ABSTRACT
In order to compare different wheat cultivars in terms of remobilization of stem reserves, 9 bread wheat cultivars were grown in a randomized complete block design with 3 replications under rain-fed condition in the research station of Islamic Azad University of Ardabil in 2013. In this study 14 characters of remobilization of stem reserves were measured. The results showed that Pishtaz and MV17 cultivars had the highest level of apparent remobilization of stem reserves from peduncle and lower internodes. The highest efficiency of remobilization of peduncle reserves was observed in Pishtaz and Sultan 95 and for lower internodes was observed in Sultan 95 and MV17 cultivars.

Keywords: Drought Stress, Wheat, Remobilization of Stem Reserves, Chemical Desiccation

INTRODUCTION
At least 6 million hectares of wheat planted in developing countries are considered as marginal land that their overall yield is from 0.8 to 1.5 tons per hectare (Reynolds et al., 1999). Iran with its average rainfall of 240 mm is an arid and semi-arid part of the world. In these areas due to the lack of water resources and also environment dryness, wheat yield strongly decreases. So drought stress is allocated a large part of breeding studies and more attention have been allocated to drought effects and creating the drought tolerant cultivars (Ehdai, 1993). To increase the potential yield of a crop plant, determining the physiological factors which limit the performance is important. Accumulation, translocation and distribution of carbohydrates (C) in wheat have an important impact on grain yield. In general, grain filling in wheat depends on C from two resources: current assimilation and remobilization of reserves stored in the stem and other parts, either pre-anthesis or post-anthesis (Pheloung and Siddique, 1991). Under drought stress, photosynthetic rate decreased and the materials derived from photosynthesis consume for plant survival. Thus, current assimilation decreases due to the natural aging and the effects of various stresses. Hence, an important carbon source for seed filling is remobilization of the material from vegetative parts and stem reserves (Blum, 1988). For this reason, one of the appropriate strategies for achieving acceptable performance is the acceptance of physiological parameters such as remobilization rate of carbohydrates and estimating their contribution in wheat yield under drought condition. It is obvious that various parameters of remobilization can be regarded as indirect selection criteria for drought tolerance. Estimates of the contribution of stem reserves in grain yield are different in different studies due to environmental conditions and the use of different wheat cultivars and it is varied from 6 to 100% (Blum, 1998). The tolerant cultivars have more ability to store assimilates and they have greater efficiency in transforming these reserves under stress condition (Ezzat-Ahmadi et al., 2011). Drought stress with the creation of premature aging stimulates the stem carbohydrates to have more mobility (Yang et al., 2001) and remobilization have been used successfully for selection of resistant varieties to terminal drought stress (Pannu et al., 1999). So investigating the remobilization of stem reserves in the bread wheat can be considered as a tool for selecting the drought tolerance.

MATERIALS AND METHODS
In order to compare different wheat cultivars in term of remobilization, 9 bread wheat varieties (Table 1) were grown as a randomized complete block design with 3 replications under drought stress condition at research station of Islamic Azad University, Ardabil branch, Iran in 2013. After the flowering (one week after anthesis), half of the plot were separated from other plots by cardboard walls and the foliar...
application process was done by 0.4% potassium iodide solution as leaf desiccator. After physiological maturity, grain yield has been harvested from foliar and non-foliar sections and the remobilization of stem to grain was measured by the difference between two corresponding parts.

