Produced wheat seed as affected by different tillage systems in maternal environment

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Introduction
Reduced growth and yield of crops in residues has been reported, especially in heavy wheat residues. Reduced grain yield has been attributed to climatic conditions, soil pathogens, nitrogen immobilization, phytotoxicity from decomposing surface residues, and/or poor seedling establishment (Bahrani et al., 2007). Soil conditions for conservation tillage can be improved with tillage modifications. Conservation tillage practices include reduced soil tillage systems, such as minimum tillage (MT) and no-tillage (NT) systems, aimed at increasing the soil cover with the crop residues from the previous crop (CTIC, 2010). Improved soil surface cover usually improves water capture and retention. NT is a promising practice for croplands on the Mediterranean basin, where it can improve water use efficiency (Morellet et al., 2011).

Rapid seed germination and uniform seedling emergence are essential prerequisites to reach the yield potential, quality, and ultimately profit in wheat. Greater and better synchronized germination is crucial for achieving an optimal seedling establishment and better productivity (Pirasteh-Anosheh et al., 2011; Hamidiet al., 2013). Unsuitable quality, as well as, inadequate germination and establishment are two most important of environmental problems that crop are facing. Seed quality is influenced by many factors including cultivar, genetic purity, physical purity, germinability and vigor index. Other factors such as genetic structure, environmental conditions and maternal environmental have crucial effects on seed quality (Hamidiant Pirasteh-Anosheh, 2013).

There are several reports about the effects of the maternal environment on different aspects of seed quality, including germinability, dormancy, size, and composition. Some of the frequently studied environmental factors are temperature, water availability, light (quality and photoperiod), altitude, and mineral nutrition (Contreras et al., 2008). However, there is no information about different tillage systems in maternal environmental and its effect of seed quality of produced seed. Thus, the present study was conducted to evaluate the effect of different tillage systems (conventional, minimum and no tillage) in maternal environment on seed germination of wheat cv. Shiraz.

Materials And Methods
The present study was conducted in field and laboratory of College of Agriculture, Shiraz University during 2011-2012 growing season. The field experiment is located in a semi-arid region (52° 46'E, 29° 50'N, altitude 1810 m ASL). The physico-chemical properties of the soil used for experimentation are given in Table 1. The experimental site has been cultivated by irrigated wheat. The treatment included conventional (CT), minimum (MT) and no tillage (NT). The field and
laboratory experiments was arranged in randomized complete block (RCB) and completely randomize design (CRD), respectively; with three replication in both experiments. In CT moldboard plow, twicedisc plow and leveler were used. Minimum tillage was achieved using a combined tillage tool including sweep plow, disc plow and roller. In CT and MT treatments the wheat seeds were sown using row planter; while direct planter was used for sowing in NT.

Row and plant spacing were 20 and 2 cm, respectively; expecting 2.5 million plants ha$^{-1}$ (87.5 kg seeds ha$^{-1}$). Viable wheat seeds (Shiraz cultivar) were sown in plots each 3 × 6 m in 6 November 2011. The fertilizer broadcast consisted of 150 kg ha$^{-1}$ triple superphosphate at sowing time and 250 kg ha$^{-1}$ urea (half at sowing and the other half at stem elongation). Weeds were controlled manually. The field was harvested at 16 June 2012, and grain in each plot separated for laboratory experiment.

Before the experiments, Petri dishes and solution dishes were put in oven for 24 h at 110°C. The seeds were surface sterilized with 5% NaOCl (sodium hypochlorite) for 5 min to avoid fungal invasion, followed by washing with distilled water (Pirasteh-Anosheh and Hamidi, 2013). Twenty-five seeds were placed in each petri dish. Seeds were placed in 9 cm petri dishes on two layers of filter paper (Whatman No.1). During the experiment, the Petri dishes were irrigated with distilled tap water. Dishes were placed in a germinator at 23 ± 2°C. The filter papers of each Petri dish were replaced every two days to prevent salt accumulation (Hamidi et al., 2013).

