Supplementary Materials

The numbering of these paragraphs is the same as in the main manuscript for easy reference

Supplementary Material S1 (4.2 Germination test)

For each crop a germination test was carried out on filter paper in Petri dishes containing salt solution at different concentrations (ECw): 0.02 (control), 4.6, 9.2, 13.6, 18.0, 22.2 and 26.4 dS m^{-1}). For each treatment, three replications were applied. The Petri dishes were hermetically sealed with Parafilm to prevent evaporation and kept in a dark growth chamber at a temperature of 20-22°C. A seed was considered germinated when the radicle had extended at least 5 mm. The number of seeds germinated was recorded daily for up to 12 days. The germination percentage (%) at 12 days is calculated as : GP = seeds germinated/total seeds x 100. The mean germination time (MGT) was calculated as follows:

$$MGT_j = \frac{\sum(n_{ij} \times T_i)}{\sum n_{ij}}$$

where MGT_j is the mean germination time for treatment j with j= 1, …., 7, n_{ij} is the number of seeds germinated on day i for treatment j. T_i is the number of days from sowing.

Supplementary Material S2 (4.3. Field trial)

The field experiment was carried out in Southern Italy at the CNR-ISAFOM experimental station located in Vitulazio (CE) on the Volturno river plain, (25 m a.s.l.; 14°12'E and 41°07'N) in 2002, on a clay loam soil (Table S1) in plots of two adjacent fields, one cultivated with maize, hybrid Sacro (FAO 500) and one cultivated with hemp Fibranova.

The site was used for other trials (since 1995) to evaluate the effects of saline-sodic irrigation on crop production and soil chemical-physical characteristics [71]. The experimental set-up was the same throughout the seven years (1995-2001) and the saline treatments were repeated each year on the same plots, so that the effects of salt accumulation in the soil could also be assessed. A preliminary investigation was carried out to determine the field conditions prior to the trial, i.e. by measuring the electrical conductivity of the saturated paste EC_e and soil texture on soil samples taken at three depths (0.0-0.3, 0.3-0.6 and 0.6-0.9 m) for each plot of the previous experiment 1995-2001. No significant differences (Table S1) were observed in the soil texture at all sample locations and for the three different soil layers. The EC_e measurements led to identify specific sites having significantly different values of EC_e , which were grouped into four saline treatments (C, S_1, S_2 and S_3) with increasing EC_e initial values (Table S2a). The EC_e value for the S_1, S_2 and S_3 treatments did not change in the different plots but increased significantly with depth in each treatment.

The treatments were distributed in randomized block in four repetition for a total of 16 plots for both maize and hemp. To avoid interferences among adjacent plots, each of 100 m^2, a space of 1.5 m was left uncultivated both for maize and hemp. The same irrigation treatment was applied to all plots of both crops.

Table S1- Soil texture and the Soil Water Content (SWC) at sowing for the soil layer 0.0-0.9 *m* with standard error (SE) and coefficient of variation (CV) of each observation.

	Maize			**Hemp**		
Parameters	**(%)**	**SE**	**CV (%)**	**(%)**	**SE**	**CV (%)**
Clay	39.89	0.33	2.88	38.91	0.27	2.41
Silt	34.39	0.31	3.10	33.90	0.29	3.00
Sand	25.72	0.19	2.52	27.19	0.23	2.96
SWC at -0.02 MPa *(cm^3 cm^{-3})*	0.3956	0.0017	1.47	0.3887	0.0029	2.60
SWC at -1.5 MPa *(cm^3 cm^{-3})*	0.2199	0.0025	3.90	0.2025	0.0027	4.52

Table S2- Initial **(a)** and mean seasonal values (**b**) of the electrical conductivity of saturated paste *(EC_e dS m^{-1})* for each crop, treatment, soil layer. For each treatment, values followed by a different letter are significantly different at P≤ 0.01, standard deviation given in brackets.

	(a)				**(b)**			
	Maize							
Soil layer	**C**	**S_1**	**S_2**	**S_3**	**C**	**S_1**	**S_2**	**S_3**
(m)	*(dS m^{-1})*				*(dS m^{-1})*			
0.0-0.3	0.82(±0.09)	1.91(±0.14) c	3.08(±0.36)c	5.09(±0.4)0c	0.81(±0.10)	1.96 (±0.28)b	2.83(±0.25) c	4.98 (±0.62)c
0.3-0.6	0.93(±0.17)	2.43(±0.19)b	3.82(±0.51)b	6.43(±0.41)b	1.03(±0.25)	2.33(±0.20) ab	3.79(±0.41) b	6.68(±0.52) b
0.6-0.9	0.97(±0.18)	2.90(±0.22)a	5.27(±0.38)a	7.65(±0.35)a	1.00(±0.14)	2.45(±0.17) a	5.26(±0.70) a	7.77(±0.24) a
0.0-0.9	0.91(±0.17)	2.41(±0.32)	4.06(±1.0)	6.39(±1.12)	0.95(±0.20)	2.25(±0.44)	3.96(±0.88)	6.48(±1.04)
	Hemp							
	C	**S_1**	**S_2**	**S_3**	**C**	**S_1**	**S_2**	**S_3**
	(dS m^{-1})				*(dS m^{-1})*			
0.0-0.3	0.73(±0.04)	1.89(±0.17) b	3.50(±0.50)b	6.74(±0.50)b	0.82(±0.06)	2.21(±0.36) c	3.60(±0.96) c	6.31(±0.36) b
0.3-0.6	0.91(±0.07)	3.05 (±0.27)a	4.25(±0.23)ab	7.47(±0.49)a	0.98(±0.09)	2.95(±0.34) b	4.24(±0.21) b	7.23(±0.56) a
0.6-0.9	1.01(±0.08)	3.58(±0.74) a	4.45(±0.41)a	7.99(±0.29)a	1.05(±0.10)	3.49(±0.47) a	4.71(±0.37) a	7.55(±0.96) a
0.0-0.9	0.88(±0.13)	2.84(±1.05)	4.07(±0.57)	7.40(±0.70)	0.95(±0.13)	2.88(±0.66)	4.18(±0.56)	7.03(±0.68)

