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EFFECT OF THE INTERACTIONS BETWEEN MOISTURE CONTENT, SEED STORAGE TIME AND USE OF PESTICIDES ON SEED GERMINATION, VIABILITY AND VIABILITY INDICATORS OF WHEAT CROP

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ABSTRACT

In order to determine the effect of moisture content, storage time and pesticide (fungicide & insecticide) application in wheat variety Bezostaja -1, an experiment was conducted in Split-Split plot, randomized complete block design with three replications for two years at Ankara University. The main plots have three seed moisture levels viz. standard, standard +1.5% and standard + 3 percent at the time of disinfect application. The Split plots (sub plot) have treatments like seed storage time viz: 0, 1, 2 and 14 months and sub- sub plot was pesticide application and types and pesticide level. In this study two pesticides viz. Diaconazole (% 1), Chlorpyrifos - ethyl (% 25 w p) was used either individually or in combination. Various wheat characters which studied in present study are Coefficient of Velocity of Germination (CVG), Germination Index (GI), Germination Rate Index (GRI), Coleoptile length, Root length, Fresh weight and Dry weight. Result of study revealed that interactions between pesticides, seed storage and seed moisture content have significant effect (1%) on the various studied growth characteristics such as CVG, GI, GRI, Shoot length, root length, fresh weight and dry weight. Further, it was reported that the traits such as seed germination percentage, germination index, fresh weight and root length have very higher efficiency in the maintenance of seed for one to two months at the application of anti-fungal toxins with 9.5 % moisture Content. While minimum storage efficiency was reported when combination of pesticides (fungicide + insecticide) were applied at 12.5% moisture.

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1 Introduction

Wheat is one of the most important cereal crops in the world, together with rice and maize; it provides more than 60% of the calories and proteins of human nutrition (Nord et al., 2009). From last few decades despite of increasing crop yield intensive agricultural and monoculture systems adversely affected its production. Although, use of fertilizers, herbicides, pesticides and modified seeds have significant effect on the crop production but according to world pesticides trade continues use of stable insecticides and pesticides induced resistance in the pest or insect and losses resulting from pest damage continuously increases (Gliessman, 2000). Further, although use of improved seeds and cultural practices can be a better option of pesticides but farmers still rely on the use of pesticides and they continuously increased dose of pesticide for getting more production this operation not only increase the cost of farming but also cause health and environmental hazards (Clark & Scott, 1982). This excess use of pesticides also responsible for the loss of biodiversity by destroying soil micro-organisms and other organisms, sometime these pesticides reached to the ground water and also contaminate (Lu & Terry, 1995).

Among various factors which influencing crop productivity, seed quality and seed moisture contents are most important one. According to Dupriez & De Leener (1989) best quality seed have high germination capacity and resultant seedlings are vigor than the poor quality seeds. Seed quality is a condition under which mother plants were raised such as moisture and temperature regimes during fruit maturation, and fertilizer application (Chowdhury, 1999). Farmers and crop producer used seed treatment for increasing the seed quality along with yield and to reduce the transmission of pathogens (Khanzada et al., 2002). The purpose of these seed treatments are to control seed-borne pathogens or to protect seeds from soil borne pathogens (Ashley & Martin, 2003). According to Khanzada et al. (2002) 80-90 percent farmers were used pesticides even after the harvesting seed disinfectant for preventing their harvested crop from post harvesting insect and pests (Borgen, 2004).

Efficacy of seed treatment depends on various factors such as physiological & physical conditions of the seed, storage conditions, storage time and types of disinfectant used. Therefore producers should be aware about the types of pesticides used and its active ingredients. Information's regarding the effect of moisture contents and proper time of pesticide application in wheat production is in scarcity; therefore present study has been under taken to evaluate the effect of various moist contents on the pesticide application and on various germination components of the wheat crops.

