Midas

MARGINAL LANDS, INDUSTRIAL CROPS
AND INNOVATIVE BIO-BASED VALUE CHAINS

Deliverable D2.3 Testing advanced material on multi location trials

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Partners

UNICT, CRES, AUA, IFCV, CIEMAT

Introduction

D2.3 aims to present the first results of the work designed under sub-task 2.2.1 entitled "Advanced breeding material on multi-location trials". The aim of this sub task was to compare advanced breeding material (at high TRL: 6/7) of four industrial crops (3 annual: hemp, crambe and castor bean and one perennial: miscanthus) on multi-location field trials in Europe (Italy, Greece, Spain and Serbia) (Figure 1).

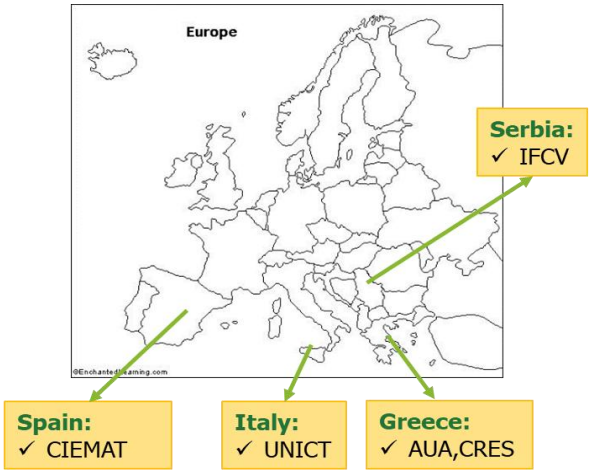


Figure 1: Sites of the multi-location field trials

The advanced breeding material has been obtained by breeding programs conducted by the Wageningen University during previous EU projects, with the exclusion of castor bean that the has been provided by Kaiima Company (Campinas—São Paulo, Brazil).

The annual industrial crops will be evaluated on the multi-location trials for at least two subsequent growing periods (2024 – 2025), while miscanthus will be establish in 2025 and maintained until the project completion. In table 1 presented the sites of the trials as well as the crops per site that will be tested. The crops are evaluated under non-limiting conditions, adopting irrigation and fertilization inputs to evaluate the crop potential in the environments where the crops are tested.

Table 1: Details of the multi-location field trials with advanced breeding material.

Partners	Crops	Selected crops	Site	Planned sowing period	Marginality factor
AUA, CRES	Miscanthus	+	Lexaina	Spring 2025	Unfavorable texture (sand >68%) Low organic matter (1.12%)
	Crambe	+	Lexaina	Early spring 2024	
	Hemp	+	Lexaina	Spring 2024	
	Castor	+	Lexaina	Spring 2024	
IFCV	Miscanthus				Excessive humidity, low soil fertility (low organic matter), unfavorable soil properties (salinity, high clay content), risks of flooding, underground water
	Crambe	+	Žabalj	Early spring 2024	
	Hemp	+	Žabalj	Spring 2024	
	Castor	+	Žabalj	Spring 2024	
CIEMAT	Miscanthus				Unfavorable texture (>75% Sand). Low organic matter ≈1%. Low rainfall (400-500mm) high aridity Index
	Crambe	+	CEDER. Lubia in Soria	Spring 2024	
	Hemp	+	CEDER. Lubia in Soria	Spring 2024	
	Castor	+	CEDER. Lubia in Soria	Spring 2024	
UNICT	Miscanthus	+	Uni. Farm Catania	Spring 2025	Low soil organic matter <1% Dryness: precip. / PET< 0.5 Low irrigation input for miscanthus and castor, rainfed for crambe and hemp
	Crambe	+	Uni. Farm Catania	Autumn 2024	
	Hemp	+	Uni. Farm Catania	Spring 2024	
	Castor	+	Uni. Farm Catania	Spring 2024	

CRES & AUA

Authors: *Efthymia Alexopoulou & Eleni G Papazoglou*

The field trials were set up in Lexaina in 2024 (Figure 2) for three annual crops: castor bean, crambe and hemp. The trials will be also carried out in 2025 and will be enlarged to include the trials of miscanthus genotypes.

