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DEVELOPMENT OF POST-FLOWERING DROUGHT TOLERANT SORGHUM HYBRIDS FOR THE SAHELIAN ZONE

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ABSTRACT

Sorghum is the fourth most produced cereal in Mali following maize, rice and millet. It is grown either in rainfed conditions or in flood recession conditions in lakes, ponds or along the Niger and Senegal rivers. However, its yield (829 kg/ha) remains low due to various abiotic and biotic constraints, including the effects of post flowering drought. One of the limiting factors of its production in the Sahelian zone remains the very frequent post-flowering drought. Data collected from Mali's meteorological stations from Niono to Sikasso indicates a prevalence of drought in every other year between 1950 and 2015.

The development of post-flowering drought-tolerant sorghum hybrids is one of the best approaches to increase the level of sorghum productivity and production in the Sahelian zone, which is often affected by the effect of drought. Thus, A/B lines (sterility maintainer) and R lines (fertility restorer) with the "stay green" trait have been developed in Mali . The objective is to ensure food security and income of farmers in the Sahelian zone of Mali through the development and dissemination of sorghum hybrids tolerant to post -flowering drought .

Thirty-eight (38) hybrids from combinations between the different groups of parents were compared to 2 controls in a 2-replication Alpha lattice design. The study was conducted at the Kolombada Agricultural Research Substation and the Cinzana Agricultural Research Station). The characteristics analyzed were plant height, number of green leaves at physiological maturity and grain yield.

The evaluation showed through statistical analysis, significant différences between hybrids for plant height, number of green leaves and grain yield. The average plant height varied from 250 to 130 cm in Kolombada against 317 to 117 cm in Cinzana . The number of green leaves at physiological maturity varied from 4 to 7 in Kolombada and from 3 to 6 in Cinzana . In Kolombada, grain yield varied from 915 kg/ha to 4841 kg/ha against 363 kg/ha to 3503 kg/ha in Cinzana. The gain in grain yield of the hybrids compared to the best hybrid control Fadda varied from 25 to 106%, thus confirming the performance of the new hybrids compared to the hybrids in diffusion. The results of the drought indices (GMP and YSI) made it possible to distinguish twenty-one new hybrids tolerant to post-flowering drought. The identified hybrids will thus be evaluated in areas with low rainfall.

Keywords: Sorghum Bicolor, Hybrids, Stay -green, Tolerance, Grain Yield, Post-flowering Drought, Food Safety

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1. INTRODUCTION

Sorghum [Sorghum bicolor (L.) Moench] is one of the main cereals grown in the world. It ranks fifth in the world after wheat, rice, corn and barley. It generally constitutes the basis of the diet of the majority of the population in tropical semi-arid zones. It remains one of the main cereal crops in developing countries. Mali is one of the major producers of sorghum in West Africa with a production of 1,360,684 tonnes for 1,639,394 ha (DNA 2022). The main constraints to sorghum cultivation are insufficient and poorly distributed rainfall, low soil fertility, low productive potential of local varieties, insects, weeds, diseases, socio-economic conditions and especially drought, which often leads to food shortages. Indeed, drought is one of the main limiting factors of agriculture in the Sahelian zone of Mali (TRAORE et al. 2007). Terminal drought (post-floral) requires special attention because it is the most recurrent form in the arid and semi-arid regions of Mali. The development of varieties (OPV and hybrids) of drought-tolerant sorghum is one of the best approaches to increase the level of productivity and production in the Sahelian zone often reduced by the effect of drought. In sorghum, the form of drought tolerance best characterized at the post-floral stage is the "stay green" trait. Thus, A/B lines (sterility maintainer) and R lines (fertility restorer) with the "stay green" trait have been developed in Mali (SISSOKO et al. 2015). It is therefore important to develop hybrids for their tolerance to post-floral drought. However, F1 hybrids have contributed significantly to increasing cereal and fodder yields in most countries of the world. House et al. (1996) showed that the percentage increase in grain yield of the hybrid compared to improved and local varieties was 15 to 66% and 7 to 131%, respectively. According to (Rattunde 2011), the grain yield of a hybrid can increase by more than 30% than local varieties in station and 20% in farm environment.

