J. of Plant Production, Vol. 1 (1): 27 - 37, 2010

EFFECTS OF HARVESTING DATE AND STORAGE PERIOD ON WHEAT (*Triticum aestivium L*.,) SEED VIABILITY

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ABSTRACT

Harvesting date and storage period has considerable influence on wheat seed quality as measured by germination ability under favorable and stress conditions and seedling vigor as well. Tow field experiments were conducted at Tag El-Eiz Experiment Station, Agriculture Research Center during 2005/2006 and 2006/2007 seasons, while storage studies and viability tests were conducted at Giza seed Technology Lab. under common conditions from June 2006 till December 2008. The aim of this study was to investigate the effect of three harvesting dates i.e, 60, 70 and 80 days after 50% heading and four storage periods i. e. 0, 6, 12 and 18 months on wheat seed quality. The results revealed that early harvesting (60 days after 50% heading) reduced seed germinablity under optimal and stress conditions, seedling vigor and seed electrical conductivity. Meanwhile, seed harvested after 70 and 80 days after 50% heading had high viability so that the differences in quality measurements were insignificant. The results revealed also that prolonging storage periods cause deterioration in seed quality and it was more obvious in earlier harvested seeds and those had high moisture content. Moreover, the variation in seed moisture content at harvesting time and during storage was related with the degree of seed deterioration. A combination of quality traits or lab. Testes are more useful than evaluation of one trait by single test. The results suggested harvesting wheat seeds (c.v. Giza 168) after 70 days from mentoring 50% heading or with about 14 % moisture content and storage for 12 month under open-air storage in order to have seed germination above the standard of wheat certified seed (85%).

INTRODUCTION

Wheat (*Triticum aestivum*, L.) is considered one of the most important cereal crops overall the world and the main crop in Egypt. Raising the productivity of wheat crop is a fundamental goal of the farmer and this could be achieved through optimizing the culture practices, especially harvesting the seed crop. Harvesting time is also an important factor affecting seed quality. Harvesting is usually done when the seed moisture content is considerable low for proper threshing and safe storage. Delayed until complete field dryness of the crop with attendant losses due to shattering, wheat plants exposed to lodging, birds, rodents and the adverse climatic conditions. In this connection wheat plants must be harvested is minimum with losses to realize the maximum return from all production practices. On the other hand seed viability is affected by many factors such as harvesting time and storage conditions. Early harvesting and high seed moisture content reduces its viability more rapidly because of mold growth and insect damage, FAO (1983).

Seed is an indispensable input in agricultural production. Seed germination termed physiological quality according to Louwaars and Van Marrewijk (1996), and it is the most important trait for seed marketing. The seed harvested optimum maturity should be possessing maximum germination and vigor and after declines due to various factors are expected Harrington (1972). Also Qun and Sun *(*2007), reported that seedling vigor is a more promising seed quality character reflecting potential seed germination and field emergence. On the other hand, physiological maturity of the seed at harvest defined as the time enough for seeds to reach its maximum dry weight and its one of the factors that influences the vigor of any seed lot. Rasyad *et al*. (1990), concluded that harvesting wheat at physiological maturity stage is the best for wheat genotypes to attain the highest level of seed quality. In this connection, viability denotes the egree to which a seeds alive, metabolically active, and possess enzymes capable of catalyzing metabolic reactions needed for germination and seedling growth Copeland (1976). Abd-Alla (1996), studied the effect of different harvest dates on grain quality of wheat. He found that germination and seedling dry weight were best when harvested 164 or 171 days after sowing, and lowest when harvested 150 days after sowing. El-Mowafy (2004), stated that harvesting wheat at 47 days after heading increased gradually both of percentage and rate of germination, shoot and root length and seedling dry weight, but electrical conductivity decreased.