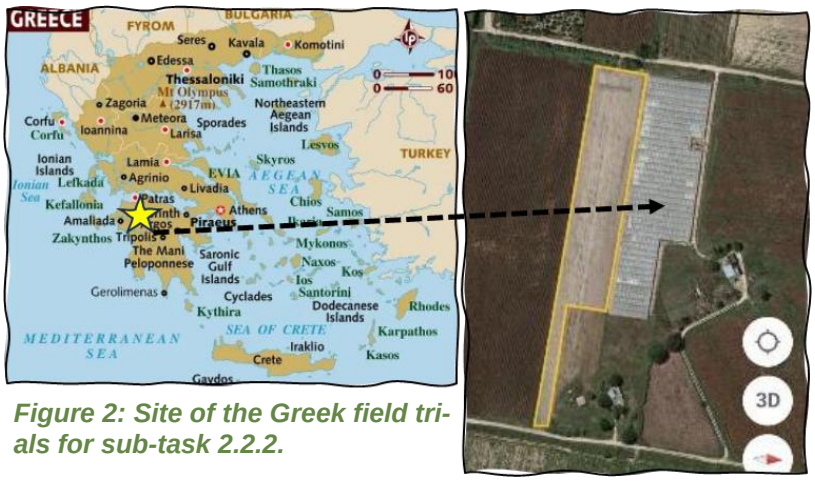


Figure 2: Site of the Greek field trials for sub-task 2.2.2.

In terms of castor bean two field trials had been carried out the 1st was focused on castor bean varieties (Dunay, Ibar, Beges, Rozi) provided by IFCV (Serbia) and the 2nd on castor bean hybrids (Tamar, KS2030, KS2019, Kariel, Mia) provided by KAIIMA company. In both castor bean trial, the comparison of the varieties/hybrids had been done in three blocks.

The hemp trial included four varieties: Futura 75, Futura 83, Fedora 17, Felina 32 in three blocks.

In Figure 3 presented the crambe trial at two-time frames. As it is shown the trial had a very nice density and the plantation was harvested 27th of June 2024 (103 growing cycle). Due to the late arrival of the seeds the crambe trial was sown on 11th of March 2024.

Figure 3: View of crambe field trial at two-time frames

The best mutant was the one with number 2 with seed yields of 1.61 t/ha, while the corresponding value for Galactica was 1.47 t/ha (Figure 4). All mutants (apart from M3) gave higher seed yields compared to Galactica. The dry straw yields (t/ha) at the final harvest were around 3.5 t/ha. The oil content of crambe mutants and Galactica will be measured as well as the calorific value of the residual biomass.

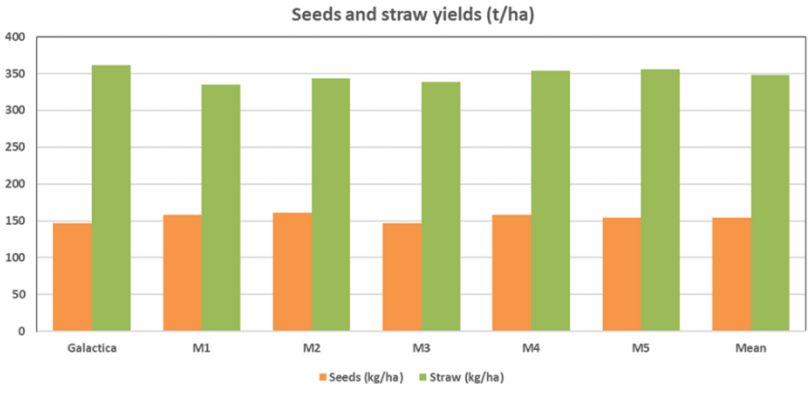


Figure 4: Seeds and straw yields (t/ha) for crambe mutants and Galactica in 2024

In terms of castor bean higher seed yields had been recorded by the hybrids provided by Kaiima company compared to the varieties provided by IFCV as presented in Figure 5.

