International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:9, No:8, 2015

Germination and Seed Vigor Response of Five Wheat Cultivars to Stress of Premature Aging Effects

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***Abstract*—**To evaluate the vigor of wheat seeds and stress of premature aging effects on germination percentage, root length and shoot length of five wheat cultivars that include Vynak, Karkheh, Chamran, Star and Kavir which underwent a period of zero, two, three, four days in terms of premature aging with 41°C temperature and 100% relative humidity. Seed germination percentage, root length and shoot length in these conditions were measured. This experiment was conducted as a factorial completely randomized design with four replications in laboratory conditions. The results showed that each of aging treatments used in this experiment can be used to detect differences in vigor of wheat varieties. Wheat cultivars illustrated significant differences in germination percentage, root length and shoot length in terms of premature aging. The wheat cultivars; Astar and Vynak had maximum germination percentage and Karkheh, respectively Kavir and Chamran had lowest percentage of seed germination. Reactions of root and shoot length of wheat cultivars was also different. The results showed that the seeds with a stronger vigor affected less in premature aging condition and the difference between the percentage of seed germination under normal conditions and stress was significant and the seeds with the weaker vigor were more sensitive to the premature aging stress and the premature aging had more severe negative impact on seed vigor.

***Keywords*—**Wheat cultivars, seed vigor, premature aging effects.

I. Introduction

CROP seeds, in commerce are subjected to varying degrees of water and temperature stresses during development, maturation, harvest, and storage, and then during imbibitions and germination following sowing. Only seeds, best coping with these conditions, are capable of rapid germination and establishment of healthy seedlings and are essential for efficient crop production. Seed deterioration leads to reduction in seed quality, performance, and seedling establishment. It is estimated that poor seed performance can cause 500 million dollar loss annually. Thus, it is important to gain a fundamental understanding of the processes of seed deterioration [1]. The optimum germination and establishment of seedling and its importance in agriculture is very important. So that success or failure of production strongly dependent on the produce of complete and rapid seed germination and seedling. The Maximum value of seedlings are established when the seed can overcome on the environmental conditions and shows a good response [2]. Tests that determine seed vigor plays an important role in seed production and in their marketing decisions. Seed mass with high vigor can be more stressful in field conditions and being planted early. The seed vigor test can be used to decide on holding a special seed mass in the seed stock used for a longer time [3].

Vigor can be defined as the ability of a seed to germinate rapidly and produce a normal seedling under a wide range of conditions [4]. Seed vigor is something that cannot be seen or measured until the seed germinates. Even then, vigor measurements are hard to correlate to final yield. There is no one universal vigor test for all seeds. A vigor test can only measure one phase of early seedling growth. There are several tests that are used by seed companies to measure vigor in the seed lot. Several examples of tests for seed vigor include looking at either cool and/or warm germination stress tests, uniformity and rate of radical protrusion, measuring radicle growth over a certain period of time, conductivity of seed leachate, accelerated aging, various seedling growth tests such as root length and seedling height, and more recently, a technique developed by the Ball Seed Company utilizing image analysis of cotyledon expansion [3], [5].

During storage of seeds, aging leads to a progressive decrease in their vigor, and then in a loss of their viability [1]. The ageing of seeds is indicated by delayed germination, slower growth and increased susceptibility to environmental stress, eventually leading to loss of viability [6], [7].

Accelerated ageing of seeds at elevated relative humidity and high temperature lost germination and seed viability and vigor. Physiological aging in seeds entails a series of degenerative changes that lead to a loss of viability. Aging usually begins after physiological maturity when seeds are of optimum quality. Major factors influencing the extent of aging are seed moisture content and temperature, with an increase in either or both accelerating the rate of aging [8]. Physiological changes during aging include decreases in enzyme activity, respiration, protein synthesis, increased lipid peroxidation and the deterioration of membranes [9]. The technique of accelerated aging is commonly used to determine the storage potential of seed lots and to evaluate their vigor [10].

Accelerated aging involves exposure of seeds to high humidity and temperature. The environmental conditions and periods of exposure that are effective for enhancing seed physiological age can range from mild (25 to 30°C, 75 to 94% RH for 6 to 24 wk) to severe (45°C, 100% RH for 1 to 8 d) [10], [11]. It is assumed that accelerated aging amplifies the deteriorative processes that normally take place during prolonged storage [10] as changes occurring during accelerated aging appear to be the same as those of natural

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aging [12]. In addition, if a significant level of anaerobic respiration occurs during the accelerated aging treatment, its by-products (ethanol) could be responsible for the loss of seedling vigor in the aged seeds. However, very high levels of ethanol would have to accumulate in the seed before a significant decrease in seedling vigor would be detected [13].

The aim of this work is to show seed vigor and germination percentage of five wheat cultivars under different conditions of accelerated aging.

