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The effect of drought stress on some grain qualitative traits of bread wheat

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Introduction: One of the highest levels of cultivation among major food crops belongs to wheat. In the world, wheat can provide approximately 20% of total dietary calories and protein and a large amount of health-promoting nutrients in the human diet (Hazard *et al*., 2020). Due to drought's effect on the yield and quality of final consumption, the increase in world population and climate change, we require an increase in wheat production (Yang *et al*., 2023). In previous studies, the effect of drought stress in different stages of growth on wheat grain yield has been widely investigated, but there are not that many studies on the effect of drought stress on grain quality. Wheat grain contains three main components: approximately 80% starch and 10% protein, and the rest consist of minerals, fat, fiber, etc (Shewry *et al*., 2013). Several parameters distinguish seed quality. Some of these parameters for measuring quality are protein (Mutlu *et al*., 2011), starch (Kim and Kim, 2021; Li *et al*., 2020), and moisture (Scariot *et al*., 2018; Karunakaran *et al*., 2001). This research was conducted with the aim of the effect of drought stress on some quality parameters of wheat grain including grain moisture, grain protein percentage and grain starch percentage.

Materials and methods: This research was aimed to investigate and evaluate 23 bread wheat genotypes with two wheat varieties as checks (Pishtaz and Pishgam) which were prepared from Seed and Plant Research Institute, Karaj. Two field experiments were carried out at the research farm of Faculty of Agriculture, Razi University, Kermanshah using randomized complete block designs with three replications during the cropping season 2020-2021 under normal irrigation and rain-fed conditions. Each plot included a plant density of 400 seeds per square meter and five two meter lines spaced distance of 25 cm. The examined traits included seed moisture content, protein percentage and starch percentage. To measure the traits, 70 grams of the harvested grains from each plot were weighed and then measured by the NIR device available in the central laboratory of Lorestan University. Data analysis was performed with SAS 9.1.3 software, including combined analysis of variance and mean comparisons.

Table and Figure:

Table 1:Combined analysis of variance for qualitative traits in 25 bread wheat genotypes under rain-fed and normal conditions

Sources of Variation	Degrees of Freedom	Mean of Squares (MS) M	P	S
Environment	1	1.233**	4.96^{ns}	0.068*
Replication/ Environment	4	0.121^{ns}	1.549^{ns}	0.009^{ns}
Genotype	24	0.170**	8.34**	0.073**
Genotype × Environment	24	0.132^{ns}	1.746^{ns}	0.0165^{ns}
Error	96	0.085	1.540	0.0166
Coefficient of Variation (CV%)		4.43	8.38	5.21

ns, * and ** are non-significant difference, significant at the 5 and 1 percent probability levels, respectively
M : Moisture %, P: protein % and S: starch %

Table 2: Mean comparison of 25 bread wheat genotypes in terms of measured traits using LSD test

