IRANIAN WINTER WHEAT'S (*Triticum aestivum* L.) INTERFERENCE WITH WEEDS: I. GRAIN YIELD AND COMPETITIVE INDEX

Mohammad Ali Baghestani¹, Eskandar Zand and Saeid Soufizadeh

ABSTRACT

Competitive ability of Iranian winter wheat genotypes against weeds were studied in three separate experiments during 1999 to 2002 growing seasons at Plant Pest and Disease Research Institute, Karaj. All experiments were conducted in a randomized complete block design with factorial arrangement of treatments and four replications. In the first experiment, 12 wheat genotypes were studied under weed free and natural spectrum of weed infestation. In the second and third experiments, six genotypes of most and least competitive ability in the first experiment were selected and grown in the absence and presence of *Avena ludoviciana* (wild oat) at 80 plants m⁻² and *Goldbachia laevigata* at 30 plants m⁻². Results of first experiment showed significant differences in weed suppressive ability among wheat genotypes. According to the results of this experiment 6618, M-75-15 and M-75-13 genotypes were selected as the most, and Alamout, Qafqaz and M-75-5 were selected as the least competitive genotypes. Grain yield of 6618 genotype not only did not decrease under weed infestation but also increased. On the other hand, this genotype caused the highest reduction in weed biomass compared with other genotypes, indicating that it may be considered as both a weed tolerant and a weed suppressive crop. In second and third experiments, 6618 and M-75-5 genotypes were also selected as the most and least competitive genotypes, respectively. Overall results of the three years of experiment show that the stability of CI in 6618 genotype was more than all the others and it can be introduced as a genotype having high competitive ability against weeds especially *A. ludoviciana* and *G. laevigata*. In contrast, competitive ability of M-75-5 genotype compared to other genotypes was the least but stable. The results of these experiments also revealed that wheat competitive ability depend heavily on the range of genotypes used and the magnitude of the environmental and genotypexenvironment variation.

**Key words:** Competitive ability, *Goldbachia laevigata*, wild oat.

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INTRODUCTION

Yield loss due to weed competition in Iranian wheat fields has been reported to be about 21% (Montazeri et al. 2005). Over the last three decades wheat production in many parts of the world has relied heavily on herbicide as the primary method of weed management (Montazeri et al. 2005). But environmental safety concerns, increasing occurrence of herbicide resistance in weed species, and the need to reduce input costs have caused a growing awareness that intensive use of chemical weed control does not fit well in sustainable agriculture systems (Wyse, 1994). Pest tolerant improved crops would be a useful tool to reduce dependence on pesticides. Although insect- and disease-tolerant crops have long been selected and used in crop production systems, research efforts have only recently focused on crop tolerance to weeds (Ngouajio et al. 2001; Lemerle et al. 2001). If a crop cultivar can tolerate weeds, it may reduce the need for synthetic herbicide (Gealy et al. 2003), allow the use of less costly and more environmentally sound herbicides (Wicks et al. 1994; Pester, 1991), decrease the number of cultivations, or improve yield stability in weedy fields (Wyse 1994; Lindquist and Mortensen, 1998).