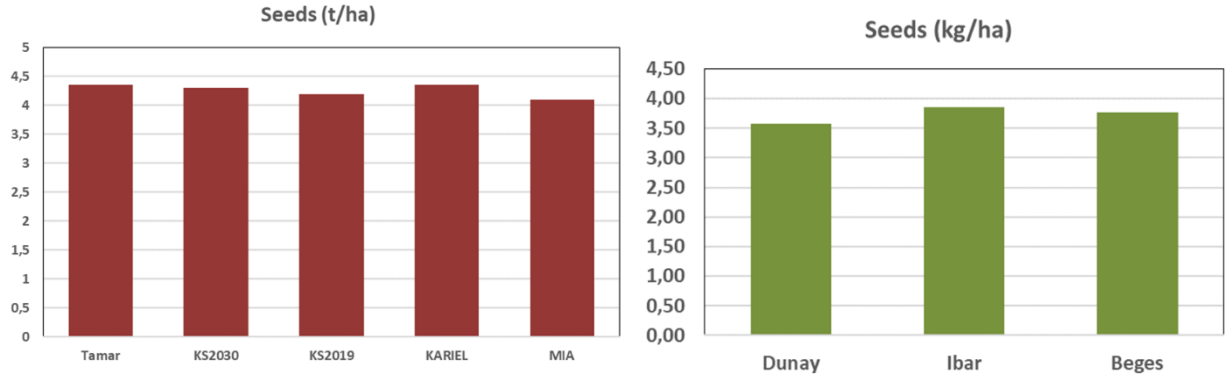


Figure 6: Comparison among the seed yields of castor bean hybrids from Kaiima on the left and among the varieties of IFCV on the right

Among the four varieties provided by IFCV the best performed was IBAR with 3.86 t/ha seeds. It was also the variety with the smaller percentage of green racemes at the harvest. It was impossible to harvest Rozi because all seeds at the harvested time were in the soil (Figure 6).

Among the five hybrids provided by KAIIMA the best performed was Tamar and Kariel with 4.36 t/ha seeds. Quite high yields were recorded by KS2030 (4.31 t/ha). The view of castor bean hybrids are presented in Figure 7.

Figure 5: View of Rozi plants at the maturity stages. The majority of the castor bean seeds were on the soil at the harvesting time (9/9/24).

Figure 7: View of castor bean trial where the Kaiima hybrids were compared.

Among the four varieties tested it was found out that Futura 75 and Futura 83 gave double dry stem yields compared to Fedora 17 and Felina 32 (Figure 8). Futura 83 was productive compared to Futura 75 and Felina 32 was productive compared to Fedora 17.

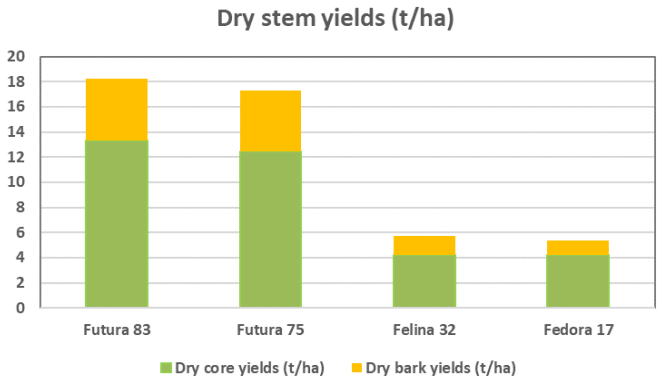


Figure 8: Comparison of dry stems yields (t/ha) among the four tested hemp varieties

CIEMAT

Authors: *Carlos Martín Sastre, Marina Sanz Gallego and Luis Saul Esteban*

The experimental site is located in Cubo de la Solana (Castile and León, Spain) and covers an area of 0.5 ha hectares (Figure 9). The soil is characterized by low organic matter ≈1%, as well as high sand content and significant stoniness (>15%), conditions that enhance drainage but may require measures to improve water retention and fertility. Climate conditions were Continental Mediterranean with cold winters, warm summers and low rainfall level.