Also Girishi *et al.* (1976), reported that the loss in seed viability after storage for 6 months varied from 70 to 22%. Odiemah (1987), reported that seed viability and seedling vigor significantly decreased with prolonging storage period. El-borai *et al.* (1993), found that increasing storage period from 6 to 30 months decreased the germination percentage and emergence from 85% to 10%, and also seedling lengths and dry weight were decreased during storage. Mersal *et al*. (2006), studied the effect of storage periods on wheat seed quality. The results revealed that prolonging storage period reduced germinability (as measured by germination percentage, germination index and germination rate), seedling vigor (plumule and radical length, seedling dry weight and its vigor index) and accelerated seed aging. Meanwhile, prolonging storage period increased mean germination time, electrical conductivity and dry weight losses of the seed. Malaker *et al.* (2008), found that seed germination decreased with the increase of storage period.

The aim of this study was to determine the effect of different harvesting dates and storage periods on wheat seed quality as measured by seed viability and seedlings vigor.

MATERIALS AND METHODS

Two experiments were carried out at Tag-El-Ezz Research and Laboratories of Seed Technology Research section, Giza, Station Agricultural Research Center, Egypt during 2005/ 2006 and 2006/ 2007 seasons. Seeds samples of the cultivar Giza 168 were obtained from Wheat Res. Department Field Crops Research Institute, Agricultural Research Center. Randomized

Block Design with four replicates was utilized for field experiments. The seeds were planted by hand in 10th and 15th of November during the first and second seasons, respectively. Other agronomic practices were done as recommended for the region of wheat crop cultivation. The seed crop was harvested at three dates namely 60 (H_1), 70 (H_2), and 80 (H_3) days from 50% heading (DA50%H). A day to 50% heading of tested wheat cultivar under the experimental conditions in both seasons was 104 days. Heads were harvested and immediately thrashed by hand to avoid seed injury and cleaned from dust. Storage study was conducted under normal conditions during the period from June 2006 till December 2008. Seeds were stored in cloth bags for four periods i.e. 0, 6, 12 and 18 months after harvest. The samples of each harvested crop and of each storage period were undergo to various laboratory testes for evaluating seed quality traits according to the recommendation outlined by International Seed Testing Association ISTA (1985), Alvarado and Bradford (1987) and Ruan and Tylkowska (2002).These include the following:

$$\textbf{Germination index} = \frac{N_1 + N_2 + N_3 + N_4}{Ti}$$

N_1, N_2, N_3 and N_4 = First, Second, Third and Four Counts, respectively
Ti = Count time.

$$\textbf{Mean germination time} = \frac{(N_1 \times T_1) + (N_2 \times T_2) + (N_3 \times T_3) + (N_4 \times T_4)}{N_1 + N_2 + N_3 + N_4}$$

N_1, N_2, N_3 and N_4 = First, Second, Third and Four Counts, respectively.
T_1, T_2, T_3 and T_4 = Time of First, Second, Third and Four Counts, respectively)

Seedling vigor index = S D W X G. P.
S. D. W = Seedling dry weight.
G. P. = Germination percentage.

$$\textbf{Germination energy} = \frac{N_1 + N_2}{M} \textbf{ X } 100$$

N_1, and N_2 = First and Second Counts
M = Total number of seeds planted

Germination rate defined according to Bartlett (1937).

$$\textbf{Germination rate} = \frac{a + (a + b) + (a + b + c) + \ldots\ldots + (a + b + c + m)}{n\,(a + b + c + \ldots\ldots\ldots\ldots + m)}$$

Where (a, b, c,….. and m) number of seedlings emerged at the first count, second count and final count and (n) it is the number of counts.

At the final count, ten normal seedlings from each replicate were

randomly taken randomly to measure plumule and radical length in (mm), after then, the seedlings were dried in hot-air oven at 85 ^{0}C for 12 hours to obtain the seedling dry weight (g) according to Krishnasamy and Seshu (1990). Accelerated after seed aging test was measured conducted to ISTA (1985).

