Seventh framework programme
Food, Agriculture and Fisheries, and Biotechnology

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

Sweet Fuel

Sweet Sorghum
an alternative energy Crop

Grant Agreement n° 227422

Deliverable 1.15:

Over 10 sorghum hybrids with a PIU ≥ 30days recommended for temperate zones biomass production

Composition of the consortium

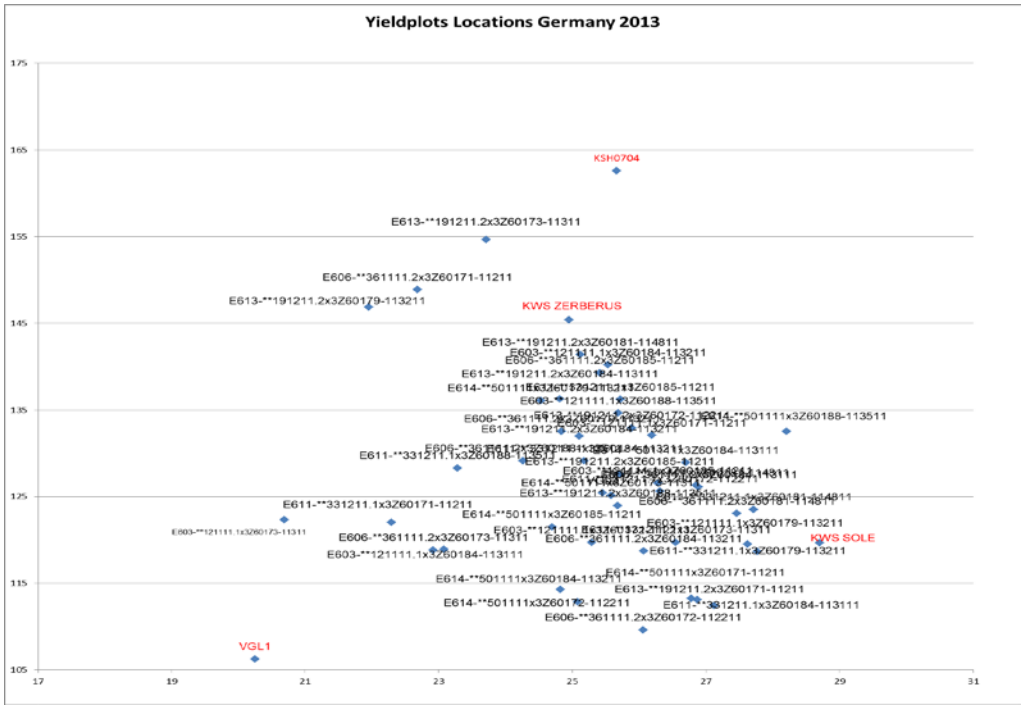
CIRAD
ICRISAT
EMBRAPA
KWS
IFEU
UniBO
UCSC
ARC-GCI
UANL
WIP

Results (KWS):

Results of the testing locations in Italy and Germany

Testcross hybrid seed (TC-seed) was planted on six locations in Germany and on two locations in Italy. Based on the results from the per se selection and the yield test data a set of females and restorer were selected for hybrid seed production in the winter nursery. TC seed was produced on five females (E603-**121111, E606-**361111, E611-**331211, E613-**191211, E614-**501111) and eight males from the restorer-pool (3Z60171-11211, 3Z60172-112211, 3Z60173-11311, 3Z60179-113211, 3Z60181-114811, 3Z60184-113111, 3Z60185-11211, 3Z60188-113511). In Germany 4 locations could be harvested (Einbeck, Uelzen, Klein Wanzleben and Seligenstadt). The location in Günzburg was lost, because of a low germination rate of the hybrids and Seydaland because of severe lodging before harvest.
In Graphic 1 the average yield compared to the dry matter content of the tested hybrids is shown (TDY = Total Dry matter Yield in dt/ha; TDC= Total Dry matter Content in %). To compare the new hybrids we used the check varieties KSH0704, KWS ZERBERUS, KWS SOLE and VGL1 (= variety BIOMASS 150). The germination rate of VGL1 was very low, so the yield potential of this hybrid is not correct shown in Graphic 1, but could be used for the alignment of our material for the trait TDC. The yield potential in 2013 is below the commercial hybrid KSH0704 in Germany. For a successful application of our hybrids it is necessary, that to reach an higher yield potential or dry matter content compared to the available hybrids on the market.

