

Supplementary

Table S1. Main soil characteristics of the experimental locations.

| Parameters | CF2018 | MA2018 | SO2019 | VE2019 |
|---|--------|--------|--------|--------|
| Sand (%) | 33 | 30 | 47 | 45 |
| Loam (%) | 46 | 61 | 38 | 48 |
| Clay (%) | 21 | 9 | 18 | 7 |
| pH (KCl 1:2.5) | 7.1 | 7.5 | 6.9 | 7.4 |
| Total calcareous (%) | 4 | 53 | 5 | 62 |
| Active calcium carbonate (%) | n.d. | 1.2 | n.d. | 2.9 |
| Organic matter (%) | 1.55 | 2.0 | 1.77 | 1.61 |
| Total nitrogen (%) | 0.18 | 0.24 | 0.18 | 0.14 |
| Phosphorus available (mg kg ⁻¹) | 44 | 7 | 30 | 18 |
| Potassium exchangeable (mg kg ⁻¹) | 131 | 41 | 146 | 85 |

n.d. = not detected

Table S2. Monthly mean temperature and total rainfall during the hemp crop cycle for each environment of the previous 28-year period (1992–2019).

| Environment | | April | May | June | July | August | September | October |
|--------------|-----------------------|-------|------|------|------|--------|-----------|---------|
| Campoformido | Mean temperature (°C) | 12.9 | 17.6 | 21.2 | 23.1 | 23.1 | 18.5 | 14.0 |
| | Rainfall (mm) | 120 | 126 | 128 | 116 | 127 | 175 | 160 |
| Majano | Mean temperature (°C) | 12.8 | 17.6 | 21.3 | 23.3 | 23.3 | 18.8 | 14.1 |
| | Rainfall (mm) | 125 | 137 | 126 | 117 | 134 | 173 | 155 |
| S.Osvaldo | Mean temperature (°C) | 12.8 | 17.6 | 21.2 | 23.1 | 23.0 | 18.6 | 13.9 |
| | Rainfall (mm) | 119 | 128 | 126 | 118 | 130 | 169 | 165 |
| Verzegnis | Mean temperature (°C) | 12.5 | 16.0 | 20.3 | 22.3 | 21.3 | 17.3 | 12.6 |
| | Rainfall (mm) | 160 | 197 | 182 | 172 | 192 | 188 | 280 |

Table S3. Main cropping management techniques adopted for hemp cultivation.

| | CF2018 | MA2018 | SO2019 | SO2019D | VE2019 | VE2019D |
|--|---------------------------------------|---------------------------------------|---|---|---|---|
| Previous crop | soya | soya | maize | maize | fallow | fallow |
| Soil tillage | Ploughing at 30 cm + harrowing (n. 2) | Ploughing at 30 cm + harrowing (n. 2) | Ploughing at 30 cm + harrowing (n. 2) | Ploughing at 30 cm + harrowing (n. 2) | Grubber at 20 cm + stone burier (n.1) | Grubber at 20 cm + stone burier (n.1) |
| Fertilization as (kg ha ⁻¹ N, P ₂ O ₅ , K ₂ O) | 20 t of mature manure in pre-sowing | 80-40-80 (in pre-emergence) | 100-50-100 In pre-sowing (75% of N in post-emergence) | 100-50-100 In pre-sowing (50% of N in post-emergence) | 100-50-100 In pre-sowing (75% of N in post-emergence) | 100-50-100 In pre-sowing (50% of N in post-emergence) |
| Sowing time | 26/04 | 27/04 | 02/05 | 09/06 | 07/05 | 18/06 |
| Irrigation (mm) | 150 | 0 | 210 | 180 | 60 | 60 |

Table S4. Main phenological parameters in multiyear trial.

| Cultivar | Environment | Date of sowing (doy) | Date of Flowering (doy) | Date of seed Maturity (doy) |
|----------|-------------|-------------------------|-------------------------------|-----------------------------------|
| Fedora | CF2018 | 116 | 176 | 225 |
| | MA2018 | 116 | 179 | 232 |
| | SO2019 | 122 | 176 | 225 |
| | VE2019 | 158 | 211 | 242 |
| | SO2019D | 154 | 200 | 234 |
| | VE2019D | 199 | 234 | 261 |
| Felina | CF2018 | 116 | 178 | 232 |
| | MA2018 | 116 | 196 | 258 |
| | SO2019 | 122 | 178 | 232 |
| | VE2019 | 158 | 222 | 258 |
| | SO2019D | 154 | 210 | 238 |
| | VE2019D | 199 | 239 | 265 |
| Ferimon | CF2018 | 116 | 173 | 230 |
| | MA2018 | 116 | 182 | 235 |
| | SO2019 | 122 | 173 | 230 |
| | VE2019 | 158 | 220 | 255 |
| | SO2019D | 154 | 205 | 236 |
| | VE2019D | 199 | 241 | 255 |
| Futura | CF2018 | 116 | 199 | 246 |
| | MA2018 | 116 | 203 | 265 |
| | SO2019 | 122 | 216 | 246 |
| | VE2019 | 158 | 225 | 251 |
| | SO2019D | 154 | 220 | 250 |
| | VE2019D | 199 | 235 | 281 |
| Zenit | CF2018 | 116 | 178 | 222 |
| | MA2018 | 116 | 178 | 232 |
| | SO2019 | 122 | 197 | 235 |
| | VE2019 | 158 | 217 | 246 |
| | SO2019D | 154 | 207 | 244 |
| | VE2019D | 199 | 232 | 272 |

