

EFFECT OF STORAGE RELATIVE HUMIDITY (RH) ON GERMINATION AND VIGOUR OF WHEAT SEED

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ABSTRACT

This study was conducted during the period from June to November, 2004 with a view to study the effect of storage relative humidity (RH) on germination and vigour of wheat seed. Four different storage relative humidities (viz. 50%, 60%, 70% and 80%) and two crop varieties (wheat cv. Satabdi and wheat cv. Gourab) were used as treatment variables. Seed moisture content (SMC), germination and vigour test of seeds were done at one months interval starting from 10 July to 10 November 2004, while the initial test for SMC and germination was done on 10 June, 2004. The results showed that storage relative humidity, crop variety and their interaction significantly influenced the seed moisture content, germination and vigour index. The moisture contents of wheat seed in storage were found between 7.9-8.8, 9.5-10.0, 12.0-12.5 and 15.3-16.0%, respectively for 50, 60, 70 and 80% RH against their initial moisture content of 8.4-9.5% just before storage. The germination and vigour of all the varieties decreased with increases RH. For each of the crop variety, the highest germination was obtained at 50% RH. No seed germination was occurred in any of the variety stored at 80% RH after two months of storage. More than 92% seed germination was recorded from all the varieties after 6 months of storage. The seeds kept at 70% RH showed 83% germination in July 2004 that reduced to 74% in November.

Keywords: Relative humidity, germination, vigour and wheat.

INTRODUCTION

Wheat (*Triticum aestivum*) is one of the major leading cereals in the world, which ranks first in terms of acreage and production. About one third of the world population live on wheat grain for their subsistence (Henderson, 1987). It is the second most important cereal crop in Bangladesh next rice. Wheat covered 7.74 million ha having a total production of 2.19 million tons of grain in 2000-2001 (BBS, 2001). Wheat contributes about 45% of digestible energy and 30% of the total carbohydrate in the human diet (Evans, 1993). The grain contains 12.0% protein, 1.7% fat, 69.6% carbohydrate and 27.2% mineral matter (BARI, 1997). Seed moisture content and storage temperature perhaps, play the most dominant role in maintaining good seed viability during storage (Harrington & Minges, 1961). The seed moisture content comes into equilibrium with the adsorption and desorption phenomenon. The seed moisture equilibrium depends on relative humidity in storage environment to a greater extent and on temperature to a much lesser extent.

The higher moisture content in seed deteriorates the seed quality through insect and disease attack (Pingale, 1978). The effect of temperature on seed quality at storage has been explained by Harrington (1973). A low relative humidity (RH) in storage environment ensures longer storing capability. Available reports indicated that 35% RH together with 15 °C resulted in minimum loss in viability and ensured satisfactory storage up to 36 months while with 50-70% RH it was possible up to 9 months in storage environment (Tango *et al.*, 1977). Therefore, the present study was undertaken i) to find out the moisture content of wheat seed in relation to relative humidities in storage environment and ii) to explore the comparative seed quality performance of wheat varieties under different relative humidities in storage.

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MATERIALS AND METHODS

A pot experiment was conducted at the seed laboratory of the Agronomy Department of Bangladesh Agricultural University, Mymensingh during the period from June to November, 2004 with a view to study the effect of relative humidity on physiological qualities of wheat seed. Two wheat varieties, namely wheat cv. Satabdi and Gourab with four levels of storage relative humidity, i.e., 50%, 60%, 70% and 80% were used as treatment variables. The experiment was laid out in a Completely Randomized Design (CRD) with three replications. Seeds were sown on 16 November, 2003. Wheat cv. Gourab and Satabdi were harvested on 22 and 26 February 2004, respectively. After proper drying, moisture content of the seeds were maintained between 8 to 10%, and kept in polythene bags before storing in storage containers at the designed relative humidities.

Preparation of storage container with different relative humidities

Glass jar of 28 cm diameter × 35.56 cm height were used as storage container. Glycerine solution was prepared by mixing glycerine with water in different ratio to establish different levels of relative humidities as per experimental specifications as follows (Hill, 1999).