The aim of this study is to increase sorghum production and productivity in Mali through the development of hybrids tolerant to post-flowering drought and well adapted to the agro-ecological conditions of the Sahel. The methodology used will allow:

- Determine the agro-morphological parameters of hybrids under different water supply conditions
- Identify hybrids tolerant to post-flowering drought and combining grain yields and grain quality

2. F1 EVALUATION OF F1 HYBRIDS FOR THEIR TOLERANCE TO POST-FLOWERING DROUGHT

The trial was implemented in two sites.

- **The Kolombada Agricultural Research Substation**

It is located in the Koulikoro Region, in the Rural Commune of Guégneka. The geographical coordinates are latitude 12041', longitude 7059' and altitude 310 m (Figure 5). The climate is Sudano-Sahelian with two seasons. A rainy season from June to October and a dry season from November to May. The dry season is subdivided into a cold period, from November to February and a hot period, from March to May. The soil is of two types: sandy-clayey and sandy-loamy.

- **The Cinzana Agronomic Research Station**

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The Cinzana Agronomic Research Station is located in the Rural Commune of Cinzana, 45 km from Ségou and 5 km from the tarred national road (RN6) (Ségou-Mopti axis). It is on longitude 5057'West, latitude 13015' North and has an altitude of approximately 280 m. The climate is Sudano-Sahelian with an average annual rainfall of 400 to 600 mm. There are different types of soil.

- **Rainfall situation in the countryside**

In 2022, the average annual rainfall was above normal in both sites: 1216.9 mm in Kolombada and 806.2 mm in Cinzana. The month of October corresponding to the flowering and grain filling stages was little watered for the good filling of the grains in Kolombada as well as in Cinzana (Figure 1). On the other hand, in 2023 it was slightly lower than in 2022. Periods of drought were observed throughout the campaign in Cinzana

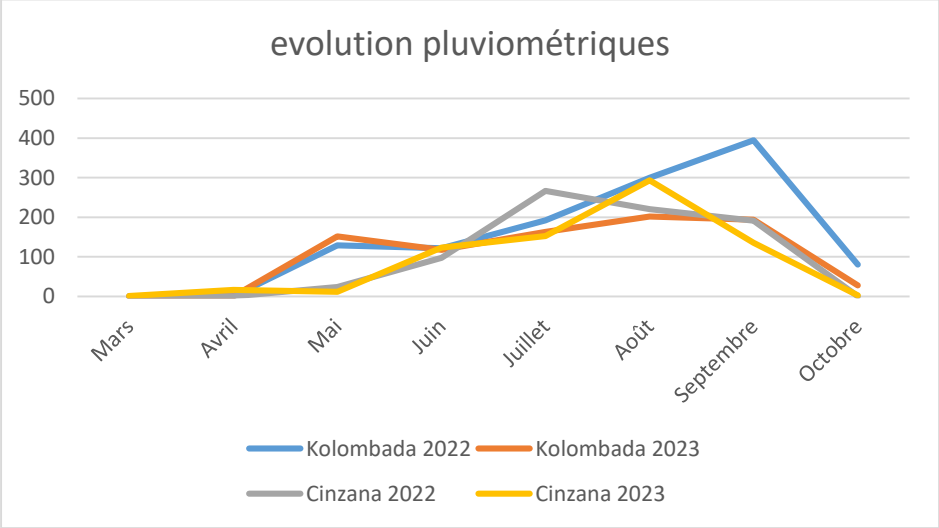

Figure 1: Rainfall (mm) of 2022 and 2023 in the two sites

3. MATERIALS AND METHODS

Thirty-eight (38) hybrids produced and the two controls were evaluated in an alpha lattice system in two replicates. Each hybrid was sown on 2 lines of 3 m long at spacings of 0.75 m between the sowing lines and 0.30 m on the sowing line. Thinning was carried out at two plants per pocket. The seeds were treated with Apron Star, a fungicide/insecticide against damping-off and insect damage at a dose of 10 g of the product/4 kg of seeds. 100 kg of cereal complex (17N-17P-17K) was applied per hectare 15 days after sowing. Urea was applied at a dose of 50 kg/ha at heading. Observations focused on plant height, number of green leaves at physiological maturity and grain yield.