Table 1: Genotypes used in the experiment

<table>
<thead>
<tr>
<th>Row</th>
<th>Cultivar</th>
<th>Row</th>
<th>Cultivar</th>
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<tbody>
<tr>
<td>1</td>
<td>Rasad</td>
<td>6</td>
<td>Gaspard</td>
</tr>
<tr>
<td>2</td>
<td>Pishtaz</td>
<td>7</td>
<td>Gascogen</td>
</tr>
<tr>
<td>3</td>
<td>Konya 2002</td>
<td>8</td>
<td>Sisson</td>
</tr>
<tr>
<td>4</td>
<td>Sultan 95</td>
<td>9</td>
<td>Seri 82</td>
</tr>
<tr>
<td>5</td>
<td>MV 17</td>
<td>--</td>
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</tr>
</tbody>
</table>

Characters (Hossain et al., 1990)

**A:** Apparent remobilization of reserves under foliar application
A = stem dry weight of foliar application at maturity – stem dry weight at the time of foliar application

**B:** Apparent remobilization of reserves under foliar application from peduncle (B)
B = peduncle dry weight at maturity – peduncle dry weight at the time of foliar application

**C:** Apparent remobilization of reserves under foliar application from Penultimate (C)
C = Penultimate dry weight at maturity – Penultimate dry weight at the time of foliar application

**D:** Apparent remobilization of reserves under foliar application from lower internodes (D)
D = lower internodes dry weight at maturity – lower internodes dry weight at the time of foliar application

**E:** Apparent remobilization percentage from peduncle (E)
E = (peduncle dry weight at maturity – dry weight of peduncle at the time of foliar application) * 100

**F:** Apparent remobilization percentage from Penn Ultimate (F)
F = (the dry weight of Penn Ultimate at maturity time – dry weight of Penn Ultimate at the time of foliar application) * 100

**G:** Apparent remobilization percentage from lower internodes (G)
G = (the dry weight of lower internode at maturity – dry weight of lower internode at the time of foliar application) * 100

**H:** The remobilization efficiency of reserves under foliar application (H)
H = (stem dry weight at the time of foliar application/ apparent remobilization of reserves under foliar application) * 100

**I:** The remobilization efficiency of reserves under foliar application from peduncle (I)
I = (peduncle Dry weight at the time of foliar application/ apparent material remobilization from peduncle) * 100

**J:** The remobilization efficiency of reserves under foliar application from Penultimate (J)
J = (penultimate Dry weight at the time of foliar application/ apparent material remobilization from Penultimate) * 100

**K:** The remobilization efficiency of reserves under foliar application from lower internodes (K)
K = (lower internodes dry weight at the time of foliar application/ apparent material remobilization from lower internodes) * 100

**L:** Retranslocation Efficiency (L)
L = [(stem especial weight before foliar application – stem especial weight after foliar application)/ stem especial weight before foliar application] * 100

**M:** The proportion of grain filling from translocate materials (M)
M = (The seed weight at the time of foliar application- seed weight at the maturity)/ (The shoot weight at the time of foliar application- shoot weight at the time of foliar application) * 100

**N:** Weight reduction percentage in the treating of foliar application compared to control treatment (N)
N = (contribution of remobilization in yield / photosynthetic/ contribution of remobilization in yield)
RESULTS AND DISCUSSION

The results of analysis of variance (Table 2) showed that there were significant differences among cultivars in all of the traits except for C, G, J, L and M characters, which implies the presence of sufficient genetic variability among these cultivars. Among the studied traits, D, F, G, H, J and K have the lower coefficient of variation.

Mean Comparisons

Apparent Remobilization of Reserves in Foliar Application

MV 17 genotype with the average of 0.787 had a significant difference with others and associated with Gaspard genotype was divided in a superior statistically group and Sisson genotype with the average of 0.364 had the lowest apparent remobilization of reserve material in treating of foliar application with other genotypes and they located in a same class (Figure 1).

Apparent Remobilization of Reserves under Foliar Application from Peduncle

Pishtaz genotype with the average of 0.0673 had a significant difference with others and with the Rasad, Konya 2002, MV 17, Gaspard and Seri82 were divided in a superior group and the Sisson genotype with the average of 0.011 allocated the lowest apparent remobilization of reserve material in treating of foliar application from peduncle (Figure 2).