Genotype	m			p			S		
	Rain-fed	Normal	Total	Rain-fed	Normal	Total	Rain-fed	Normal	Total
WC-4924	6.85	6.35	6.60	13.90	16	14.95	2.42	2.51	2.47
WC-4582	6.75	6.90	6.83	13.35	14.40	13.88	2.36	2.51	2.44
WC-4592	6.55	6.65	6.60	15.95	15.35	15.65	2.70	2.67	2.69
WC-47341	6.75	6.70	6.73	12.55	13.60	13.08	2.34	2.31	2.33
WC-4965	6.55	6.25	6.40	15.00	15.95	15.48	2.65	2.58	2.62
WC-4840	6.40	6.30	6.35	15.55	16.15	15.85	2.45	2.44	2.45
WC-4958	6.90	6.55	6.73	12.15	14.30	13.23	2.27	2.38	2.33
WC-47399	6.85	6.75	6.80	13.75	15.00	14.38	2.46	2.39	2.43
WC-4600	6.70	6.60	6.65	14.25	15.15	14.70	2.48	2.53	2.51
WC-4987	6.70	6.60	6.65	14.55	13.35	13.95	2.41	2.32	2.37
WC-47615	6.55	6.20	6.38	15.30	16.75	16.03	2.46	2.55	2.51
WC-4612	6.60	6.55	6.58	14.05	12.65	13.35	2.54	2.26	2.40
WC-5001	6.65	6.45	6.55	14.75	13.90	14.33	2.53	2.47	2.50
WC-4994	6.85	6.55	6.70	12.95	16.65	14.80	2.58	2.63	2.61
WC-47638	6.65	6.70	6.68	14.55	14.20	14.38	2.49	2.50	2.50
WC-47583	6.70	6.65	6.68	13.75	13.90	13.83	2.39	2.38	2.39
WC-47522	6.55	6.65	6.60	16.65	16.70	16.68	2.61	2.51	2.56
WC-47569	6.65	6.50	6.58	16.50	16.20	16.35	2.58	2.42	2.50
Pishtaz	6.75	5.46	6.11	13.35	11.95	12.65	2.29	2.02	2.16
Pishgam	6.95	6.50	6.73	14.85	15.30	15.08	2.57	2.44	2.51
WC-47640	6.65	6.75	6.70	13.40	14.10	13.75	2.49	2.42	2.46
WC-47467	6.40	6.20	6.30	16.75	16.00	16.38	2.62	2.55	2.59
WC-4553	6.75	6.60	6.68	13.95	15.10	14.53	2.40	2.38	2.39
WC-4583	6.90	6.50	6.70	14.65	15.80	15.23	2.56	2.53	2.55
WC-4554	6.60	6.75	6.68	17.10	16.20	16.65	2.59	2.48	2.54
Minimum	6.40	5.46	6.11	12.15	11.95	12.65	2.29	2.02	2.16
Maximum	6.95	6.90	6.83	17.10	16.75	16.68	2.70	2.67	2.69
Mean	6.65	6.49	6.60	14.54	14.97	14.76	2.48	2.44	2.47
LSD (5%)	0.20	0.64	0.463	1.81	2.23	1.98	0.15	0.25	0.206

Results and Discussion: Based on combined analysis of variance (Table 1), the environment effect was significant for grain moisture percentage and grain starch percentage. Also, the genotype effect for all the traits was significant (P< 0.01). Mean comparison of the total average of the two environments for the genotypes showed that Pishtaz, WC-47467 and WC-47615 genotypes had the lowest percentage of moisture. Also, genotypes WC-47522, WC-4554 and WC-47467 had the highest percentage of protein. WC-4592, WC-4965 and WC-4994 genotypes showed the highest percentage of starch for both environments, respectively. Mean comparisons by LSD method for grain moisture percentage under rain-fed conditions showed that genotypes WC-47467, WC-4840 and WC-47615 had the lowest moisture content (Table 2). Under normal irrigation conditions, Pishtaz, WC-47467 and WC-47615 genotypes had the lowest moisture percentage. In rain-fed environment, WC-4554, WC-47467 and WC-47522 genotypes, while under in normal irrigation, WC-47615, WC-47522 and WC-4994 genotypes had the highest percentage of grain protein. For starch grain percentage in rain-fed conditions, genotypes WC-4592, WC-47467 and WC-47522 also had the highest averages in normal irrigation conditions. Nouri and Taliman (2022) reported that drought stress reduced the amount of starch in wheat seeds. Based on the percent reduction due to drought stress for the studied traits including grain moisture percentage, protein percentage and starch percentage was calculated as -2.46, 2.87 and -1.63 respectively. Li et al (2024) reorted that, drought stress led to decreased content of starch and its compounds, while simultaneously glutenin macropolymers and protein fractions incresded, which ultimately caused an overall increase in total protein content. Grains with high moisture can lead to a decrease in wheat quality which affects the utilization of the final grain product, the development of fungus and mold and lower grading in the market (Preston et al., 1991). Without proper control, moisture can create a favorable environment for insects and microorganisms that damage wheat grain quality (Ziegler et al., 2021; Müller et al., 2022).

Conclusion: According to the results of the research, the high seed moisture was not suitable for the seed quality. The genotypes WC-47615, WC-47522, WC-4592 and WC-47467 were identified as superior entries in terms of the qualitative traits.

Keywords: Rain-fed conditions, Quality characters, Wheat.

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