International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 12, No. 2, p. 168-175, 2018

RESEARCH PAPER OPEN ACCESS

Functional analysis of competition for resources between durum Wheat (*Triticum turgidum* L. var. *durum*) and two species of weeds *Galiuma parine*, *Fumaria officinalis* in Tiaret, Algeria

Elong Menna Ilham*[1], Larid Mohamed[1], Taibi Khaled[2]

[1]*Laboratory of Biodiversity, Water and Soil conservation, University of Abdelhamid Ben Badis, Mostaganem, Algeria*

[2]*Department of Natural and Life Sciences, University de IbnKhaldoun, Tiaret, Algeria*

Key words: *Triticum turgidum* var. *durum*, *Galiuma parine, Fumaria officinalis*, Competition, Soil biofertility

http://dx.doi.org/10.12692/ijb/12.2.168-175 Article published on February 26, 2018

Abstract

Given the important role of weeds in the biodiversity and biofertilisation of agricultural soils, the main objective of our study is to estimate their impact on the availability of mineral elements in the soil and on the physiological parameters and crop yield of cereals in a semi-arid environment. Thus, two most common weeds are *Galiuma parine* and *Fumaria officinalis* in the study area with 30 and 20 plants/m² respectively were selected and combined with durum wheat (*Triticum turgidum* L. var. *durum*), with the same densities to form three combinations on twelveplotsof 1 m². These are Wheat-*G. aparine* (TtGa), Wheat-*F. officinalis* (TtFo) and Wheat-*G. aparine-F. officinalis* (TtGaFo) compared simultaneously with a pure durum wheat (Tt) treatment. Physical-chemical analyseswere carried out before sowing and during heading stage for the soil and after harvest for the soil and the plant (Tt). The results showed that the presence of both weeds was only beneficial effects on both physiological and wheat yield parameters and on soil fertility with a significant increase of N, P_2O_5, K, Na and CaCO3. Hence, we will have to think of other associations to possibly reduce the input of phytochemicals and move to develop agroecology.

* **Corresponding Author:** Elong MennaIlham ✉ mennailham_elong@yahoo.fr

Introduction

Strategic cereal crop for the majority of world's populations, durum wheat (*Triticum turgidum* L. var. *durum*) belongs to the Gramineae family, which is grown in arid and semi-arid regions of Algeria (Bouthiba *et al.,* 2008). High productivity of this crop requires good weed control in field (Siyahpoosh *et al.,* 2012). But, weed control in recent decades has led to the intensive use of herbicides which has caused serious pollution problems and damage to biodiversity (Zhang *et al.,* 2015). Chemical fertilisers are the main factors to maintain soil fertility, but more application with unsuitable management reduces organic matter availability in soil(Galal and Shehata, 2015) and decline number of weeds (Franke *et al.,* 2009).

Therefore, in many developing countries this has led to restrictions in the use of herbicides and to the promotion of agro ecosystems (Olesen *et al.,* 2004). The presence of weeds in cultivated crops can affect production and quality of the crop by competing for light, moisture, nutrients and space (Ashenafi and Dalga, 2014).

Wheat grain yield loss has been found to be 30% due to weed infestation (Khan *et al.,* 2016). In other hand, many studies indicate that weed diversity may have a positive impact on the functioning of agro-ecosystems (Franke *et al.,* 2009). It is in this sense that our study will be oriented where it will be shown that weeds can become service plants if they are used in a more efficient way.

Materials and methods

Presentation of the study area

The study was carried out at Experimental Farm of Tiaret University (North-West, Algeria). With fallow as a previous cultural, a silty-sandy to sandy-loamy texture, irregular rainfall (275 to 550 mm) and average temperatures ranging from 5 to 36 ° C.

The site is located in a rain-fed and cereal area at an altitude of 956 m, latitude of 35°15'11"N and longitude of 01°14'04"E.