Relative Humidity (RH) %	Glycerine (ml)	Water (ml)
50	95	5
60	92	8
70	72	28
80	55	45

One hundred ml of glycerine solution was kept at the bottom of each glass jar and then a support or bench made of bamboo stick and iron net was inserted into the jar on which cloth bags (10.16 cm×20.32 cm) containing 200 g seeds were kept. Thus in each container two cloth bags containing seeds were placed and the jar was then covered with its lid. Each glass jar was made air tight with the help of scotch tape. Before placing the glycerine solution, the glass jar and bamboo benches were thoroughly cleaned and were made sterilized with boiled water. The relative humidity (RH%) was measured with a thermo hygrometer at the time of seed sampling from each container in each month.

Seed moisture test

Seed moisture content was measured using high constant temperature oven dry method following the ISTA rules (1993). About 5-8 g of seeds were taken in the aluminium dish and dried in the oven at 130 °C for 2 hours. Then the moisture content was calculated by the following formula:

$$\text{Moisture content (\%)} = \frac{W_1 - W}{W_1 - W_2} \times 100$$

Where, W = Weight of blank aluminium dish with lid.

W₁ = Weight of seed plus aluminium dish with lid before drying

W₂ = Weight of seed plus aluminium dish with lid after drying.

Germination test

Germination test was done following modified paper folding method. Randomly selected 100 seeds in three replicates per bag were used for germination test. Two sheets of kitchen towel were placed upon one sheet of newspaper (30.48cm× 25.40cm) and the papers were moistened with distilled water. One hundred seeds of the test variety was placed on the wet paper and another piece of kitchen towel was placed on it. The paper was moistened further as required with distilled water and folded. The folded paper was kept in a polythene bag (38.1cm×25.4cm) to prevent moisture loss. The polythene bags were kept standing in a bucket. Additional moisture was given into the polythene bag if needed to keep the paper moist.

Seedling evaluation was done at 7 days after placing the test. The number of normal seedlings, abnormal seedlings and dead seeds were recorded. The sum of three replicates per bag was used and the germination was expressed in percentage.

Vigour index (VI)

Top of the paper (TP) method (using a glass petridish) was used to measure vigour index. Randomly collected 50 seeds in four replicates per bag was used. Kitchen towel paper was placed in a glass petridish and was moistened with distilled water. Vigour test for each variety from each glass container was carried out taking 200 seeds at every sampling time.

The daily record for germination of seeds was noted starting from 1 day up to 7 days of placement of seeds during test. After sprouting of seedlings having 2 cm long radicle were taken as germinated seeds. Vigour index (VI) was calculated by the following formula (Maguire, 1962).

$$VI = \frac{x_1}{n_1} + \frac{x_2}{n_2} + \frac{x_3}{n_3} + \dots + \frac{x_n}{n_n}$$

Where, x_1 = no of seedlings at first count,

n_1 = no. of days to first count,

x_2 = no of seedlings at 2nd count,

n_2 = no. of days to 2nd count,

x_n = no. of seedlings at final count

n_n = no. of days to final count

Statistical analysis

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique and the means were compared by Duncan's Multiple Range test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Seed moisture content

Effect of storage relative humidity

The effect of storage relative humidity on moisture content of seed was statistically significant for each months of test from July to November, 2004 (Table 1). Data presented in the table it is clear that the seed moisture content increased with the increases of relative humidity. In July 2004, the highest (15.2%) seed moisture content was found with 80% RH compared to only 8.2% with 50% RH. In August, September, October and November the highest seed moisture content were 15.6%, 15.7%, 15.7% and 15.9% with 80% RH and 8.4%, 8.3%, 8.3% and 8.3% at 50% RH, respectively (Table 1).

Effect of variety

A significant varietal effect on seed moisture content was observed during July to November, 2004 except August (Table 1). In July, September, October and November it was found that wheat cv. Gourab contained the highest seed moisture where as wheat cv. Sotabdi had the lowest seed moisture content (Table 1). In July 2004, the seed moisture content of wheat cv. Sotabdi was 11.5% while it was 11.6% in case of wheat cv. Gourab. During November, the seed moisture content for Wheat cv. Sotabdi was 11.7% while wheat cv. Gourab contained 11.8% seed moisture

Storage relative humidity × Variety

The interaction effect of storage relative humidity and variety on moisture content of wheat seed was significant for the month of July, October and November, 2004 (Table 2). The highest seed moisture content i.e., 15.4%, 15.8% and 16.0% was recorded during July, October and November, respectively treated with 80% storage RH, while the lowest seed moisture content i.e., 8.5, 8.7 and 8.7%, respectively was recorded in case of wheat cv. Sotabdi treated with 50% storage RH (Table 2).