Planting a more competitive wheat cultivar has been suggested as a cultural practice to suppress weed growth (Ogg and Seefeldt, 1999). Researchers have shown that differences in weed competitiveness of crop cultivars are the rule rather than the exception (Callaway, 1992). There are many crops with examples of cultivar tolerance to weed, including soybean (Burnside, 1972; Bussan et al. 1997), rice (Gealy et al. 2003; Gibson et al. 2003; Ni et al. 2000), canola (Zand and Beckie, 2002), cotton (Bridge and Chandier, 1988), tomato (Ngouajio et al. 2001) and wheat (Callaway, 1992; Baghestani et al. 1999; Lemerle et al. 2001; Ogg and Seefeldt, 1999; Zand et al. 2001). The competitive ability of a crop can be measured either as suppression of weed growth and seed production by the crop (competitive index), or as crop yield loss, which is the ability of the crop to tolerate weed presence and maintain grain yield, 'crop tolerance' (Goldberg, 1990; Jordan, 1993). Jordan (1993) stated that a competitive cultivar should maintain its yield when competing with weeds (low weed interference) and at the same time, reduce the growth and seed production of the weeds against which it is competing. In the study conducted by Challaiah et al. (1986), the most competitive winter wheat cultivar (Turkey) had the smallest percent yield reduction when competing against downy brome (Bromus tectorum L.) and reduced the biomass of the downy brome more than other less competitive cultivars. Lemerle et al. (2001) have determined that crop competitive ability may be negatively associated with its yield, particularly under weed-free environment. In UK, wheat varieties that produced the greatest grain yield in weed-free plots were the most severely affected by weed competition (De Lucas and Froud-Williams, 1975). In contrast, in Australia no relationship was observed between weed-free yield and percent yield loss (Lemerle et al. 1996a, 2000; Cousens and Mokhtari, 1998; Gill and Coleman, 1999; 2000). But although there have been previous studies of varietal differences in competitiveness of wheat, including attempts to correlate morphology with crop yield reduction (Moss, 1985; Challaiah et al. 1986; Wicks et al. 1986; Lemerle et al. 1996a), these have examined only a small part of the available gene pool.
Few studies have been conducted to determine the competitiveness of Iranian winter wheat cultivars against weeds. Our objectives were to investigate the interference between Iranian winter wheat cultivars and weeds.

MATERIALS AND METHODS

A three year experiment (one preliminary and two supplementary) was conducted during 1999 to 2002 growing seasons, at Plant Pest and Disease Research Institute, Karaj (35° 59' N 52° 60' E, 1160 masl), Iran on a sandy clay soil. Each year the experimental area was plowed and followed by two disking in the fall to prepare the seedbed for planting. The mean annual rainfall is 250mm and the climate is arid. Long term mean, maximum and minimum annual temperatures are 13.7°C, 41°C and −21.7°C, respectively. All the experimental fields were fallowed during previous year.

1. Preliminary experiment (1999-2000 growing season)

The experiment was laid out in a randomized complete block design with a factorial arrangement and replicated four times. Treatments consisted of 12 wheat genotypes (Navid, Qafqaz, Niknejad, Mahdavi, Marvdasht, Alamout, M-75-17, M-75-5, M-75-13, 6517, and 6618), each kept under weedy and weed free conditions. Naturally occurring weed populations were used in the experiment. Weed species in order of dominance were wild oat (A. ludoviciana), G. laevigata, brome grass (Bromus sp.), wild rye (Secale cereale), and ryegrass (Lolium rigidum). But, A. ludoviciana and G. laevigata comprised about 90 percent of the total weed population. Ammonium phosphate and urea were applied at rates of 150 and 100 kg ha⁻¹ based on soil analysis, respectively, prior to seeding. Top dress of urea was applied at tillering and heading stages at rate of 50 kg ha⁻¹ at both stages.

The wheat genotypes seeds were obtained from Cereal Research Section of Iranian Seed and Plant Improvement Institute, Karaj, Iran. Wheat was sown at a density of 400 viable seed m⁻². Each plot consisted of four rows, 9 m in length with a 0.6 m interrow spacing, and each planted to two rows of wheat on Oct 22, 1999. A full irrigation, and pest and disease program were employed so that at no time during growing season these factors appear to constrain yield.

The crop and weed were harvested on 5 June 2000. Harvested area in each plot was 2.4 m² (2 m of the 4 center rows). Harvested materials were separated into weed and wheat, and weed biomass, wheat biomass and grain yield were determined. Percent wheat grain yield reduction was also calculated as the proportion of wheat grain yield under weedy condition to the same amount under weed free condition, minus one and multiply by 100. Competitive ability of the wheat cultivars with weeds were calculated from the following equation (Challaiah et al. 1986; Zand et al. 2001):

$$CI = \frac{Var_i}{Var_{mean}} / \frac{Weed_i}{Weed_{mean}}$$

Where $Var_i$ is the yield of genotype $i$ in the presence of weed, $Var_{mean}$ is the mean yield of all genotypes in the presence of weed, $Weed_i$ is the weed biomass related to genotype $i$ and $Weed_{mean}$ is the mean weed biomass at mixture with all genotypes.
Finally, three genotypes with high competitive ability and three genotypes with low competitive ability were selected and used for the supplementary experiments.