Plant material

Thus, among several species of weeds inventoried in the wheat fields in the study area, our choice for the experiment focused on two species for their abundance: *Galiuma parine* L. and *Fumaria officinalis*. The first is part of the family of Rubiaceae, also called Cleaver (Ramdani *et al.,* 2013). It has a climbing, prostrate or sometimes low and erect habit, and is found in grassy, partially shaded habitats at lower elevations (Marwat *et al.,* 2013). It is relatively resistant to depth of sowing and soil aggregate size (Fahad *et al.,* 2015), can germinate in a wide range of temperatures <5 ° C and> 20 ° C (Mennan and Zandstra, 2005).

The second, common Fumitory belongs to the family of Fumariaceae, annual and perennial plants. It is a small common weed that contains many chemical components such as alkaloids, flavones and phenols (Goetz *et al.,* 2009).And is found in grassy, partially shaded habitats at lower elevations (Marwat *et al.,* 2013).

Experimental protocol

The interest of our work is to design the competitive effect of these two weeds *G. aparine* (Ga) and *F. officinalis* (Fo) on the availability of mineral elements in the soil and the yield of durum wheat (Tt).

The evaluation of the competitive impact of the insertion of Galium and Fumaria with durum wheat without the use of phytochemicals for the control of weeds has been compared between several associations TtGa, TtFo, TtGaFo and a corresponding control, wheat only (Tt). Everything was done on twelve micro-plots of 1x1m with 03 repetitions for each combination.

The previous crop of the experimental plot being an unworked fallow, which allowed a maximum emergence of weed species. After exploration of the study area, the highest level of weed contamination was characterized by *G. aparine* and *F. officinalis* with average densities of 30 and 20 plants/m^2, respectively. More frequent and more abundant in the study area, these species were retained with the same densities during the different combinations in the experiment. Thus, the sowing were always carried out in December on the micro-plots randomly installed for each combination (TtGa, TtFo and TtGaFo) with as control wheat alone (Tt). To ensure the reproducibility of the experiment, all plots were received the same manual weeding every week during the growth period. No serious incidence of insects or diseases was observed and no chemicals were applied to either plants.

In each treatment, soil samples were taken from top soil (0-30 cm) using a manual agricultural auger, before sowing, at heading period and at the end of the season. All the collected samples were achieve the physical-chemical analyses. Other samples of wheat (Tt) at the heading stage and after growing season have undergone almost the same analysis, and have been measured for physiological and yield parameters.

The total concentration of nitrogen N (%) was measured by the Kjeldahl method (ISO 11261), the available phosphorus P_2O_5 (ppm) was determined by the method of Joret Hebert AFNOR: X31-161 and the determination of the inorganic ions K and Na was performed according to the method described by Lafon *et al.,* 1996.

Organic matter MO (%) was determined by the method of Anne (1945) and soil carbonate analysis were determined using the Bernard calciminer. At the time of harvest, the wheat plants were collected manually to measure physiological and yield parameters (number and height of tillers, number of ears per m2, number of grains per ear, weight of grains per ear and weight of grains per m2).

We used excel windows for statistical analysis, the results obtained during the experimentation were presented graphically where they are in the form of histograms with their standard deviations to illustrate the different comparisons between treatments.

Results

Effect of weeds on total soil nitrogen (N%)

Better progress soil nitrogen was noted in all treatments at the end of the season comparing to the beginning of the season.

The best increase was showed in the combination of both weeds with wheat in treatment TtGaFo with 0.45% while it was minimal in the treatment control (Tt) with only 0.23% (Fig.1).

