plants

Endophyte Inoculation and Elevated Potassium Supply on Productivity, Growth and Physiological Parameters of Spring Barley (*Hordeum vulgare* L.) Genotypes Over Contrasting Seasons

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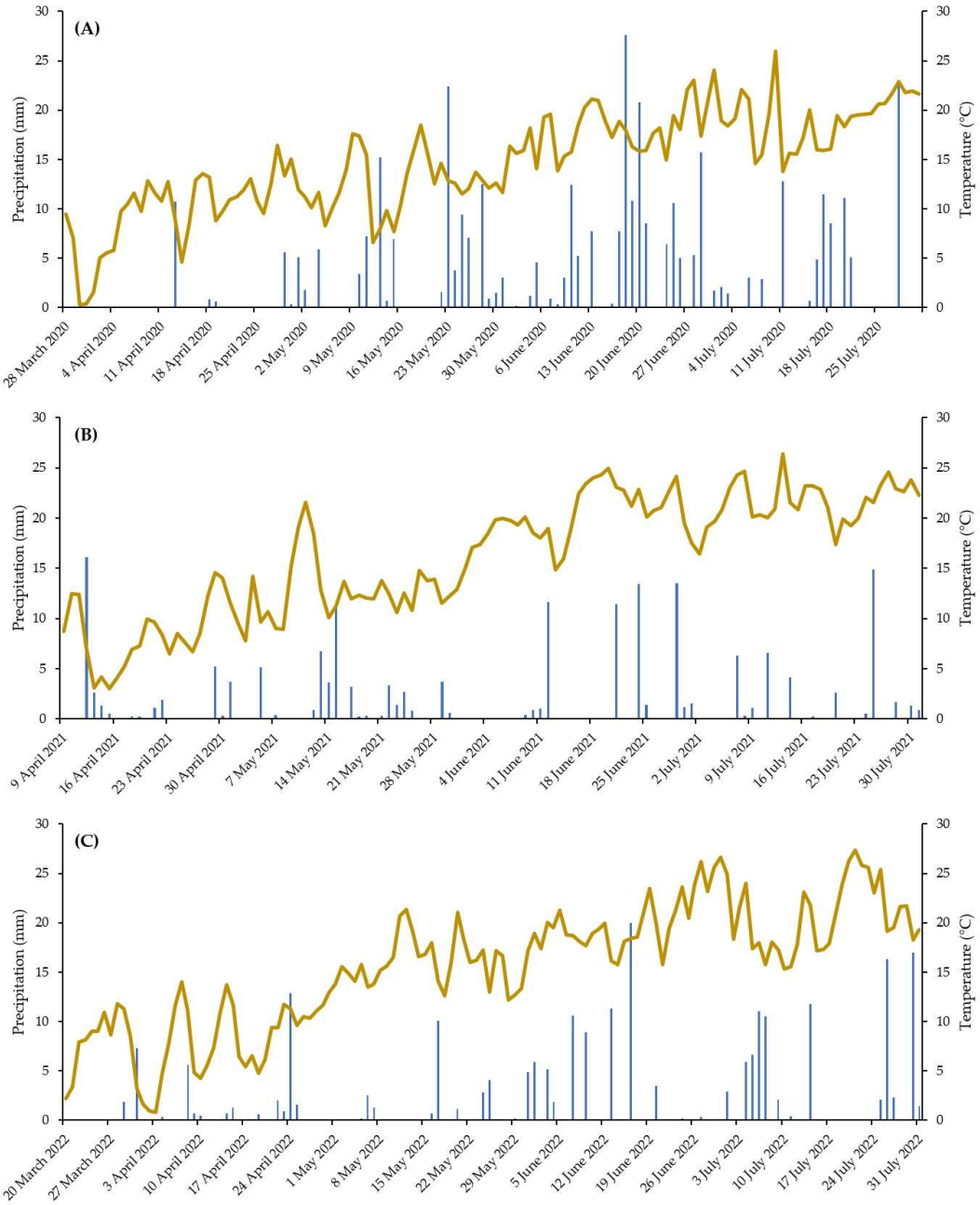

Figure S1. Mean temperatures and precipitation in growing seasons (**A**) 2020; (**B**) 2021; (**C**) 2022.

Table S1. The nutrient content in the soil taken at the experimental site before experiments.