Conductivity test: It was evaluated for each harvested crop at times intervals (0,6,12 and 18 months) according to the procedures outlined by Matthews and Alison (1987). The HANNA conductivity meter (Hi 80333) was used where fifty seeds in three replications of tested samples were weighted to 2 decimal numbers and placed in a 500 ml flask and 250 ml of distilled water was added. The flask were covered and placed in an incubator at a constant temperature of 20 C^0 for 24 hours after which the contents of the flasks were gently stirred. The electrical conductivity was measured in the solution after removing the seeds. The results were reported as (*µ mohs* per gm of seed). The electrical conductivity and the meaning of two readings were calculated as follows:

$$EC = \frac{\text{Reading of } R_1}{\text{Wt. of 50 seeds in } R_1} + \frac{\text{Reading } R_2}{\text{Wt. of 50 seeds } R_2} + \frac{\text{Reading of } R_3}{\text{Wt. of 50 seeds in } R_3} \div 3$$

Where, R_1, R_2 and R_3 = number of replicate
Wt_1, Wt_2 and Wt_3 = weight of seed samples

Seed moisture content: It was evaluated for each harvested crop at times intervals (0, 6, 12 and 18 months) according to ISTA rules (1985).

Data were statistically analysis according to Gomez and Gomez (1984). The treated averages were compared using the least Significant Difference (LSD) method. Correlation coefficient were computed according to Svap (1937).

RESULTS AND DISCUSSION

Data in Table (1) show that harvesting dates had significant effects on the studied traits namely germination percentage, germination after seed aging, germination index and germination energy. The lowest means of the studied traits were recorded at 60 days after 50% heading. Whereas the highest means of germination percentage under optimum conditions (93 and 93%), germination after seed aging (80 and 81%), germination index (18.50 and 18.68) and germination energy (64.38 and 68.31) were recorded for seeds harvested at 80 days after 50% heading. According to the International Seed testing Association, ISTA, and the ultimate objective of testing for germination is gain information with respect to field planting value of the seed and provides results, which can be used to compare the value of different seed lots. The minimum germination percentage of certified wheat seed should not be less than 85%. Seeds harvested at 60 days of 50%

heading did not met the minimum seed certification standards while seeds harvested at and after 70 and 80 days after 50% heading had high viability, so that germination differences were insignificant. On the other hand, the values of germination percentage after seed aging were clearly influenced by the time at which the seed crop was harvested.

Table (1): Effect of harvesting dates on seed germination (%), germination after aging, Germination index, germination energy in 2005/ 2006 and 2006/ 2007 seasons.

Harvest date	Germination %		Germination after aging (%)		Germination index		Germination energy	
	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07
60 DA50%H	81	80	62	58	14.83	14.75	37.25	35.31
70 DA50%H	92	91	79	80	18.45	18.53	63.88	66.13
80 DA50%H	93	93	80	81	18.50	18.68	64.38	68.31
L.S.D. at 5%	3	2	3	2	1.19	1.06	3.40	3.64

The germination percentages were 62, 58 % for seed harvested at 60 days after 50% heading and they were 79,80% and 80,81 % for seed harvested at 70 and 80 days after 50% heading. It is clear that seeds harvested at 70 and 80 days after 50% heading were less affected by aging treatment, compared to seed harvested at earlier time. It is apparent that environmental variation during seed maturity has little effect on the viability of wheat seed, provided that the ripening processes are not interrupted by premature harvesting. The results of germination indexes and the germination energy had similar trend as those of germination testes before and after seed aging. The more mature seed the higher germination index and germination energy. Similar observation were reported by Harrington (1972), Copeland (1976), Rasyad *et al*. (1990), Abd- Alla (1996) and Qun and Sun (2007). They noticed that viability denotes the egree to which a seeds alive, metabolically active, and possess enzymes capable of catalyzing metabolic reactions needed for germination and the seed harvested at optimum maturity should be in order to get maximum germination and vigor.

