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Wheat-Weed Competition for Nutrients in Kahramanmaraş, Turkey

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Abstract: This study was carried out to determine nutrient competition between wheat and three most commonly found weed species in wheat fields of Kahramanmaraş City, Turkey. The weeds studies were animated oat (*Avena sterilis* L.), darnel ryegrass (*Lolium temulentum* L.) and wild mustard (*Sinapis arvensis* L.). The measured nutrients were P, K, Ca, Mg, Na, Fe, Mn, Zn and Cu. The results of paired t-test statistics showed that animated oat plant leaves removed significantly higher concentrations of Ca and Na and lower concentrations of P and Fe compared with accompanying wheat plant leaves. Wild mustard was better competitor for Ca, Mg, Na, Fe and Zn compared to wheat plants. Manganese was the only nutrient for which wheat was more successful for the uptake. Darnel ryegrass removed significantly higher levels of Ca, Na and Fe compared with the accompanying wheat plants.

Key words: Wheat, weed, competition, nutrients

INTRODUCTION

There are controversial reports regarding wheat-weed competition for nutrients. Some researchers found that weeds are more efficient for the uptake of plant nutrients compared to crops (Appleby *et al*., 1976; Hoveland *et al*., 1976). Soil fertility effect on wheat-weed competition with a special emphasize on N has been studied (Lintell-Smith *et al*., 1992; Jørnsgard *et al*., 1996). Nalewaja and Arnold (1970) reported that weeds become more competitive with wheat as fertility improves. Blackshaw *et al*. (2004) studied effect of P fertility on plant competition between wheat and 22 weed species and found that 17 weed species out of 22 increased shoot biomass and took higher levels of P compared to wheat with increasing levels of P. They also found that at low P fertility only 4 weed varieties were superior to wheat crop for P uptake. Yin *et al*. (2005) also mentioned that weed community composition w as mainly affected by soil P availability.

Information on crop-weed competition for nutrients is crucial for developing fertilizer management strategies as components of Integrated Weed Management (IWM) programs. An IWM system should enhance the competitive ability of the crop to suppress weed growth (Swanton and Weise, 1991). Grassy weeds animated oat (*Avena sterilis* L.) and darnel ryegrass (*Lolium temulentum*) and broad leaf weed wild mustard (*Sinapis arvensis* L.) are the most vigorous competitors in wheat fields in Kahramanmaraş, Turkey (Tursun, 2002). This study was carried out to determine nutrient competition between wheat and the three most commonly found weed species in wheat fields of Kahramanmaraş City, Turkey.

MATERIALS AND METHODS

Soil and plant samples of this study were collected from wheat fields surrounding Kahramanmaraş City, Turkey. Wheat and the accompanying weed samples along with soil samples were collected at milk development stage of wheat where weed infestation was roughly 10-20 m^{-2}. Ten weed and wheat samples were collected at each sampling point. Soil samples were taken using a hand probe to 20 cm soil depth and were composites of four cores within a 1 m radius.

The study materials consisted of 10 weed, wheat and soil samples for each weed studied and, therefore, 30 weed, wheat and soil samples were collected for the study.

The soil samples were dried and crushed to pass 2 mm sieve. The samples were analyzed for ammonium acetate extractable K, Ca, Mg and Na (Helmke and Sparks, 1996; Suarez, 1996), organic matter by wet oxidation (Nelson and Sommers, 1996), Olsen phosphorus (Kuo, 1996), DTPA-extractable Fe, Zn, Mn and Cu (Lindsay and Norvell, 1978), soluble salts (Rhoades, 1996), pH (Thomas, 1996), $CaCO_3$ (Loeppert and Suarez, 1996) and percent saturation.

Plant samples were digested with $HNO_3/HClO_4$ mixture for P, K, Ca, Mg, Na, Fe, Mn, Zn and Cu (Jones

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and Case, 1990). Vanadomolybdophosphoric acid method was used for total P (Kuo, 1996) and the total concentrations of K, Ca, Mg, Na, Fe, Mn, Zn and Cu were determined using atomic absorption spectrophotometer.