Seed germination was recorded daily up to 8 and 15 days after sowing for 25/20 and other regimes, respectively; when no seed germinated. A seed was considered germinated when radical emerged by about 2 mm in length (Pirasteh-Anosheh et al., 2011). In each recording, ten seedlings were randomly selected from each petri dish, and their averages were considered as sample data. The measured traits included germination percentage (equation 1; Pirasteh-Anosheh and Hamidi, 2013), germination rate (equation 2; Pirasteh-Anosheh et al., 2011) radicle and shoot length, as well as, vigor index (equation 3; Razmiet al., 2013).

$$GP = \frac{n}{N}$$

In equation 1; GP is Germination percentage, n is number of seeds germinated, and N is total number of seeds planted. In equation 2; GR is the germination rate, n is the number of seeds germinated on a specific day, and D is the number of days from the start of experiment. In equation 3; VI, RL, SL, and GP are vigor index, radicle length, shoot length and germination percentage, respectively.

Data were subjected to analysis of variance (ANOVA) and significant differences between treatment means determined by the least significant difference (LSD) test at P < 0.01 level using the computer software SAS v. 9.1.

**Results And Discussion**

Tillage system had significant effect on grain weight that grain developing in CT was heavier than those in ZT; however developed grains in MT had no significant difference with two other tillage systems (Fig. 1A). This difference led to varied grain yield between tillage systems; which the highest and the lowest grain yield were observed in CT and ZT, respectively (Fig. 1B). It has been shown that heavy residues of irrigated crops left on the soil surface (e.g. in ZT) reduced wheat kernel weight and/or grain yield due to poor crop establishment, disease transmission and nitrogen immobilization (Bahrani et al., 2013).

Wheat germination percentage was influenced by tillage systems in maternal environmental; so that the highest germinated seeds were obtained from CT treatments, while seed germination of MT and ZT significantly were lower. There were no significant difference between germination percentage of wheat seed in MT and ZT (Fig. 1A). Germination rate also was greater in CT that had no significant with MT; whereas ZT treatment had the lowest germination rate (Fig. 2B). Germination and seedling establishment are critical phases in the life cycle of many plant species (Biere et al., 1991). Strong effects of maternal environment during seed development percentage and rate of germination have been reported for a variety of environmental factors; however there is no report studying tillage systems. Bieret al. (1991) found that maternal effects predominated in the determination of progeny seed size and germination characteristics. Enhanced germination rate and percentage in CT could be associated to greater seed storage. Vera (1997) reported that heavy seeds germinated earlier and showed better germination, which can be due to bigger storage reserves of these seeds.

The greater seedling growth was achieved in CT and had no significant difference with MT; so that the highest radicle and plumule was observed in CT and MT, while Zero tillage had the lowest radicle and plumule (Fig. 2). Furthermore, vigor index had similar trend, so the highest and the lowest vigor index was found in CT and ZT, respectively (Fig. 3). It has been known that greater radicle length might be due to greater seed size. Seed size also affects other seedling growth such as plumule length, root and shoot dry weight (Sawan, 1999).

The results indicated that conservation tillage systems including MT and ZT had negative effect on produced seed, so the seed developed in such systems had lower germination percentage and rate. Thus, this impact should be added to other disadvantages of conservation tillage systems; which consisted low temperature in soil surface, outbreaks of weeds and diseases. Reduced seed germination and seedling growth as affected by conservation tillage systems could be due to lower seed size (shown in our study), or higher level of inhibition components. More studies for understand this probabilities is needed.
Table 1. Some physico-chemical properties of the field experimental soil

<table>
<thead>
<tr>
<th>EC (dS m⁻¹)</th>
<th>pH</th>
<th>OM (%)</th>
<th>N (%)</th>
<th>P (mg kg⁻¹)</th>
<th>K (mg kg⁻¹)</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.62</td>
<td>7.04</td>
<td>1.03</td>
<td>0.25</td>
<td>13.45</td>
<td>693</td>
<td>Silty loam</td>
</tr>
</tbody>
</table>

Figure 1. Seed weight (A) and grain yield (B) as affected by three tillage systems in field

Figure 2. Germination percentage (A) and rate (B), plumule and root length (C) and vigor index (D) as affected by three tillage systems in maternal environment

References