2 Materials and Methods

Present study was conducted in the cropping season of 2013-2014 at the agricultural research station of Ankara University in Ankara Turkey. Seeds of Bezostaja-1 bread wheat variety were used for this study. Two chemical materials viz fungicide and insecticide included Diaconazol (1%) and Chlorpyrifos - ethyl (25% WP) were collected from local vendor and used either individually or in combination. Study was conducted by split- split plot method in a randomized complete block design with three replications. Three level of seed moisture content viz. 9.5% (as control), 11 and 12.5% was considered as main plot; seed moisture content (11 and 12.5%) was adjusted by adding water. Storage time (0, 1, 2, 14 month) was considered as sub factor (split plot) and pesticide treatment included without pesticide (control), fungicide alone, insecticide alone and combination of both was considered as sub – sub factor (split – split plot). Hundred healthy seeds for each treatment were selected manually by hand picking method. Various growth attributes such as Seed germination, Coefficient of velocity of germination (CVG), Germination rate (GI), Germination rate index (GRI), Coleoptile length, Root length, plantlet fresh and dry weight was calculated according to method given by Sharafizad et al.(2013). In order to measured detail (CVG, GI, and GRI):CVG is characterized by speed and acceleration of germination and calculated from the following equation (Maguire, 1962).

$$CVG= G1+G2+G3+...Gn / (1\times G1) + (2\times G2) + (3\times G3) +... (N \times Gn)$$

Whereas G1-Gn: the number of germinations since the first day until the last day.

Germination Index (GI) and germination rate index (GRI) was calculated by the equation given by Throneberry & Smith (1955), for this following formula was used.

$$GI = (n\times N1) + (7\times N2) + (6\times N3) + (5\times N4) +...+ (1\times Nn)$$

Whereas N= the number of seed germination, n= day end

$$GRI= G1/1+G2/2+G3/3+...Gn/n$$

Here Gn = the number of germination seed in n day, n= day end

All the collected data were analyzed with SPSS version 19.1 were grouped according to Duncan test and the relationship between characteristics revealed.

3 Results and Discussion

Analysis of interaction between moisture content of seed storage time and pesticide applications suggested a significant difference at level 1% for all the studied germination characteristic and component such as percent seed germination, coefficient of velocity of germination (CVG), germination index (GI), germination rate index (GRI), coleoptiles length, root length, fresh weight and dry weight.

Further, in case of trilateral interaction between seed storage time, seed moisture content and application of pesticides (fungicides and insecticides) most of the studied trait was reported significant at 1% while some traits such as GI, GRI, and coleoptile length was reported significant at 5%.

3.1 Effect of interaction on seed germination

In seed Germination characteristics, highest germination percentage (99%) was reported from the treatment containing fungicide with a two-month storage period and 9.5% seed moisture while the lowest germination percent (75.33%) was reported in the combined application of pesticides and herbicide along with one month storage at 12.5% moisture (Table 2). In general, germination percentage reduced with the increasing storage time and reducing moisture. Govender et al. (2007) reported that corn seed kept in storage for one year under natural conditions can reduce seed germination and this reduction in germination may be because of the infection of pathogenic fungi under storage condition.

Table 1 Analysis of variance study between various interaction such as seed moisture, storage time and pesticide application.

		Components of germination							
Source	df	PSG	CVG	GI	GRI	Coleoptile Length	Root length	Fresh Weight	Dry Weight
L	2	4.04	2. 06	1.93	2.14	2.06	0.44	0.09	0.66
Seed moisture	2	17.57*	7.33	20.94**	21.81**	23.29**	4.17	5.28	0.12
Error	4								
Storage time	3	18.81**	5.76**	20.14**	22.02**	12.01**	4.75 *	45.75**	14.22 **
Seed moisture × Storage time	6	7.77**	7.55**	3.53 *	4.81**	1.48	5.32 **	24.09**	3.64**
Error	18								
Pesticide	3	10.99**	18.31**	3.64*	4.18**	183.24**	24.56**	3.89 *	6.91**
Seed moisture × pesticide	6	4.83**	5.21**	2.63*	2.57*	3.00 *	1.89	1.04	2.07
Storage time × pesticide	9	3.93**	6.77**	1.50	1.89	5.38 **	5.67 **	1.47	1.64
Seed moisture × Storage time × pesticide	18	7.53**	8.34 **	3.77**	4.08**	1.98 *	2.31**	2.88**	2.28**
Error	72								
Coefficient of Variation %		2.49	0.31	1.83	1.95	10.96	11.47	7.08	7.07

