Seventh framework programme
Food, Agriculture and Fisheries, and Biotechnology

Specific International Co-operation Actions
Small or medium scale focused research project

Sweet Sorghum
an alternative energy Crop

SWEETFUEL / Grant Agreement n° 227422

WP5
Deliverable 5.1:

Identification of cold resistance and responsive genotypes in dry and temperate regions best suitable for breeding programs

Composition of the consortium
CIRAD
ICRISAT
EMBRAPA
KWS
IFEU
UniBO
UCSC
ARC-GCI
UANL
WIP

Field evaluation of cold tolerance of several commercial biomass sorghum hybrids

Deliverable 5.1 was modified as decided in the second annual meeting held in South Africa (February, 2011). Instead of working with new developed genotypes (for which the availability of seeds is limited) it was decided to work only on commercial hybrids that WP1 partners have and can provide plenty of seeds for large field trials. KWS and ICRISAT indicated their readiness to provide three hybrids each, so the provision of seeds was arranged immediately after the meeting. KWS hybrids (Bulldozer, Tarzan, and Zerberus) arrived on time for the planned sowing time experiment. Even though ICRISAT did all the arrangements very efficiently and rapidly, seed arrived to Bologna during the first days of May, so in this season only the best sowing time was tested for the ICRISTAT hybrids (ICSSH 19, ICSSH 58, and ICSSH 31). In Bologna the best sowing time for sorghum is within the first two weeks of May, therefore early sowing dates will give a good indication of the cold tolerance of the different hybrids. KWS hybrid were sown on 24 March (I), 7 April (II), 19 April (III), and 9 May (IV). The ICRISAT hybrids were sown only on 9 May. The objective of this study was to understand the adaptability of biomass sorghum to cold conditions and early sowing under temperate climates. The coming season (2012), cold tolerance of all six available hybrids will be tested again by early sowing. This deliverable will be completed next year.

Material and methods

In the 2011 season, cold tolerance was evaluated in qualitative and quantitative productivity terms. The laboratory analysis of structural carbons (cellulose, hemicelluloses, and lignin) will be carried out in the coming months. Therefore, only a summary of partial results is presented here.

The soils were ploughed to a 0.3m depth in the autumn, then tilled to seedbed preparation before the sowing time. Each plot was 21.6 m^2 with four repetitions. Seeding was performed in rows of 0.45 m apart and 0.04 m distance along the row. Thinning to a density of 12 plants m^{-2} was performed during the first growth stages. The average germination percent of the hybrids was about 82% at 25^{o}C. Plant growth was monitored on an area of 0.45 m^2 along crop cycle. The average sampling interval was 15 days. At each date, plant height, stem basal diameter, number of stems, and phenological stages were determined. Emergence index (EI) was calculated as: EI = $\sum$(Ej x Dj)/E; where Ej is the emergence on day j, Dj is the days after sowing, and E the final stand. Final stand count was taken before thinning to the desired plant density. Soil temperature was measured for two weeks after sowing in each sowing time with a manual digital soil thermometer. At the final harvest, ^{o}Brix%, and fresh and dry matter production was determined on an area of 7.2 m^2. Samples for the evaluation of quality traits were also taken and stored.

Preliminary results

All three hybrids showed an increased emergence speed as the soil temperature increased due to the advancement of the season from early to the end of spring. The range of days to full emergence at the coldest sowing dates (I and II; 24 March and 7 April, respectively) was 16-17 days, while at the hottest sowing time (IV; 9 May) plants required about 10 day to emerge (Fig. 1, top left). Moreover, later sowing resulted in faster growth in plant height, but no significant differences among hybrids were found. On the other hand, at early sowing times (I and II) the Bulldozer hybrid showed significantly higher growing rates than the other two hybrids (Fig. 1, top right). In addition Bulldozer produced the highest dry biomass when sown early in the season (Fig.1, bottom right). However, early sowing was inversely related to the stem elongation rates (Fig. 1, bottom left), indicating that the adaptability of Bulldozer to cold (early sowing) is better explained by a higher accumulation of biomass (higher stem and leaves dry weight and higher number of tillers) due to the extended season than by the accelerated growth in height. It is interesting to note that all hybrids increase the speed of growth (stem elongation rates) at later sowing times, but this was not necessarily translated into an increased accumulation of biomass probably because the early inflorescence development induced translocation of photosynthates to the panicle.