Season	P (mg·kg^{-1})	K (mg·kg^{-1})	Ca (mg·kg^{-1})	Mg (mg·kg^{-1})	pH/KCl
2020	70	208	2553	285	5.04
2021	46	137	2355	253	5.27
2022	120	170	2890	153	6.44

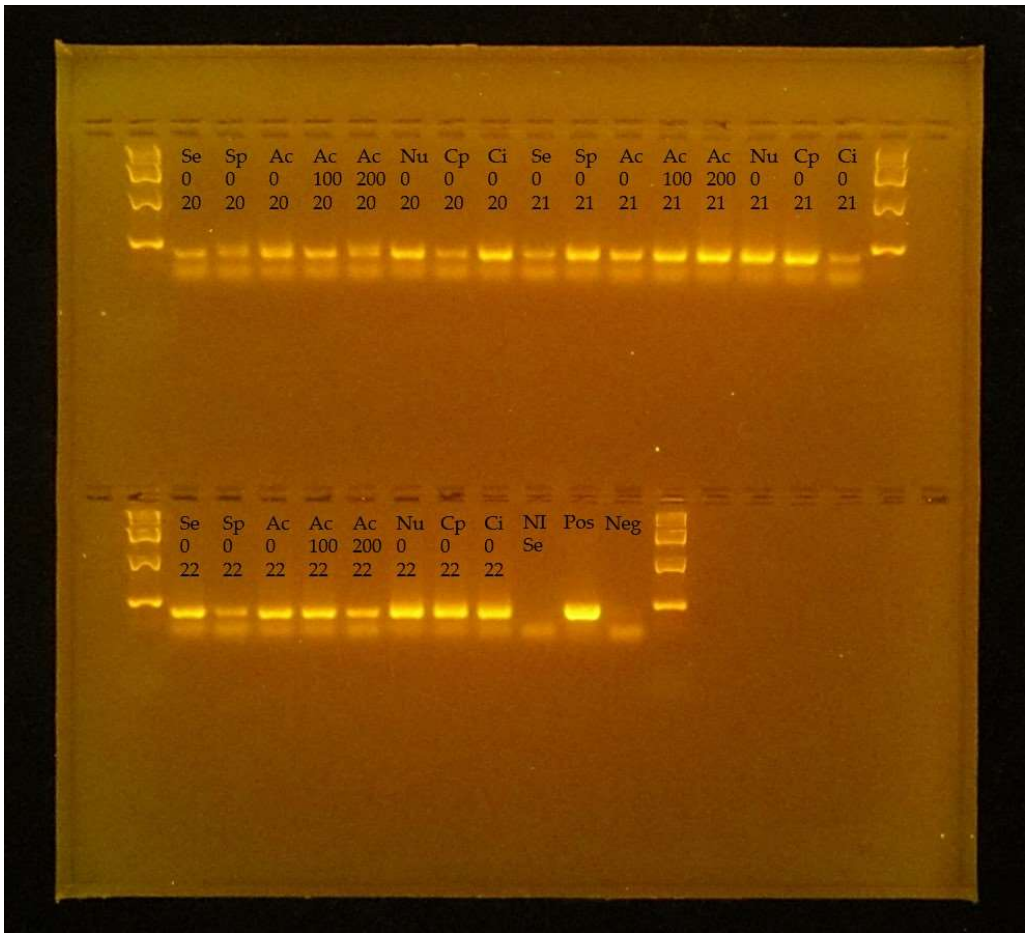

Figure S2. Electrophoresis gel of the PCR products using *Serendipita indica*-specific primers. Samples were isolated from barley roots in seasons 2020–2022. Se – Sebastian, Sp – Spitfire, Ac – Accordine, Nu – Nutans Afganistan, Cp – CPI 18197, Ci – CI 6388 genotypes; 0, 100, 200 – kg/ha potassium supply; 20 – season 2020, 21 – season 2021, 22 – season 2022; NI – not inoculated; Pos – positive control using fungal DNA, Neg – negative control.