** Values are significant probability; here CVG (Coefficient of velocity of germination); GI (germination index); GRI (germination rate index); FGP (Final germination percent), RL (root length), FWS (fresh weight seedling), DWS (dry weight seedling) and PSG (Percent seed germination).

Table 2 Effect of pesticide, storage time and moisture content interaction on seed germination.

Treatments	Percentage Germination	0 Month (No Storage)	1 Month Storage	2 Months Storage	14 months storage
Free from pesticides	12.5 % Moisture	98.67	98.67	96.67	94.67
	11% Moisture	97.00	97.00	98.00	93.33
	9.5% Moisture	97.00	97.00	96.00	96.00
Only Pesticides	12.5 % Moisture	98.67	95.00	97.00	96.00
	11% Moisture	95.33	97.67	96.00	91.33
	9.5% Moisture	98.00	96.00	99.00	96.00
Only Herbicide	12.5 % Moisture	96.67	97.67	95.00	89.67
	11% Moisture	94.67	94.00	97.67	92.00
	9.5% Moisture	96.00	98.67	97.00	94.33
Herbicide + Pesticide in combination	12.5 % Moisture	97.67	75.33	97.33	92.33
	11% Moisture	97.00	97.67	95.33	88.33
	9.5% Moisture	96.67	98.00	96.00	94.33

Table 3 Effect of pesticide, storage time and moisture content interaction on Coefficient of velocity of germination.

Treatments	Percentage Germination	0 Month (No Storage)	1 Month Storage	2 Months Storage	14 months storage
Free from pesticides	12.5 % Moisture	25.01	25.00	25.09	25.01
	11% Moisture	25.00	25.05	25.01	25.14
	9.5% Moisture	25.04	25.03	25.02	25.01
Only Pesticides	12.5 % Moisture	25.01	25.05	25.08	25.03
	11% Moisture	25.10	25.03	25.04	25.16
	9.5% Moisture	25.04	25.03	25.00	25.02
Only Herbicide	12.5 % Moisture	25.03	25.03	25.13	25.24
	11% Moisture	25.09	25.05	25.03	25.12
	9.5% Moisture	25.04	25.03	25.05	25.03
Herbicide + Pesticide in combination	12.5 % Moisture	25.04	25.87	25.05	25.16
	11% Moisture	25.08	25.07	25.03	25.34
	9.5% Moisture	25.07	25.05	25.09	25.08

3. 2 Effect of interaction on coefficient of germination velocity

Coefficient of Germination Velocity was calculated by the formula proposed by Maguire (1962), among various tested highest coefficient of germination velocity was 25.87 and it was reported in the treatment containing combination pesticides at 12.5% moisture on the one month storage time. This coefficient was immediately (25.34) followed by the combination of pesticides and herbicide along with 11 percent moisture and 14 months storage period. No significant differences was reported among various treatments and this thing indicated that storage time and moisture was not adversely affected the coefficient of germination, although some reduction was reported with storage time and reducing moisture,it seems that the effect of pesticides on short storage times would be increased CVG (Table 3). Results are in agreement with the findings of Sharafizan et al. (2013) those have reported a significant effect of seed priming and drought condition and interaction between these two on germination coefficient. Further, Zare & Tavili, (2000) compared the seed priming with different levels of salicylic acid and reported a significant effect of these two on coefficient of seed germination, these observation favor the findings of this study.