Data in Table (2) show more details about seed germination tests. These include first germination count, germination rate and mean germination time. Earlier harvesting reduced the number of normal seedlings at the first count. It was 46 and 40 seedlings from seed harvested seed harvested at 60 days after 50% heading and increased to be 61 and 63 seedlings when seed harvested at 70 days after 50% heading. Furthermore, there were no significant germination differences in the first count when the seeds were harvested at and after 70 days after 50% heading. The results of the germination rate agreed with those of first germination count where seeds harvested lately at time 80 and 70 day after 50% heading, respectively, were capable of germination fast than seeds harvested at 60 days after 50% heading. The main germination time, referring to the number of normal seedlings at certain count, was higher as seeds were harvested at earlier time i.e.60 days after 50% heading. Generally, there were no significant differences in physiological seed quality as seeds were harvested at 70 and 80 days after 50% heading. Similar results were obtained by Abd-Alla (1996)

and El-Mowafy (2004), they revealed that harvesting wheat at 47 days after heading and 164 or 171 days after sowing increased gradually germination percentage and rate and lowest when harvested 150 days after sowing.

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Table (2): Effect of harvesting dates on first germination count, germination rate, mean germination time, in 2005/ 2006 and 2006/ 2007 seasons.

Harvest date	First germ. Count %		Germination Rate		Mean germ. Time (Day)	
	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07
60 DA50%H	46	40	0.38	0,34	4.7	4.80
70 DA50%H	61	63	0.62	0,59	2.4	2.70
80 DA50%H	66	63	0.63	0,60	3.1	2.70
L.S.D. at 5%	3	3	0.06	0.25	0.1	1.1

Table (3) shows seedling characters as affected by harvesting dates. It is obvious that differences in seedling measurements were insignificant in both seasons, which disagreed with the effects of harvesting date on seed germination under favorable and unfavorable conditions. This may reveal that seedling characters are not a good indicator of seedling vigor and therefore additional criteria should consider when evaluating seed quality. These results are in agreement with those Hwang *et al.* (1987), they recorded that seedling height did not differ between seeds harvested at 25 and 30 days after flowering in wheat.

Table (3): Effect of harvesting dates on Plumule length, Radical length and Seedling dry Weight in 2005/ 2006 and 2006/ 2007 seasons.

Harvest date	Plumule length (cm)		Radical length (cm)		Seedling dry Weight (g)	
	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07
60 DA50%H	5.2	4.9	6.2	5.9	0.332	0.328
70 DA50%H	5.4	5.4	6.5	6.2	0.337	0.334
80 DA50%H	5.6	5.2	6.5	6.1	0.336	0.338
L.S.D. at 5%	0. 6	0.5	0.4	0.3	0.010	0.011

Data in Table (4) show Effect of storage periods on physiological seed quality as measured by germination percentage under laboratory conditions. Seeds harvested after 70 and 80 days from 50% heading had germination percentage above the Egyptian minimum seed certification standard (85%) at time of harvest the seed crop and even after 12 months storage. Harvesting the seed crop after 60 days from 50% heading reduced germination percentage lower than the minimum standard and the deterioration of the seeds during storage in the open air was faster than those harvested after 70 and 80 days from 50% heading. Prolonging storage period more than 12 months affected adversely seed germination so that the seeds harvested after 70 and 80 days from 50% heading did not meet the minimum seed certification standard. In Egypt, the storage period from harvesting the seed crop until next planting is about 6 months and the weather temperature is

relatively high so that changes in seed moisture content are limited. Seeds remained after planting time is over should be stored for further 12 months until second planting season comes up. Through this period the temperature in the open –air storage decreases in the winter months and increase again in the summer moths. Such temperature changes would followed by changes in the moisture content of stored seeds which could be the main reason for seed deterioration after 12 months. The reduction in seed viability and seedlings vigor traits might be due to, with increasing storage periods, wheat seeds might be infested with stored pests (insects and fungi) or might be due to, the increase of some organic compounds in respiration process with increasing storage periods. The present results were similar to those previously reported by Girishi *et. al.* (1976), Odiemah (1987), El-borai *et al.* (1993), Mersal *et. al*. (2006) and Malaker *et al.* (2008), they found that prolonging storage period reduced germination percentage.