doy = Day Of the Year

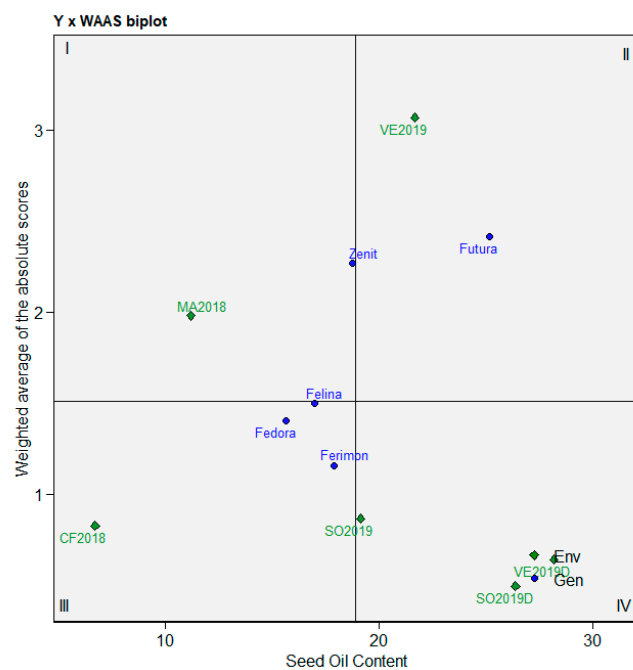


Figure S1. WAAS biplot for Seed oil content. Futura showed the highest seed oil content and it depends on environments. Among environments, CF2018 showed the lowest seed oil content, whereas delaying in sowing time increased seed oil content (highest values in SO2019D and VE2019D).

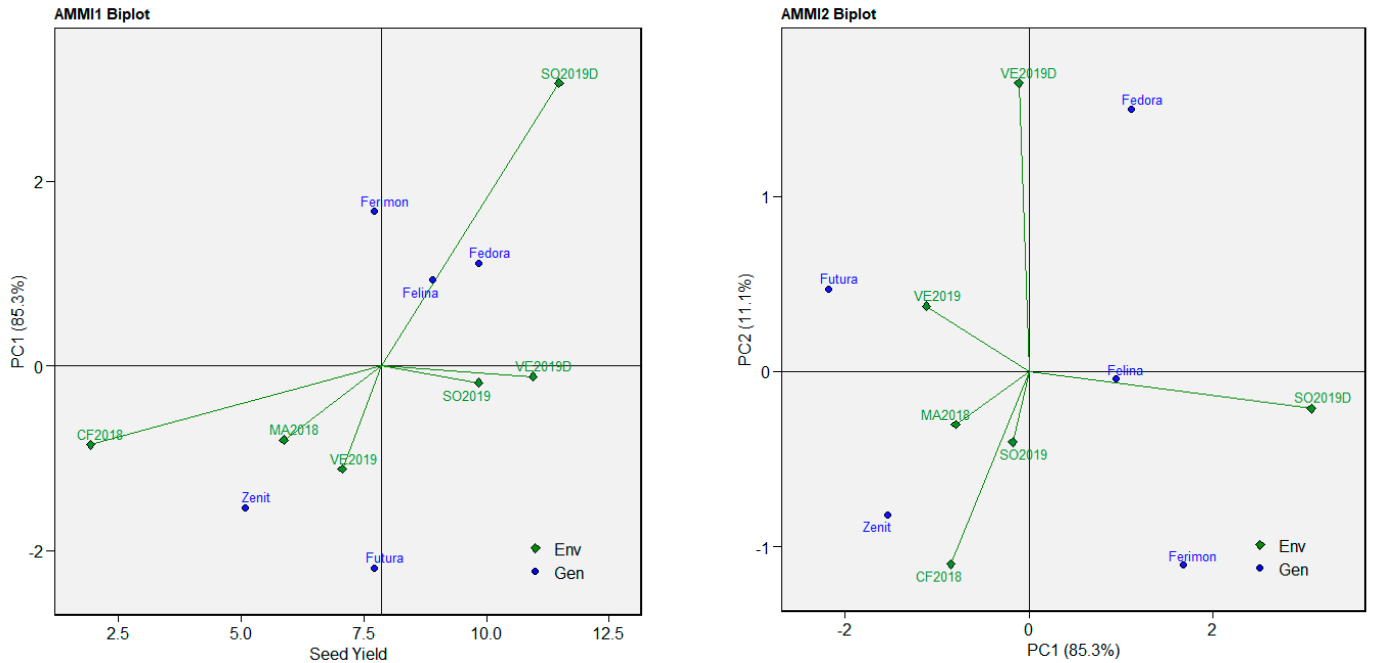


Figure S2. AMMI1 biplot 1 (left) and 2 (right) for Seed Yield.