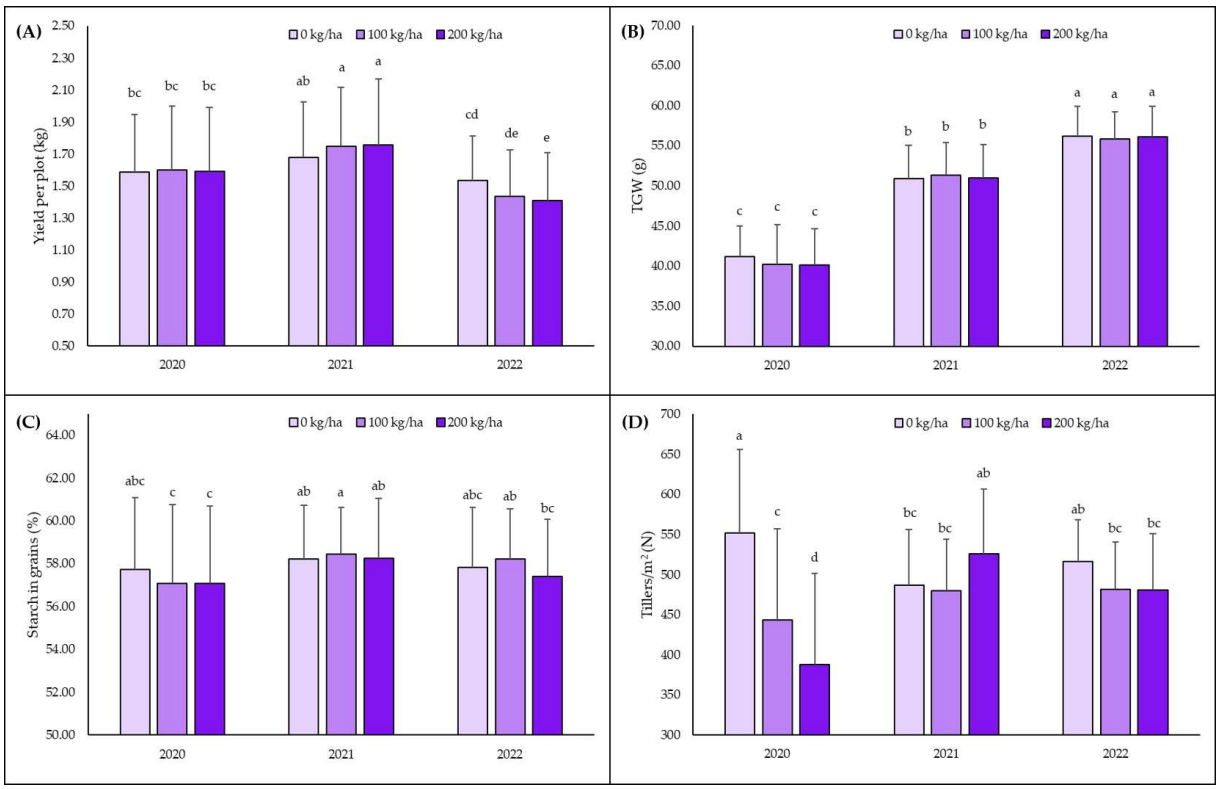

Figure S3. Interaction of fertilization and season on productive parameters and tillering. (**A**) yield per plot; (**B**) thousand grains weight; (**C**) starch in grains; (**D**) tillers. Columns represent means, bars *SD* (n = 30) followed by the same letter if there was no statistical difference according to Tukey$_{0.05}$ test.

Table S2. Interaction of fertilization, inoculation and season factors on the thousand grains weight and plant height. Treatment is in format fertilization (0, 100, or 200 kg of potassium per ha) × inoculation (NI – not inoculated, *S. indica* – *Serendipita indica*) × season (2020–2022). Data represent means ± *SD* (n = 12 for *S. indica*; n = 18 for NI) followed by the same letter if there was no statistical difference according to Tukey$_{0.05}$ test for unequal sample sizes.

Treatment	TGW (g)	Plant height (cm)
0×NI×2020	40.56 ± 3.82 ^{cd}	84.8 ± 6.5 ^{a}
0×NI×2021	50.91 ± 3.85 ^{b}	75.3 ± 7.5 ^{cd}
0×NI×2022	56.14 ± 3.80 ^{a}	68.1 ± 6.6 ^{f}
0×*S. indica*×2020	41.98 ± 3.86 ^{c}	82.0 ± 8.8 ^{ab}
0×*S. indica*×2021	50.80 ± 4.77 ^{b}	75.3 ± 8.4 ^{cde}
0×*S. indica*×2022	56.32 ± 3.69 ^{a}	70.5 ± 6.8 ^{cdef}
100×NI×2020	40.22 ± 4.96 ^{cd}	84.9 ± 9.8 ^{a}
100×NI×2021	51.24 ± 4.44 ^{b}	76.2 ± 6.6 ^{bcd}
100×NI×2022	55.88 ± 3.37 ^{a}	71.0 ± 8.5 ^{cdef}
100×*S. indica*×2020	40.13 ± 5.14 ^{cd}	88.4 ± 7.5 ^{a}
100×*S. indica*×2021	51.34 ± 3.80 ^{b}	75.5 ± 7.0 ^{bcd}
100×*S. indica*×2022	55.88 ± 3.51 ^{a}	68.5 ± 7.9 ^{f}
200×NI×2020	40.69 ± 4.97 ^{cd}	86.3 ± 7.2 ^{a}
200×NI×2021	50.73 ± 4.09 ^{b}	76.4 ± 5.7 ^{bc}
200×NI×2022	55.98 ± 4.00 ^{a}	68.6 ± 8.4 ^{f}
200×*S. indica*×2020	39.27 ± 3.81 ^{d}	88.0 ± 8.3 ^{a}

200×*S. indica*×2021	51.33 ± 4.43 ^{b}	76.2 ± 5.9 ^{bcd}
200×*S. indica*×2022	56.34 ± 3.65 ^{a}	69.5 ± 10.0 ^{ef}