The Apparent Remobilization of Reserves under Foliar Application from Lower Internodes

The highest level of apparent remobilization of MV17 genotype allocated Reserve material under treating the foliar application from lower internodes with the average of 0.439 and had a significant difference with others and with Sultan 95 genotype and Gaspard were divided in the superior group and Pishtaz genotype with the average of 0.219 allocated the lowest apparent remobilization of reserve material under treating of foliar application from lower internodes and they were located in C class with konya 2002, Rasad, Gascogen, Sisson and Seri 82 (Figure 3).

The Percentage of Apparent Remobilization from Peduncle

Pishtaz genotype the average of 20.32% had significant difference and with the Rasad genotype was divided in a superior statistical group. The Sisson genotype with the average of 2.99% allocated the lowest apparent remobilization from peduncle (Figure 4).

The Percentage of Apparent Remobilization from Penultimate

The highest percentage of apparent remobilization from Penultimate was allocated to Gascogen with the average of 34.15% and had not a significant difference with others except Sultan 95 genotype and were located in superior statistical group and Sultan 95 genotype with the average of 20.87% had the lowest apparent remobilization from Penn Ultimate and alone was located in class B (Figure 5).

The Remobilization Efficiency of Reserves in Foliar Application

Sultan 95 genotype with the average of 40.49% had a significant difference with others and with Pishtaz, MV 17, Gaspard, Gascogen and Seri 82 were located in class A and the Sisson genotype and konya 2002 respectively with 30.18% and 30.69% had the minimum remobilization efficiency of reserve material in treating of the foliar application and they were divided in class C (Figure 6). Davidson and cavalier (1992) reported the shoot portion ratio in the final grain yield about 10 to 12% and in drought condition; this percentage was over 40%. Generally during the seed filling, current photosynthesis is affected by various abiotic and alive stresses and this time, the shoot remobilization as an important process can compensate the reduction in seed yielding. In the study of Ahmadi et al., (2004) only 2 cultivars from 4 cultivars under the drought stress were more efficient and therefore it can be concluded that material remobilization in optimal moisture conditions plays an important role in the seed yielding.

Remobilization Efficiency of Reserves in Foliar Application from Peduncle

The highest percentage of reserve remobilization in treating of foliar application from peduncle was allocated by Pishtaz and Sultan 95 genotype with 26.04 and 25.24 averages. And this genotype with Konya 2002, MV 17, Gaspard and Seri 82 were divided in a same class. And Sisson genotype allocated
the lowest remobilization of reserve material in treating of foliar application from peduncle and with Rasad and Gascogen were divided in class C (Figure 7).

**The Remobilization Efficiency of Reserves in Foliar Application from Lower Internodes**

Sultan 95 and MV 17 respectively by 52.69 and 51.81 averages had a significant difference with others and with Pishtaz, Gaspard, Gascogen and Seri 82 were divided in Class a. And the Sisson, Konya 2002 and Rasad genotypes with 40.56, 41.91, 41.56 averages, allocated the minimum remobilization efficiency of reserve material in treating of foliar application from lower internodes and they were divided in class B (Figure 8).

**The Percentage of Weight Reduction in Foliar Application in Compared to Control Treatment**

The highest percentage of weight loss in treating the foliar application in compared with control treating was allocated by Rasad genotype with 30.52 averages. And this genotype with Konya 2002, sultan 95, Mv 17, Gaspard and Seri 82 were divided in the superior statistical group and Pishtaz genotype with 9.46 average allocated the minimum weight loss in treating of foliar application in compared with control treating and this genotype with Sisson, Sultan 95 and Gascogen were divided in class C (Figure 9).

