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Abstract

Seed germination of Sicilian durum wheat landraces under the influence of different temperature regimes †

mauro vaccarella *, benedetto frangipane, claudia miceli, luciano raimondo, antonino rigoglioso

[1] Council for in Agricoltural Research and Economics - Research Center for Plant Protection and Certification Viale Regione Siciliana sud/est, 8669 – 90121 Palermo – Italy; benedetto.frangipane@crea.gov.it; (B.F.); luciano.raimondo@crea.gov.it (L.R.); antonino.rigoglioso@crea.gov.it (A.R.); claudia.miceli@crea.gov.it (C.L.)

* Correspondence: mauro.vaccarella@crea.gov.it

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Abstract: The aim of this study was to determinate how different temperature regimes affect seed germinating traits of four conventional varieties of durum wheat (Simeto, Core, Antalis and Orizzonte) and eight landraces (Bidì, Capeiti 8, Castiglione glabro, Faricello, Francesa, Perciasacchi, Timilia Reste Bianche e Timilia Reste Nere). Nine parameters were measured under laboratory condition: germination, shoot length, root length, roots number, seed vigor index, fresh shoot weight, fresh root weight, dry shoot weight, dry root weight. Experimental units were arranged in a two factorial design using a complete randomize design (CRD) with four replications. Results of variance analysis showed that different temperature and genotypes had highly significant effect on all parameters studied. Faricello, Castiglione glabro and Perciasacchi have good germination to low temperature and Bidì has a good growth rate of many germination traits that makes this landrace very attractive.

Keywords: durum wheat, landraces, germination traits, temperature

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1. Introduction

Sicily, with its variable pedoclimatic conditions, represents an important source of agro-biodiversity. In this context, over the past centuries, farmers have made a continuous selection that has led to the creation of numerous landraces. Today 23 Sicilian durum wheat landraces [(Triticum turgidum L. subsp. durum (desf.) Husn.] are listed in the national register of varieties. Wheat landraces are composed of traditional crop varieties developed by farmers through many years of natural and human selection and are adapted to local environmental conditions and management practices. Landraces are named and maintained by traditional farmers to meet their social, economic, cultural, and environmental needs. Landraces, which have arisen through a combination of natural selection and the selection performed by farmers usually have a broader genetic base and can therefore provide valuable characteristics important for breeding [1]. Seed germination and seedlings vigor are prerequisites for successful stand establishment and are extremely important factors in determining the yield of the crop [2]. Temperature is a key factor driving this physiological process and, since no previous work on these genotypes has been carried out, it was thought to perform this research. The aim of this study was to determine how different temperature regimes affect seed germinating traits of four conventional varieties of durum wheat most cultivated in Sicily (Simeto, Core, Antalis and Orizzonte) and eight landraces (Bidì, Capeiti 8, Castiglione glabro, Faricello, Francesa, Perciasacchi, Timilia Reste Bianche [Timilia R..B.]e Timilia Reste Nere [Timilia R.N.]). This first information could be useful for future breeding programs.

2. Results

Temperature, genotype and their interaction determined highly significative differences in all the germination traits studied as reported in Table 1.

Table 1: Factorial analysis of variance showing the means square of the temperature and genotypes and their interaction for the germination traits studied

	degree of fredom	Germination (%)	Shoot Lenght (cm)	Root Lenght (cm)	Number of roots	Seed Vigor Index	Fresh Shoot Weight (mg)	Fresh Root Weight (mg)	Dry Shoot Weight (mg)	Dry root Weight (mg)
Temperature (T)	2	***	***	***	***	***	***	***	***	***
Genotype (G)	11	***	***	***	***	***	***	***	***	***
T X G	22	***	***	***	***	***	***	***	***	***
Error	108	17,583	0.322	0.337	0.204	4099.379388	0.086	0.081	0.004	0.003

*** significantly different at P < 0,0001

Raise in temperature has determined a specific increasing trend of value for Shoot Length, Seed Vigour Index, Fresh Shoot weight, Dry Shoot Weight, and Dry Root Weight. The growth of the root system has decreased to the highest temperature. Timilia Reste bianche had the best germination percentage in all the temperature regimes tested; Perciasacchi and Faricello showed the highest germination percentage at 10°C and 20 °C; at the highest temperature, these data were statistically significantly reduced. For Shoot length and Seed Vigor Index at 10°C, there was no difference between the genotypes analyzed. Bidì has a good growth rate of many germination traits that makes this landrace very attractive. The influence of different temperature level on all the parameters considered is shown in tables 2 and 3 (the most interesting genotypes are highlighted in green).

