Determination of biological values in wheat and barley kernels dried to certain periods after germination

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Abstract
This study was conducted at the research laboratory of University of Selcuk, Konya, Turkey. The effect on biological values of three different germination period (control, 24 and 48 hours) and six different drying periods (control, 1, 4, 7, 10 and 13 days) in two species (wheat and barley) were examined. Kernels that were not germinated (control) and which were germinated for 24 and 48 hours in 20°C germination condition were taken into climate room for germination and emergence tests after they were dried to control, 1, 4, 7, 10 and 13 days on 35°C. The elongation of germination period (control, 24 and 48 hours) and drying period resulted in important decrease in biological values. For germination and emergence values in wheat and barley, while the highest germination and emergence values were determined in counting after germinating (0, 24 and 48), the lowest germination and emergence values were determined in kernels subjected to drying 13 hours.

Key words: Cool Season Cereals, Germination Period, Drying Period, Biological Value

Introduction
Changes to the global climate, notably to regional spatial and temporal temperature patterns (Houghton et al., 1996), from increased atmospheric concentrations of greenhouse gases are predicted to have important consequences for crop production (Parry, 1990). Both plant growth and development are affected by temperature (Porter and Moot, 1998). Cereal is a crop being the highest production and consumption in the world. In Turkey, wheat is the most extensive crop, grown on about 7.5 million ha. Production is 17.7 million and average yield is 2.3 ton ha⁻¹. Barley is grown on about 2.7 million ha. Production is 5.9 million ton and average yield is 2.2 ton ha⁻¹ (Anonymous, 2009). Temperatures that lie outside the range can have severe results for crops, significantly reducing yields. Both high and low temperatures decrease the rate of the dry matter production (Tanner and Sinclair, 1983). In Central Anatolian region, rainfall is low and irregular and drought may occur at any period during the growing season, including autumn months. Water stress will then affect cereals during their early stages of growth when the plant starts germination. Tolerance to drought is important character in increase of plant production. This is the more important for dry land wheat production in worldwide. Yield in limited soil moisture mainly depends on tolerance to drought. Physiologic and genetic basis of tolerance to drought did not completely determine but it is known that there is significant difference between wheat genotypes in some morphological and physiological characteristic in terms of tolerance to drought (Öztürk 1999).

Seeds of many plant species are extremely tolerant to harsh environmental conditions provided they are in a state of desiccation. In this dry state, their metabolic activity is drastically reduced to a very low level while retaining their ability to germinate for considerable periods (Loïc and Isabelle, 2008). In dry land where soil moisture is not
enough for germination, farmers delay sowing. Drought after sowing is a major problem, which decreases germination and emergence. Considerable experimental work has been undertaken in order to understand how wheat responds to extreme condition. This study was conducted to determine germination and emergence rates in wheat and barley kernels dried to certain periods.

**Material and methods**

This study was conducted at the research laboratory of University of Selcuk in Konya province of Turkey. In the study, effect on biological values of three different germination period (control, 24 and 48 hours) and six different drying periods (control, 1, 4, 7, 10 and 13 days) in wheat (*Triticum aestivum* L. cv. Gerek 79) and barley (*Hordeum vulgare* L. cv. Karatay-94) species. Both cultivars were widely grown in dry farming areas of Central Anatolian. Kernels that were not germinated (control) and were germinated for 24 and 48 hours in 20°C germination condition were taken into climate room for germination and emergence tests after they were dried to control, 1, 4, 7, 10 and 13 days in 35°C condition of drying oven. 40 kernels were placed to each germination and emergence. Petri plates on filter paper for germination values and pots for emergence values were used. After required conditions were provided to germination and emergence, it was counted for germination values in 4 and 7 days after putting and for emergence values in 7 and 12 days after sowing. The research was arranged in completely randomized design as three replications. Date was subject to statistical analysis using a computer package MSTAT-C. The means of treatments were evaluated and ranged according to the Duncan Test.

**Results and discussion**

It was found that there were statistically significant differences between germination (control, 24 and 48 hour), drying (control, 1, 4, 7, 10 and 13), species (wheat and barley), species x drying interaction, species x germination, germination x drying interaction, germination x drying x species interaction in 4 and 7 day germination values and 7 and 12 day emergence values (p<0.01). Wheat is generally considered to enjoy an optimum temperature range of 20°C the course of root growth. Maximum temperatures for root growth were reported 20-26°C (Petr, 1991) and 35°C (Wardlaw and Moncur, 1995). Our study shows that wheat and barley kernels that were normally germinated (control, 24 and 48 h) had 100 % germination rates. However, when they are subject to drought, germination rates decreased drastically %93.3 in wheat and %71.1 in barley. It was determined that barley was affected more than wheat (Table 1).