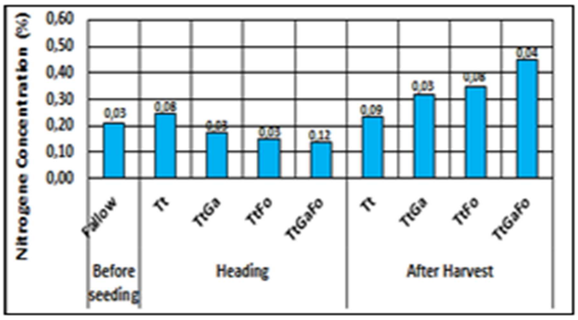

Fig. 1. Effect of weeds on soil nitrogen (N%).

Effect of weeds on soil available phosphorus (P_2O_5)

After harvest, the quantity of available phosphorus in the soil increased significantly in presence of galium (TtGa). We were recorded 224.68 ppm compared to the beginning of the season with 187.37 ppm, while there were a strong depression (85.72 ppm) of this element in the treatment control (Tt) (Fig. 2).

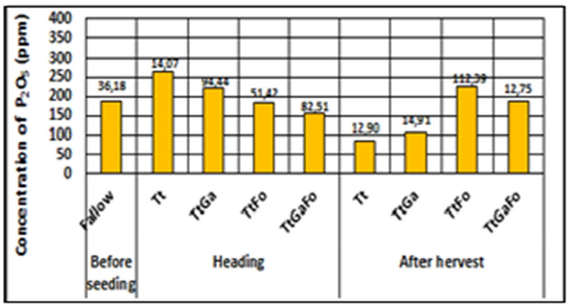

Fig. 2. Effect of weeds on soil available phosphorus (P_2O_5)

Effect of weeds on soil potassium (K)

The soil potassium content decreased in all treatments tested after harvest compared to the beginning of the experiment except treatment (TtFo) where the concentration of K was higher, it reached a quantity of 33U (Fig. 3).

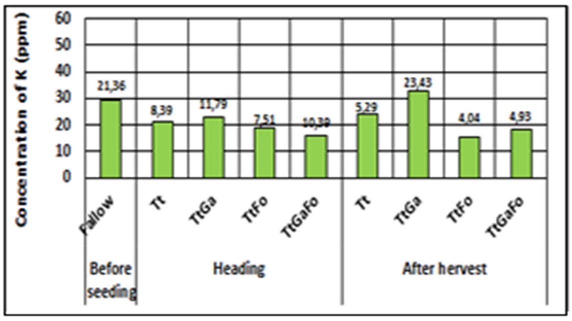

Fig. 3. Effect of weeds on available potassium (K).

Effect of weeds on concentration of sodium (Na)

In the absence of weeds (Tt), soil sodium content was lower at heading period than the other combinations but after harvest, soil sodium was accumulated considerably in presence of both weeds compared to the presence of only one weed with wheat where it was slightly increased in TtGa (Fig. 4).

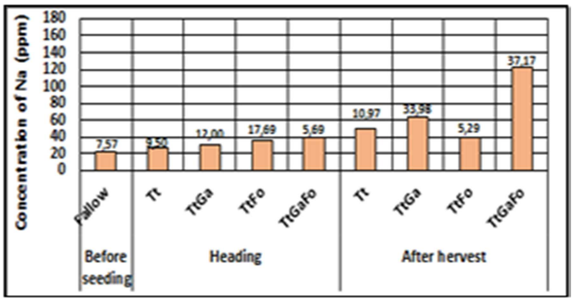

Fig. 4. Effect of weeds on soil available sodium (Na).

Effect of weeds on soil organic matter (OM%)

The concentration of organic matter in soil was decreased continuously from the beginning of the season regarding to the treatment control(Tt). While the combination of each of the weeds tested with durum wheat favors a low increase in the soil organic matter and this content was decreased during the joint association of the two weeds with wheat (TtGaFo) during and at the end of the agricultural cycle (Fig. 5).