AMMI1 biplot visualizing GEI in relation to grain yield and IPCA1 (variance). The direction of the environmental vectors shows whether those environments produced yields that were above or below average. In our trial, IPCA1 explained 85.3% of the total variance and the obtained results are comparable to the WAAS index. Comparing our results to those of Campbell et al. (2019), Futura was more productive and stable cultivar for seed production in the environments they tested than in north-eastern Italian environments. On the other hand, Felina was a high yielding cultivar in both environments, but it was the one that showed the highest stability index in our environments and the lowest in those of Campbell et al. (2019).

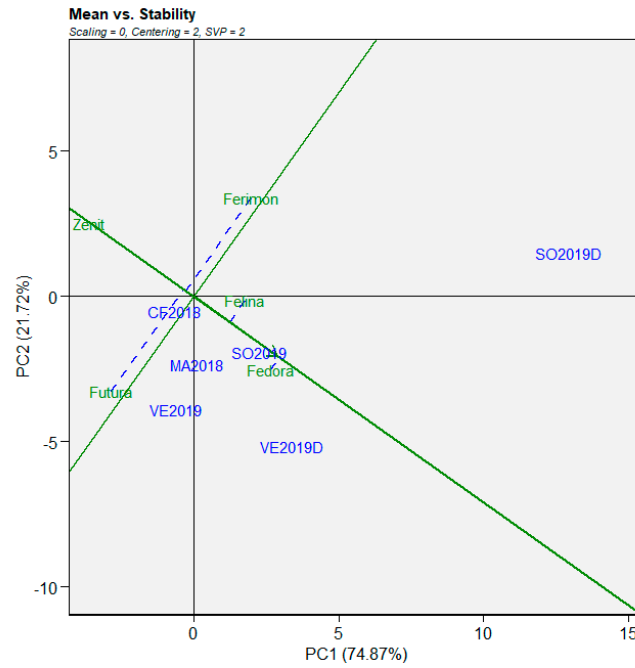


Figure S3. GGE biplot type 2 Mean performance vs. stability for seed yield.

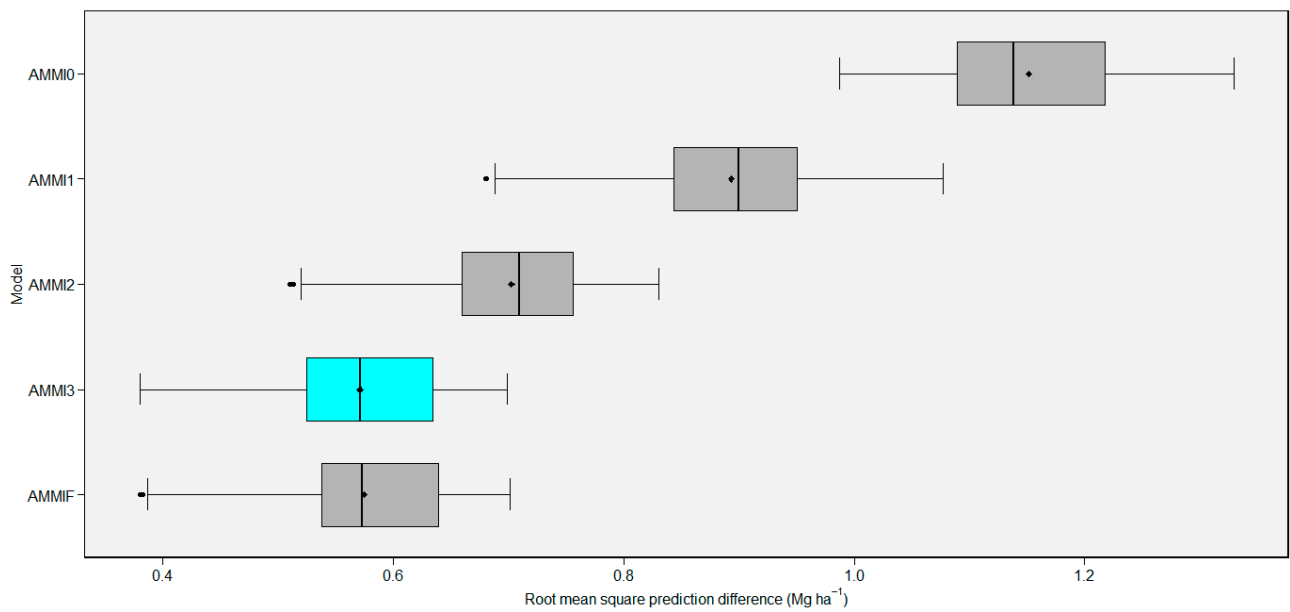


Figure S4. Cross-validation for the full AMMI-family model (1000 re-samples were performed for each cross-validation). AMMI3 model was the best model for seed yield prediction.