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Table 1: List of F1 hybrids and their respective parents.

N°	Females	Males	Hybrids	N°	Females	Males	Hybrids
1	104P1-2A	021-ECS-102	104P1-2A/021-ECS-102	20	104P3-2A	021-EPDU -134	104P3-2A/021-EPDU -134
2	104P1-2A	021-ECS-174	104P1-2A/021-ECS-174	21	12A	021-ECS-102	12A/021-ECS-102
3	104P1-2A	021-ECS-25	104P1-2A/021-ECS-25	22	12A	021-ECS-25	12A/021-ECS-25
4	104P1-2A	021-ECS-43	104P1-2A/021-ECS-43	23	12A	021-ECS-43	12A/021-ECS-43
5	104P1-2A	021-ECS-123	104P1-2A/021-ECS-123	24	12A	021-ECS-123	12A/021-ECS-123
6	104P1-2A	021-ECS-82	104P1-2A/021-ECS-82	25	12A	021-ECS-82	12A/021-ECS-82
7	104P1-2A	021-ECS-45	104P1-2A/021-ECS-45	26	12A	021-ECS-86	12A/021-ECS-86
8	104P1-2A	021-ECS-95	104P1-2A/021-ECS-95	27	12A	021-ECS-71	12A/021-ECS-71
9	104P1-2A	021-ECS-71	104P1-2A/021-ECS-71	28	12A	021-ECS-81	12A/021-ECS-81
10	104P1-2A	021-ECS-81	104P1-2A/021-ECS-81	29	12A	021-EPDU -134	12A/021-EPDU-134
11	104P3-2A	021-ECS-102	104P3-2A/021-ECS-102	30	ICSA176003	021-ECS-102	ICSA176003/021-ECS-102
12	104P3-2A	021-ECS-174	104P3-2A/021-ECS-174	31	ICSA176003	021-ECS-174	ICSA176003/021-ECS-174
13	104P3-2A	021-ECS-25	104P3-2A/021-ECS-25	32	ICSA176003	021-ECS-25	ICSA176003/021-ECS-25
14	104P3-2A	021-ECS-43	104P3-2A/021-ECS-43	33	ICSA176003	021-ECS-123	ICSA176003/021-ECS-123
15	104P3-2A	021-ECS-82	104P3-2A/021-ECS-82	34	ICSA176003	021-ECS-86	ICSA176003/021-ECS-86
16	104P3-2A	021-ECS-86	104P3-2A/021-ECS-86	35	ICSA176003	021-ECS-45	ICSA176003/021-ECS-45
17	104P3-2A	021-ECS-45	104P3-2A/021-ECS-45	36	ICSA176003	021-ECS-95	ICSA176003/021-ECS-95
18	104P3-2A	021-ECS-95	104P3-2A/021-ECS-95	37	ICSA176003	021-ECS-81	ICSA176003/021-ECS-81
19	104P3-2A	021-ECS-71	104P3-2A/021-ECS-71	38	ICSA176003	021-EPDU -134	ICSA176003/021-EPDU-134

- Drought Tolerance Index

Thirty-eight (38) hybrids from combinations between different parents were planted under these natural rainfall conditions. Two indices were used to evaluate these hybrids for drought tolerance.

- ✓ Yield Stability Index (YSI) (higher index is better)
- ✓ Geometric Mean Productivity (GMP), (higher value is better)

Kolombada = Rainfed condition without drought period

Cinzana = Rainfed condition with drought periods

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Table 2: Formulas used for drought index

No.	Formulas	Authors	Significations
2	YSI: Yield stability index = Ys / Yp	Bouslama and Schapaugh (1984)	A higher index means drought tolerance under water stress and without water stress.
4	GMP: Geometric mean productivity = (Yp*Ys) 0.5	Fernandez (1992)	A higher index means drought tolerance in the event of water stress and no water stress between the two irrigation levels.