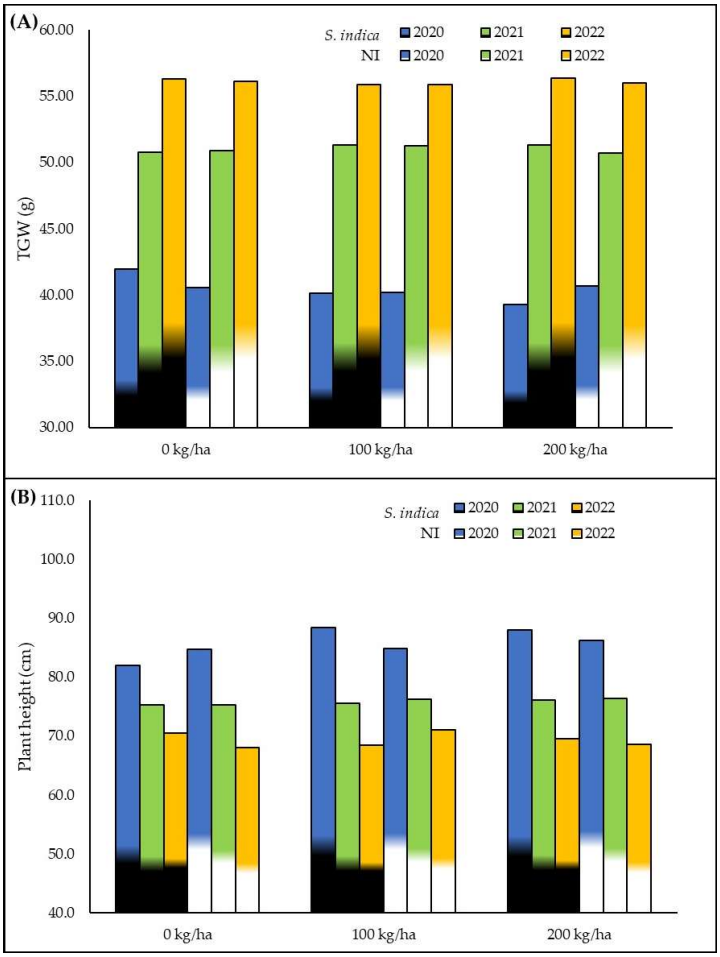

Figure S4. Interaction of fertilization, inoculation, and season factors on the (**A**) thousand grains weight (TGW) and (**B**) plant height. Fertilization doses 0, 100, or 200 kg of potassium per ha, season (2020–2022); and inoculation (NI – not inoculated, *S. indica* – *Serendipita indica*). Data represent means (n = 12 for *S. indica*; n = 18 for NI). Statistical significance and *SD* values are shown in the Supplementary Table 2.

Table S3. Interaction of genotype, fertilization and season factors on the tillering, plant height and carbon isotope signature ($\delta^{13}C$). Treatment is in format genotype × fertilization (0, 100, or 200 kg of potassium per ha) × season (2020–2022). Data represent means ± *SD* (n = 5) followed by the same letter if there was no statistical difference according to Tukey$_{0.05}$ test.

Treatment	Tillers/m^2 (N)	Plant height (cm)	$\delta^{13}C$ (‰)
Sebastian×0×2020	608 ± 74 ^{ab}	75.4 ± 2.1 ^{defghijklmnop}	-29.8 ± 0.3 ^{lmnopqrs}
Sebastian×0×2021	610 ± 21 ^{ab}	61.6 ± 2.9 ^{stuv}	-29.1 ± 0.1 ^{ghijklmno}
Sebastian×0×2022	535 ± 75 ^{abcdefgh}	60.8 ± 1.9 ^{tuv}	-27.6 ± 0.2 ^{de}
Sebastian×100×2020	602 ± 56 ^{abc}	80.6 ± 3.8 ^{bcdefghijkl}	-30.2 ± 0.5 ^{s}
Sebastian×100×2021	573 ± 27 ^{abcd}	63.8 ± 3.0 ^{rstuv}	-29.1 ± 0.4 ^{ghijklmno}
Sebastian×100×2022	558 ± 80 ^{abcdef}	58.0 ± 3.5 ^{v}	-27.8 ± 0.2 ^{ef}
Sebastian×200×2020	486 ± 120 ^{bcdefghijk}	78.6 ± 1.3 ^{bcdefghijklm}	-30.3 ± 0.5 ^{s}
Sebastian×200×2021	642 ± 14 ^{a}	65.8 ± 0.8 ^{opqrstuv}	-28.9 ± 0.0 ^{ghijkl}