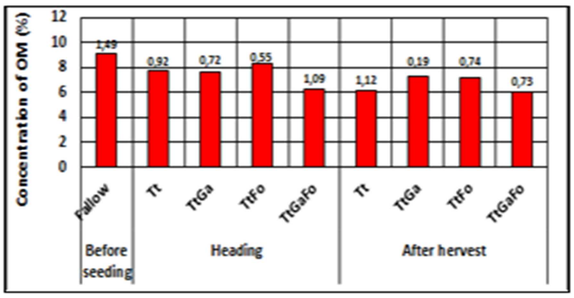

Fig. 5. Effect of weeds on soil organic matter (OM).

Effect of weeds on soil calcium carbonate content (CaCO3%)

Calcium carbonate analysis on soil recorded the lowest values at the beginning of the wheat crop. During this period, the accumulation of calcium carbonate in the TtGaFo treatment were much higher than the other area where the treatment TtFo were the lower. After harvest, there were no significant differences compared to the first time (Fig. 6).

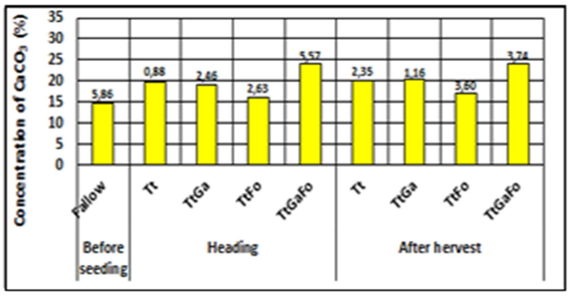

Fig. 6. Effect of weeds on soil calcium carbonate ($Ca\ CO_3$).

Effect of weeds on yield components of wheat

Number of tillers

There were no detectable differences among the different associations. The number of tillers per plant at the treatments TtGa Fowith 3.96 and TtFo with 3.30 was higher compared to the treatment Tt, while the plotTtGa where recorded the lowest number with 2.37 (Fig. 7).

Number of grains per spike

The number of grains per ear is considered as the main yield element in wheat crop. Results showed less variation in all the associations. The maximum and minimum values were obtained in treatment Tt and treatment TtGaFo, respectively with 56 and 50 grains/spike. These values did not decline significatively in the presence of *F. officinalis* and *G. aparine* (Fig. 7).

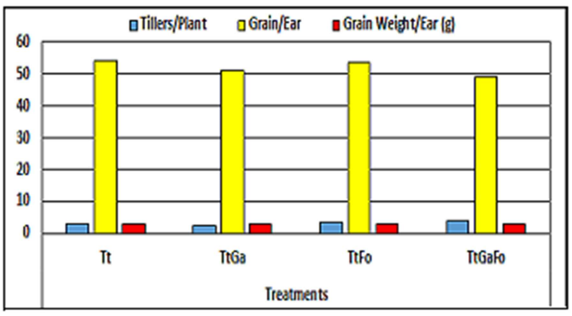

Fig. 7. Effect of weeds on number of tillers/plant, number and weight of grains/ear.

Grains weight per spike

Grains weight per spike plays an important role in yield formation, because it affects harvest index. Despite some slight variations, data related to grains weight per spike indicated that presence of two weeds has not significantly affected it. The combination of TtFo gave the highest grain weight per spike with 3.19g. Whereas, the lowest weight was observed in combination of both weeds with durum wheat (TtGaFo) with 2.74 g (Fig. 7).

Maximum height of wheat plants

The maximum height is considered the best indicator of the effects of competition. Data showed that the presence of the weeds *G. aparine* and *F. officinalis* has not a significant effect on the maximum height of wheat plants. The tallest plant (102.67 cm) of wheat were observed in the plot TtGa, while the shortest (96.83 cm) were recorded in plot TtFo (Fig. 8).