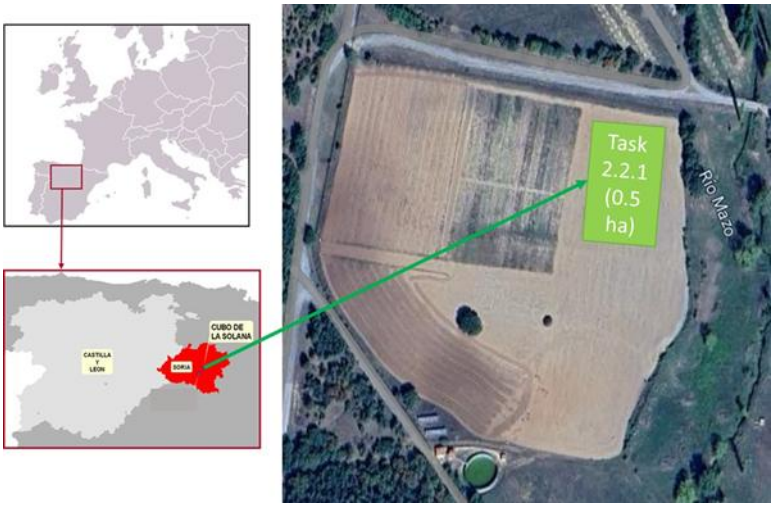
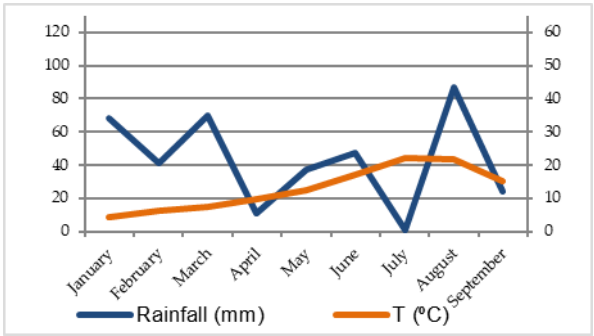


Figure 9: Location of experimental fields of the CEDER-CIEMAT in Lubia (Soria)

Figure 10: Establishment of the field experiment with three crambe and four hemp cultivars

The crops used for the field test were crambe (Crambe abyssinica Hochst. ex R. E. Fr.) cultivar Galactica, Mutant 2 and Mutant 5; Hemp cultivar Fedora 17, Futura 75, Futura 83 and Felina 32 (Figure 10). The crops were stablished following a randomized strip design with three repetitions of 100 m2 per each crop variety/cultivar. For the establishment of the crops 260 kg/ha of an N-P-K: 22-8-10 fertilizer was applied the 21th of May of 2024 in presowing. After the fertilization, a tillage operation with a cultivator was performed the 23rd of May of 2024. Finally, the sowing was performed using a seed drill the 24 of May of 2024 at the following seeding rates: 23 kg/ha for all crambe varieties and 28 kg/ha for Fedora 17, 35 kg/ha for Futura 75, 28 kg/ha for Futura 83 and 32 kg/ha Felina 32 hemp varieties.

The growing season was characterized by no rainfall in July and high temperatures (Figure 11), this situation together with the late sowing led to not harvesting crambe due to very low productivity for mechanical harvest (Table 2).



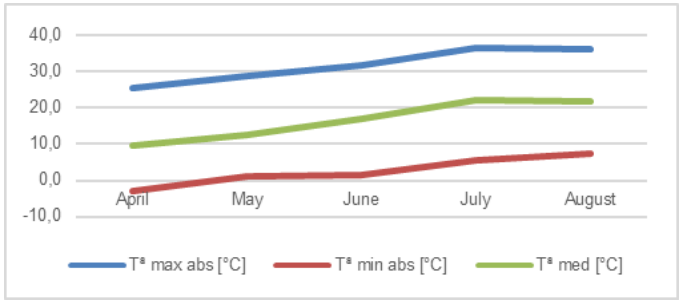


Figure 11: Meteorological data for the growing period.

As very low or cero rainfall could happen for summer months at Soria, we are studding a change in the sowing date to autumn for crambe for the second season, to see if we can obtain better results if autumn rains are well used by the crops and minimum temperatures are not too low for the crops.