Sebastian×200×2022	568 ± 41 abcd	58.6 ± 2.6 uv	-27.7 ± 0.2 de
Spitfire×0×2020	568 ± 144 abcd	85.6 ± 6.4 abcdef	-30.0 ± 0.4 qrs
Spitfire×0×2021	480 ± 33 bcdefghijkl	72.0 ± 2.1 ijklmnopqr	-29.2 ± 0.2 ghijklmnop
Spitfire×0×2022	530 ± 24 abcdefgh	65.0 ± 3.2 pqrstuv	-27.3 ± 0.3 cde
Spitfire×100×2020	430 ± 91 defghijklm	82.4 ± 3.4 bcdefghij	-30.1 ± 0.3 rs
Spitfire×100×2021	529 ± 42 abcdefgh	74.4 ± 2.3 efghijklmnopq	-29.0 ± 0.2 ghijklmn
Spitfire×100×2022	473 ± 33 bcdefghijklm	67.0 ± 5.4 nopqrstuv	-27.2 ± 0.4 cde
Spitfire×200×2020	393 ± 57 ghijklm	86.0 ± 3.9 abcde	-30.1 ± 0.3 rs
Spitfire×200×2021	533 ± 28 abcdefgh	80.0 ± 2.0 bcdefghijkl	-29.0 ± 0.2 ghijklmn
Spitfire×200×2022	473 ± 63 bcdefghijklm	64.8 ± 3.6 qrstuv	-27.4 ± 0.4 cde
Accordine×0×2020	538 ± 116 abcdefgh	86.2 ± 3.0 abcde	-29.8 ± 0.3 nopqrs
Accordine×0×2021	508 ± 21 abcdefghi	81.4 ± 2.2 bcdefghijk	-28.5 ± 0.3 fg
Accordine×0×2022	496 ± 43 abcdefghi	67.2 ± 3.1 nopqrstuv	-27.4 ± 0.3 cde
Accordine×100×2020	542 ± 37 abcdefg	88.0 ± 6.3 abc	-29.8 ± 0.3 mnopqrs
Accordine×100×2021	494 ± 17 abcdefghij	81.0 ± 1.0 bcdefghijk	-28.8 ± 0.4 ghijk
Accordine×100×2022	472 ± 28 bcdefghijklm	67.8 ± 2.3 mnopqrstu	-26.9 ± 0.2 cd
Accordine×200×2020	447 ± 98 cdefghijklm	90.0 ± 1.6 ab	-29.8 ± 0.2 lmnopqrs
Accordine×200×2021	572 ± 22 abcd	81.4 ± 1.7 bcdefghijk	-28.9 ± 0.1 ghijk
Accordine×200×2022	464 ± 81 bcdefghijklm	65.8 ± 4.1 opqrstuv	-27.0 ± 0.3 cde
Nutans Afganistan×0×2020	562 ± 69 abcde	90.0 ± 6.0 ab	-29.5 ± 0.3 hijklmnopqrs
Nutans Afganistan×0×2021	488 ± 21 abcdefghijk	83.2 ± 2.0 bcdefghi	-28.7 ± 0.1 gh
Nutans Afganistan×0×2022	500 ± 36 abcdefghi	75.6 ± 6.0 defghijklmno	-26.0 ± 0.4 ab
Nutans Afganistan×100×2020	320 ± 46 m	91.8 ± 14.1 ab	-29.6 ± 0.3 klmnopqrs
Nutans Afganistan×100×2021	418 ± 23 defghijklm	81.2 ± 1.6 bcdefghijk	-28.7 ± 0.2 ghi
Nutans Afganistan×100×2022	442 ± 35 defghijklm	83.2 ± 2.8 bcdefghi	-25.7 ± 0.8 a
Nutans Afganistan×200×2020	339 ± 133 jklm	98.4 ± 8.5 a	-29.3 ± 0.4 ghijklmnopqr
Nutans Afganistan×200×2021	385 ± 15 hijklm	74.4 ± 1.5 efghijklmnopq	-28.6 ± 0.3 fg
Nutans Afganistan×200×2022	442 ± 55 defghijklm	84.2 ± 5.9 bcdefgh	-26.0 ± 0.5 ab
CPI 18197×0×2020	489 ± 82 abcdefghijk	77.2 ± 6.7 cdefghijklmn	-30.1 ± 0.1 s
CPI 18197×0×2021	405 ± 18 fghijklm	73.6 ± 2.5 fghijklmnopqr	-29.0 ± 0.2 ghijklm
CPI 18197×0×2022	532 ± 86 abcdefgh	72.4 ± 6.8 ijklmnopqr	-26.7 ± 0.2 bc
CPI 18197×100×2020	412 ± 65 efghijklm	86.0 ± 9.8 abcde	-29.5 ± 0.3 ijklmnopqrs
CPI 18197×100×2021	422 ± 39 defghijklm	73.6 ± 1.5 fghijklmnopqr	-29.3 ± 0.2 ghijklmnopqr
CPI 18197×100×2022	447 ± 52 cdefghijklm	72.6 ± 1.5 hijklmnopqr	-26.6 ± 0.5 bc
CPI 18197×200×2020	337 ± 72 klm	83.6 ± 5.0 bcdefghi	-29.6 ± 0.3 jklmnopqrs
CPI 18197×200×2021	514 ± 30 abcdefgh	75.4 ± 1.7 defghijklmnop	-29.2 ± 0.2 ghijklmnopq
CPI 18197×200×2022	442 ± 53 defghijklm	70.6 ± 3.6 klmnopqrst	-26.7 ± 0.2 bc
CI 6388×0×2020	548 ± 136 abcdefg	87.6 ± 7.2 abcd	-29.9 ± 0.2 opqrs
CI 6388×0×2021	429 ± 18 defghijklm	80.0 ± 1.2 bcdefghijkl	-28.8 ± 0.3 ghijk
CI 6388×0×2022	504 ± 27 abcdefghi	73.4 ± 3.8 ghijklmnopqr	-27.0 ± 0.3 cde
CI 6388×100×2020	354 ± 33 ijklm	89.0 ± 10.7 abc	-30.0 ± 0.6 qrs
CI 6388×100×2021	445 ± 10 defghijklm	81.6 ± 1.1 bcdefghijk	-28.8 ± 0.3 ghij
CI 6388×100×2022	499 ± 39 abcdefghi	71.4 ± 2.6 jklmnopqrs	-27.4 ± 0.3 cde
CI 6388×200×2020	325 ± 127 lm	85.2 ± 4.4 abcdefg	-30.0 ± 0.4 pqrs
CI 6388×200×2021	508 ± 19 abcdefghi	81.0 ± 1.9 bcdefghijk	-28.7 ± 0.3 gh
CI 6388×200×2022	496 ± 59 abcdefghi	69.8 ± 5.7 lmnopqrst	-27.3 ± 0.4 cde