Table 2: Germination traits and seed vigor index of eight durum wheat landraces and four modern cultivar under the influences of different temperature regimes

Source of variation		Germination (%)	Shoot Lenght (cm)	Root Lenght (cm)	Roots number	Seed Vigor Index
Temperature x Genotype						
10 ℃	Antalis	94.5 af	1.41 n	3.09 k	3.02 i	133.29 k
	Bid ì	93 ai	1.32 n	3.11 k	3.95 gh	123.59 k
	Capeiti 8	87.5 fj	1.05 n	2.12 l	3.12 i	92.12 k
	Castiglione G.	86.5 hj	1.65 n	3.58 k	3.32 hi	143.15 k
	Core	86 ij	1.34 n	3.13 k	3.07 i	115.50 k
	Faricello	96.5 ad	1.51 n	3.11 k	3.55 hi	145.34 k
	Francesa	89.5 dj	1.57 n	2.79 kl	4.62 dg	141.30 k
	Orizzonte	93 ai	1.47 n	2.79 kl	3.45 hi	137.03 k
	Perciasacchi	96 ae	1.96 n	3.06 k	4.22 fg	187.92 k
	Simeto	93.5 ah	1.08 n	2.72 kl	3 i	101.23 k
	Timilia R.B.	96 ae	1.47 n	3.59 k	3.1 i	141.06 k
	Timilia R.N.	86.5 hj	1.26 n	2.86 kl	2.97 i	109.40 k
20 ℃	Antalis	96 ae	8.27 lm	10.42 ab	5.02 ae	793.5 hi
	Bid ì	94.5 af	10.3 hi	11.29 a	5.15 ae	972.1 fg
	Capeiti 8	92.5 aj	8.79 jl	6.22 fi	4.92 bf	812.2 hi
	Castiglione G.	85.5 j	12 de	10.43 ab	5.1 ae	1021.7 df
	Core	90 cj	9.6 ij	8.32 c	5.67 ab	864.7 h
	Faricello	99 a	10.7 gh	5.84 gi	5.32 ad	1059.1 df
	Francesa	91.5 bj	10.8 fh	7.58 cd	5.15 ae	991.8 ef
	Orizzonte	98.5 ab	8.39 km	10.02 b	5.15 ae	826.1 hi
	Perciasacchi	96 ae	10.3 hi	5.79 gi	5.7 a	984.0 eg
	Simeto	89.5 dj	7.74 m	8.28 c	4.95 af	693.0 j
	Timilia R.B.	97 ac	9.14 jk	6.12 fi	4.77 df	886.4 gh
	Timilia R.N.	95 ae	11.5 eg	11.08 a	4.5 eg	1095.8 cd
30 ℃	Antalis	95.5 ae	10.83 fh	6.89 df	3.4 hi	1034.0 df
	Bid ì	89.2 dj	14.14 b	7.16 de	5.35 ad	1261.2 b
	Capeiti 8	72 k	10.39 hi	3.60 k	3.37 hi	757.3 ij
	Castiglione G.	90.5 cj	13.20 c	6.90 df	5.32 ad	1195.8 b
	Core	94 ag	12.54 cd	4.84 j	4.9 cf	1179.5 bc
	Faricello	72.5 k	11.63 ef	6.16 fi	5.35 ad	842.8 h
	Francesa	87 gj	16.51 a	5.88 gi	5.12 ae	1433.8 a
	Orizzonte	93.25 ah	13.04 c	6.12 fi	4.77 df	1214.0 b
	Perciasacchi	89 ej	12.15 de	5.69 hj	5.62 ac	1082.3 de
	Simeto	89.5 dj	10.78 fh	6.47 eh	4.92 bf	963.8 fg
	Timilia R.B.	96.5 ae	12.78 cd	6.73 dg	4.57 dg	1232.9 b
	Timilia R.N.	73.2 k	14.19 b	5.42 ij	4.6 dg	1037.6 df

In each column, mean followed by common letter are not significantly different with Duncan's Multiple Range test at 5 % probability level

Table 3: Fresh shoot, fresh root, shoot dry and root dry weight of eight landraces and four modern cultivar of durum wheat under the influences of different temperature regimes.