The best hemp variety for 2024 season was Fedora 17 with a biomass yield of 3.15 Mg DM/ha (Table 2), this is because plants achieve a good height of around 2 m and had better establishment than the rest of the cultivars, almost 7 stems/m2 versus less than 4 stems/m2 for the others. In contrast, Felina 32 achieved the worst yield (1.278 Mg DM/ha) because plant development was worse (≈1.5 m height) and the establishment of the crop with 3.7 stems/m2 was not that good as for Fedora 17.

Table 2: Harvest results for species and cultivars (cv)

Crop	H (cm)	Number stems/m2	Yield (MgDM/ha)	Harvest Date
Crambe			Not Harvested	Not Harvested
Hemp cv Fedora 17	192	6.7	3.150	13/09/24
Hemp cv Futura 75	190	1.6	1.186	13/09/24
Hemp cv Futura 83	209	2.7	2.329	13/09/24
Hemp cv Felina 32	153	3.6	1.278	13/09/24

Figure 12: View of hemp trial (the harvest was done on 13th of September 2024)

In the next growing season, we will maintain most promising hemp varieties and we will try to incorporate others, if possible, more adapted to our climate conditions. We will try to sow before both crambe and hemp. We will study the possibility of watering but the availability is restricted.

IFCV (Institut Za Ratarstvo i Povrtarstvo Institut od Nacionalnog Znacaja za Republiku Srbiju)

Authors: *Ana Jeromela*

The experimental site is located in Žabalj (Serbia, Figure 13) and covers an area of 0,65 ha. The task was performed by team from the Institute of Field and Vegetable Crops - IFVCNS, and the same marginal field was used for the WP3 trial. Coordinates are: 45°20'44.4"N 20°04'37.0"E; Altitude (m asl): 77.

The site was opted because of the complex marginality structure. The marginality constraints of the chosen plot were:

- excessive humidity (limited soil drainage and excess soil moisture),
- low soil fertility (low content of organic matter),
- unfavorable soil properties (salinity, high clay content),
- bad conditions for rooting and unfavorable terrain conditions (risks of flooding, underground water)

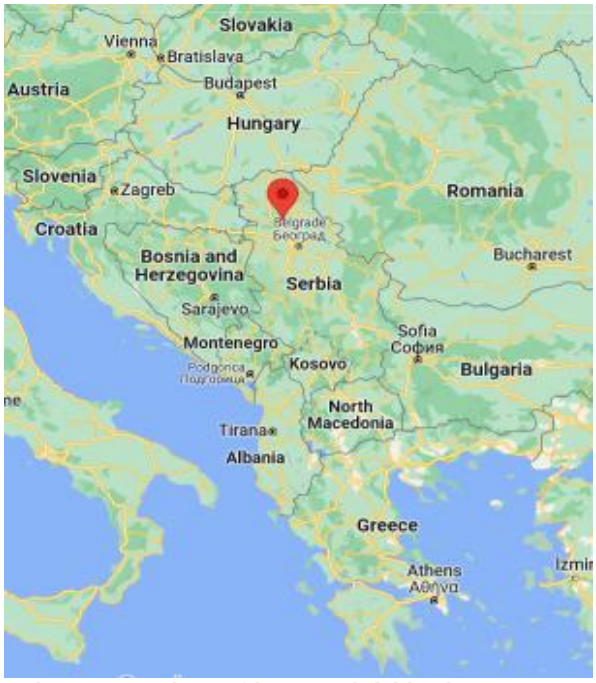


Figure 13: View of hemp trial (the harvest was done on 13th of September 2024)

Seedbed preparation was carried out, with plowing, followed by harrowing before sowing. Experimental trials (Figures 14, 15) were not fertilized. Kaiima company provided the castor bean seeds of the genotypes: C1012 A, C1012 B, C1016, while the genotypes: Begej, Dunav, Ibar and Rozi, were the result of the breeding efforts of the IFVCNS seed production programmes. Castor bean was sown manually due to the complexity of the trial plot, on April 22nd. The inter row spacing was 70cm.

17m	BEGEJ		DUNAV		IBAR		C1012A		C1012B		ROZI	
	5m	1m	5m	1m	5m	1m	5m	1m	5m	1m	5m	1m
	35m											

Figure 14: Layout of castor bean trial (6 varieties/hybrids) were compared.