Number of ears per m²

Data analysis indicated a small decrease in the number of ears per m². It is clear that the best results were observed in TtGa treatment followed by plots in which *G. aparine* and *F. officinalis* were associated with wheat (TtGaFo) with 564 / m². Although minimum spikes 410/m² were recorded on the treatment Tt (Fig. 8)

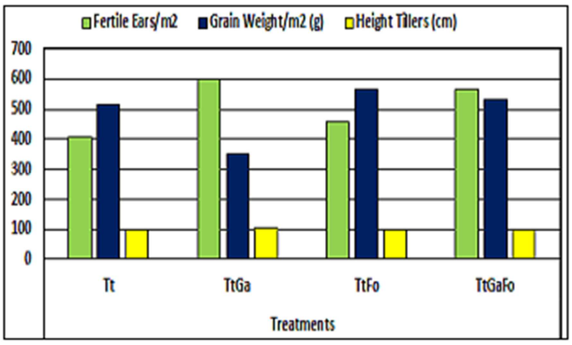

Fig. 8. Effect of weeds on wheat yield parameters.

Weight of grains/m²

An examination of data on weight of grains/m² presented in Figure 8. indicated that good results were registered in treatment TtFo with 565g/m² followed by treatment TtGaFo with 535g/m²comparing to the treatment control. Whereas, the treatment TtGa were showed the lowest result with 351g/m².

Discussion

A new approach to biodiversity-friendly weed management is therefore intentional to improve the beneficial functions derived from weeds by maintaining desirable species with high value for the agro-ecosystem (Tilman *et al.,* 2002).

After examining the information available in literature on the impact of yield crop and soil nutrient content, we have focused on combination of two weeds *Galium aparine* and *Fumaria officinalis* with durum wheat in semi-arid zone. According to (Dangwal *et al.,* 2010), weeds compete with cultivated species for space, water, sunlight, moisture and nutrients.

Effect of weeds on nutrient elements

Through the results of this preliminary investigation, the joint association of two weeds *G. aparine* and *F. officinalis* with durum wheat improves significantly the concentrations of total nitrogen and available phosphorus in the soil. In addition, the combination of these two species with the variety of durum wheat has given good results compared to the control treatment. But, we showed a remarkable fall in amount of potassium (K) in the soil in presence of weeds. Contrary to (Lehoczky *et al.,* 2013), they found that the competition for total nitrogen (N) was very hard between maize and weeds. Thus, (Shafiq *et al.,* 1994) stated that weeds compete more effectively with rainfed wheat for nitrogen.

While another authors (Galal and Shehata, 2015) declared that some weeds may be beneficial for rice in soils contaminated with heavy metals such as *C. deformis*, which accumulated lower amounts of macronutrients and higher concentrations of heavy metals.

Effect of weeds on crop yield

In cultivated fields, the interest of maintaining weed does not significantly reducing the yield of the crop-cultivated species as some researchers have shown (Cook *et al.,* 1997).

The obtained results prove that 30 plants/m² of *Galiuma parine*and 20 plants/m² of *Fumaria officinalis* has not remarkable significant influence in wheat yield. Same results have been found by (Tlig*et al.,*2012) in their test of interspecific competition between weed and barley (*Hordeum vulgare*), when they stated that *Diplotaxis hara* has not got a significant competitive effect on the growth parameters of barley and presence of this weed has not affect the parameters of barley yield.

The presence of 30 plants of *Galiuma parine* in treatments causes a slight decrease in the number of tillers per plant and number of grains per spike compared to treatment wheat only, while the number of spike per m²and maximum height of plants have increased. These results agree to ascertainments of (Armin and Asghripour, 2011),they said that wild oat had harmful effects on wheat yield, so increase in wild oat density results in the reduction of wheat yield through decrease in fertile tiller per plant and spike/m².