Source of variation		Fresh Shoot Weight (mg)	Fresh Root Weight (mg)	Dry Shoot Weight (mg)	Dry root Weight (mg)
Temperature x Genotype					
10 ℃	Antalis	0.4617 k	0.6811 mo	0.0526 n	0.0663 jk
	Bid ì	0.4363 k	0.9815 jo	0.0716 n	0.0825 jk
	Capeiti 8	0.2291 m	0.5596 o	0.0815 mn	0.1103 ik
	Castiglione G.	0.6810 jk	1.0770 hn	0.0824 mn	0.1242 hj
	Core	0.4375 k	0.8208 ko	0.0554 n	0.0816 jk
	Faricello	0.6588 jk	1.1933 fl	0.0698 n	0.0841 jk
	Francesa	0.5213 jk	1.0346 io	0.0876 mn	0.1327 hj
	Orizzonte	0.4809 jk	0.8271 ko	0.0324 n	0.0539 jk
	Perciasacchi	0.9407 j	1.5105 ci	0.0650 n	0.0774 jk
	Simeto	0.3728 k	0.7381 lo	0.0175 n	0.0359 k
	Timilia R.B.	0.5442 jk	0.9857 jo	0.0223 n	0.0499 jk
	Timilia R.N.	0.3400 k	0.6961 mo	0.0625 n	0.0843 jk
20 ℃	Antalis	4.3350 gh	2.1443 ab	0.4484 jk	0.3880 be
	Bid ì	6.6412 a	2.3131 a	0.6471 dg	0.4181 cd
	Capeiti 8	3.5081 i	1.2488 ek	0.3546 kl	0.3017 f
	Castiglione G.	5.4981 cd	1.3392 cj	0.6685 cf	0.5482 a
	Core	4.3463 gh	1.5476 ch	0.7424 ad	0.6057 a
	Faricello	4.7441 eg	1.0253 jo	0.3799 jl	0.2135 g
	Francesa	5.1078 de	1.3270 cj	0.3714 kl	0.1666 gi
	Orizzonte	4.3351 gh	2.4757 a	0.4170 jk	0.3011 f
	Perciasacchi	5.1253 de	1.2857 dk	0.3049 l	0.0992 ik
	Simeto	4.0420 h	1.7661 bc	0.6986 be	0.6131 a
	Timilia R.B.	3.1003 i	0.5980 no	0.1729 m	0.0669 jk
	Timilia R.N.	5.1396 de	1.6358 cf	0.4501 jk	0.3253 ef
30 ℃	Antalis	4.6846 eg	1.5776 cg	0.5450 hi	0.3310 df
	Bid ì	7.0183 a	1.7215 be	0.8039 a	0.4291 bc
	Capeiti 8	3.2843 i	1.1161 gm	0.5508 gi	0.4540 b
	Castiglione G.	5.7140 bc	1.2156 fl	0.5948 fh	0.5393 a
	Core	4.7191 eg	1.7313 bd	0.7485 ac	0.4120 bd
	Faricello	4.5531 fg	1.0100 jo	0.6080 eh	0.3825 be
	Francesa	5.9970 b	1.6373 cf	0.7910 ab	0.4135 bd
	Orizzonte	4.9540 ef	1.0208 jo	0.7129 ad	0.4149 bd
	Perciasacchi	6.0263 b	2.1114 ab	0.7531 ac	0.4092 bd
	Simeto	4.7570 eg	1.2778 dk	0.5920 fh	0.3934 be
	Timilia R.B.	4.3625 gh	1.1190 gm	0.4765 ij	0.3603 cf
	Timilia R.N.	4.8374 ef	0.9465 jo	0.5590 gi	0.1998 gh

In each column, mean followed by common letter are not significantly different with Duncan's Multiple Range test at 5 % probability level

The Pearson correlation between germination parameters has been evaluated separately for three-level of temperature because of the significant interaction of genotypes and temperature [3]. A correlation study among germination parameters showed a positive and highly significant correlation of Shoot Length with Seed Vigor Index and Fresh Shoot Weight in all temperature regimes. No positive and significant correlation between

Germination and Shoot length, Root length, Fresh Shoot Weight, Fresh Root Weight, Dry Shoot weight, and Dry Root Weight has been (see table 4).