In this season, temperatures in May were generally favorable for the initial stages of the development of summer crops. Season was characterized with temperatures above long-term average, especially during mid-July and August, when temperatures were 8°C and 7°C above the long-term average. All genotypes germinated, with the exception of C1016; however, the plants were stunted by the extremely high temperatures and prolonged drought that we experienced from the end of June through the beginning of September. This resulted in extreme dwarf growth, where the plant height did not exceed 60cm in any genotype (Figure 15). The plants managed to bloom and develop seeds (all except genotype Rozi) and seeds and biomass samples were collected immediately after harvest. The harvest date for all genotypes was 12 September 2024. We are planning to further

analyze the following traits: plant height, total plant weight, number of racemes, seed weight, biomass residues, oil content, fatty acid composition. In the next growing season, the experiment will be repeated with the same genotypes and using the same methodology.

Figure 15: View of the castor bean trial (6 varieties/hybrids) were compared.

Figure 16: View of the castor bean plants. Due to high temperatures and the drought periods the plants were too short and the development of the plants was not good.

UNICT (University of Catania)

Authors: *Salvatore Luciano Cosentino, Giorgio Testa, Sebastiano Andrea Corinzia*

The aim of the task is to compared advanced breeding material of hemp (*Cannabis sativa* L.), miscanthus (Miscanthus spp.), crambe (*Crambe maritima* L.) and castor bean (*Ricinus communis* L.) in multi-location field trials. The trial conducted by UNICT will compare 10 genotypes of castor (C1012, C1012, ID11, ID15, ID2, Kariel, KS2019, KS2030, Mia, Tamar) and 3 genotypes of hemp (Futura 83, Mona, Nashinoide) under non-limiting soil water availability. The trial has been set at the Experimental Farm of the University of Catania (10 m a.s.l., 37°24' N, 15° 03' E) in a soil with the following conditions: 11.8% silt, 55.9% sand, 32.3% clay, 1.4% organic matter.

The sowing of hemp took place on 7/05/2024 using a mechanical precision seeder at 125 m-2 germinable seeds density. The sowing of castor took place on 21/05/2024 using a manual single-row seeder (Terradonis) at 3.3 m-2 germinable seeds density for castor and sorghum respectively.

Figure 17: View of the hemp trial in Catania, Sicily

The trial of crambe and miscanthus will start in autumn 2024 and spring 2025 respectively. Irrigation is provided by a drip irrigation system providing 100% of maximum crop evapotranspiration (ETm) restoration. Daily ETm is calculated according to: ETm = ET0 × Kc, where ETm is the maximum daily evapotranspiration (mm) and Kc is the crop coefficients (Kc) according to (Allen et al., 1998, p. 56).

LAI increased during the growing cycle of hemp, reaching the highest values at the beginning of the flowering phase. Futura 83 reached the highest LAI at 4.3, while Mona and Nashinoide had lower LAI values, reaching 3.3 and 3.1 respectively (Figure 18).

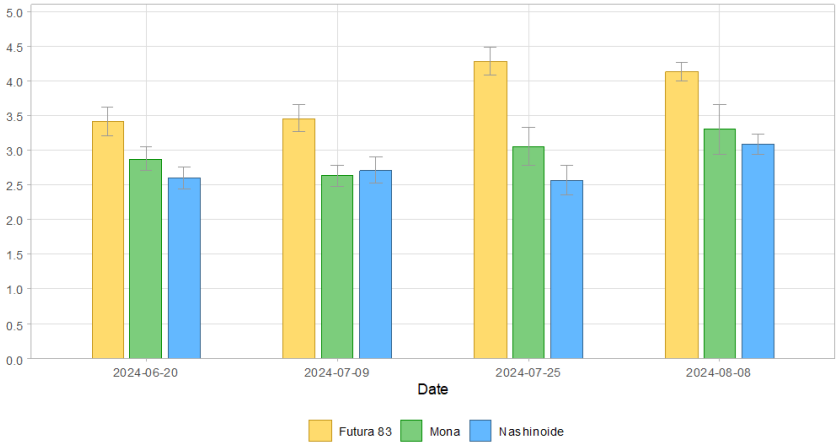


Figure 18: Leaf Area Index of 3 varieties of hemp (Futura 93, Mona, Nashinoide) during 3 dates.