Due to the results from the preliminary experiment, M-75-15, M-75-13 and 6618 were selected as genotypes with high competitive ability and Alamout, Qafqaz and M-75-5 were selected as low competitive ability genotypes, and were applied for the supplementary experiments.

Plots were fertilized with 150 kg ha\(^{-1}\) ammonium phosphate and 50 kg ha\(^{-1}\) potassium sulfate prior to seeding. Nitrogen fertilizer was applied as urea at the same times and rates as the preliminary experiment. Wheat seeding procedure, rate and planting pattern were similar to that of the preliminary experiment. A. ludoviciana and G. laevigata (the two dominant weed species in the preliminary experiment) seeds were sown simultaneously with wheat and later thinned to 50 and 30 plants per m\(^2\). It should be mentioned that seed viability of A. ludoviciana and G. laevigata were 32 and 80\%, respectively. Planting dates were September 8 in 2000, and September 5 in 2001. During the growing season, all weed species except G. laevigata and A. ludoviciana were hand weeded.

The experiments were conducted using a factorial arrangement in a randomized complete block design replicated four times. Experimental treatments consisted of 6 wheat cultivars and 2 levels of weed species (Goldbachia laevigata and Avena ludoviciana). Moreover, two additional plots of pure stands of wheat, G. laevigata, and A. ludoviciana were included in the experimental treatments.

Final harvest was performed on June 7 and June 22 in 2001 and 2002, respectively. Harvest area was 2.4m\(^2\) (1m long of 2nd and 3rd rows). Harvested plants were separated into wheat and weed, oven-dried at 75\(^\circ\)C for 48 hours to obtain uniformity in moisture and weighed. Grain yield was also measured. In these experiments the same methodology was used for measuring weed biomass, grain yield, wheat biomass and competition index as the preliminary experiment.

All data were analyzed using PROC GLM procedure in SAS software (SAS Institute, 1996). Means separation test was performed using Duncan multiple range test (DMRT). Since the interaction between experimental treatments and year of experiment was significant in the supplementary experiment, data were analyzed separately for each location.
RESULTS AND DISCUSSION

1. Preliminary experiment (1999-2000 growing season)

Weed biomass was significantly affected by wheat genotypes (Table-1). Maximum weed biomass was obtained from the plots in which M-75-5 genotype was planted. In contrast, the plot planted by 6618 genotype produced the least weed biomass but was not significantly different with those of M-75-13, Mahdavi and Niknejad genotypes (Table-1). Also, significant differences existed among wheat cultivars under weed free and weedy conditions (Table-1). Under weed-free condition, the genotypes Alamout and Qafqaz produced the highest and lowest grain yields, respectively. But under competition with weeds, Alamout ranked amongst the lowest yielding wheat genotypes, indicating that this genotype is not a good competitor of weeds. The highest yielding genotype under weed infested condition was 6517, which was significantly different with all other genotypes. Our finding is in agreement with those of De Lucas and Froud-Williams (1976) in UK who found that wheat varieties produced the highest grain yield in weed free plots were the most severely affected by weed competition. Nonetheless, Lemerle et al. (2001) stated that the degree of association between wheat competitive ability and weed free yield depend heavily on the range of genotypes used and the magnitude of the environmental and genotype*environment variation. Percent grain yield reduction was the highest in Alamout (21%) compared to other cultivars (Table 1). This shows that Alamout is not a weed tolerant genotype. Van Heemst (1985) reported that mean wheat yield loss from weeds was 25%. In his investigation on the competitive ability of 10 wheat cultivars, Challaih et al. (1986) reported that yield losses between the varieties ranged from 9 to 21% at one site to 20-41% at the other. Surprisingly, grain yield of 6618, 6517, M-75-13, M-75-15, and Niknejad genotypes not only did not decrease under weed competition but also increased in this condition (Table-1). This is perhaps because under weed-free condition, sufficient availability of resources like light and nutrients cause wheat to produce more tillers resulting in a consequent source limitation in reproductive stage, an increase in tiller infertility and poor grain filling (Hay and Walker, 1989). But all other cultivars showed lower grain yield under weed infested condition, the highest reduction belonged to Alamout cultivar. But under weedy condition and due to the interplant competition, although fewer tillers are produced but the plant is capable to fully develop their tillers.