Generally, the optimal soil temperature for growth of the roots of wheat plants during the vegetative stage is below 20°C (Nielsen and Humphries, 1966; MacDowell, 1973) and lowers than that for shoots. Temperatures higher than 35°C have shown to reduce terminal root growth and accelerate its senescence (Wardlaw and Moncur, 1995). In our study, temperature after germination was 35°C. But, germinated wheat and barley kernels were subjected to dry 1-13 day. Longevity of drying time caused decrease in 7 day germination values. While germination values in wheat kernels subjected to drying (control, 1, 4, 7, 10 and 13 days) after germinating (48 hour) successively were 100, 100, 97.5, 95.8, 98.3 and 90.0 %, germination values in barley kernels 100.0, 100, 80.8, 79.2, 75.8 and 59.2 %.

When crop plants are subjected to prolonged water shortage, this affects virtually all physiological processes, including growth (McDonald and Davies, 1996), signaling pathways (Chaves et al., 2003), gene expression (Denby and Gehring, 2005), respiration (Ribas-Carbo et al., 2005) and photosynthesis (Flexas et al., 2004). In our study, barley was affected more than wheat by drought. The highest fall in 7 day emergence values was
seen 39.2% in wheat and 47.5% in barley kernels that were dried to 13 day after 48 h germination (Table 3).

Root growth is generally more sensitive to temperature than that of above-ground plant parts (Nielsen and Humphries, 1966). This study showed that 12 day emergence values in wheat and barley were affected by drought. The highest fall was 46.7% in wheat and 55.0% in barley kernels that were drying to 13 day after 48 h germination (Table 4). While average 7 and 12 emergence values in wheat successively were 88.3, 68.8, 73.8, 85.0, 81.25 and 42.95%, emergence values in barley were 97.5, 73.3, 71.7, 67.5, 65.4 and 51.5%.

### Table 1. Effect on 4 day germination rates of germination and drying periods in wheat and barley

<table>
<thead>
<tr>
<th>Species</th>
<th>Germ. (hour)</th>
<th>Drying time (day)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Wheat</td>
<td>C</td>
<td>100.0a*</td>
<td>100.0a</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>100.0a</td>
<td>100.0a</td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>100.0a</td>
<td>100.0a</td>
</tr>
<tr>
<td>Average</td>
<td>100.0a**</td>
<td>100.0a</td>
<td>98.1ab</td>
</tr>
<tr>
<td>Barley</td>
<td>C</td>
<td>100.0a</td>
<td>91.7a-e</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>100.0a</td>
<td>85.8d-g</td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>100.0a</td>
<td>100.0a</td>
</tr>
<tr>
<td>Average</td>
<td>100.0a</td>
<td>92.5c</td>
<td>85.0d</td>
</tr>
<tr>
<td>Average control</td>
<td>100.0a***</td>
<td>95.8ab</td>
<td>95.4abc</td>
</tr>
<tr>
<td>Average 24 hour</td>
<td>100.0a</td>
<td>92.9bcd</td>
<td>90.0bcd</td>
</tr>
<tr>
<td>Average 48 hour</td>
<td>100.0a</td>
<td>100.0a</td>
<td>89.2cd</td>
</tr>
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<td>General Average</td>
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<td>96.3b</td>
<td>91.5c</td>
</tr>
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</table>

*species x germination period x drying period; **species x germination period; ***germination period x drying period; germ. (germination).

### Table 2. Effect on 7 day germination rates of germination and drying periods in wheat and barley

<table>
<thead>
<tr>
<th>Species</th>
<th>Germ. (hour)</th>
<th>Drying time (day)</th>
<th>Mean</th>
</tr>
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<tbody>
<tr>
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<tr>
<td>Wheat</td>
<td>C</td>
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<td>100.0a</td>
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<tr>
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<tr>
<td></td>
<td>48</td>
<td>100.0a</td>
<td>100.0a</td>
</tr>
<tr>
<td>Average</td>
<td>100.0a**</td>
<td>100.0a</td>
<td>98.1a</td>
</tr>
<tr>
<td>Barley</td>
<td>C</td>
<td>100.0a</td>
<td>91.7a-d</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>100.0a</td>
<td>85.8cde</td>
</tr>
<tr>
<td></td>
<td>48</td>
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<td>100.0a</td>
</tr>
<tr>
<td>Average</td>
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<td>92.5b</td>
<td>85.0c</td>
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<tr>
<td>Average control</td>
<td>100.0a***</td>
<td>95.8ab</td>
<td>95.4abc</td>
</tr>
<tr>
<td>Average 24 hour</td>
<td>100.0a</td>
<td>92.9bcd</td>
<td>90.0bcd</td>
</tr>
<tr>
<td>Average 48 hour</td>
<td>100.0a</td>
<td>94.2abc</td>
<td>100.0a</td>
</tr>
<tr>
<td>General Average</td>
<td>100.0a</td>
<td>96.3b</td>
<td>91.5c</td>
</tr>
</tbody>
</table>