Table 1. Effect of storage relative humidity and variety on moisture content of wheat seed during storage from July to November, 2004

Storage Relative humidity (%)	Seed moisture content (%)				
	July	August	September	October	November
50	8.2 b	8.4 d	8.3 d	8.3 d	8.3 d
60	9.8 c	9.9 c	10.0 c	9.9 c	9.9 c
70	12.2 b	12.3 b	12.3 b	12.3 b	12.4 b
80	15.4 a	15.6 a	15.7 a	15.7 a	15.9 a
Level of significance	***	***	***	***	***
CV (%)	1.74	3.10	2.81	1.06	1.56
Variety					
Wheat cv. Sotabdi	11.5 ab	11.7	12.0 a	11.7 a	11.7 a
Wheat cv. Gourab	11.6 a	11.7	11.7 a	11.8 a	11.8 a
Level of significance	***	NS	***	***	***
CV (%)	1.74	3.10	2.81	1.06	1.56

* = Significant at 5% level, ** = Significant at 1% level, *** = Significant at 0.1% level.

In a column, figures having similar letter(s) do not differ significantly at 5% level as per DMRT.

Table 2. Interaction effect of storage relative humidity and variety on moisture content of wheat seed during storage from July to November, 2004

Storage relative humidity (%) × variety	Seed moisture content (%)				
	July	Aug.	Sept.	Oct.	Nov.
50 × Wheat cv. Satabdi	8.5 g	8.7	8.8	8.7 f	8.7 e
50 × Wheat cv. Gourab	8.6 g	8.8	8.8	8.8 f	8.8 e
60 × Wheat cv. Satabdi	9.9 e	10.0	10.7	10.0 d	10.0 d
60 × Wheat cv. Gourab	9.9 e	10.0	10.0	10.0d	10.0d
70 × Wheat cv. Satabdi	12.3 cd	12.4	12.4	12.5 b	12.5 c
70 × Wheat cv. Gourab	12.5 c	12.4	12.4	12.5 b	12.5 c
80 × Wheat cv. Satabdi	15.3 b	15.5	15.6	15.7 a	15.7 b
80 × Wheat cv. Gourab	15.4 ab	15.5	15.7	15.8 a	16.0 a
Level of significance	**	NS	NS	***	***
CV (%)	1.74	3.10	2.81	1.06	1.56

* = Significant at 5% level, ** = Significant at 1% level, *** = Significant at 0.1% level.

In a column, figures having similar letter(s) do not differ significantly at 5% level as per DMRT.

Germination

Effect of storage relative humidity

Storage relative humidity showed a significant effect on germination of wheat seed in different months during storage from July to November, 2004 (Table 3). At each month's germination test it was found that the germination percentage decreased with the increases of storage relative humidity. In July 2004, the highest germination percentage (96.7%) was recorded which were storage with 50% RH while it decreased to only 57.3% storage with 80% RH (Table 3). During August, the germination percentage of seeds storage with 50% RH was 96% which was reduced to 30.2% storage with 80% RH. In September, it was 95.3% storage with 50% RH, which was reduced to 82.3% in case of 70% storage RH, but the seeds stored at 80% RH failed to germinate (Table 3).

Effect of variety

Variety had a significant effect on germination of wheat seed at each month of storage from July to November, 2004 (Table 3). Wheat cv. Sotabdi gave the highest germination percentage while wheat cv. Gourab gave the lowest germination percentage. The germination percentage of wheat cv. Sotabdi was 82.8% while it was recorded 81.7% with wheat cv. Gourab in July (Table 3). In November testing, the germination percentage for wheat cv. Sotabdi was 64.2% while it was 63.3% in wheat cv. Gourab (Table 3).

Table 3. Effect of storage relative humidity and variety on germination percentage of wheat seed during storage from July to November, 2004