4. RESULTS

- **Plant heights (cm)**

The results of the analysis of variance revealed a highly significant difference between the hybrids for plant height with a repeatability of 44 to 67% (Appendix ?).

The average plant height measured at Kolombada was 185 cm. The hybrid ICSA176003/021-ECS-25 E36-1 (154 cm) was the shortest while the sensitive control Fadda (254cm) gave the tallest height (Appendix 1).

At Cinzana, the hybrids ICSA176003/021-ECS-45 (317cm), 104P1-2A/021-ECS-71 (258 cm) had a tall height. On the other hand, the sensitive control Fadda (117 cm) was the shortest (Appendix 1).

- **Number of green leaves at physiological maturity**

The results of the analysis of variance showed a highly significant difference between the hybrids for the number of green leaves at physiological maturity in both localities with a repeatability of 52 to 55% (Appendix ?). In Cinzana, the mean number of green leaves at physiological maturity was 5 (Appendix 1). The highest number of green leaves at physiological maturity (7) was obtained by B35 the control of tolerance to post-floral drought. Seven hybrids had a higher number of green leaves at physiological maturity (6) compared to the controls E36-1 and Fadda.

In Kolombada, the mean number of green leaves at physiological maturity was 6 leaves. Hybrids 104P3-2A/021-EPDU -134 and 12A/021-ECS-86 had the lowest mean number of green leaves (3) (Appendix 1). The highest mean number of green leaves (7) was recorded by 4 hybrids (104P3-2A/021-EPDU-134, 104P3-2A/021-ECS-95, 104P1-2A/021-ECS-123, ICSA176003/021-ECS-174, ICSA176003/021-ECS-102, 104P1-2A/021-ECS-71) and the resistant control E36-1.

- **Grain yield (kg/ha)**

ANALYSIS OF VAGINAL showed highly significant differences among hybrids for grain yield across all sites with a repeatability of 46 to 76% (Appendix 1). In Kolombada, grain yield of

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hybrids varied from 362 to 4841 kg/ha with an average of 2793 kg/ha (Appendix 3). Twenty-three hybrids were more productive than the resistant control E36-1 (1246 kg/ha) and the sensitive control Fadda (2244 kg/ha) to post-flowering drought (Appendix 1).

In Cinzana, the average grain yield observed was 1907 kg/ha (Appendix 2). The hybrids ICSA176003/021-ECS-25 (3503 kg/ha), 104P1-2A/021-ECS-71 (3430 kg/ha) and 12A/021-ECS-123 (3293 kg/ha), were more productive than the tolerant control E36-1 (1842 kg/ha) and the sensitive control Fadda (972 kg/ha). The lowest grain yield (363 kg/ha) was recorded by the hybrid 104P3-2A/021-ECS-25 (Appendix 1). For all localities combined, the grain yield gain of the hybrids compared to the best sensitive hybrid control Fadda varied from 23% to +106% (Appendix 1). Thirty-four (34) hybrids recorded the best gains in grain yields compared to the best control which is the Fadda hybrid (Appendix?).

- **Identification of hybrids tolerant to post-flowering drought**

The two tolerance indices derived from grain yield: the yield stability index (YSI) and the geometric mean productivity index (GMP) were used to determine drought tolerant hybrids.

- ✓ The yield stability index (YSI) ranged from 0.09 to 1.77 with an average of 0.76. The hybrids ICSA176003/021-ECS-25 (1.77), 12A/021-ECS-86 (1.70) and 12A/021-ECS-71 (1.54) recorded the highest values of the yield stability index compared to the resistant control E36-1 (1.48) and, Twenty-eight hybrids recorded the highest values of the yield stability index compared to the sensitive control Fadda (0.43). (Table 4). These hybrids are therefore tolerant to drought. On the other hand, two hybrids obtained the lowest value of the yield stability index.