Table (4): Effect of harvesting dates and storage periods on wheat Seed germination (%) in 2005/ 2006 and 2006/ 2007 seasons.

Storage period	60 DA50%H		H70 DA50%		80 DA50%H	
	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07
0 month	81	80	92	91	93	93
6 month	79	76	89	87	93	92
12 month	74	71	87	87	88	86
18 month	69	67	٨٢	81	80	80
L.S.D. at 5%	4	3	4	3	3	4

Table (5) show that there was an affect of harvesting date on electrical conductivity of the seeds. Earlier harvesting (60 days after 50% heading at zero period of storage) increased the electrical conductivity values. When the seeds harvested after 70 and 80 days after 50% heading the electrical conductivity values was obviously reduced. The more mature seeds the lower electrical conductivity values were obtained. Differences in electrical conductivity values were reduced after 6 months and became limited after 12 months from storage the seeds regardless of the time of harvesting the crop. The interaction effect between harvesting time and storage period was insignificant so that the evaluation of electrical conductivity as a quality measure is more valuable for time of harvesting than the period of storage the seed crop.

Table (5): Effect of storage periods and harvesting dates on seed electrical conductivity (*μ S*/ cm/ gm) in 2005/ 2006 and 2006/ 2007 seasons.

Storage period	60 DA50%H		70 DA50%H		80 DA50%H	
	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07
0 month	3. 85	3.89	1.43	1.56	1.09	1.11
6 month	3. 75	3.79	2.13	2.89	1.94	1.63
12 month	3. 64	3.69	3.65	3.76	3.68	3.97
18 month	4.08	4.09	3.34	3.77	3.33	3.45
L.S.D. at 5%	0.94	1.07	0.95	1.12	0.76	0.84

Table (6) shows seed moisture content as affected by harvesting time.

Seed moisture content was decreased gradually as harvesting date was delayed and storage period was increased. Significant differences were found between seed stored for 12 months and that stored for 0 and 6 months. But insignificant differences were found between seed stored for 12 months and that stored for 18 months. Agrawal (1996), stated that the initial moisture of the seed is probably the most important factor influencing seed deterioration during storage. Harrington (1972), studied the relationship between seed viability as measured by germination percentage and changes in seed moisture during storage. He suggested a rule of thump of seed storage, which states that for each 1 percent reduction in moisture content the storage life of the seed is doubled. Changes of seed moisture due to time of harvesting and storage period in table (5) may be helpful for explaining the reduction in seed germination during storage (table 4). It obvious that if the seeds are stored at higher initial moisture content than 15 % and storage period is increased up to 18 month as, the deterioration of seed germination capacity is highly reduced.

Table (6): Effect of harvesting date and storage period on seed moisture content %) in 2005/ 2006 and 2006/ 2007 seasons.

Storage period	2005/06			2006/07		
	60D A50%H	70D A50%H	80 D A50%H 6	60 D A50%H	70 D A50%H	80D A50%H
0 month	15.9	14.1	13.9	16.1	14.2	14.1
6 month	15.1	14.4	14.2	15.2	14.4	14.1
12 month	14.6	14.1	13.9	14.8	14.3	14.1
18 month	14.3	14.0	13.9	14.4	14.2	14.0
L.S.D. at 5%	0.3	0.2	0.2	0.4	0.3	0.2

The correlation coefficient for the relationship between seed germination and other viability criteria was only positively and significant at 5% level in the case of accelerated aging germination (R= 0.992) and seedling length (R= 0.734). But it was negatively and significantly correlated with the value of electrical conductivity (R= -0.925 and -0.725) when the seed crop was harvested after 70 and 80 days after 50% heading. This indicated the importance of conducting aging and electrical conductivity tests as supplemental tests in addition to germination test in order to have more precision evaluation of wheat seed quality. It is to be noted that the Correlation Coefficient for the relationship between seed germination and seed moisture content was negatively and significantly correlated as the seed crop was harvested after 60 days after 50% heading (R= - 0.891) which explained the poor seed storability (Table 4). The present results are similar to those previously reported by Mersal *et. al*. (2006), they found negative correlation of germination percentage with electrical conductivity and moisture content but, correlation of germination percentage with accelerated aging germination and seedling length were positive.