Storage relative humidity(%)	Germination (%) ^t				
	July	August	September	October	November
50	96.7 (79.7 a)	96.0 (78.7 a)	95.3 (77.7 a)	94.7 (76.8 a)	93.9 (75.8 a)
60	94.9 (76.9 b)	94.3 (76.3 b)	93.9 (75.8 b)	92.8 (74.4 b)	92.0 (73.6 b)
70	83.0 (69.7 c)	82.8 (65.6 c)	82.3 (65.1 c)	78.3 (62.4 c)	73.5 (59.1 c)
80	57.3 (49.2 d)	30.2 (33.3 d)	0.00 (0.14 d)	0.00 (0.14 d)	0.00 (0.14 d)
Level of significance	***	***	***	***	***
CV (%)	2.11	2.21	1.93	2.28	2.11
Variety					
Wheat cv. Sotabdi	82.8 (68.0 ab)	75.4 (63.4 b)	67.9 (54.9 ab)	65.5 (52.8 bc)	64.2 (51.8 bc)
Wheat cv. Gourab	81.7 (66.9 b)	74.3 (62.1 c)	66.8 (53.7 c)	64.9 (52.2 c)	63.3 (51.0 c)
Level of significance	**	***	***	***	***
CV (%)	2.11	2.21	1.93	2.28	2.11

^tFigures in parenthesis indicates the Arc Sine transformed value.

* = Significant at 5% level, ** = Significant at 1% level, ***= Significant at 0.1% level.

In a column, figures having similar letter(s) do not differ significantly at 5% level as per DMRT.

Storage relative humidity × Variety

The interaction effect of storage relative humidity and variety on germination of wheat seed was statistically significant for the months of September, October, and November but not in July and August, 2004 (Table 4).

Table 4. Interaction effect of storage relative humidity and variety on germination percentage of wheat seed during storage from July to November, 2004

Storage relative humidity (%) × Variety	Germination (%) ^t				
	July	Aug.	Sept.	Oct.	Nov.
50 × Wheat cv. Satabdi	97.3 (80.7 a)	96.7 (79.6 ab)	96.0 (78.5 ab)	95.3 (77.6 ab)	94.7 (76.7 ab)
50 × Wheat cv. Gourab	96.7 (79.6 ab)	95.7 (78.1 ab)	95.0 (77.1 bc)	94.0 (76.0 bc)	93.3 (75.1 bc)
60 × Wheat cv. Satabdi	95.3 (77.6 bc)	95.0 (77.1 bcd)	94.7 (76.7 bce)	92.7 (74.3 c)	92.0 (73.6 cd)
60 × Wheat cv. Gourab	94.0 (76.0 c)	93.3 (75.0 d)	93.0 (74.7 e)	92.3 (74.0 c)	91.3 (72.9 d)
70 × Wheat cv. Satabdi	81.3 (64.4 e)	81.3 (64.4 fg)	81.0 (64.2 g)	74.0 (59.4 e)	70.0 (56.8 f)
70 × Wheat cv. Gourab	80.7 (64.0 e)	80.7 (64.0 g)	79.3 (63.0 g)	73.3 (59.0 e)	68.7 (56.0 f)
80 × Wheat cv. Satabdi	57.3 (49.2 f)	28.7 (32.4 ij)	0.00 (0.14 h)	0.00 (0.14 f)	0.00 (0.14 g)
80 × Wheat cv. Gourab	55.3 (48.1 f)	27.3 (31.5 j)	0.00 (0.14 h)	0.00 (0.14 f)	0.00 (0.14 g)
Level of significance	NS	NS	**	***	***
CV (%)	2.11	2.21	1.93	2.28	2.11

^tFigures in parenthesis indicates the Arc Sine transformed value. * = Significant at 5% level, ** = Significant at 1% level, ***= Significant at 0.1% level. In a column, figures having similar letter(s) do not differ significantly at 5% level as per DMRT.

During September, October and November testing, the highest germination percentage was recorded in case of wheat cv. Sotabdi stored with 50% storage RH. Whereas, the seeds stored with 80% storage RH failed to germinate (Table 4). Seeds of wheat cv. Gourab stored with 70% storage RH showed the lowest germination percentage (Table 4).

Vigour Index

Effect of storage relative humidity

The effect of storage relative humidity on vigour index of wheat seed was significant for each months of test from July to November, 2004 (Table 5). The vigour index decreased with the increases of relative humidity. In July 2004, the highest vigour index (29.9) was found with 50% storage RH while it decreased to only 18.4 with 80% storage RH (Table 5). In August, September, October and November the highest vigour index were 29.9, 29.6, 29.5 and 29.2 storage with 50% RH while those were 24.8, 23.9, 22.3, 22.0 and 21.4 at 70% storage RH, respectively (Table 5). But after two months of storage the vigour index reduced to zero at 80% storage RH as there was no germinated seeds (Table 5).