After plowing, the soil was treated with Phorate 5 G Siapa (CHIM) 40kg ha^{-1} and fertilized with 150 e 140 *kg ha*$^{-1}$ of N e P_2O_5 respectively on the sowing date.

Sowing of hemp and maize was done on May 20th and 22sd 2002 respectively. The sowing of the hemp in the plots, with intra-row distance of 0.2 *m*, required 45 *kg ha*$^{-1}$ of seeds. The maize cultivar "Sacro" was sown at spacing of 0.60 × 0.23 *m*. The mean number of plants at harvest ± SE in the 56 m^2 plot was 65.1 *m*$^{-2}$ ±5.1; CV 7.8% for hemp and 6.17 *m*$^{-2}$ ± 0.34; CV 5.6% for maize. The different sowing density of the two crops reflects the agronomic techniques applied to hemp and maize. To cultivate fiber hemp the density must be about 100 pt m^{-2} to achieve a good quality of fiber. A weed control was applied on maize before plant emergency. Two sprinkler irrigations of 15 *mm* each were applied after sowing to guarantee a uniform plant emergency. The hemp emergency occurred on May 30th and June 10th for maize. In 2002 the rainfall was well distributed through the crop cycle from middle of July to August (Figure S1**)**. In 2002 there were 123.6 mm of rain for maize and 112.2 mm for hemp. The 14 days mean temperature diverged slightly from the 10-years average with slightly higher values in post emergence. The rainfall of 2002 was higher than the mean rainfall of the previous 10-years in all 14 day intervals. In 2002 there were 35 (16/7), 32.2 (30/7), 25 (11/8) and 31.4 (29/8) mm of rain for maize for a total amount of 123.6 *mm*. For the hemp the rain on 9/6 (20 mm) had to be added in post- emergence and the one on 29/8 (31.4 mm) had to be removed because it fell after the harvest date for a total of 112.2 *mm*.