Significant differences were observed among CI of different wheat genotypes (Table-1). The genotype 6618 had the highest CI significantly different from all other genotypes. This can be attributed to the high grain yield of this genotype under competition with weeds. This is accompanied by very low weed biomass in the presence of this genotype, which shows the genotype capability to suppress weeds successfully. In the study conducted by Challaih et al. (1986), the most competitive winter wheat cultivar (Turkey) had the smallest percent yield reduction when competing against downy brome (Bromus tectorum L.) and reduced the biomass of the downy brome more than other less competitive cultivars. Goldberg (1990) has stated that a competitive crop can be defined as either a crop that maintains its yield well in the presence of weeds (tolerance to weed pressure) or as one that is able to reduce weed growth significantly (weed suppressive ability). As a result this genotype may be considered as both a weed tolerant and a weed suppressive crop. The genotypes M-75-5, Qafqaz, 6517, Navid and Alamout had the lowest CI, respectively, and there were no significant differences among
these genotypes in this respect (Table-1). In fact, these genotypes could not reduce weed biomass considerably, indicating their poor suppressive ability. As observed, although the genotype 6517 had a yield increase under weed infested condition (weed tolerant crop) but it was not able to reduce weed biomass compared to other genotypes which is consistent with findings of De Lucas and Froud-Williams (1976). Totally, wheat genotypes used in the preliminary experiment were ranked according to their CI into four groups: (i) genotypes with high grain yield and high weed biomass (6517, Marvdasht, Navid); (ii) genotypes with high grain yield but low weed biomass (M-75-13, 6618, M-75-15); (iii) genotypes with low grain yield but high weed biomass (M-75-15, Qafqaz, Alamout); and (iv) genotypes with low grain yield and low weed biomass (M-75-17, Mahdavi, Niknejad).

Table-1. Weed biomass, wheat grain yield under weedy and weed free conditions, percent grain yield reduction and competitive index in the preliminary experiment (1999-2000).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Weed biomass (g m⁻²)</th>
<th>Grain yield weed free (kg ha⁻¹)</th>
<th>Grain yield infested (kg ha⁻¹)</th>
<th>Grain yield reduction (%)</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alamout</td>
<td>664d*</td>
<td>5337a</td>
<td>4178e</td>
<td>-21.70</td>
<td>0.77ef</td>
</tr>
<tr>
<td>Marvdasht</td>
<td>576d</td>
<td>5113b</td>
<td>4859c</td>
<td>-4.96</td>
<td>1.02de</td>
</tr>
<tr>
<td>Navid</td>
<td>806c</td>
<td>5112b</td>
<td>4801c</td>
<td>-6.09</td>
<td>0.74ef</td>
</tr>
<tr>
<td>M-75-13</td>
<td>314ef</td>
<td>4992bc</td>
<td>5332b</td>
<td>+6.79</td>
<td>2.18b</td>
</tr>
<tr>
<td>M-75-15</td>
<td>380e</td>
<td>4925cd</td>
<td>5153b</td>
<td>+4.62</td>
<td>1.68c</td>
</tr>
<tr>
<td>6517</td>
<td>1044b</td>
<td>4921cd</td>
<td>5582a</td>
<td>+13.42</td>
<td>0.66ef</td>
</tr>
<tr>
<td>M-75-5</td>
<td>1258a</td>
<td>4852cde</td>
<td>4471d</td>
<td>-7.85</td>
<td>0.43f</td>
</tr>
<tr>
<td>Niknejad</td>
<td>287ef</td>
<td>4745de</td>
<td>4905c</td>
<td>+3.34</td>
<td>2.10bc</td>
</tr>
<tr>
<td>Mahdavi</td>
<td>289ef</td>
<td>4723ef</td>
<td>4697cd</td>
<td>-0.56</td>
<td>2bc</td>
</tr>
<tr>
<td>6618</td>
<td>197f</td>
<td>4671ef</td>
<td>5349b</td>
<td>+14.5</td>
<td>3.36a</td>
</tr>
<tr>
<td>M-75-17</td>
<td>430e</td>
<td>4557f</td>
<td>4486d</td>
<td>-1.56</td>
<td>1.32d</td>
</tr>
<tr>
<td>Qafqaz</td>
<td>916bc</td>
<td>4072g</td>
<td>3992e</td>
<td>-1.97</td>
<td>0.54f</td>
</tr>
</tbody>
</table>

*In each column, means followed by same letter(s) do not differ significantly by DMRT at α₀.₀₅.