Effect of variety

A significant varietal effect on vigour index of wheat seed was observed at each month of storage from July to November, 2004 (Table 5). It was found that wheat cv. Satabdi contained the highest vigour index and wheat cv. Gourab had the lowest vigour index. In July, August, September, October and November the highest vigour index was recorded in case of wheat cv. Satabdi were 27.0, 25.4, 21.2, 21.1 and 20.8 while those were 26.4, 24.8, 20.6, 20.5 and 20.2, respectively from the wheat cv. Gourab (Table 5).

Storage relative humidity × Variety

The effect of storage relative humidity and variety on vigour index of wheat seed was significant for each months of test from July to November, 2004 (Table 6). The highest vigour index was observed from wheat cv. Satabdi storage with 50% RH while the lowest from the wheat cv. Gourab at 80% storage RH (Table 6). The vigour index of seed decreased with the advancement of storage time and reached to zero with 80% storage RH after two months of storage (Table 6).

Table 5. Effect of storage relative humidity and variety on vigour index of wheat seed during storage from July to November, 2004

Storage relative humidity(%)	Vigour index				
	July	August	September	October	November
50	29.9 a	29.9 a	29.6 a	29.5 a	29.2 a
60	29.6 b	29.6 b	29.3 b	29.1 b	28.7 b
70	24.8 c	23.9 c	22.3 c	22.0 c	21.4 c
80	18.4 d	14.9 d	0.00 d	0.00 d	0.00 d
Level of significance	***	***	**	***	***
CV (%)	0.37	0.24	0.17	0.14	0.12
Variety					
Wheat cv. Sotabdi	27.0 a	25.4 a	21.2 a	21.1 a	20.8 a
Wheat cv. Gourab	26.4 b	24.8 b	20.6 b	20.5 b	20.2 b
Level of significance	***	***	**	***	***
CV (%)	0.37	0.24	0.17	0.14	0.12

* = Significant at 5% level, ** = Significant at 1% level, ***= Significant at 0.1% level.

In a column, figures having similar letter(s) do not differ significantly at 5% level as per DMRT.

Storing of damaged seed even in good storage might result in quality deterioration and ultimately seed viability is lost. Therefore, further study with the effect of threshing and processing methods need to be done to find out the ways and means of storing wheat seed in storage with high viability from one rabi season to the next.

Table 6. Interaction effect of storage relative humidity and variety on vigour index of wheat seed during storage from July to November, 2004

Storage relative humidity(%) × Variety	Vigour index				
	July	Aug.	Sept.	Oct.	Nov.
50 × Wheat cv. Satabdi	32.0 a	32.0 a	31.4 a	31.4 a	31.2 a
50 × Wheat cv. Gourab	31.0 c	30.9 c	30.6 b	30.3 c	30.1 c
60 × Wheat cv. Satabdi	31.9 b	31.8 b	31.4 a	31.3 b	30.8 b
60 × Wheat cv. Gourab	30.8 c	30.8 d	30.3 c	30.1d	29.9 d
70 × Wheat cv. Satabdi	25.2 f	23.9 gh	22.0 j	21.7 j	21.4 k
70 × Wheat cv. Gourab	25.1 fg	23.8 h	21.6 k	21.5 k	20.9 l
80 × Wheat cv. Satabdi	18.8 i	14.1 k	0.00 l	0.00 l	0.00 m
80 × Wheat cv. Gourab	18.6 j	13.9 l	0.00 l	0.00 l	0.00 m
Level of significance	***	***	***	***	***
CV (%)	0.37	0.24	0.17	0.14	0.12

* = Significant at 5% level, ** = Significant at 1% level, ***= Significant at 0.1% level.

In a column, figures having similar letter(s) do not differ significantly at 5% level as per DMRT.

CONCLUSION

In conclusion, after one month of storage, wheat seed moisture content (SMC) increased with increases of storage RH. At 50% storage RH the SMC was 7-8% while it was 15-16% at 80% storage RH. Germination percentage and vigour of wheat seed decreased with increases of storage RH. The germination percentage in August with 50% storage RH was 96% but stored with 80% it was 30%. The seed failed to germinate with 80% storage RH in September and thereafter. The germination percentage of wheat seed for both the varieties was above 92% at 50-60% storage RH while it was 73% with 70% storage RH after 6 months of storage. This result suggests that wheat seed can be stored from one rabi season to the next with above 92% germination capacity if stored at 50-60% RH or at seed moisture content below 10% in storage under normal room temperature.

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