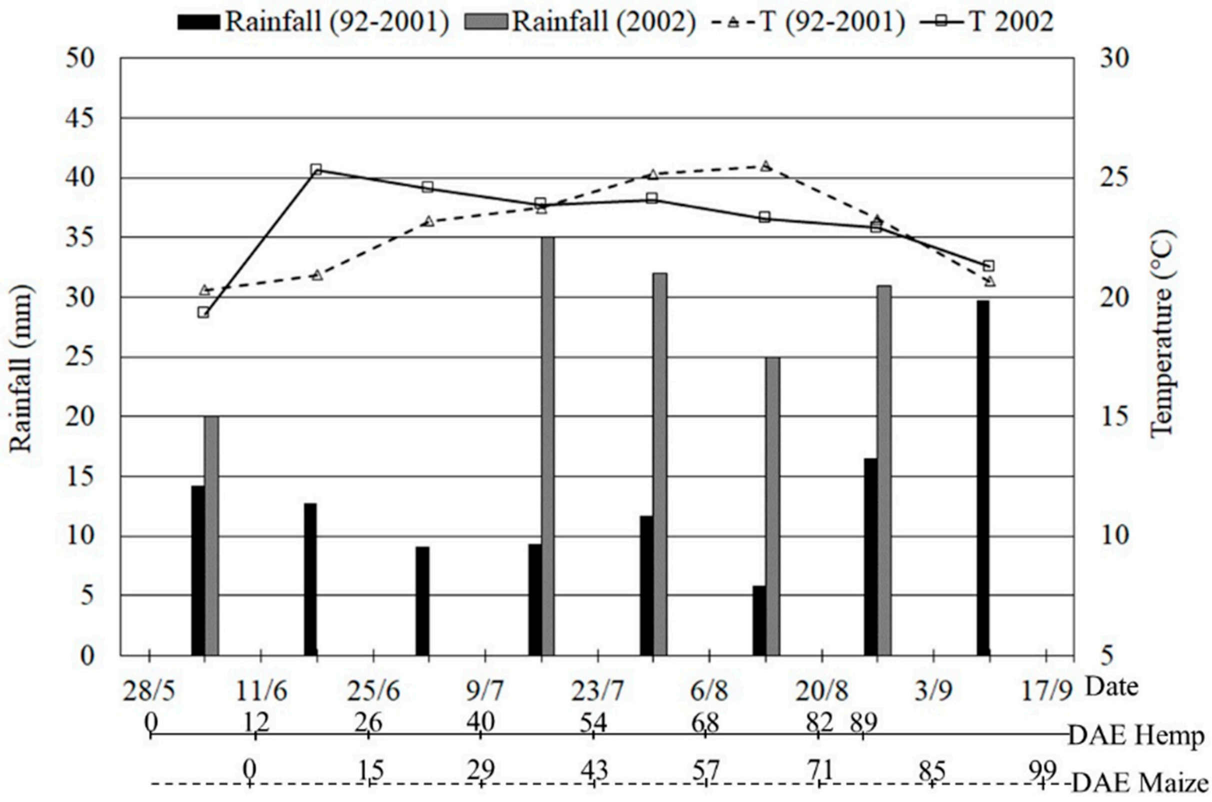


Figure S1– Rainfall and mean air temperature during the crop seasons 2002 and averaged over 1992-2001: Rainfall is the total precipitation that fell during the 10 days preceding the dates indicated on the x-axis, while air temperature is the average in the 10 days preceding the dates indicated;: X-axis: date during the crop cycle (top); days after emergence of hemp (center) and maize (bottom).

The experimental area was fed by drip irrigation. Drippers at 4 l h^{-1} and at a high density per *m*^{2} (0.4 x 0.4 m) were used for hemp and (0.6 × 0.25 *m*) for maize. This design allowed to supply at each irrigation an amount of water of 250 *m*^{3} *h*$^{-1}$*ha*$^{-1}$ to hemp and 267 *m*^{3} *h*$^{-1}$*ha*$^{-}$ to maize ensuring that all the irrigated surfaces were completely wet.

Since the 25th of June , a total of five and four irrigations at an interval of 14 days were applied during the crop cycle with a total amount of irrigation water of 231 *mm* and 201 *mm* for maize and hemp respectively. The irrigation water had an electrical conductivity of 0.9 $dS\ m^{-1}$.

Until plant emergency and starting from June 6th for each replication, measurements of soil moisture by the gravimetric method were carried out at depths of 0.0-0.3, 0.3-0.6 and 0.6-0.9 m. The soil water content was measured before and 24 h after each irrigation, at hemp harvest (27/8/2002) and at maturity of maize seeds (17/9/2002). The electrical conductivity of the saturated paste (EC_e) was determined according to Rhoades [72] on the soil samples taken after each irrigation event and at harvest at the same depth as for the soil moisture measurements. These measurements allow to estimate also the $\overline{EC_e}$, i.e. the seasonal average of the EC_e for each layer or for soil profile 0.0-0.9 m.

An area of 56 m^2 in each plot was used to measure plant growth during the crop cycle and yield at harvest. At the plant emergency and starting from June 11th with a 14-days interval up until harvest, 4 plants of maize and 15 plants of hemp were taken from each plot to determine the leaf area (LA) and the total plant dry matter (W). These measurements led to divide the crop cycle into the following intervals: hemp 0-12; 12-26; 26-40; 40-54; 54-68; 68-82; and 82-89 DAE. Maize 0-15; 15-29; 29-43; 43-57; 57-71; 71-85 and 85-99 DAE. The leaf area duration, LAD, was estimated according to Hunt [73], i.e. LAD (d) = $(LAI_i+LAI_{i+1})/2\times(T_{i+1}-T_i)$; where LAI_i is the leaf area index at Time i (T_i) and the LAI_{i+1} is the leaf area index at time i+1(T_{i+1}) where i=0; 12; 26; 40; 54; 68 and 82 DAE for hemp and 0; 15; 29; 43; 57; 71; and 85 DAE for maize, while i+1= 12; 26; 40; 54; 68; 82 and 89 DAE for the hemp and 15; 29; 43; 57; 71; 85 and 99 DAE for the maize.

At harvest the fiber content of hemp was determined chemically on a 0.5 m portion of dried stem (at 105°C). The stem was boiled for 30 min in a solution of 0.25% Na_2CO_3 to eliminate the bark, the fiber was extracted by boiling the bark for 120' in a solution of 2% NaOH and dried in a ventilated oven at 105°C.