2. Supplementary experiments (2000-2001 and 2001-2002 growing season)

Genotype 6618 yielded the most under weed free condition in both years of experiment (Table-2). Significant differences existed between this genotype and the others in this respect in 2000-2001. However, there were not any significant differences in grain yield between this genotype, and Alamout, M-75-13 and M-75-15 in 2001-2002. The lowest grain yield under weed free condition belonged to Qafqaz in both years (Table-2). In 2000-2001, genotype 6618 also produced the highest grain yield in competition with G. laevigata and A. ludoviciana (Table-2). However, the difference was only significant with M-75-15 and M-75-5 in case of G. laevigata, and with M-75-5 only under A. ludoviciana competition. In 2001-2002, the results were a little different. Alamout and M-75-15 yielded the most in competition with G. laevigata and A.
ludoviciana, respectively, although they did not significantly differ with 6618 genotype (Table-2). Under weed infested condition, M-75-5 and Qafqaz produced the lowest grain yield in 2000-2001 and 2001-2002, respectively. As it is observed, genotype 6618 acted well in the supplementary experiments as in the preliminary experiment. This indicates that this genotype could show a good and stable performance in all experimental years in this respect. Similarly, genotype Qafqaz which ranked the last in the preliminary experiment also showed a weak performance in the supplementary experiments, indicating its poor competitive ability. Our findings are in agreement with Australian data, which showed a strong positive correlation between weed free grain yield and weedy yield (Cousens and Mokhtari, 1998; Gill and Coleman, 1999; Lemerle et al. 2001). A general comparison among wheat varieties used in this experiment reveals that there is genetic variability for competitiveness in Iranian winter wheat genotypes which can be considered as a good genetic pool to increase competitive ability of less competitive genotypes.

In 2000-2001, Alamout’s CI in the presence of both weed species was the highest and significantly differed with those of all other genotypes except M-75-13 and 6618 in A. ludoviciana and G. laevigata infestation, respectively (Table-3). Although being lower than Alamout, 6618 also had an acceptable CI in this year. But in 2001-2002, 6618 genotype possessed the highest CI, although not significantly different from M-75-15 and Alamout under A. ludoviciana infestation (Table-3). As observed, Alamout was ranked third after 6618 and M-75-15 in the presence of G. laevigata. While being high, the stability of 6618 CI in the presence of this weed was more than that of Alamout and M-75-15, a more desirable case in selecting highly competitive genotypes. Slaper and Kernich (1996) stated that yield stability is an important objective of agricultural progress, should be considered in researches. The lowest CI in the supplementary experiments belonged to M-75-5 except in the presence of A. ludoviciana in 2000-2001 under which M-75-15 had the lowest CI (Table-3). This result agrees with the results of the preliminary experiment in which M-75-5 and Qafqaz possessed the lowest CI (Table 1). Like the present study, many other researchers have documented differential competitive ability against weeds among existing wheat varieties in the experiments (Challaiah et al. 1986; Blachshaw, 1984; Lemerle et al. 1996a; Olesen et al. 2004).

According to the above results and like the preliminary experiment, genotype 6618 which yielded high both under weed-free and weed infested conditions, had low A. ludoviciana and G. laevigata biomass, and high CI can be introduced as a highly competitive genotype. This genotype maintained its high CI both in the preliminary and supplementary experiments. On the other hand, although Alamout showed low yield under weed infested condition, high weed biomass and low CI in the preliminary experiment (Table 1), but it acted better in the supplementary experiments (Tables 2, 3) and possessed high CI in the presence of both weed species. Overall results of the three years of experiment (Tables 1, 3) show that the stability of CI in 6618 genotype was more than all the others and it can be introduced as a genotype having high competitive ability against weeds especially A. ludoviciana and G. laevigata. These findings may indicate that 6618 genotype has more adaptation to the environmental conditions of the experimental location than Alamout. Lemerle et al. (2001) has strongly emphasized on the importance of the genotype×environment interaction on wheat and local adaptation to optimize wheat competitive ability. The reason may be attributed some extent to the
The genotypes M-75-15 and M-75-13 that were selected as genotypes having high competitive ability in the preliminary experiment, acted instable against A. ludoviciana and G. laevigata in the supplementary experiments and showed variations in their grain yield and CI under weed infestation. According to these results, a correct conclusion cannot be made for these genotypes. This also shows the great effect of season on wheat competitive ability against weeds. Cousins and Mokhtari (1998) reported that genetic variation in wheat competitive ability is often confounded with effects of site and season, and therefore ranking of current varieties is inconsistent between environments.