- ✓ The geometric mean productivity (GMP) index varied from 0.02 to 5.42. Thirty-four hybrids recorded the highest values of the geometric mean productivity index compared to the two controls resistant E36-1 and sensitive Fadda. (Table 4). In both indices (YSI and GMP) hybrids 104P1-2A/021-ECS-43, 104P1-2A/021-ECS-45, 104P1-2A/021-ECS-71,104P3-2A/021-ECS-71,104P3-2A/021-ECS-45,12A/021-ECS-102, 12A/021-ECS-123, 12A/021-ECS-43, 12A/021-ECS-81 and ICSA176003/021-ECS-86 (Table 4) are among the best in grain yield at both sites. Twenty-one hybrids are among the best in both drought tolerance indices.

Table 3: Results between grain yield (t/ha) and drought tolerance indices on the station

N°	Designations	Grain yield (t/ha)		Drought Tolerance Index Values	
		Cinzana	Kolombada	YSI	GMP
1	104P1-2A/021-ECS-102	1,813	3,289	0,55	2,98
2	104P1-2A/021-ECS-123	1,014	3,762	0,27	1,91
3	104P1-2A/021-ECS-174	2,111	3,685	0,57	3,89
4	104P1-2A/021-ECS-25	2,703	2,743	0,99	3,71

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5	104P1-2A/021-ECS-43	2,897	3,741	0,77	5,42
6	104P1-2A/021-ECS-45	2,555	2,483	1,03	3,17
7	104P1-2A/021-ECS-71	3,43	2,736	1,25	4,69
8	104P1-2A/021-ECS-81	1,893	4,215	0,45	3,99
9	104P1-2A/021-ECS-82	2,251	4,164	0,54	4,69
10	104P1-2A/021-ECS-95	1,148	4,841	0,24	2,78
11	104P3-2A/021-ECS-102	2,033	3,2	0,64	3,25
12	104P3-2A/021-ECS-174	2,154	2,263	0,95	2,44
13	104P3-2A/021-ECS-25	0,363	3,859	0,09	0,7
14	104P3-2A/021-ECS-43	1,069	3,645	0,29	1,95
15	104P3-2A/021-ECS-45	2,761	3,054	0,9	4,22
16	104P3-2A/021-ECS-71	2,568	3,256	0,79	4,18
17	104P3-2A/021-ECS-82	2,686	2,264	1,19	3,04
18	104P3-2A/021-ECS-86	0,668	3,291	0,2	1,1
19	104P3-2A/021-ECS-95	2,038	2,496	0,82	2,54
20	104P3-2A/021-EPDU -134	1,892	2,441	0,78	2,31
21	12A/021-ECS-102	2,803	3,098	0,9	4,34
22	12A/021-ECS-123	3,293	2,672	1,23	4,4
23	12A/021-ECS-25	0,454	1,491	0,3	0,34
24	12A/021-ECS-43	2,861	3,296	0,87	4,71
25	12A/021-ECS-71	2,84	1,847	1,54	2,62
26	12A/021-ECS-81	2,523	2,751	0,92	3,47
27	12A/021-ECS-82	1,926	2,287	0,84	2,2
28	12A/021-ECS-86	1,555	0,915	1,7	0,71
29	12A/021-EPDU-134	1,378	1,857	0,74	1,28

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30	ICSA176003/021-ECS-102	0,671	3,561	0,19	1,19
31	ICSA176003/021-ECS-123	1,67	2,521	0,66	2,11
32	ICSA176003/021-ECS-174	2,326	2,503	0,93	2,91
33	ICSA176003/021-ECS-25	3,503	1,975	1,77	3,46
34	ICSA176003/021-ECS-45	1,601	2,885	0,55	2,31
35	ICSA176003/021-ECS-81	1,029	3,079	0,33	1,58
36	ICSA176003/021-ECS-86	2,618	2,828	0,93	3,7
37	ICSA176003/021-ECS-95	1,052	2,551	0,41	1,34
38	ICSA176003/021-EPDU-134	2,279	3,412	0,67	3,89
Témoins					
	E36-1	1,842	1,246	1,48	1,15
	Fadda	0,972	2,244	0,43	1,09
	Moyenne	1,94	2,8	0,76	2,73
	Maximum	3,5	4,841	1,77	5,42
	Minimum	0,13	0,362	0,09	0,02

- Indices: GMP (higher value is better), YSI (higher index is better)