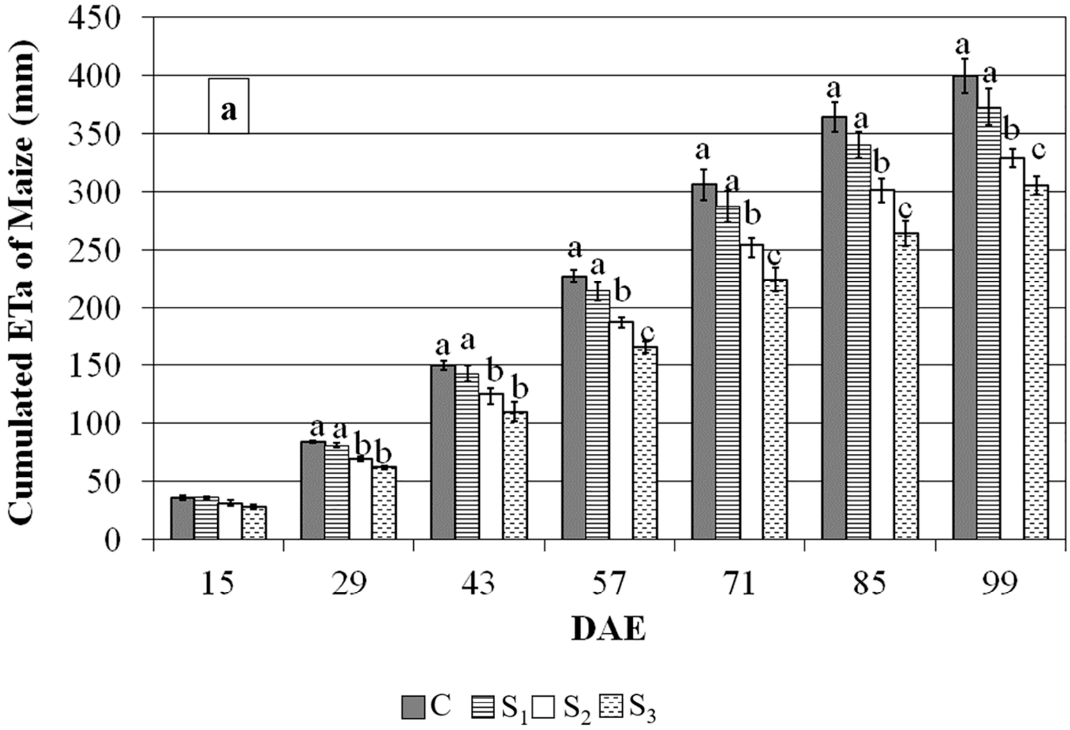
Statistical analysis of data was performed by SPSS 16.0 software (SPSS for Windows, Version 16.0, Chicago, USA). All of the data obtained were analysed using ANOVA and the mean values of all variables were compared using Duncan's multiple range test.

Supplementary Material S3 (5. RESULTS)
S3.1. (5.1 Germination test)

Table S3- Germination, (%) and mean germination time (MGT) in days: interaction saline treatment × Hemp and Maize, *EC_w* is the electrical conductivity (dS m^{-1}) of the water used for the germination test. Values followed by different letter under the same category are significantly different at P≤ 0.01, standard deviation given in brackets

Germination (%)							
Treatment / cultivar	**ECw (dS m^{-1})**						
	0.02	**5.4**	**9.6**	**13.8**	**18**	**22.2**	**26.4**
Maize Sacro	98.0 (±1.6) ab	98.0 (±1.6) ab	98.7 (±1.9) ab	74.7 (±6.6) fgh	64.7 (±5.7) h	40.0 (±3.3) i	20.7 (±4.7) l
Hemp Fibranova	100.0 (±0) a	100.0 (±0) a	98.0 (±2.8) ab	94.0 (±4.3) bcd	93.0(±5.1) bcde	85.7(±2.6) ef	74.3(±5.9) fgh
Mean germination time (MGT)							
Treatment / cultivar	**ECw (dS m^{-1})**						
	0.02	**5.4**	**9.6**	**13.8**	**18**	**22.2**	**26.4**
Maize Sacro	2.38(±0.03) l	2.82(±0.19) hil	3.15(±0.21) ghi	4.49(±0.10) bcd	4.75(±0.24) bc	5.05(±0.10) b	5.96(±0.26) a
Hemp Fibranova	2.89(±0.07) hil	2.67(±0.29) il	3.35(±0.09) fgh	3.61(±0.05) efg	4.02(±0.03) de	4.57(±0.12) bcd	4.96(±0.03) b

S3.2. (5.3. Crop water use, leaf area duration, dry matter accumulation and WUE)