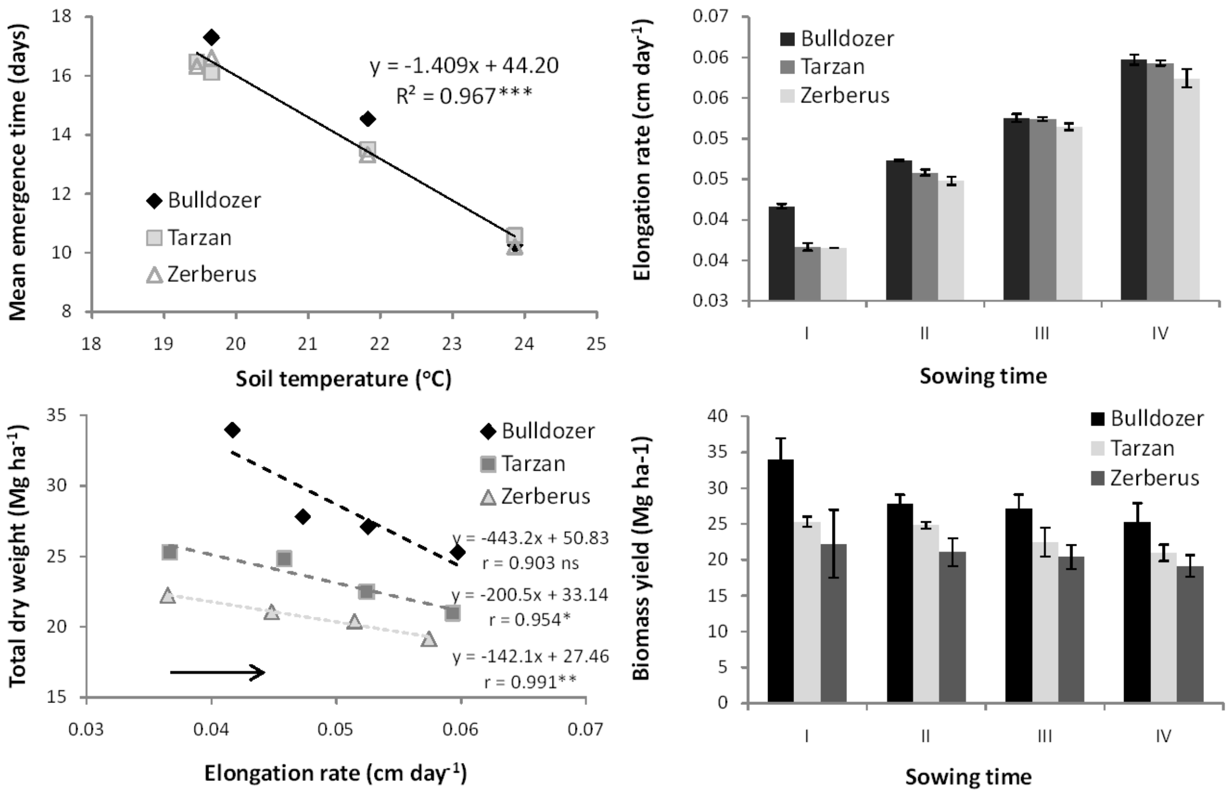

Fig. 1. Mean emergence time (top left), averaged season relative growth rate (top right) based of plant height measurements, relationship between total biomass production and elongation rate (bottom left), and total dry biomass productivity (bottom right) of three sweet sorghum hybrids sowed at four sowing times (I = 24 march; II = 7 April; III = 19 April; IV = 9 May).

Among the ICRISAT hybrids (ICSSH 19, ICSSH 31, and ICSSH 58) production ranged between 19.6 and 25.6 Mg ha^{-1} of total biomass, with the ICSSH 19 being the most productive and ICSSH 58 the least, though no significant differences between ICSSH 31 and ICSSH 58 were found (data not shown). These yields are comparable to those obtained with the KWS hybrids sowed in May. The laboratory analysis will reveal if they also have similar qualitative traits or not. Moreover next field trial will help to identify the most cold resistant ICRISAT hybrid.