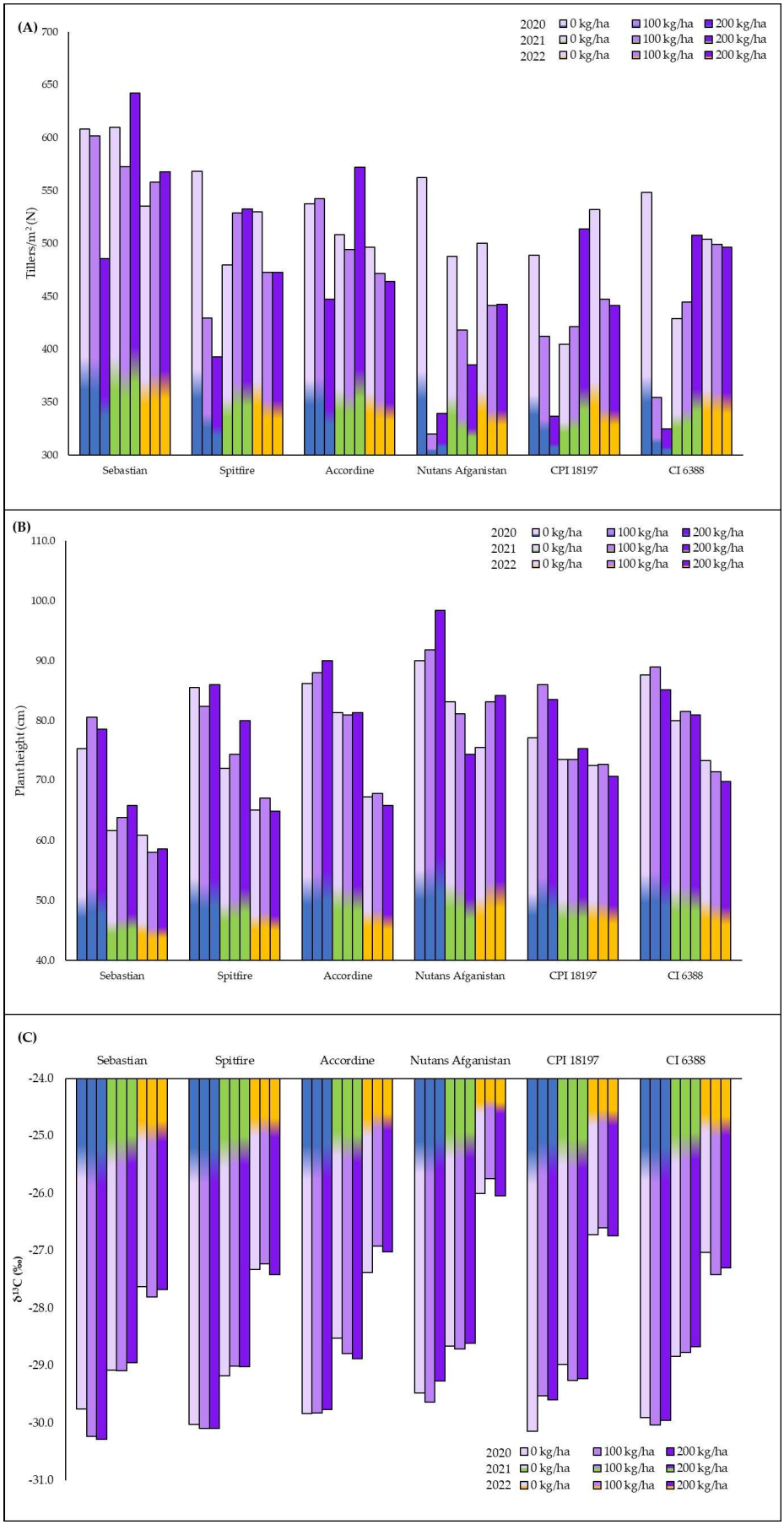
(A)
2020 0 kg/ha 100 kg/ha 200 kg/ha
2021 0 kg/ha 100 kg/ha 200 kg/ha
2022 0 kg/ha 100 kg/ha 200 kg/ha
Tillers/m² (N)
700
650
600
550
500
450
400
350
300
Sebastian
Spitfire
Accordine
Nutans Afganistan
CPI 18197
CI 6388
(B)
2020 0 kg/ha 100 kg/ha 200 kg/ha
2021 0 kg/ha 100 kg/ha 200 kg/ha
2022 0 kg/ha 100 kg/ha 200 kg/ha
Plant height (cm)
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
Sebastian
Spitfire
Accordine
Nutans Afganistan
CPI 18197
CI 6388
(C)
Sebastian
Spitfire
Accordine
Nutans Afganistan
CPI 18197
CI 6388
δ¹³C (‰)
-24.0
-25.0
-26.0
-27.0
-28.0
-29.0
-30.0
-31.0
2020 0 kg/ha 100 kg/ha 200 kg/ha
2021 0 kg/ha 100 kg/ha 200 kg/ha
2022 0 kg/ha 100 kg/ha 200 kg/ha