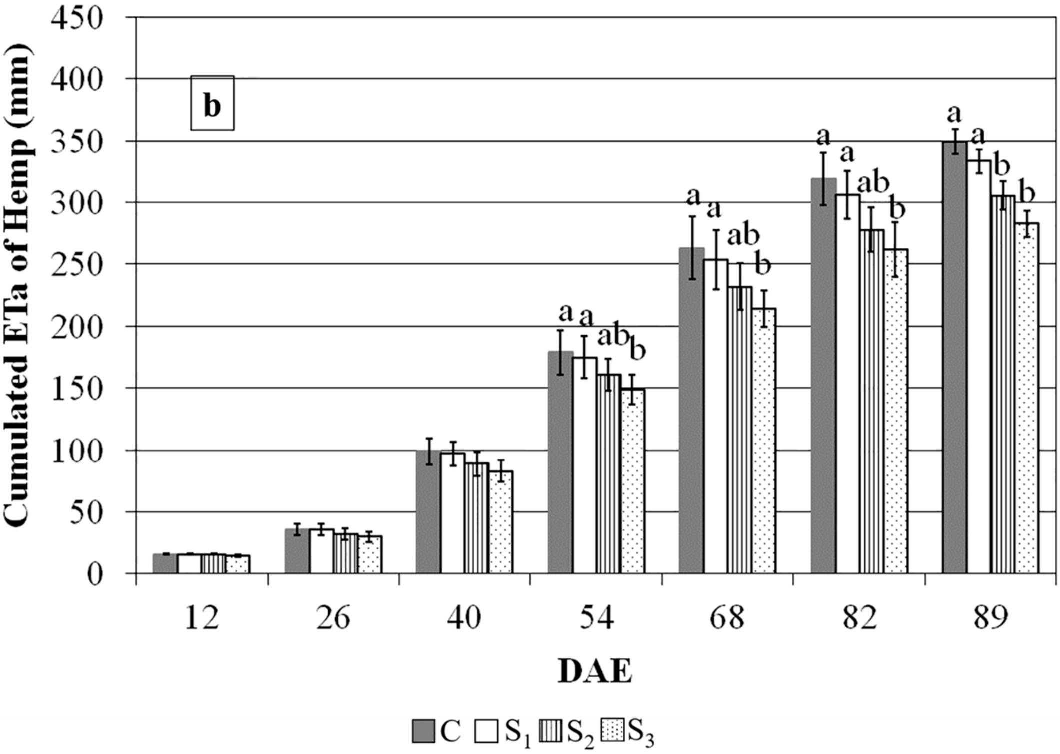


Figure S2 – Cumulated actual crop evapotranspiration (ETa mm): Maize (**a**) for each saline treatment (C = 0.95 dS m^{-1}, S_1 = 2.25, S_2= 3.96 and S_3= 6.48 dS m^{-1} for the soil layer 0.0-0.9 m) at different DAE (days after emergence). Hemp (**b**) for each saline treatment (C = 0.95 dS m^{-1}, S_1 = 2.88, S_2= 4.18 and S_3= 7.03 dS m^{-1} for the soil layer 0.0-0.9 m) at different DAE. At each DAE any pairs of values indicated by bars are significantly different at P≤0.01 if labelled with different letters, standard deviation indicated by error bars.