### Table 2: Mean squares in analysis of variance related to remobilization characters

<table>
<thead>
<tr>
<th>Sources of change</th>
<th>df</th>
<th>A*</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
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<tbody>
<tr>
<td>Rep</td>
<td>2</td>
<td>0.40</td>
<td>0.0005</td>
<td>0.006</td>
<td>0.03**</td>
<td>48.59*</td>
<td>8.96</td>
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<td>Genotype</td>
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<td>0.049*</td>
<td>0.001*</td>
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<td>80.19**</td>
<td>68.86**</td>
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<tr>
<td>Error</td>
<td>16</td>
<td>0.017</td>
<td>0.0004</td>
<td>0.002</td>
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<td>16.02</td>
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<td>Coefficient of variance</td>
<td></td>
<td>26.03%</td>
<td>44.33%</td>
<td>34.59%</td>
<td>22.96%</td>
<td>43.21%</td>
<td>12.29%</td>
<td>17.30%</td>
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*and**: significant in the probability level of 5% and 1%

### The continued table 2-

<table>
<thead>
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<th>J</th>
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<td>25.90%</td>
<td>10.39%</td>
<td>25.07%</td>
<td>74.46%</td>
<td>32.16%</td>
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</table>

*and**: significant in the probability level of 5% and 1%

*Apparent remobilization of reserve materials under treating of foliar application (A), Apparent remobilization of reserved material under treating of foliar application from peduncle (B), Apparent remobilization of reserved material under treating of foliar application from Penn Ultimate (C), Apparent remobilization of reserved material under treating of foliar application from lower internodes (D), Apparent remobilization percentage from peduncle (E), Apparent remobilization percentage from Penn Ultimate (F), Apparent remobilization percentage from lower internodes (G), The remobilization efficiency of reserve material under treating of foliar application (H), The remobilization efficiency of reserve material under treating of foliar application from peduncle (I), The remobilization efficiency of reserve material under treating of foliar application from Penn Ultimate (J), The remobilization efficiency of reserve material under treating of foliar application from lower internodes (K), Transmission Efficiency (L), The portion of seed filling from transferred material (M) and Weight reduction percentage in the treating of foliar application compared to control treating (N)
Figure 1: the averaged genotype were studied due to the apparent remobilization of reserve material in treating of foliar application

The average treatments with similar letters do not have significant difference, according to Duncan's multiple range tests in the 5% level.

Figure 2: the averaged genotype were studied due to the apparent remobilization of reserve material in treating of foliar application from peduncle

The average treatments with similar letters do not have significant difference, according to Duncan's multiple range tests in the 5% level.

Figure 3: the averaged genotype was studied due to the apparent remobilization of reserve material in treating of foliar application from lower internodes
The average treatments with similar letters do not have significant difference, according to Duncan's multiple range tests in the 5% level.

Figure 4: the averaged genotype was studied due to the apparent remobilization percentage from peduncle

The average treatments with similar letters do not have significant difference, according to Duncan's multiple range tests in the 5% level.

Figure 5: The averaged genotype was studied apparent remobilization from Penn Ultimate

The average treatments with similar letters do not have significant difference, according to Duncan's multiple range tests in the 5% level.

Figure 6: the averaged genotype was studied due to the efficiency apparent remobilization of reserve material in treating of foliar application
The average treatments with similar letters do not have significant difference, according to Duncan's multiple range tests in the 5% level.

Figure 7: The averaged genotype was studied due to the efficiency apparent remobilization of reserve material in treating of foliar application from peduncle

The average treatments with similar letters do not have significant difference, according to Duncan's multiple range tests in the 5% level.

Figure 8: The averaged genotype was studied due to the efficiency apparent remobilization of reserve material in treating of foliar application from lower internodes

The average treatments with similar letters do not have significant difference, according to Duncan's multiple range tests in the 5% level.

Figure 9: The averaged genotype was studied due to the efficiency apparent remobilization of weight reduction in treating of foliar application in compared with control treating

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The average treatments with similar letters do not have significant difference, according to Duncan's multiple range tests in the 5% level.

Conclusion

The results showed that Pishtaz and MV17 cultivars had the highest level of apparent remobilization of stem reserves from peduncle and lower internodes. The highest efficiency of remobilization of peduncle reserves was observed in Pishtaz and Sultan 95 and for lower internodes was observed in Sultan 95 and MV 17 cultivars.

REFERENCES

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