In conclusion, the time of harvesting of the wheat seed was found to be

a major factor responsible for a part of the variation in seed viability and its storability. Accordingly, the results of this study suggested harvesting wheat crop not before 70 days from mentoring 50% seed heading. Dealing harvesting date up to 80 days form 50% seed heading may reduce seed germiability particularly if the seed is stored for a period longer than 6 months. On the other hand, a combination of viability testes is more useful than a single tests taking into consideration the importance of germination test is a criteria of marketing the certified seeds.

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تأثير ميعاد الحصاد ومدة التخزين على حيوية تقاوى القمح

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يهدف هذا البحث إلى تحديد الميعاد الملائم لحصاد محصول القمح الخام من الصنف جيزة ١٦٨ المزمع أعداده كتقاوي وكذلك تأثير مدة التخزين على جودة تقاوى القمح. أجريت تجربتان حقليتان بمحطة البحوث الزراعية بتاج العز محافظة الدقهلية التابعة لمركز البحوث الزراعية خلال موسمي ٢٠٠٦/٢٠٠٥ ، ٢٠٠٧/٢٠٠٦ ، في حين تم تخزين عينات التقاوي تحت الظروف العادية خلال الفترة من يونيو ٢٠٠٦ حتى نهاية ديسمبر ٢٠٠٨ . كذلك أجريت تجارب تقييم حيوية التقاوى بمعامل قسم بحوث تكنولوجيا البذور بالجيزة. تم حصاد محصول القمح ناتج التجارب الحقلية فى ثلاث مواعيد هى ٦٠، ٧٠، ٨٠ يوم بعد ٥٠% من طرد السنابل وتم تخزين عينات من المحصول الناتج لمدد ٠، ٦، ١٢، ١٨ شهر .

أوضحت النتائج أن:-

الحصاد المبكر (٦٠ يوم بعد طرد ٥٠% من السنابل) أدي إلي انخفاض حيوية التقاوي التي تم تقييمها بعدة اختبارات معملية اشتملت على الإنبات تحت الظروف المثلي وتحت ظروف الإجهاد الرطوبى والحرارى (اختبار الشيخوخة) وقوة إنبات البادرات ودرجة التوصيل الكهربى للبذور ، بينما كانت الفروق فى جودة التقاوى ضئيلة بين ميعادى حصاد المحصول (٧٠ ،٨٠ يوم بعد طرد ٥٠% من السنابل). كما أوضحت النتائج حدوث تدهور فى حيوية التقاوى مع زيادة مدة التخزين ، وكان التدهور سريعا فى العينات التي مصدرها الحصاد المبكرللمحصول (٦٠ يوم بعد طرد ٥٠% من السنابل .كذلك من المرجح أن تكون الفروق فى المحتوى الرطوبى للتقاوى باختلاف مواعيد حصاد المحصول وأثناء التخزين السبب الرئيسي فى التباين فى حيوية التقاوى . كما أوضحت نتائج الدراسة أن استخدام توليفة من الاختبارات المعملية فى تقييم حيوية التقاوى أفضل من الاعتماد على اختبار واحد. وتقترح الدراسة حصاد محصول القمح بعد حوالي ٧٠ يوم من ملاحظة ٥٠% من طرد السنابل فى الحقل وبحيث تكون رطوبة البذور فى المحصول الخام حوالي ١٤%.

قام بتحكيم البحث

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