*species x germination period x drying period; **species x germination period; ***germination period x drying period; germ. (germination).
Table 3. Effect on 7 day emergence rates of germination and drying periods in wheat and barley

<table>
<thead>
<tr>
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<th>Germ. (hour)</th>
<th>Drying time (day)</th>
<th>Mean</th>
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<td>Wheat</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
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<td>92.5abc</td>
<td>90.0a-d</td>
</tr>
<tr>
<td>24</td>
<td>95.8a</td>
<td>81.6b-f</td>
<td>68.3fgh</td>
</tr>
<tr>
<td>48</td>
<td>88.3a-e</td>
<td>64.2h</td>
<td>68.3fgh</td>
</tr>
<tr>
<td>Average</td>
<td><strong>93.1a</strong></td>
<td>79.4bc</td>
<td><strong>75.6cd</strong></td>
</tr>
<tr>
<td>Barley</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>C</td>
<td>88.3a-e</td>
<td>81.7b-f</td>
<td>79.2e-g</td>
</tr>
<tr>
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<td>91.7abc</td>
<td>74.2fgh</td>
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<td>48</td>
<td>97.5a</td>
<td>73.3fgh</td>
<td>70.0fgh</td>
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<tr>
<td>Average</td>
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<td><strong>73.9cde</strong></td>
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<tr>
<td>Average control</td>
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<td>87.1a-d</td>
<td>84.6b-e</td>
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<td>Average 24 hour</td>
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<td>77.9d-g</td>
<td>70.4gh</td>
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<td>Average 48 hour</td>
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<tr>
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<td>77.9d</td>
<td><strong>74.7b</strong></td>
</tr>
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</table>

*species x germination period x drying period; **species x germination period; ***germination period x drying period; germ. (germination).

Table 4. Effect on 12 day emergence rates of germination and drying periods in wheat and barley

<table>
<thead>
<tr>
<th>Species</th>
<th>Germ. (hour)</th>
<th>Drying time (day)</th>
<th>Mean</th>
</tr>
</thead>
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<td>4</td>
</tr>
<tr>
<td>Wheat</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>95.0abc*</td>
<td>94.2a-d</td>
<td>95.0abc</td>
</tr>
<tr>
<td>24</td>
<td>97.5a</td>
<td>81.7c-f</td>
<td>77.5e-j</td>
</tr>
<tr>
<td>48</td>
<td>88.3a-f</td>
<td>73.3g-j</td>
<td>79.2e-j</td>
</tr>
<tr>
<td>Average</td>
<td><strong>93.6a</strong></td>
<td><strong>83.1bcd</strong></td>
<td><strong>83.9bc</strong></td>
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<tr>
<td>Barley</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>90.8a-e</td>
<td>86.7a-g</td>
<td>80.8d-j</td>
</tr>
<tr>
<td>24</td>
<td>97.5a</td>
<td>81.7c-i</td>
<td>75.0f-j</td>
</tr>
<tr>
<td>48</td>
<td>97.5a</td>
<td>73.3g-j</td>
<td>73.3g-j</td>
</tr>
<tr>
<td>Average</td>
<td><strong>95.3a</strong></td>
<td><strong>80.6cde</strong></td>
<td><strong>76.4de</strong></td>
</tr>
<tr>
<td>Average control</td>
<td>92.9a***</td>
<td>90.4abc</td>
<td>87.9bcd</td>
</tr>
<tr>
<td>Average 24 hour</td>
<td>97.5a</td>
<td>81.7c-g</td>
<td>76.3fg</td>
</tr>
<tr>
<td>Average 48 hour</td>
<td>92.9ab</td>
<td>73.3g</td>
<td>76.3fg</td>
</tr>
<tr>
<td>General Average</td>
<td><strong>94.4a</strong></td>
<td><strong>81.8b</strong></td>
<td><strong>80.1b</strong></td>
</tr>
</tbody>
</table>

*species x germination period x drying period; **species x germination period; ***germination period x drying period; germ. (germination).

Conclusion

In early sowing, because of scare of soil moisture, re-germination of dried kernel is a problem in cereal growing. In this case, cereals germination and emergence are affected negatively. Cereals should be sown according to meteorological data which gives us information of sowing date that is more suitable for sowing. If there is drought after sowing like this, cereals must be watered where region have irrigation possibilities. In this study, drought causes to decrease germination and emergence rates in cereals. Seed rate in sowing can be increased in dry land where it seems to be drought. Thereby drought that causes fall in the yield can be stopped.
References