Among the castor bean varieties, Kariel reached the highest LAI at 2.2, while Mia reached the lowest value at 1.3 (Figure 19).

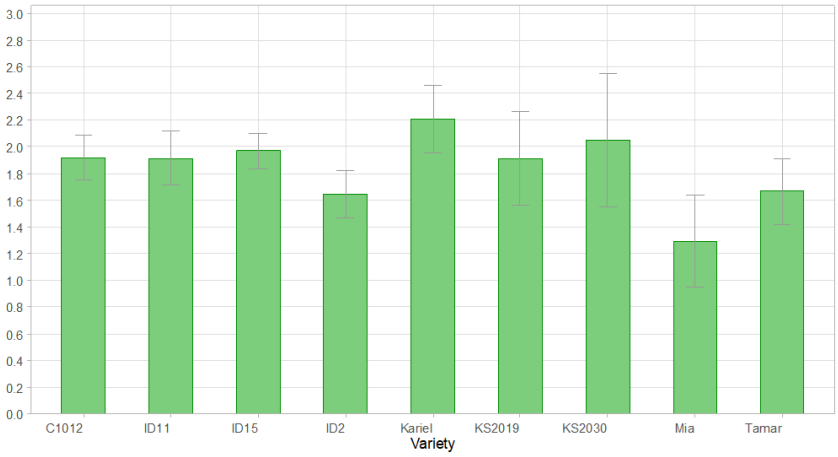


Figure 19: Leaf Area index of 9 varieties of castor bean on 8/8/2024.

The harvest of hemp took place on 29/10/2024. Futura 83 was the most productive in terms of total above-ground biomass (AGB), reaching 7.8 Mg ha-1, while Mona and Nashinoide had lower AGB yield reaching 2.4 and 3.1 respectively) (Figure 20). The harvest of castor began on 25/11/2024 and the analysis of the results is not yet completed.

The next actions for 2025 is to run the crambe sowing in January 2025 and to do the establishment of miscanthus in spring 2025.

It should be pointed that that in terms of castor bean higher number of varieties/hybrids had been compared by all partners compared to the planned actions.

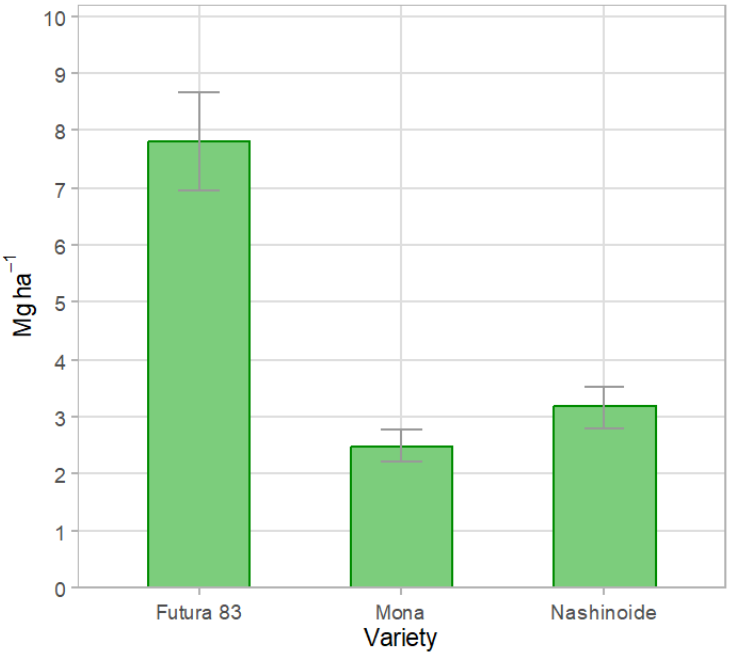


Figure 20: Total aboveground biomass of 3 varieties of hemp (Futura 93, Mona, Nashinoide).