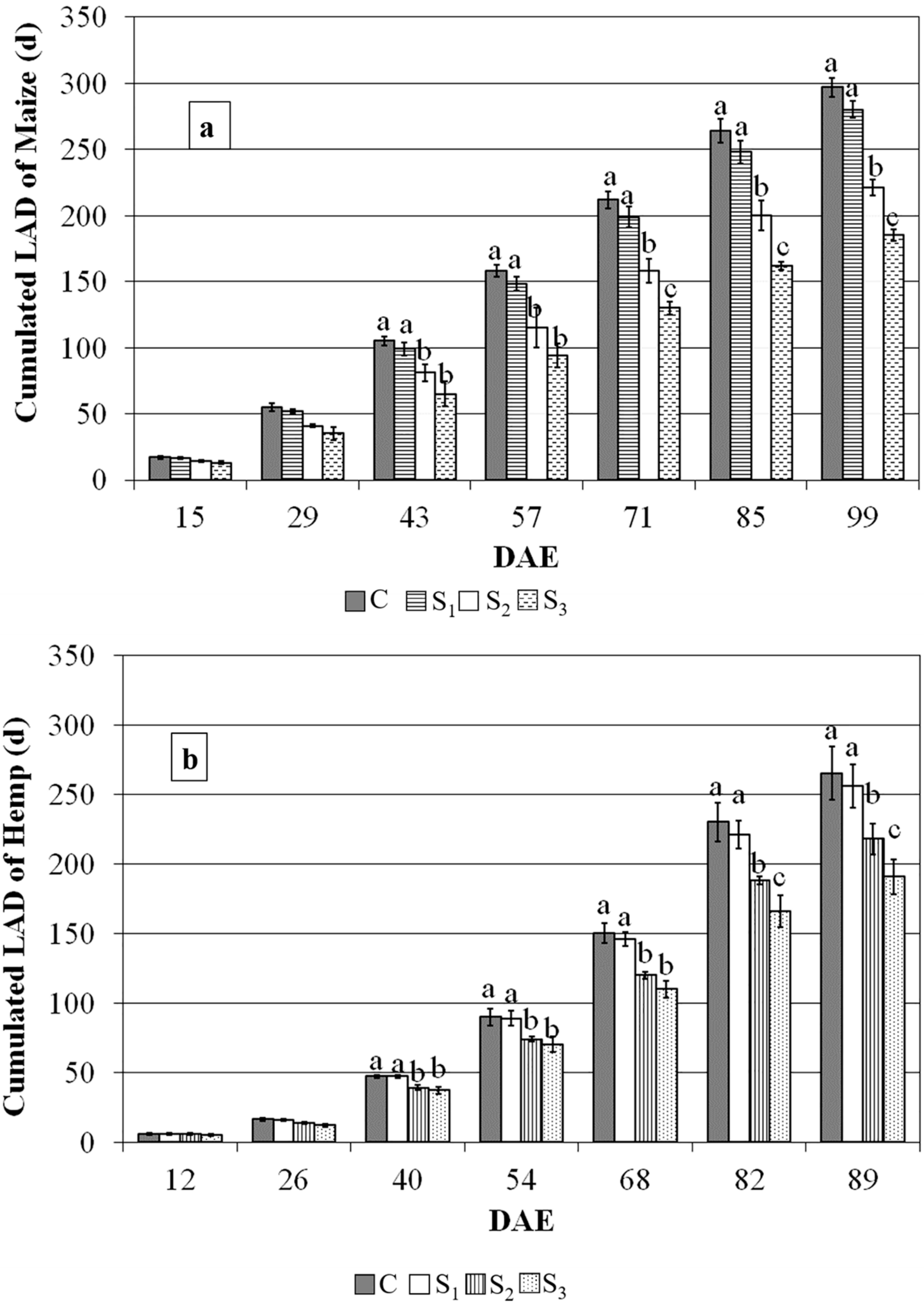


Figure S3 – Cumulated Leaf area duration (LAD): Maize (**a**) for each saline treatment (C = 0.95 dS m^{-1}, S_1 = 2.25, S_2= 3.96 and S_3= 6.48 dS m^{-1} for the soil layer 0.0-0.9 m) at different DAE (days after emergence). Hemp (**b**) for each saline treatment (C = 0.95 dS m^{-1}, S_1 = 2.88, S_2= 4.18 and S_3= 7.03 dS m^{-1} for the soil layer 0.0-0.9 m) at different DAE. At each DAE any pairs of values indicated by bars are significantly different at $P \leq 0.01$ if labelled with different letters, standard deviation indicated by error bars.

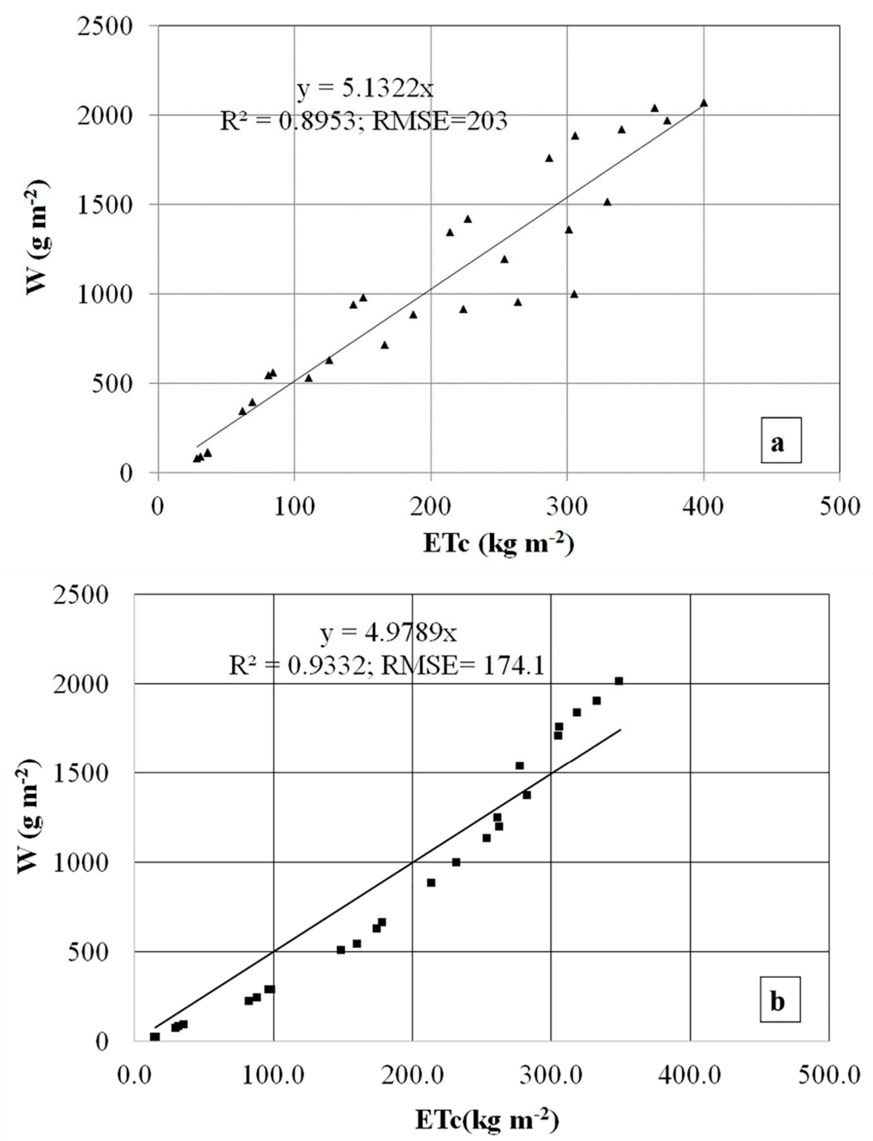


Figure S4– Dry weight shoot (W) plotted vs. actual crop evapotranspiration (ETa) of all the saline treatments through the crop season: Maize (**a**) and Hemp (**b**).

S3.3. (5.4 Response to water and salt stress, and salt tolerance)

The Ky factor for our experiment was determined as below explained.

To calculate (1-ETa/ETm) we assumed that:

ETm = cumulative evapotranspiration of treatment C at 15, 29, 43, 57, 71, 85 and 99 DAE for maize and 12, 26, 40, 54, 68, 82 and 89 DAE for hemp.