II. Methods And Materials

The experiment consisted of five wheat varieties Vynak, Karkheh, Chamran, Star and Kavir. These wheat varieties were obtained from the Research Center for Agriculture and Natural Resources of Khuzestan Province in southwest of Iran. The factorial experiment with completely randomized design based with four replications was done in the research laboratory of Agriculture Department of Islamic Azad University of Ahvaz Branch.

The wheat varieties of the experiment for 0,2,3,4 days were in the temperature of 410C and relative humidity of 100% was exposed to conditions of accelerated aging. Seeds were placed inside the incubator with Memert brand with ± 0.1 0 C accuracy.

For the seed germination standard test, 1 00 seeds of any varieties and aging treatments were placed in 4 replications each with 25 numbers of seed in Petri dishes with a diameter of 10 Cm on the filter paper. Seeds were disinfected with 20% bleach and then washed with distilled water. Moisture needed for germination process was provided by adding 5 ml of distilled water to each Petri dish. The seeds were heated for 5 days at 20°C and at the end, germination was measured. Seeds were considered germinated when the radicle was at least 2 mm. At the end of the period from any Petri dish 10 seedlings selected randomly and root length and shoot length were measured. The Analysis of variance was performed with statistical software, SAS 9.1 and Excel 2003 software was used for simple correlation coefficients and draw charts.

III. Results And Discussion

The results showed that there are significant differences in seed germination of the varieties (Table I). Among the varieties, Star had the highest germination percent. Vynak, Karkheh, Chamran and Kavir, had reduction about 16.2, 18.3, 47.35, 27.13 percent respectively, in the number of seeds (Table II). The mean of germination percentage in different aging treatments were different (Table III). Germination at 4 days of aging treatment in compare with the control treatment was lower at around 28.26 percent (Table III). The results also show the interaction between cultivars and different aging treatments (Table III).

Various aging treatments could show strong differences in germination of seed. So that there is no statistical difference between the Control and the three Vynak, Chamran, Star in the 0 day (control) treatment. In 2 days aging treatment germination was significantly reduced germination percentage of Karkheh and Kavir in compare with the other three cultivars. In 3 days aging tretment, the result showed a dramatic reduction in germination percentage of Karkheh, Kavir, Chamran compare with two cultivars Vynak and Star. In the treatment 4 days aging, Vynak and Star Superior Karkheh and lowest germination percentage allocated to the Kavir.

TABLE I
Analysis of Variance of Seed Traits in Premature Aging Condition

S.O.V	DF	Mean of Square		
		Germination Percent	Shoot Length	Root Length
Varieties (V)	4	0.3136**	0.7596**	0.3403**
Ageing (A)	2	0.3146**	0.6706**	1.5647**
V * A	8	0.0291*	0.1642**	0.1430**
Error	45	0.0119	0.03397	0.0378
CV		14.09	9.67	8.05

*, **: Significant at 5% and 1% levels, respectively.

TABLE II
Interaction between Variety and Premature Aging on Germination

Ageing (Day)	Cultivar					Mean
	Vynak	Karkheh	Chamran	Star	Kavir	
0	95 a	89 a	92 a	96 a	89 a	92 a
2	89 a	69 cd	87 ab	97 a	69 cd	82 b
3	86 ab	42 ef	68 cd	87 ab	56 de	68 c
4	87 ab	37 f	70 bcd	83 abc	51 ef	66 c
Mean	89 a	59 c	79 b	91 a	66 c	

Within each column figures sharing same letter are non-significantly ($P < 0.05$) different.

Statistical difference was found between the results of root length (Table I). Between varieties, Vynak had the highest root length than other varieties. Karkheh, Chamran, Star, Kavir, had reduction in root length respectively, about 21.68, 6.10, 21.12, 12.4% compared to the best variety (Table III). Test results also show the effects of aging were different between varieties and treatments.

Aging treatments showed the difference among root length of varieties. And the influence of aging treatments on root length was similar to their effect on germination. So that the mean of root length of varieties in 2, 3 and 4 day aging treatments was statistically different with the mean of root length in control treatment was (Table IV).

TABLE III
Reduction Percentage of Germination Treats in Different Cultivars and Levels of Premature Aging

Cultivar	Germination Percent	Shoot Length	Root Length
Vynak	16.2	-	-
Karkheh	18.3	24	21.68
Chamran	47.35	0.88	6.10
Star	-	11.11	21.12
Kavir	27.13	7.55	12.4
Ageing (Day)	Germination Percent	Shoot Length	Root Length
0	0	0	0
2	10.86	6.66	7.66
3	27	8.44	17.51
4	28.26	20	23

The Shoot length of seedlings in 2, 3 and 4 day aging treatments was respectively, 6.66, 8.44 and 20.00 per cen t lower than it was in the control treatment (Table III). Karkheh, Chamran, Star, Kavir, had redu ction in shoot length respectively, about 24.00, 0.88, 11.11, 7.55 % compared to the best variety (Table III). In the 4 days aging treatment Karkheh and Vynak varieties had the highest root length and the lowest root length allocated to the Kavir.