Generally, our results differ from those of (Mennan, 1998), when they reported that ten plants of *G. aparine*/m² reduced wheat grain yield by 18% in Turkey. In addition, (Aziz *et al.,* 2009) said that Galium species might cause yield losses up to 32% at densities of 72 plants/m² in wheat. In other research, winter wheat yields were reduced from 12 to 57% by *G. aparine* competition in field trials in England (Wilson and Wright, 1987). (Baye and Bouhache, 2007), in their study, showed that growth parameters of maize were affected by the presence of silverleaf nightshade, also, *Parthenium* weed (*Parthenium hysterophorus* L.) has caused yield losses on maize (*Zea mays* L.); These results were reported by (Safdar *et al.,* 2015).About the other weed, 20 plants of *Fumaria officinalis* increase number of tillers per plant, weight of grains per spike and weight of grains per m², whereas it presence affect slightly on number of grains per spike and height of plants. In collected works, we do not found results comparable or dissimilar.

The competition between crop and weeds is often maximum when they share the same resources at the same time. This is often the case of plants of the same species where the architecture is very similar (wheat and black-grass/oilseed rape and wild mustard/beetroot and goosefoot) (Valantin-Morison *et al.,* 2008).

Conclusion

The available results are highly variable, but we note generally any significant reduction in crop yields in the presence of weeds. In our case, the two weeds tested (*G. aparine* and *F. officinalis*) has not caused a significant loss in crop yield and it has a beneficial impact on soil nutrients.

References

Armin M, Asghripour M. 2011. Effect of plant density on wild oat competition with competitive and non-competitive wheat cultivars. Agricultural Sciences in China **10**,1554-1561. http://dx.doi.org/10.1016/S1671-2927(11)60151-X

Ashenafi M, Dalga D. 2014. Effect of herbicides on weed dynamics and yield and yeild attribute of bread wheat (*Triticum aestivum* L.) in south eastern part of Ethiopia. International Journal of Technologie Anhancing and Emerging Engineering Research **2(4),** 2347-4289.

Aziz A, Tanveer A, Ali A, Yaseen M. 2009. Density dependent interactions between cleavers (*Galium aparine*) and wheat (*Triticum aestivum*) planted at different times. Pakistan Journal of Agricultural Science **46**, 258–265.

Baye Y, Bouhache M. 2007. Etude de la compétition entre la morelle jaune (Solanum elaeagnifolium Cav.) et le maïs de printemps (*Zea mays* L.). Journal Compilation **37**,129–131.

Bouthiba A, Debaeke P, Hamoudi SA. 2008. Varietal differences in the response of durum wheat (*Triticum turgidum* L. var. *durum*) to irrigation strategies in a semi-arid region of Algeria. Irrigation Science **26,** 239-251. http://dx.doi.org/10.1007/s00271-007-0089-5

Cook RT, Bailey SER, McCrohan CR. 1997. The potential for common weeds to reduce slug damage to winter wheat: laboratory and field studies. Journal of Applied Ecology **34(1),** 79-87.

Dangwal LR, Singh A, Singh T, Sharma C. 2010.Effect of weeds on the yield of wheat crop in Tehsil Nowshera. Journal of American Science **6(10)**, 405-407.

Fahad S, Hussain S, Chauhan BS, Saud S, Wu C, Hassan S, Tanveer M, Jan A, Huang J. 2015. Weed growth and crop yield loss in wheat as influenced by rowspacing and weed emergence times. Crop Protection **71**, 101-108. http://dx.doi.org/10.1016/j.cropro.2015.02.005

Franke AC, Lotz LAP, Van Der Burg WJ, Van Overbeek L. 2009. The role of arable weed seeds for agroecosystem functioning. Weed Research **49**,131-141. http://dx.doi.org/10.1111/j.1365-3180.2009.00692.x

Galal TM, Shehata HS. 2015. Impact of nutrients and heavy metals capture by weeds on the growthand production of rice (*Oryza sativa* L.) irrigated with different water sources. Ecological Indicators **54,** 108–115. http://dx.doi.org/10.1016/j.ecolind.2015.02.024

Goetz P, Ghedira K, Le Jeune R. 2009. *Fumaria officinalis* L. (Fumariaceae). Phytothérapie **7**, 221-225. http://dx.doi.org/10.1007/s10298-009-0399-2