Qafqaz was introduced as a genotype with low competitive ability in the preliminary experiment. This genotype along with M-75-5 maintained this characteristic in the supplementary experiments too and always ranked the lowest CI against the two studied weed species. Results obtained in the supplementary experiments showed that Qafqaz had a higher yield in the presence of A. ludoviciana than its weed-free treatment (Table-2), while M-75-5 had always lower yield in A. ludoviciana and G. laevigata infested treatments than its weed-free condition. In other words, the latter genotype better maintained its low competitive ability through the experiments.

In total, the genotype 6618 can be introduced as the most competitive genotype in this study. In contrast, competitive ability of M-75-5 genotype compared to other genotypes was the least but stable. It is noteworthy to mention that differences in wheat competitive ability existed in the present study, but ranking for competitive ability is often confounded with environmental factors, making recommendations for farmers unreliable. To achieve better result, better understanding about morphological and physiological traits contributing wheat competitive ability is of most help.

### Table-2. Grain yield of wheat genotypes under weed free A. ludoviciana and G. laevigata infested conditions in supplementary experiments.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Weed free (kg ha⁻¹)</th>
<th>With A. ludoviciana (kg ha⁻¹)</th>
<th>With G. laevigata (kg ha⁻¹)</th>
<th>Weed free (kg ha⁻¹)</th>
<th>With A. ludoviciana (kg ha⁻¹)</th>
<th>With G. laevigata (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6618</td>
<td>4270a</td>
<td>3381a</td>
<td>3489a</td>
<td>4896a</td>
<td>3888a</td>
<td>4654a</td>
</tr>
<tr>
<td>Alamout</td>
<td>3782b</td>
<td>3310a</td>
<td>3079ab</td>
<td>4258ab</td>
<td>4168a</td>
<td>4041ab</td>
</tr>
<tr>
<td>Qafqaz</td>
<td>2969d</td>
<td>3377a</td>
<td>3216ab</td>
<td>3457c</td>
<td>2715b</td>
<td>3457b</td>
</tr>
<tr>
<td>M-75-13</td>
<td>3339c</td>
<td>3372a</td>
<td>3464a</td>
<td>4300ab</td>
<td>3704a</td>
<td>3752b</td>
</tr>
<tr>
<td>M-75-15</td>
<td>3629b</td>
<td>2944b</td>
<td>3175ab</td>
<td>4389ab</td>
<td>3834a</td>
<td>4746a</td>
</tr>
<tr>
<td>M-75-5</td>
<td>3503bc</td>
<td>2685b</td>
<td>2927b</td>
<td>3972bc</td>
<td>2743b</td>
<td>3483b</td>
</tr>
</tbody>
</table>

*In each column, means followed by the same letter do not differ significantly by DMRT at α₀.₀₅.*
Table 3. Competitive index of wheat genotypes in the presence of A. ludoviciana and G. laevigata in the supplementary experiments.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6618</td>
<td>1.58b</td>
<td>1.31ab</td>
<td>1.52a</td>
<td>7.9a</td>
</tr>
<tr>
<td>Alamout</td>
<td>2.09a</td>
<td>1.67a</td>
<td>1.28a</td>
<td>1.1cd</td>
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<tr>
<td>Qafqaz</td>
<td>0.79d</td>
<td>0.82cd</td>
<td>0.82b</td>
<td>0.55d</td>
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<td>1.86ab</td>
<td>1.05bc</td>
<td>0.81b</td>
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<td>0.42e</td>
<td>1.01c</td>
<td>1.29a</td>
<td>1.6bc</td>
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<tr>
<td>M 75-5</td>
<td>1.22c</td>
<td>0.67d</td>
<td>0.77b</td>
<td>0.43d</td>
</tr>
</tbody>
</table>

*In each column, means followed with same letter do not differ significantly by DMRT at α0.05.

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