Statistics: Differences among soil samples collected for each weed type were compared using ANOVA statistics. Competition between wheat and the accompanying weed type for nutrients was evaluated with paired t-test statistics (SPSS, 1998).

RESULTS

Usually wheat fields infested with animated oat also had wild mustard infested areas and soil samples for these two weeds were collected from same fields. Therefore; all the soil properties measured for soils of animated oat and wild mustard were not statistically different (Table 1). Both soils had clay texture based on percent saturation value, slightly alkaline pH, low salt content, low and very low lime, medium organic matter, very high exchangeable, Ca, Mg and K, low Olsen P, adequate amounts of available Mn, Zn and Cu and finally low Fe. Soil samples of darnel ryegrass, on the other hand, had clay loam texture, slightly alkaline pH, low salt content, high lime, medium organic matter, very high AAE-Ca, adequate AAE-Mg, high AAE-K, high Olsen P, low DTPA-Fe and adequate amounts of DTPA extractable Mn, Zn and Cu (Table 1). Adequacy of plant nutrients in soils were evaluated based on critical values reported by Lindsay and Norvell (1978) and Rehm *et al.* (1995).

Soil samples of darnel ryegrass showed significant differences for some soil properties compared with the soil samples collected with the other two weeds. Darnel ryegrass soils had significantly higher lime, AAE-Ca, Olsen P and DTPA extractable Zn and Cu but lower percent saturation and AAE-Mg compared with soils samples of animated oat and wild mustard.

Animated oat (*Avena sterilis* L.)-wheat competition: The results of paired t-test statistics (Table 2) showed that animated oat plant leaves removed significantly higher concentrations of Ca and Na compared with accompanying wheat plant leaves. Leaf sample analyses, however, indicated that wheat had higher P and Fe content than animated oat plant. There were no significant differences between animated oat and wheat plants for uptake of the nutrients such as K, Mg, Cu, Zn and Mn. Anaç *et al.* (1987) also studied wheat-wild oat competition and found that wheat removed higher levels of P and Zn and lower levels of K, Ca, Mg, Fe and Mn compared to wild oat plants. Tepe *et al.* (1997) reported that weeds were better competitors for the nutrients with the exception of P compared to wheat. These findings indicate that P fertility and Ca availability of soils may affect wheat-animated oat competition.

Table 1: ANOVA of the measured properties of soil samples collected with different weed-wheat samples

	Soils of animated oat	Soils of wild mustard	Soils of darnel ryegrass
% Saturation	74.38a	74.66a	64.78b
pH	7.23ns	7.15ns	7.40ns
Soluble salts	0.13ns	0.13ns	0.13ns
% $CaCO_3$	1.21b	0.71b	24.64a
Org. Matter (%)	2.23b	2.51ab	2.85a
AAE-Ca	4041.71b	4023.85b	7744.07a
AAE-Mg	1969.29a	2014.14a	418.19b
AAE-K	405.40ns	428.56ns	297.44ns
AAE-Na	33.15a	27.10ab	20.27b
Olsen P	5.24b	6.47b	12.47a
DTPA-Fe	1.03ns	1.18ns	0.98ns
DTPA-Mn	34.36ns	35.53ns	21.23ns
DTPA-Zn	1.00b	1.09b	1.69a
DTPA-Cu	0.58b	0.42b	0.90a
Number of samples	10	10	10

Table 2: Paired t-test statistics of the measured nutrients for leaf samples of animated oat and wheat

	Animated oat	Wheat	t-value	p-value
K (%)	2.22±0.37	2.01±0.20	1.912	0.088
P (%)	0.18±0.04	0.23±0.04	-5.508	0.000
Ca (%)	0.43±0.05	0.37±0.05	3.02	0.015
Mg (%)	0.43±0.15	0.45±0.16	-1.585	0.147
Na (%)	0.46±0.48	0.02±0.01	2.910	0.017
Fe (mg kg^{-1})	18.35±5.77	28.94±18.28	-2.387	0.041
Mn (mg kg^{-1})	111.42±16.45	121.66±51.50	-0.686	0.510
Zn (mg kg^{-1})	21.03±5.27	24.71±2.63	-2.091	0.066
Cu (mg kg^{-1})	8.30±4.18	7.64±3.31	0.666	0.522