Figure S5. Interaction of genotype, fertilization, and season factors on the (**A**) tillering; (**B**) plant height; and (**C**) carbon isotope signature ($\delta^{13}C$). Fertilization doses 0, 100, or 200 kg of potassium per ha, season (2020–2022). Data represent means (n = 5). Statistical significance and *SD* values are shown in the Supplementary Table 4.

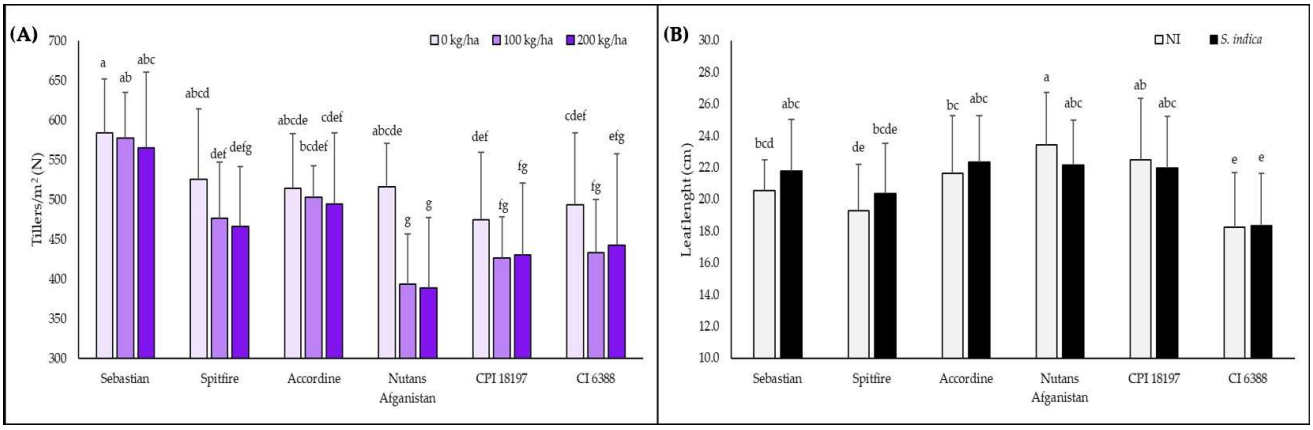

Figure S6. (**A**) Tillering of different genotypes in interaction with fertilization – columns represent means, bars *SD* (n = 15); (**B**) Leaf length in interaction of genotype and inoculation – columns represent means, bars *SD* (n = 18 for *S. indica*; n = 27 for NI); followed by the same letter if there was no statistical difference according to $Tukey_{0.05}$ test.

Table S4. Interaction of genotype, fertilization and inoculation factors on the tillering. Treatment is in format genotype × fertilization (0, 100, or 200 kg of potassium per ha) × inoculation (NI – not inoculated, *S. indica* – *Serendipita indica*). Data represent means ± *SD* (n = 6 for *S. indica*; n = 9 for NI) followed by the same letter if there was no statistical difference according to $Tukey_{0.05}$ test for unequal sample sizes.

Treatment	Tillers/m² (N)
Sebastian×0×NI	580 ± 63 ^{abc}
Sebastian×0×*S. indica*	591 ± 80 ^{abc}
Sebastian×100×NI	561 ± 36 ^{abcd}
Sebastian×100×*S. indica*	602 ± 77 ^{ab}
Sebastian×200×NI	586 ± 54 ^{abc}
Sebastian×200×*S. indica*	535 ± 137 ^{abcdefghi}
Spitfire×0×NI	551 ± 105 ^{abcde}
Spitfire×0×*S. indica*	488 ± 34 ^{abcdefghijk}
Spitfire×100×NI	477 ± 89 ^{abcdefghijk}
Spitfire×100×*S. indica*	478 ± 32 ^{abcdefghijk}
Spitfire×200×NI	452 ± 73 ^{defghijk}
Spitfire×200×*S. indica*	487 ± 82 ^{abcdefghijk}
Accordine×0×NI	540 ± 67 ^{abcdefg}
Accordine×0×*S. indica*	475 ± 56 ^{abcdefghijk}
Accordine×100×NI	506 ± 50 ^{abcdefghij}
Accordine×100×*S. indica*	499 ± 23 ^{abcdefghij}
Accordine×200×NI	510 ± 83 ^{abcdefghij}
Accordine×200×*S. indica*	470 ± 101 ^{abcdefghijk}
Nutans Afganistan×0×NI	522 ± 68 ^{abcdefghi}
Nutans Afganistan×0×*S. indica*	509 ± 28 ^{abcdefghij}
Nutans Afganistan×100×NI	402 ± 57 ^{hijk}