3.3 Effect of interaction ongermination index

At Germination index trait, the highest index value of 1986 was reported in the seeds treated with fungicide after one month storage and at 9.5 percent moisture contents while lowest germination index (1755) was reported in the seed treated by pesticides with 12.5 percent moisture content and one month storage (Table 4). With increasing storage time and decreasing moisture content germination index were found reduced. Study conducted by Clark & Scott (1982) suggested that seed disinfection by pesticides affect germination index. Similar type of findings was reported by Randhawa et al. (1985).

Table 4 Effect of pesticide, storage time and moisture content interaction on Germination index.

Treatments	Percentage Germination	0 Month (No Storage)	1 Month Storage	2 Months Storage	14 months storage
Free from pesticides	12.5 % Moisture	1977^{a}	1973^{a}	1961^{ab}	1897^{d}
	11% Moisture	1940^{b}	1956^{b}	1964^{ab}	1911^{cd}
	9.5% Moisture	1907^{cd}	1948^{b}	1928^{bc}	1924^{c}
Only Pesticides	12.5 % Moisture	1977^{a}	1916^{c}	1964^{ab}	1928^{bc}
	11% Moisture	1939^{b}	1961^{ab}	1932^{bc}	1875de
	9.5% Moisture	1972^{a}	1928^{bc}	1980^{a}	1922^{c}
Only Herbicide	12.5 % Moisture	1941^{b}	1961^{ab}	1940^{b}	1865^{e}
	11% Moisture	1918^{c}	1896^{d}	1961^{ab}	1876de
	9.5% Moisture	1932^{bc}	1981^{a}	1956^{ab}	1895^{d}
Herbicide + Pesticide in combination	12.5 % Moisture	1962^{ab}	1755^{f}	1963^{ab}	1888^{d}
	11% Moisture	1944^{b}	1915^{c}	1969^{ab}	1871de
	9.5% Moisture	1895^{d}	1976^{a}	1948^{b}	1907^{cd}

Value without common letter is showing statistically significant difference

Table 5 Effect of pesticide, storage time and moisture content interaction on Germination rate index.

Treatments	Percentage Germination	0 Month (No Storage)	1 Month Storage	2 Months Storage	14 months storage
Free from pesticides	12.5 % Moisture	1.030^{a}	1.027^{ab}	1.023^{ab}	0.987^{d}
	11% Moisture	1.010^{bc}	1.020^{b}	1.023^{ab}	0.993^{c}
	9.5% Moisture	1.017^{b}	1.017^{b}	1.003^{bc}	1.003^{bc}
Only Pesticides	12.5 % Moisture	1.030^{a}	0.993c	1.020^{b}	1.003^{bc}
	11% Moisture	1.010^{bc}	1.020^{b}	1.007^{bc}	0.973^{e}
	9.5% Moisture	1.027^{ab}	1.007^{bc}	1.030^{a}	1.003^{bc}
Only Herbicide	12.5 % Moisture	1.010^{bc}	1.023^{ab}	1.010^{bc}	0.967^{e}
	11% Moisture	1.000^{c}	0.990^{c}	1.023^{ab}	0.973^{e}
	9.5% Moisture	1.007^{bc}	1.033^{a}	1.020^{b}	0.983^{d}
Herbicide + Pesticide in combination	12.5 % Moisture	1.023^{ab}	0.897	1.023^{ab}	0.980^{d}
	11% Moisture	1.010^{bc}	1.027^{ab}	0.997^{c}	0.970^{e}
	9.5% Moisture	1.017^{b}	1.030^{a}	1.013^{bc}	0.990^{c}

Value without common letter is showing statistically significant difference

3.4 Effect of interaction on germination rate index

Highest rate index (10.03) was reported in the seed stored for one month and treated by fungicide with moisture content 9.5% while lowest index (0.879) was reported in one month stored seed and treated by fungicide along with pesticide at 12.5 percent moisture (Table 5).Shamsaddin et al. (2007) reported a significant reduction in GRI as a result of seed storage; this storage time reduced the ability of holding moisture in Stocked seeds. Further, Gholinejad (2011) and Tavakolikakhaki & Beheshti (2010) reported that GRI can be reduced when seeds exposed to various stressor substances. Pesticide is also one of the stressors and it reduced seed's GRI in long-term storage conditions.