TABLE IV
EFFECT OF AGING ON INTERACTION BETWEEN CULTIVARS AND ROOT LENGTH

Ageing (Day)	Cultivar					Mean
	Vynak	Karkheh	Chamran	Star	Kavir	
0	27.7 ab	30.9 a	25.1 b-e	26.8 bc	26.6 b-d	27.4 a
2	27.1 ab	24.4 b-f	25.2 b-e	26.2 b-d	23.6 b-f	25.3 b
3	24.5 b-f	20.4 f-g	21.2 e-h	24.4 b-f	22.5 d-g	22.6 c
4	25.5 b-d	18 h	20.5 f-h	22.7 c-g	18.9 gh	21.1 d
Mean	26.2 a	23.4 b	23 b	25 a	66 c	

Within each column figures sharing same letter are non-significantly ($P < 0.05$) different

In this experiment, the germination percentage of root length was a ffected, but the regression between germination percentage and root length showed a significant correlation exists between them (Fig. 1).

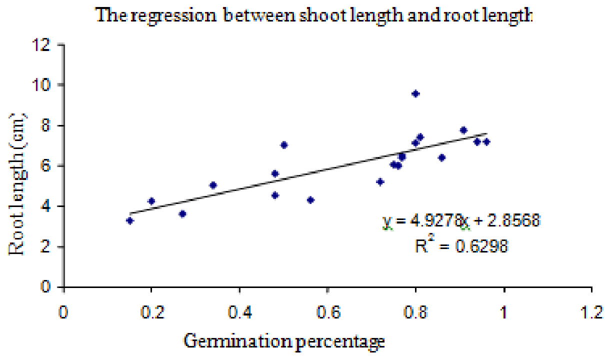

Fig. 1 The regression between shoot length and root length

Correlation coefficient between germination percentage and root length was 0.7 0 (Table V). This means that with increasing exposure time, the seeds are exposed to high heat (40 degrees) and humidity (100%) for periods of 2, 3, 4 day reduced the number of the germinated seeds and reduced root length.

TABLE V
CORRELATION COEFFICIENTS BETWEEN VARIOUS TRAITS OF WHEAT IN 4 LEVELS OF THE PREMATURE AGING IN 0, 2, 3 AND 4 DAYS

NO.	trait	1	2	3
1	Shoot length	1		
2	Root length	0.65**	1	
3	Germination percent	0.55**	0.70**	1

Bingham et al. showed that premature aging decreased root and shoot growth rate and only in more severe p remature aging treatments the germination was significantly decreased. Premature aging effects on germination were different from the effects on their development is the root and shoot [14].

The results contained in Table VI indicate that the differences in shoot length were statistically significant. The effects of aging treatments on the sho ot length were as the same as the effects on the germination and root length. Analysis of variance showed significant differences in shoot length of different aging treatments. So that the shoot length in 2, 3 and 4 day of aging treatments was r espectively, 6.66, 8.44, 20.00 percent lower than in the control treatment (Table III).

The 4 day of aging treatment Vynak variety had the highest shoot length and the lowest shoot length allocated to Karkheh. Although in this experiment germination was less affected by aging treatments than shoot length and root length, but the correlation coefficient between them was 0.55 (Table V).

The correlation between shoot length and root length of aging treatments was significant and the correlation coefficient was equal to 0.65 (Table V).

TABLE VI
EFFECT OF AGING ON INTERACTION BETWEEN CULTIVARS AND SHOOT LENGTH

Ageing (Day)	Cultivar					Mean
	Vynak	Karkheh	Chamran	Star	Kavir	
0	23.3 a	22.6 a	23 a	21 ab	22.7 a	22.5 a
2	22.8 b	17.9 b	22.8 a	20.9 ab	20.9 ab	21 b
3	22.8 b	18.2 b	22.2 ab	19.2 ab	20.6 ab	20.6 b
4	21.1 ab	9.9 c	21.2 ab	18.9 ab	19 ab	18 c
Mean	22.5 a	17.1 c	23 b	20 b	66 c	

Within each column figures sharing same letter are non-significantly ($P < 0.05$) different

The results in Table VI ind icate a significant interaction between cultivars and di fferent aging treatments on the shoot length. So that there was no difference between varieties in the control, 2, 3 and 4 day aging treatments, but in 4 day aging treatment Karkheh variety allocated the lowest shoot length to itself, but between other varieties, Vynak, Chamran, Star and Kavir there was not any significant differences.

IV. CONCLUSIONS

It was conc luded that the seeds with a stronger vigor affected less i n premature aging condition and th e difference between the p ercentage of seed germination under normal conditions and stress was significant and the seeds with the weaker vigor were more sensitive to the premature aging stress and the pre mature aging had more severe negative impact on seed vigor.

ACKNOWLEDGMENT

The author would like to thank: Chancellor for Research of Islamic Azad University for supporting this research.

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