Nutans Afganistan×100×*S. indica*	380 ± 77 ^{jk}
Nutans Afganistan×200×NI	361 ± 102 ^{k}
Nutans Afganistan×200×*S. indica*	431 ± 42 ^{defghijk}
CPI 18197×0×NI	468 ± 83 ^{abcdefghijk}
CPI 18197×0×*S. indica*	486 ± 94 ^{abcdefghijk}
CPI 18197×100×NI	441 ± 56 ^{defghijk}
CPI 18197×100×*S. indica*	405 ± 39 ^{ghijk}
CPI 18197×200×NI	451 ± 92 ^{defghijk}
CPI 18197×200×*S. indica*	401 ± 87 ^{hijk}
CI 6388×0×NI	456 ± 53 ^{bcdefghijk}
CI 6388×0×*S. indica*	551 ± 108 ^{abcdef}
CI 6388×100×NI	430 ± 78 ^{fghijk}
CI 6388×100×*S. indica*	437 ± 56 ^{defghijk}
CI 6388×200×NI	461 ± 102 ^{bcdefghijk}
CI 6388×200×*S. indica*	416 ± 137 ^{fghijk}

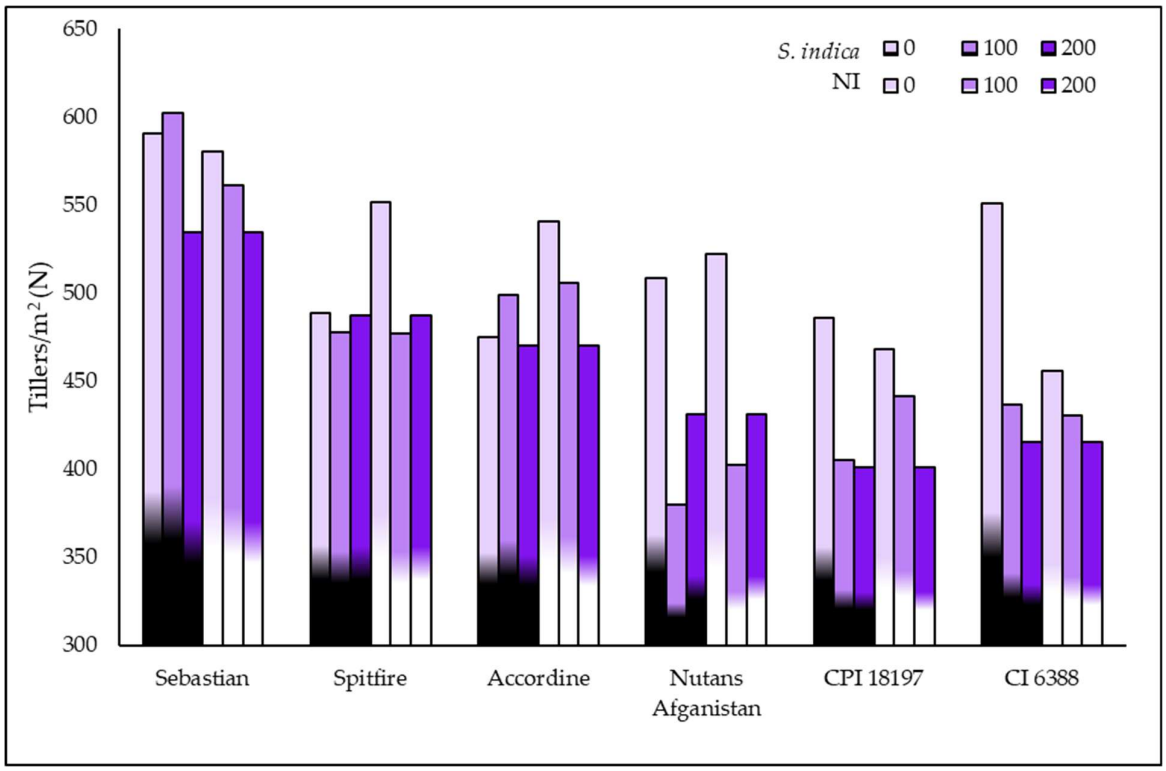

Figure S7. Interaction of genotype, fertilization, and inoculation factors on the tillering. Fertilization doses 0, 100, or 200 kg of potassium per ha, inoculation (NI – not inoculated, *S. indica* – *Serendipita indica*). Data represent means (n = 6 for *S. indica*; n = 9 for NI). Statistical significance and *SD* values are shown in the Supplementary Table 3.