3.5 Effect of interaction on coleoptile length

In case of Coleoptile length, maximum coleoptile length (5.44 cm) was reported in the seed stored for one month and having 9.5% moisture and having pesticide treatment. Very little difference was reported in all storage time and all three moisture levels. However, the shortest coleoptile length (1.33cm) was reported from the treatment containing pesticides in combination with 1 month storage time and 12.5% seed moisture content. Further, it can be concluded that the Coleoptile length was significantly affected by the storage time and application of pesticide, combined application of herbicide and pesticide caused maximum reduction in coleoptiles length (Table 6). Findings of present study are in agreement with the findings of Mandani et al. (2011) those have reported that long time storage caused a significant reduction in coleoptile length of wheat. They observed shortest coleoptile length after 14 days of storage under pesticide application and the longest length in the control condition to which no pesticide was applied.

Table 6 Effect of pesticide, storage time and moisture content interaction on Coleoptile Length (cm).

Treatments	Percentage Germination	0 Month (No Storage)	1 Month Storage	2 Months Storage	14 months storage
Free from pesticides	12.5 % Moisture	5.333^{a}	5.160^{ab}	5.167^{ab}	4.573^{c}
	11% Moisture	4.713^{bc}	4.833^{bc}	5.120^{ab}	4.740^{bc}
	9.5% Moisture	5.233^{ab}	5.440^{a}	5.067^{b}	4.673^{bc}
Only Pesticides	12.5 % Moisture	3.840^{e}	3.907 ^{de}	3.820^{e}	3.447^{ef}
	11% Moisture	4.187^{d}	3.720^{e}	3.807^{e}	3.827^{e}
	9.5% Moisture	3.893^{de}	3.587^{ef}	4.060^{de}	4.147^{d}
Only Herbicide	12.5 % Moisture	2.480^{gh}	2.840^{g}	3.213^{f}	3.787^{e}
	11% Moisture	3.187^{f}	3.100^{f}	3.507^{ef}	3.653^{ef}
	9.5% Moisture	4.087^{de}	3.360^{f}	4.273^{d}	3.907^{de}
Herbicide + Pesticide in combination	12.5 % Moisture	2.367^{gh}	1.333^{h}	2.540^{gh}	3.460^{ef}
	11% Moisture	2.473^{gh}	2.760^{g}	2.853^{g}	3.273^{f}
	9.5% Moisture	3.047^{f}	2.360^{gh}	3.560^{ef}	3.347^{f}

Value without common letter is showing statistically significant difference

Table 7 The effect of pesticide, storage time and moisture content interaction on root length (cm).

Treatments	Percentage Germination	0 Month (No Storage)	1 Month Storage	2 Months Storage	14 months storage
Free from pesticides	12.5 % Moisture	10.73^{d}	9.847^{de}	10.20^{d}	9.320^{e}
	11% Moisture	11.08^{c}	10.49^{d}	12.45^{b}	8.800^{ef}
	9.5% Moisture	11.37^{c}	11.19^{c}	11.22^{c}	9.567^{e}
Only Pesticides	12.5 % Moisture	7.940^{f}	7.953^{f}	8.440^{ef}	9.860^{de}
	11% Moisture	8.093^{f}	8.893^{ef}	9.447^{e}	8.240^{f}
	9.5% Moisture	10.56^{d}	8.333^{f}	9.013^{ef}	9.893^{de}
Only Herbicide	12.5 % Moisture	11.11^{c}	10.50^{d}	11.42^{c}	10.09^{de}
	11% Moisture	10.43^{d}	11.17^{c}	10.43^{d}	9.907^{de}
	9.5% Moisture	11.33^{c}	13.07^{a}	11.37^{c}	8.853^{ef}
Herbicide + Pesticide in combination	12.5 % Moisture	9.613^{e}	3.507^{g}	9.400^{e}	9.960^{de}
	11% Moisture	9.613^{e}	9.660^{e}	9.780^{de}	10.19^{d}
	9.5% Moisture	9.867^{de}	9.600^{e}	9.880^{de}	10.20^{d}