5. DISCUSSION

For plant height, significant variability was observed between hybrids and controls in both environments. The average height of plants observed was low in Cinzana (175 cm) compared to Kolombada (185 cm). With good rainfall (1037 mm) in Kolombada, hybrids had good plant growth resulting in an increase in plant height compared to Cinzana which recorded low rainfall (770.8 mm). Similar results were obtained by other authors. According to BRETAUDEAU et al. (1994), plants grow more in good water conditions than in water stress conditions. This justifies the good growth of plants in Kolombada. Lack of water is a determining factor for plant growth, particularly in arid and semi-arid areas. It induces in stressed plants a decrease in relative water content, internode length and a significant reduction in biomass production following a reduction in growth in diameter and height of stems (ALBOUCHI et al. 2003, DIALLO D., 2009).

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The average number of green leaves at physiological maturity observed was 5 in Cinzana and 6 in Kolombada. It could be deduced that these hybrids have the stay-green trait which is one of the indicators of tolerance to post-floral drought (Sissoko, 2015).

The decrease in the average number of green leaves at physiological maturity of hybrids under Cinzana conditions confirms the results obtained by ROSENOW et al. (1997) who showed that sorghum loses significant leaves under post-floral drought conditions.

Significant differences were observed between the hybrids in both environments for grain yield indicating that there is variability between the hybrids and the controls in each environment. The lowest grain yield (1907 kg/ha) was observed in the environment that had undergone drought periods (Cinzana) compared to Kolombada (2793 kg/ha) where there were no drought periods. Overall, the hybrids were more productive than the controls. The grain yield gain of the hybrids compared to the best hybrid control Fadda varied from 23 to 106%, thus confirming the performance of the new hybrids compared to the hybrids in diffusion. Similar results were obtained by several authors including House et al. (1996) who showed that the percentage increase in grain yield of the hybrid compared to the improved and local varieties was 15 to 66% and 7 to 131%, respectively. In semi-arid regions of Africa, gains of 47 to 66% were obtained by Kapran et al. (1997). In Mali, Diallo A., (2013) recorded gains of the order of +15 to +126%. The post-floral drought tolerance indices ranged from 0.09 to 1.77 for YSI and 0.02 to 5.45 for GMP. Twenty-one hybrids were more tolerant to post-floral drought with a drought tolerance index ranging from 0.54 to 5.42. The authors (Majid et al. 2011; Thiry et al. 2016; Khalili et al. 2004; Sio-Se Mardeh et al. 2006) revealed that high levels of GMP, YSI indices indicate terminal drought tolerance as claimed. This confirms the tolerance of the twenty-one hybrids that have high rates of GMP and PYSI indices. Similar results were obtained in Mali Teme et al (2022), mentions in his report the tolerance efficiency of sorghum E-36-1 and Tiandougou ran at 85%. The hybrids thus identified could undergo evaluation in areas with low rainfall

6. CONCLUSION

Significant differences were observed between hybrids and controls for plant height. Under good rainfall conditions at Kolombada (1037 mm) except the control Fadda, all hybrids were short-statured ranging from 164 to 238 cm. The use of parents (male and female) with reduced height allows to have hybrids with reduced height recommended for intensive production. The average number of green leaves in both conditions was 5 at Cinzana and 6 at Kolombada. It could be concluded that the hybrids have stay-green traits.

The hybrids performed better than the controls. The grain yield gain of the hybrids compared to the sensitive hybrid control Fadda varied from 23% to +106%. Thirty-three hybrids recorded the best grain yield gains compared to the hybrid control Fadda.

The hybrids ICSA176003/021-ECS-25 (1.77), 12A/021-ECS-86 (1.70) and 12A/021-ECS-71 (1.54) recorded the highest index values compared to the resistant control E36-1 tolerant. The hybrids with the highest index values compared to the tolerant control and the susceptible control can be considered tolerant to post-flowering drought. The hybrids identified as tolerant to post-flowering drought could be evaluated in the Sahelian areas with low rainfall.