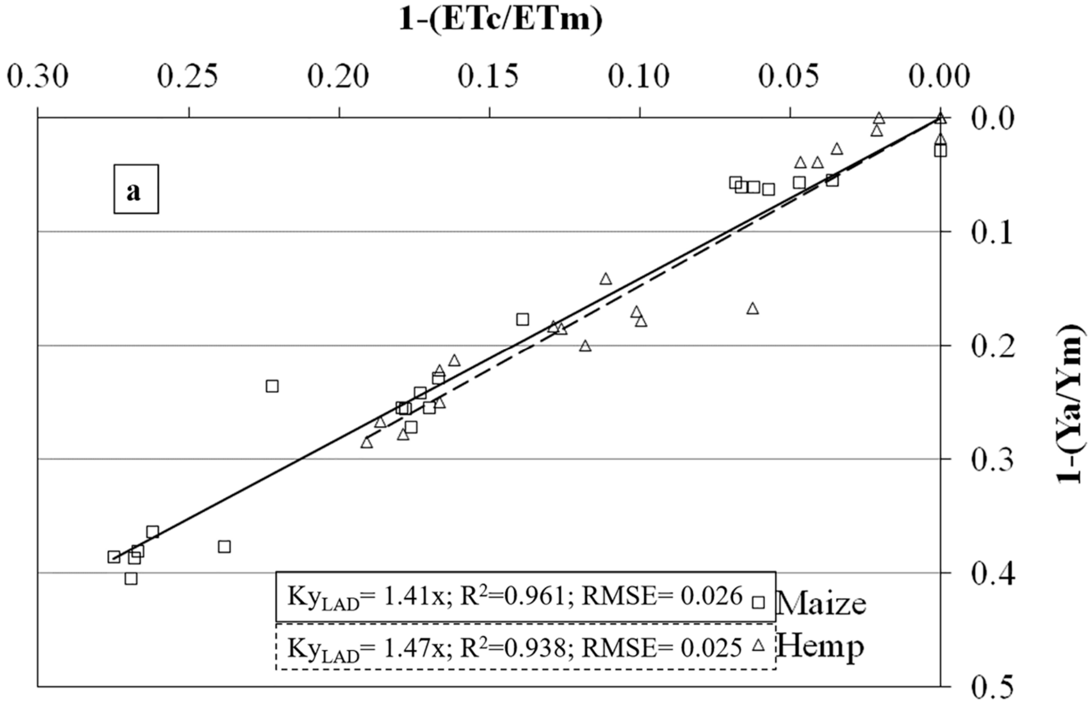
ETa = cumulative actual crop evapotranspiration of treatments S_1 , S_2 and S_3 at the DAE listed above

To calculate (1-Ya/Ym) for the shoot dry matter W: (1-Wa/Wm) we assumed that:

Wm = cumulative shoot dry matter W of treatment C at the DAE listed above;

Wa = cumulative actual shoot dry matter W of treatments S_1, S_2 and S_3 on the corresponding dates.

Similarly, the relative decreases in LAD ($1-LAD_a/LAD_m$), were calculated. In all, there were 21 observations, i.e. the averages of four replicates on the seven dates for three different saline treatments, for W, LAD.



