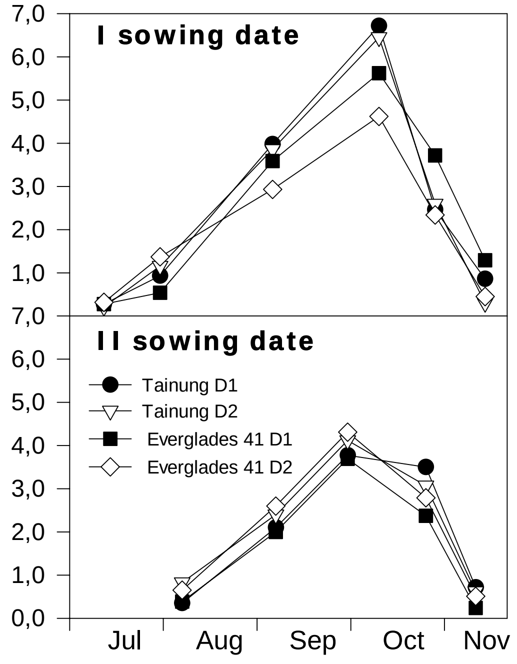


Figure 3: Node number per plant in the first and in the second sowing date.

The maximum leaf area index was obtained in the same period (beginnig of October) in both sowing dates. Later on, the LAI decreased, being almost zero in the middle of November (Fig. 4).

The highest production was observed in the first sowing date in the average of the other studied factors (14.3 t ha^{-1} against 11.9 t ha^{-1}). In the first sowing date, 'Everglades 41' yielded 15.2 t ha^{-1} against to 13.4 t ha^{-1} of 'Tainung 2'. In the average of cultivars, D_2 gave the highest yield (14.9 t ha^{-1} against to 13.7 t ha^{-1}). In the second sowing date, there were not significant differences among the studied factors (Fig. 5).

Regarding yield partitioning, stems contributed with the 97.6%, in average, to total biomass, in the first sowing date, and with the 99.7% in the second sowing date.



Month (Jul-Nov 2003)

Figure 4: Leaf Area Index (LAI) in the first and in the second sowing dates

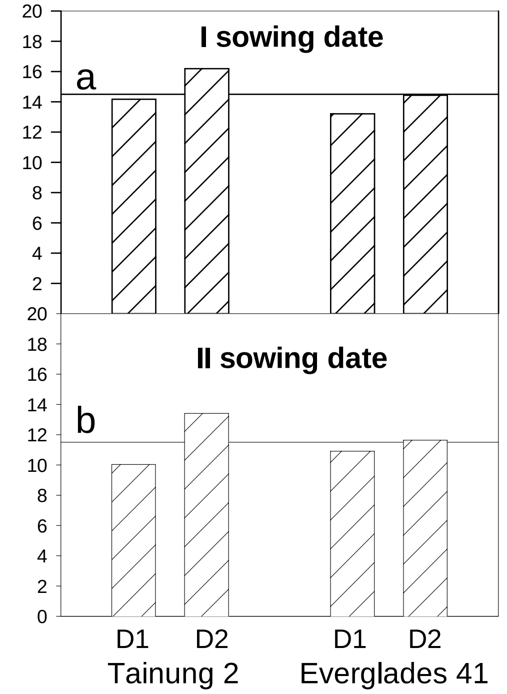


Figure 5: Yield (t ha^{-1}) obtained in relation to the studied treatments. The horizontal lines represent the mean value. Different letters correspond to significant differences.

4 CONCLUSIONS

The field experiment carried out to study the influence of sowing date, genotype and plant density in kenaf cultivated in Mediterranean environment allowed to draw the following considerations:

- all the measured traits (plant height, the number of nodes per plant, leaf area index) resulted higher in the first sowing date than the second one;
- in the average of all factors , in the first sowing date yield was higher (14.3 t ha^{-1}) than in the second (11.9 t ha^{-1}) likely because of a different amount of intercepted radiation;
- however, the level of obtained yields was quite low compared to results obtained in similar environmental conditions and this could be accounted for the late sowing date and the unusually high thermal conditions which may have reduced the photosynthetic activity [7];
- delayed sowings produce low yields because kenaf, being a short-day plant, speeds flowering and stops its growth and biomass accumulation.

5 ACKNOWLEDGMENT

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6 REFERENCES

[1] J.F. Angus, R.B. Cunninghan, M.W. Moncur, D.H. Mackenzie, Field Crops Research, (1981) 3, 365.
[2] S. Rhem, G. Espig, Verlag Joseph Margraf, Priese GmbH, Berlin (1991).
[3] M. Manzanares, J.L. Tenorio, P. Manzanares, L. Ayerbe, Biomass and Bioenergy, (2003) 5, 5, 337.
[4] S. Foti, C. Patanè, P. Guarnaccia, Agricoltura Ricerca, (1998) 178, 69.
[5] T. Nishino, K. Hirao, M. Kotera, K. Nakamae, H. Inagaki, Composites Science and Thecnology, (2003) 63, 1281.
[6] R.C. Perry, D.E. Jones, M.S. Bhangoo, Proceedings of 5th Annual International Kenaf Association Conference, (1993) 45.
[7] S. L. Cosentino, E. Riggi, G. D'Agosta, Proceedings II World Conference on Biomass. Rome, May 10-14th (2004).