Graph. 1: Yield potential of the tested restorer lines compared to the Checks (VGL 1 /Biomass 150, KWS ZERBERUS, KSH0704 and KWS SOLE)



The year 2013 was not a typical selection year compared to the last testing years for sorghum. The spring was too cold and the planting season started more or less three to four weeks later than normal. In Italy a long rainy period delayed also the planting. During the summer months the rainfall did not reach the normal limit and especially on sandy soils sorghum stops completely growing. Earliest time to start with the harvest was end of October, because the average dry matter content of the material was too low. This could be seen in Graph 1, where most of the tested material reached only 24 up to 27% TDC. For a variety application out of the Sweetfuel germplasm no hybrids could be selected.
In Italy no yield data could be produced, because a thunder storm destroyed our testing locations right before harvest.
The year 2013 will decrease the acceptance of farmers in Germany and Italy to grow Sorghum for biomass production. Compared with the yield potential of the available corn hybrids most of the farmers are disappointed with potential of sorghum in Germany.

Hybrids tested by CIRAD in France

Two yield trials evaluating respectively 44 and 7 experimental hybrids were planted at Montpellier during the 2013 summer season.

In the first trial, 44 top-cross hybrids made between the 44 male lines selected at Montpellier in 2012 and a KWS female, were planted in a preliminary yield trial with two commercial checks (Hercules and Bulldozer). After planting, the trial suffered unusual cold temperatures during all second half of May (4° below normal temperatures for this period), which gave adequate conditions for evaluating these hybrids for their early growth vigour and tolerance to low temperatures. Date of 50% flowering, plant height, stem thickness, lodging tolerance and phenotypic desirability were also assessed for all experimental hybrids and commercial checks. Dry matter content at harvest time (DM) and total dry matter yield (TDY) were measured only for the most promising hybrids and the controls.
Table 1 gives the agronomic performance and total biomass yield of the best top-cross hybrids compared to the two controls.
One hybrid showed total dry biomass yield of 29 t ha^{-1} similar to the commercial checks with a difference of about two weeks in flowering date. Seven new hybrids gave yields above 20 t ha^{-1} with a total cycle (from emergence to harvest) of less than 110 days and a dry matter content of biomass harvested above 35%. These “short-cycle” hybrids can be of great interest for sowing in double-cropping systems (e.g. late plantings after harvesting a winter cereal or rapeseed).

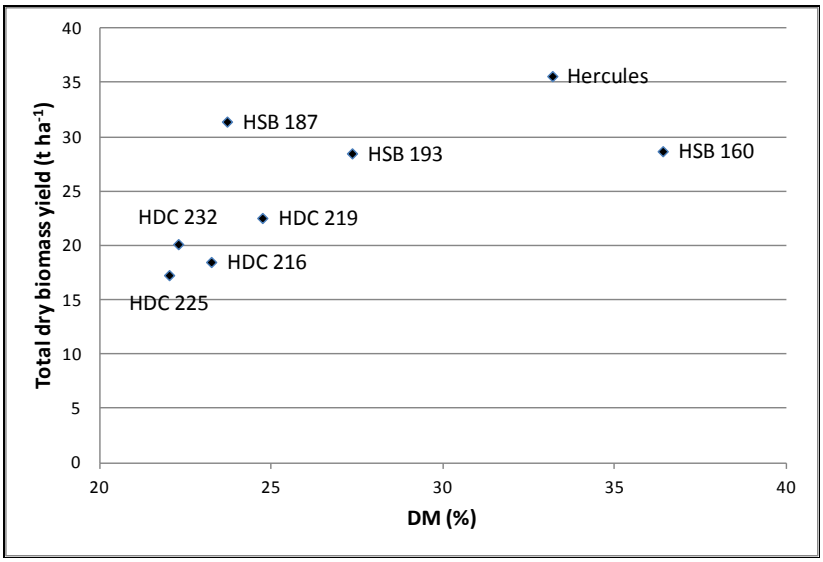
Table 1: Agronomic performance and dry biomass yield of the top 12 test-cross hybrids made with the new male lines derived from the WP1 breeding program on Restorer pool (Montpellier, Summer 2013)