Khan MA, Afridi RA, Hashim S, Khattak AM, Ahmad Z, Wahid F, Chauhan BS. 2016. Integrated effect of allelochemicals and herbicides on weed suppression and soil microbial activity in wheat (*Triticum aestivum* L.). Crop Protection**90**,34-39. https://doi.org/10.1016/j.cropro.2016.08.018

Lehoczky E, Marton L, Nagy P. 2013. Competition for nutrients between cold-tolerant maize and weeds. Soil Science and Plant Analysis **44**,526–534. https://doi.org/10.1080/00103624.2013.744156

Marwat SK, Usman K, Khan N, Khan MU, Khan EA, Khan MA, Rehman AU. 2013. Weeds of wheat crop and their control strategies in Dera Ismail Khan District, Khyber Pakhtun Khwa, Pakistan. American Journal Of Plant Sciences **4,** 66-76. http://dx.doi.org/10.4236/ajps.2013.41011

Mennan H, Zandstra BH. 2005. Effect of wheat (*Triticum aestivum*) cultivars andseeding rate on yield loss from *Galium aparine* (cleavers). Crop Protection **24,** 1061–1067. http://dx.doi.org/10.1016/j.cropro.2005.02.012

Olesen JE, Hansen PK, Berntsen J, Christensen S. 2004. Simulation of above-ground suppression of competing species and competition tolerance in winter wheat varieties. Field Crops Research **89**, 263–280. http://dx.doi.org/10.1016/j.fcr.2004.02.005

Ramdani M, Lograda T, Chalard P, Figueredo G. 2013. Chemical composition of essential oils of *Galium tunetanum* Poiret and *Galium mollugo* L. in Algeria. International Journal of Medicinal andAromatic Plants **3(3),**362-365.

Safdar ME, Tanveer A, Khaliq A, Riaz MA. 2015. Yield losses in maize (*Zea mays*) infested with parthenium weed (*Parthenium hysterophorus* L.). Crop Protection **70**,77-82. http://dx.doi.org/10.1016/j.cropro.2015.01.010

Shafiq M, Hassan A, Ahmad N, Rashid A. 1994. Crop yields and nutrient uptake by rainfed wheat and mungbean as affected by tillage, fertilization and weeding. Journal of Plant Nutrition **17(4),** 561-577. https://dx.doi.org/10.1080/01904169409364750

Siyahpoosh A, Fathi GA, Zand E, Siadat Sa, Bakhshande A, Gharineh MH. 2012. Competitiveness of different densities of two wheat cultivars with wild mustard weed species (*Sinapis arvensis*) in different densities. World Applied Sciences Journal**20(5),**748-752. http://dx.doi.org/10.5829/idosi.wasj.2012.20.05.2248

Tilman D, Cassman KG, Matson PA, Naylor R, Polasky S. 2002. Agricultural sustainability and intensive production practices. Nature**418,** 671-677.

Tlig T, Gorai M, Neffati M. 2012. Étude expérimentale de la compétition entre l'adventice *Diplotaxis harra* (Forssk.) Boiss. et l'orge (*Hordeum vulgare* var. *ardhaoui*). Ecologia Mediterranea **38(1),** 89-95.

Valantin-Morison M, Guichard L, Jeuffroy MH. 2008. Comment maîtriser la flore adventice des grandes cultures à travers les éléments de l'itinéraire technique. Innovation Agronomique **3,**27-41.

Wilson B, Wright K. 1987. Variability in the growth of cleavers (*Galium aparine*) and their effect on wheat yields. Proceedings British Crop Protection Conference Weeds, Brighton, UK **105,** 1–1058.

Zhang SZ, Li YH, Kong CH, Xu XH. 2015. Interference of allelopathic wheat with different weeds. accepted article.
http://dx.doi.org/10.1002/ps.3985