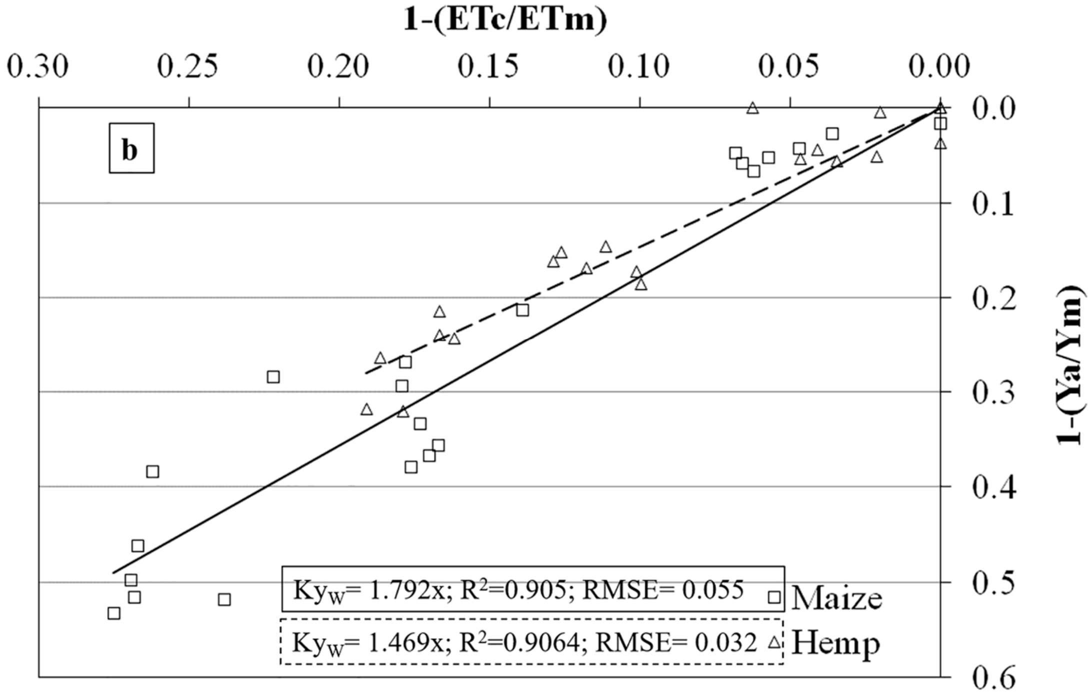


Figure S5 – Response factor for leaf area duration (LAD) (K_{LAD}) of maize (□ solid line) and hemp (Δ dotted line). LADa= cumulative actual LAD of each saline treatment and LADm= cumulative maximum LAD vs ETa= cumulative actual evapotranspiration of each saline treatment and ETm= cumulative evapotranspiration applies to treatment C, (**a**). Response factor for shoot dry weight (W) (K_W) (**b**). Wa= cumulative actual W of each saline treatment and Wm= cumulative W of treatment C vs ETa= cumulative actual evapotranspiration of each saline treatment and ETm= cumulative evapotranspiration applies to treatment C.

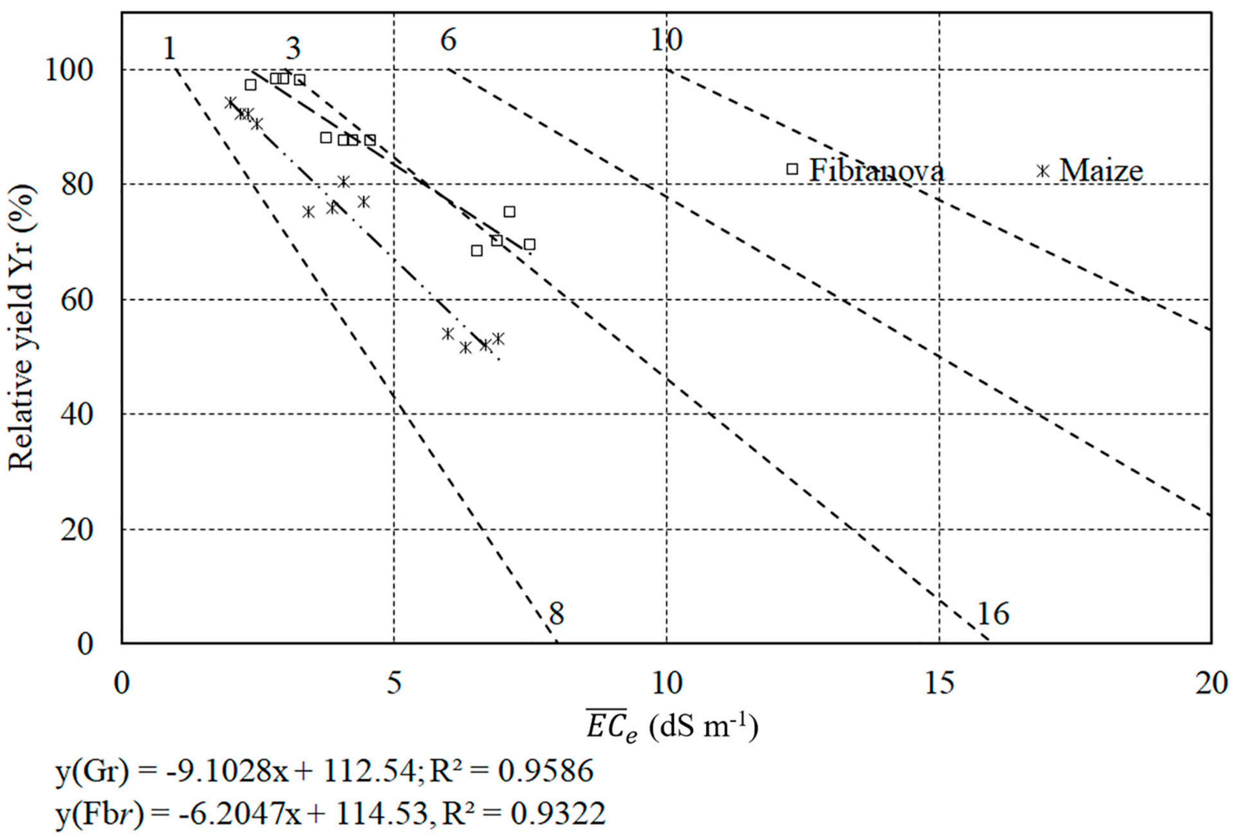


Figure S6– Relative yield Yr (%) response to increasing soil salinity expressed as seasonal average of the soil electrical conductivity of the saturated paste $\overline{EC_e}$ (dS m^{-1}) for the soil layer 0.0-0.9 m Maize: yield is the grain yield (Gr); Hemp: yield is the fiber (Fb*r*) yield. The areas indicated as S, MS, MT and T correspond to Sensitive, Moderately Sensitive, Moderately Tolerant and Tolerant according to the Maas-Hoffman model.