Hybrid code	Vigour of emergence (30/5)!	Early growth vigour ! (17/06)	Date of 50% flowering	Plant height (cm)	Stem thickness !	Lodging at harvest (%)	Phenotypic desiderability !	DM content at harvest time	TDY	Days to harvest
341602 x 3Z60171-112611	**3**	**1**	31-aug	290	5	0	3	32.38	**29.19**	122.00
341602 x 3Z60171-11112	5	4	10-aug	230	4	0	4	38.47	**25.73**	106.00
341602 x 3Z60173-116611	**3**	4	11-aug	270	6	0	4	44.42	**24.28**	107.00
341602 x 3Z60173-113111	**2**	**3**	07-aug	225	6	10	5	43.84	**23.81**	103.00
341602 x 3Z60173-112311	5	5	11-aug	280	5	0	3	40.13	**22.57**	107.00
341602 x 3Z60173-112311	**2**	**3**	12-aug	260	7	0	5	41.23	**21.87**	110.00
341602 x 3Z60173-116111	**3**	5	09-aug	260	5	0	4	42.43	**21.41**	106.00
341602 x 3Z60173-115311	**3**	**3**	07-aug	230	6	0	5	37.78	**20.19**	103.00
341602 x 3Z60170-11111	5	**3**	06-aug	220	5	0	5	39.83	**19.64**	103.00
341602 x 3Z60170-112911	**2**	**3**	08-aug	235	6	0	5	35.69	**19.19**	103.00
341602 x 3Z60173-114311	**1**	**3**	03-aug	225	7	0	5	36.88	**18.93**	100.00
341602 x 3Z60173-116511	**3**	**3**	10-aug	250	5	0	4	34.20	**18.22**	106.00
Hercules (comm. Check)	**6.4**	**4.6**	**15/9**	**338**	**2.5**	0	**2**	**31.38**	**29.80**	124.00
Bulldozer (comm. Check)	**7**	**6.2**	**>15/9**	**358**	**3**	0	**2**	**31.14**	**28.96**	124.00

1-9 scale where 1 is the best and 9 is the worth; TDY= total dry yield in t ha^{-1}

In the second trial, seven "long-cycle" biomass hybrids from Cirad were evaluated for the second year. The design was a randomized block design with two replicates. Biomass 140 (Hercules) was used as the commercial check. Each genotype was planted in two-rows plots of 5 m long. Early growth vigour, date of 50% flowering, plant height, stem thickness, lodging at harvest, phenotypic desirability, Dry matter (%) and Total Dry biomass Yield (t ha^{-1}) were assessed for all the hybrids. Harvest was carried out about 30 days after flowering date (mid-dough grain stage) for photoperiod-insensitive hybrids (one hybrid) and during the first week of October for all the photoperiod-sensitive hybrids.

With colder temperatures during May and June when compared with 2012 summer season, the hybrids from tropical origin (HDC codes) could not confirm in 2013 the high yield obtained in 2012 (example of HDC 219). In 2013, these HDC hybrids were also disadvantaged by lower plant density. Among the other experimental hybrids, HSB 160 (TDY of 28.7 t ha^{-1}, DM of 36.4%) and HSB 193 (TDY of 28.5 t ha^{-1}, DM of 28.4%) showed the best results but neither could outyield the commercial hybrid Hercules (Graph 2).



Graph 2: Yield potential and DM content at harvest of long-cycle biomass hybrids compared to the commercial check Hercules, Montpellier Summer 2013.