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Appendix 1: Summary of the analysis of variance of the different parameters

Designations	Height of plants		Number of green leaves		Grain yield (kg/ha)			
	KO	CZ	KO	CZ	KO	CZ	Moyenne	Gain/MT
104P1-2A/021-ECS-102	183	210	7	3	3289	1813	2551	59
104P1-2A/021-ECS-123	171	157	7	6	3762	1014	2388	49
104P1-2A/021-ECS-174	178	154	5	5	3685	2111	2898	80
104P1-2A/021-ECS-25	195	182	6	6	2743	2703	2723	69
104P1-2A/021-ECS-43	195	201	5	5	3741	2897	3319	106
104P1-2A/021-ECS-45	189	175	7	4	2483	2555	2519	57
104P1-2A/021-ECS-71	199	258	4	6	2736	3430	3083	92
104P1-2A/021-ECS-81	203	180	5	4	4215	1893	3054	90
104P1-2A/021-ECS-82	166	179	5	5	4164	2251	3208	100
104P1-2A/021-ECS-95	186	159	7	5	4841	1148	2995	86
104P3-2A/021-ECS-102	196	153	4	5	3200	2033	2617	63
104P3-2A/021-ECS-174	186	152	4	4	2263	2154	2209	37
104P3-2A/021-ECS-25	173	129	6	5	3859	363	2111	31
104P3-2A/021-ECS-43	199	166	6	4	3645	1069	2357	47
104P3-2A/021-ECS-45	191	166	6	5	3054	2761	2908	81
104P3-2A/021-ECS-71	190	159	6	3	3256	2568	2912	81
104P3-2A/021-ECS-82	164	205	4	5	2264	2686	2475	54
104P3-2A/021-ECS-86	181	156	6	4	3291	668	1980	23
104P3-2A/021-ECS-95	172	195	6	6	2496	2038	2267	41
104P3-2A/021-EPDU -134	190	210	6	5	2441	1892	2167	35
12A/021-ECS-102	210	214	6	5	3098	2803	2951	84
12A/021-ECS-123	189	161	7	6	2672	3293	2983	86
12A/021-ECS-25	178	151	4	4	1491	454	973	-40
12A/021-ECS-43	211	156	4	3	3296	2861	3079	91
12A/021-ECS-71	204	152	5	5	1847	2840	2344	46
12A/021-ECS-81	205	149	5	2	2751	2523	2637	64
12A/021-ECS-82	179	154	5	5	2287	1926	2107	31
12A/021-ECS-86	171	159	7	3	915	1555	1235	-23
12A/021-EPDU-134	191	168	5	5	1857	1378	1618	1
ICSA176003/021-ECS-102	185	155	5	5	3561	671	2116	32
ICSA176003/021-ECS-123	190	147	6	5	2521	1670	2096	30
ICSA176003/021-ECS-174	193	162	5	6	2503	2326	2415	50
ICSA176003/021-ECS-25	154	191	4	6	1975	3503	2739	70
ICSA176003/021-ECS-45	200	317	6	5	2885	1601	2243	40
ICSA176003/021-ECS-81	188	172	5	4	3079	1029	2054	28
ICSA176003/021-ECS-86	181	148	5	6	2828	2618	2723	69
ICSA176003/021-ECS-95	195	167	6	4	2551	1052	1802	12

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Designations	Height of plants		Number of green leaves		Grain yield (kg/ha)			
	KO	CZ	KO	CZ	KO	CZ	Moyenne	Gain/MT
ICSA176003/021-EPDU-134	198	179	6	4	3412	2279	2846	77
Témoins								
E36-1	159	140	7	5	1246	1842	1544	
Fadda	254	117	5	4	2244	972	1608	
Moyenne	**185**	**175**	**6**	**5**	**2793**	**1907**		
Probabilité	**<.001**	**0.012**	**<.001**	**0.020**	**<.001**	**0.005**		
PPDS	**30.54**	**68.85**	**1.927**	**1.992**	**1244**	**1788**		
CV%	**11.64**	**24.64**	**25.34**	**17.75**	**29.81**	**50.15**		
répétabilité	**67**	**44**	**55**	**52**	**76**	**52**		
Max	**254**	**317**	**7**	**8**	**4841**	**3503**		
Mini	**130**	**117**	**3**	**3**	**915**	**363**		

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