Value without common letter is showing statistically significant difference

3.6 Effect of interaction on root length seedling

Trends of root length show similarity with the trends observed in coleoptile length, maximum root length (13.07cm) was reported in the seed having 9.5% moisture content and stored for 1 month along with treated by herbicides. Seed with 11 percent moisture without pesticide application and stored for two months follow the highest root length. The lowest root length (3.51cm) was reported in the seed stored for one month and treated with pesticides combination at 12.5% moisture (Table 7). Results are in agreement with the findings Mandani et al. (2011) reported increase in the length of root and seedling establishment under the influence of seed size and percentage of material content announced; however, at long-term maintenance seed weight is diminished. Mohammadi (2008) reported that the percentage of normal root in *Glycine max* reduced when the storage time was increased.

3.7 Effect of interaction on fresh weights seedling

Highest average fresh weight 1.90g was reported from the treatment with herbicide at 1 month storage in 9.5% seed moisture content. Seed with 9.5% moisture and without storage period and pesticide have 1.86g fresh weigh which is not significantly different from the highest fresh weight showing treatments. Minimum fresh weight of seedlings (1.24g) has been identified with the combination of pesticides and herbicides during the 1months maintenance of the 12.5% seed moisture content (Table 8). With the storage time fresh weight reduced and after 14 months storage least fresh weight was reported for all treatments. Fresh weight at the beginning of the germination is affected by the vigor of seeds (Mathews & KhajeHosseini, 2006). The vigor is less favorable with increasing storage period or storage conditions Esmailzadeh et al. (2008).

Table 8 Effect of pesticide, storage time and moisture content interaction on fresh weight (g).

Treatments	Percentage Germination	0 Month (No Storage)	1 Month Storage	2 Months Storage	14 months storage
Free from pesticides	12.5 % Moisture	1.640^{cd}	1.753^{bc}	1.673^{cd}	1.573^{d}
	11% Moisture	1.683^{c}	1.837^{ab}	1.690^{c}	1.747^{bc}
	9.5% Moisture	1.867^{a}	1.723^{bc}	1.717^{bc}	1.720^{bc}
Only Pesticides	12.5 % Moisture	1.623^{cd}	1.790^{b}	1.603^{d}	1.570^{d}
	11% Moisture	1.577^{d}	1.823^{ab}	1.700^{c}	1.557d
	9.5% Moisture	1.837^{ab}	1.723^{bc}	1.680^{c}	1.643^{cd}
Only Herbicide	12.5 % Moisture	1.760^{bc}	1.810^{ab}	1.617^{cd}	1.730^{bc}
	11% Moisture	1.723^{bc}	1.837^{ab}	1.727^{bc}	1.447^{e}
	9.5% Moisture	1.830^{ab}	1.903^{a}	1.893^{a}	1.583^{d}
Herbicide + Pesticide in combination	12.5 % Moisture	1.723^{bc}	1.240^{f}	1.700^{bc}	1.630^{cd}
	11% Moisture	1.587^{d}	1.813^{ab}	1.750^{bc}	1.557^{d}
	9.5% Moisture	1.700^{c}	1.747^{bc}	1.650^{cd}	1.717^{bc}

Value without common letter is showing statistically significant difference

Table 9 The effect of pesticide, storage time and moisture content interaction on Dry weight (g).