Table 4: Pearson's correlation matrix for the germination parameters studied

10 ℃									
Parameter	Germination (%)	Shoot length (cm)	Root length (cm)	Root number	Seed vigor index	Fresh shoot weight (mg)	Fresh root weight (mg)	Dry shoot weight (mg)	Dry root weight (mg)
Germination (%)	**1**	0.322	0.229	0.208	0.517	0.451	0.448	-0.447	**-0.588**
Shoot length (cm)	0.322	**1**	0.547	**0.602**	**0.976**	**0.947**	**0.881**	0.234	0.212
Root length (cm)	0.229	0.547	**1**	-0.009	0.527	0.565	0.495	-0.150	-0.101
Root number	0.208	**0.602**	-0.009	**1**	**0.598**	0.518	**0.672**	0.494	0.455
Seed vigor index	0.517	**0.976**	0.527	**0.598**	**1**	**0.956**	**0.900**	0.120	0.062
Fresh shoot weight (mg)	0.451	**0.947**	0.565	0.518	**0.956**	**1**	**0.946**	0.135	0.077
Fresh root weight (mg)	0.448	**0.881**	0.495	**0.672**	**0.900**	**0.946**	**1**	0.220	0.146
Dry shoot weight (mg)	-0.447	0.234	-0.150	0.494	0.120	0.135	0.220	**1**	**0.935**
Dry root weight (mg)	**-0.588**	0.212	-0.101	0.455	0.062	0.077	0.146	**0.935**	**1**
20 ℃									
Parameter	Germination (%)	Shoot length (cm)	Root length (cm)	Root number	Seed vigor index	Fresh shoot weight (mg)	Fresh root weight (mg)	Dry shoot weight (mg)	Dry root weight (mg)
Germination (%)	**1**	-0.222	-0.214	-0.040	0.110	-0.154	0.069	**-0.666**	**-0.675**
Shoot length (cm)	-0.222	**1**	0.147	0.031	**0.943**	**0.632**	-0.307	0.044	-0.129
Root length (cm)	-0.214	0.147	**1**	-0.326	0.064	0.538	**0.756**	0.563	0.548
Root number	-0.040	0.031	-0.326	**1**	0.019	0.221	0.016	0.204	0.049
Seed vigor index	0.110	**0.943**	0.064	0.019	**1**	**0.594**	-0.298	-0.172	-0.355
Fresh shoot weight (mg)	-0.154	**0.632**	0.538	0.221	**0.594**	**1**	0.410	0.420	0.175
Fresh root weight (mg)	0.069	-0.307	**0.756**	0.016	-0.298	0.410	**1**	0.476	0.454
Dry shoot weight (mg)	**-0.666**	0.044	0.563	0.204	-0.172	0.420	0.476	**1**	**0.951**
Dry root weight (mg)	**-0.675**	-0.129	0.548	0.049	-0.355	0.175	0.454	**0.951**	**1**
30 ℃									
Parameter	Germination (%)	Shoot length (cm)	Root length (cm)	Root number	Seed vigor index	Fresh shoot weight (mg)	Fresh root weight (mg)	Dry shoot weight (mg)	Dry root weight (mg)
Germination (%)	**1**	0.083	0.545	0.105	**0.637**	0.330	0.436	0.189	0.247
Shoot length (cm)	0.083	**1**	0.209	0.475	**0.818**	**0.633**	0.137	0.525	-0.069
Root length (cm)	0.545	0.209	**1**	0.367	0.451	0.568	0.072	0.007	0.036
Root number	0.105	0.475	0.367	**1**	0.426	**0.703**	0.292	**0.577**	0.248
Seed vigor index	**0.637**	**0.818**	0.451	0.426	**1**	**0.673**	0.361	0.530	0.144
Fresh shoot weight (mg)	0.330	**0.633**	0.568	**0.703**	**0.673**	**1**	**0.586**	**0.721**	0.209
Fresh root weight (mg)	0.436	0.137	0.072	0.292	0.361	**0.586**	**1**	**0.657**	0.222
Dry shoot weight (mg)	0.189	0.525	0.007	**0.577**	0.530	**0.721**	**0.657**	**1**	0.304
Dry root weight (mg)	0.247	-0.069	0.036	0.248	0.144	0.209	0.222	0.304	**1**

Bold value are significant at 0,05 probability level

3. Discussion

All parameters studied were highly influenced by Temperature, Genotype, and their interaction. No significant difference between landraces and conventional varieties has been reported. Our findings indicate that Faricello, Castiglione glabro, and Perciasacchi have good germination to low temperature and Bidì has a good growth rate of many germination traits that makes this landrace very attractive. To confirm our findings, further research is needed.

4. Materials and methods

Seeds were tested under 3 temperature regimes (10 °C, 20 °C, and 30 °C). Experiments were laid out in a two factorial design using a complete randomized design (CRD) with four replications. Nine parameters were measured under laboratory conditions: germination, shoot length, root length, roots number, seed vigor index, fresh shoot weight, fresh root weight, dry shoot weight, dry root weight. Data were examined using analysis of variance techniques (ANOVA) to identify significant differences among temperatures and genotypes. Duncan's Multiple Range test was applied at a 5% level of probability to compare the mean differences. Pearson's correlation coefficient between different traits and the main factor was also computed.

Germination percentage was calculated based on normal seedling evaluated on the 8th day and it was expressed in percentage [4]. To calculate Seed Vigor Index, the following formula that evaluates the seedling growth has been used [5,6]:

Seed Vigor Index (SVI) = Shoot length x Germination Percentage.

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