Table 3: Paired t-test statistics of the measured nutrients for leaf samples of wild mustard and wheat

	Wild mustard	Wheat	t-value	p-value
K (%)	1.97±0.21	2.09±0.23	-1.295	0.227
P (%)	0.28±0.04	0.28±0.09	0.225	0.827
Ca (%)	2.55±0.52	0.29±0.05	14.04	0.000
Mg (%)	0.95±0.39	0.38±0.06	5.216	0.001
Na (%)	0.035±0.024	0.013±0.003	2.687	0.025
Fe (mg kg^{-1})	56.73±30.38	24.59±8.41	3.289	0.009
Mn (mg kg^{-1})	94.43±21.55	145.42±47.34	-2.486	0.019
Zn (mg kg^{-1})	30.29±4.04	24.07±5.95	3.864	0.004
Cu (mg kg^{-1})	10.94±3.27	10.35±3.17	0.679	0.514

Wild mustard (*Sinapis arvensis* L.)-wheat competition: Leaf analyses showed that wild mustard is better competitor for Ca, Mg, Na, Fe and Zn than accompanying wheat plants (Table 3). Calcium content of wild mustard leaves were almost nine fold higher than that of wheat plants. Manganese was the only nutrient for which wheat was more successful for the uptake. Wild mustard and wheat plant leaves removed similar quantities of K, P and Cu. Anaç *et al.* (1987) reported that wild mustard plants were more efficient for the uptake of Ca, K and Fe compared to wheat. Overall, divalent basic cations Ca and Mg and micronutrients Fe and Zn are the key nutrients for wheat-wild mustard competition.

Table 4: Paired t-test statistics of the measured nutrients for leaf samples of darnel ryegrass and wheat

	Darnel ryegrass	Wheat	t-value	p-value
K (%)	2.06±0.25	1.97±0.21	1.407	0.193
P (%)	0.16±0.06	0.18±0.06	-1.273	0.235
Ca (%)	1.46±0.43	1.04±0.14	3.23	0.01
Mg (%)	0.25±0.03	0.25±0.03	-0.653	0.530
Na (%)	0.06±0.013	0.013±0.005	3.944	0.003
Fe (mg kg^{-1})	21.47±5.08	17.60±3.62	2.626	0.028
Mn (mg kg^{-1})	55.57±21.65	63.00±30.26	-0.647	0.534
Zn (mg kg^{-1})	23.20±2.54	20.96±4.25	1.448	0.182
Cu (mg kg^{-1})	9.23±1.39	8.17±1.71	1.309	0.223

Darnel ryegrass (*Lolium temulentum* L.)-wheat competition: Darnel ryegrass removed significantly higher levels of Ca, Na and Fe compared with the accompanying wheat plants (Table 4). Plant uptake of the other nutrients was similar.

DISCUSSION

There are limited number of studies regarding wheat-weed competition for nutrients. Research on nutrient competition generally focused on effect of N and P fertility on weed composition (Lintell-Smith *et al*., 1992; Jørnsgard *et al*., 1996; Blackshaw *et al*., 2004). Few papers studied competition for other macro and micro nutrients (Anaç *et al*., 1987; Tepe *et al*., 1997). The results of our study reveal that generally weeds remove similar or higher concentrations of plant nutrients compared to wheat plants. All the weeds studied removed significantly higher concentrations of Ca and Na compared to wheat suggesting that Ca is very important plant nutrient for weeds. Wheat-animated oat competition for P looks promising to develop fertilizer management strategies to suppress weed growth. Significant differences in wheat and weeds for micronutrients especially for Fe show that the wheat varieties which are more efficient at uptake of Fe may have some advantageous for weed suppression.

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