Treatments	Percentage Germination	0 Month (No Storage)	1 Month Storage	2 Months Storage	14 months storage
Free from pesticides	12.5 % Moisture	0.2467^{d}	0.2467^{d}	0.3000^{b}	0.2067^{e}
	11% Moisture	0.2667^{c}	0.2600^{c}	0.2867^{bc}	0.2300^{de}
	9.5% Moisture	0.2733^{c}	0.2733^{c}	0.2500^{cd}	0.2633^{c}
Only Pesticides	12.5 % Moisture	0.2400^{d}	0.2733^{c}	0.2833^{bc}	0.2667^{c}
	11% Moisture	0.2467^{d}	0.3000^{b}	0.2833^{bc}	0.2700^{c}
	9.5% Moisture	0.3100^{b}	0.3133^{b}	0.2600^{c}	0.2367^{de}
Only Herbicide	12.5 % Moisture	0.2633^{c}	0.2567^{cd}	0.3033^{b}	0.2467^{d}
	11% Moisture	0.2800^{bc}	0.2833^{bc}	0.2800^{bc}	0.2467^{d}
	9.5% Moisture	0.2467^{d}	0.2800^{bc}	0.2833^{bc}	0.2667^{c}
Herbicide + Pesticide in combination	12.5 % Moisture	0.2867^{bc}	0.3733^{a}	0.2967^{bc}	0.2733^{c}
	11% Moisture	0.2733^{c}	0.2900^{bc}	0.2700^{c}	0.3133^{b}
	9.5% Moisture	0.2833^{bc}	0.2767^{c}	0.2700^{c}	0.2600^{c}

Value without common letter is showing statistically significant difference

3.8 Effect of interaction on dry weight seedling

The highest value in dry weight was 0.373 g and it was reported from the treatment containing pesticide and herbicide combination along with one month stored seed with 12.5% seed moisture, this was followed by the 14 month storage with 11 percent moisture and one month storage with 9.5 percent moisture in combination with pesticide and herbicides. . The minimum dry weight is 0.207g was reported in the seed stored for 14 months and moisture maintain on 12.5% without pesticide content (Table 9). Soltani et al. (2007) reported that extended storage time significantly increases the start and end time of seed germination. In addition, increasing storage period decreases dry seedling weight (Mandani et al., 2011).

Overall result of this study suggested that various traits such as germination percentage, germination index, fresh weight, and root length show highest efficiency on one or two moth storage at 9.5 percent moisture content and herbicide application. While the same traits show minimum efficacy on 12.5 percent moisture and combined application of pesticide and herbicide for the same duration. Various evidences show that the best treatment for germination of wheat seeds is disinfection by fungicides for a shorter period of one to two months in the standard moisture content (9.5%). At other tests conducted by Clark & Scott (1982) reported that treatment of wheat seed with fungicide was effective on germination rate and seed germination while the same study suggested that the treatment of the seed with fungicides have negative impact and it is not only reducing the seed germination but also reducing the efficiency. In present study, some studied traits such as CVG and dry weight of seedlings, show highest efficiency on one month storage at 12.5% moisture and combination of pesticides (fungicide + insecticide) content. Similar type of observation was reported by Tavakolikakhaki & Beheshti (2010). Further, according to Clark & Scot (1982) the effects of fungicides on and seedling dry weight were not significant. Tavakolikakhaki & Beheshti (2010) studied the effect of storage time on seed germination, seedling dry weight, shoot length, root length and root to shoot ratio and reported a significant differences among these traits. The results showed that the seed germination percentage, germination rate and other factors measured in seedling cannot predicted under laboratory conditions. However, based on this experimental results we cannot concluded on the non-use of pesticides, fungicides or insecticides for the seed treatment but it can be conclude use of these pesticides can not necessarily increase the percentage and rate of germination of wheat. However, the interaction between the type of fungicide and seed moisture content and storage time affect the characteristics of different pesticides.

Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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