Colegio de Postgraduados

Study of the allelopathic effect of some weeds on the germination of durum wheat (*Triticum durum* desf.).

Hannachi, Abdelhakim

University August 20, 1955 - Skikda. Faculty of Sciences. Department of Agronomy (Algeria). Poste of Boumagueur 05620 Batna Algeria

* Correspondence: Hakhannachi@yahoo.fr

ABSTRACT

Objective: the presence of weeds in a cereal field is detrimental for several reasons. In this study, we chose four adventitious species to test their allelopathic effect on the germination of seeds and the development of seedlings of the durum wheat variety "Simeto".

Design/Methodology/Approach: we tested the allelopathic effect at the laboratory level, by mixing weed seeds and durum wheat. In these trials, the allelopathic effect was measured.

Results: the inhibitory effect of these adventitious species manifests itself much more on the development of the seedlings, especially on the aerial parts.

Findings/Conclusions: the bindweed (*Convolvulus arvensis* L) is the most inhibiting.

Keywords: Allelopathy, Weed, Inhibition, Germination, Durum wheat (*Triticum durum* Desf.).

Citation: Hannachi, A. (2023). Study of the allelopathic effect of some weeds on the germination of durum wheat (*Triticum durum* desf.). *Agro Productividad*. https://doi.org/10.32854/agrop.v16i1.2356

Academic Editors: Jorge Cadena Iñiguez and Libia Iris Trejo Téllez

Received: August 03, 2022.
Accepted: January 05, 2023.
Published on-line: February 22, 2023.

Agro Productividad, 16(1). January. 2023. pp: 23-31.

INTRODUCTION

Cereals have long been produced in Algeria in all agro-ecological zones. This culture is very old in Algeria, durum wheat holds a first-rate place among cultivated plants. It is cultivated under rainfed regime in the majority of production areas and therefore is dependent on climatic conditions, more precisely on the amount of rain received during the plant's development cycle (Zaghouane and Bouziri, 2013).

The raison d'être of agriculture means that, in a cultivated field, any plant that is not sown or planted voluntarily is considered undesirable and the farmer has not stopped destroying these weeds, which are easy to show the harmfulness as they sometimes penalize yields. Weeds have always been a problem for agricultural producers. Heavy losses in yields and crop quality result from weed competition (Hannachi, 2010).

Image by JackieLou DL at Pixabay

Among the many enemies of crops, weeds occupy an important place. The presence of weeds or weeds in a grain field can be detrimental for several reasons. Competition for water, minerals and light, as well as toxic chemical interactions between weeds and cultivated plants (allelopathy), directly affects crop growth and yield. The massive infestation of these weeds hinders the plowing and harvesting tools and makes the success of these operations problematic. The mixture of weed seeds with cereal seeds degrades the commercial quality of the harvested product. Cereal weeds should therefore be effectively combated. Competition between weeds and crops also plays a role in yield losses (Hossain *et al.*, 2016).

The study of weeds therefore aims to control the weed flora and set up the appropriate process to eliminate it. The objective of this study is to test the allelopathic effect of some weeds on the germination of seeds and the development of seedlings of durum wheat (*Triticum durum* Desf.) Variety "Simeto".

MATERIALS AND METHODS

Plant material

Our work consists in studying the allelopathic effect of some weeds on the germination of durum wheat (*Triticum durum*) variety "Simeto", which represents the plant material used provided by the CCLS Sahki Mouhamed (Matéra) El harouche (Algeria) seed used for the test is a crop from the period 2013-2014.

Simeto

Is an Italian variety, obtained following a cross between two varieties which are capeiti and valvona, registered in 2001 and requested by ITGC. The characteristics of the variety Simeto according to the national center for control and certification of seeds and plants (2009) are:

Morphological characteristics

Medium-sized plant, white ear at maturity and short with black beard, with a semi elongated grain, habit with semi-upright tillering, and early cycle. Moderately susceptible to disease but resistant to powdery mildew.

Technological characteristics

Weight of a thousand grains is high, with very good semolina quality and protein content of 15.80%, and resistant to mitination (CNCC, 2009).

Weeds

In order to choose weed species to study their allelopathic effect on durum wheat and barley, we asked CCLS Sahki Mouhamed El harouche (Algeria) some weed species, we chose four (04) species belonging to 04 botanical families:

- Wild oats (*Avena sterilis* L.), Family: Poaceae (grasses).
- Wild bindweed (*Convolvulus arvensis* L.), Family: Convolvulaceae.

- Field mustard (*Sinapia arvensis* L.), Family: Brassicaceae (Crucifers).
- Centaury (*Centaurea nicaeensis* All.), Family: Asteraceae (Compositae).

The majority of the species chosen are problematic cereal species in the Mediterranean region.

Laboratory experimentation

Germination tests

All germination tests are carried out in Petri dishes. We used sterile plastic dishes 85 mm in diameter and 15 mm high. Tissue disks with a diameter equal to that of the dishes are placed in the Petri dishes. The same type of boxes are used for durum wheat and barley and also for each weed species. Each box is numbered with labeling.

Preliminary germination tests

In order to obtain maximum germination rates and to choose an average duration for germination tests, we carried out preliminary germination tests. All seeds used (durum wheat and weeds) are subjected to these tests.

We used two petri dishes for each species. We initially introduced 20 ml of distilled water with a graduated pipette (10 ml). Then 10 seeds of each species are placed on tissue paper in each box. Follow the germination of the seeds every day at the same time, for 10 days the speed and duration of germination of the seeds do not change significantly at ambient temperatures (from 15 to 25 °C). However, at 10 °C the seeds have a slow germination (Buhler and Leroux, 1997). On the 8^{th} day of incubation we observed that all the seeds which germinate develop a radicle (or coleorrhize) and a tigella (or coleoptile). After this incubation period we have noticed that there is no more germination and that some roots are starting to dry out.The preliminary germination tests allowed us to finalize the list of weeds. The selected species are those which have presented a germination rate greater than or equal to 50%. These preliminary tests also allowed us to determine the duration of the final germination tests (8 days). The species used for the allelopathic tests were: field mustard (*Sinapia arvensis* L.), centaury (*Centaurea nicaeensis* All.), wild oats (*Avena sterilis* L.) and bindweed (*Convolvulus arvensis* L.).

Final germination tests

We used Five Petri dishes to test the allelopathic effect of each weed species on the germination of durum wheat and barley.

Five boxes are used for durum wheat and others are used for barley. These represent the witness. Using a graduated pipette we initially introduced 20 ml of distilled water for all the petri dishes. In each Petri dish we placed 10 seeds of durum wheat or barley and 10 seeds of each adventitious species except the witnesses. The boxes are covered immediately. We chose healthy seeds (without anomalies) and which are almost the same size. After installing the prepared petri dishes in the laboratory, we followed the germination and took notes.

Determination of germination percentages

After 8 days of incubation, the experiment is stopped and the percentage of germination of durum wheat (photos 1, 2, 3,4) in each box is determined. We considered as germinated seed that which developed a coleorhize.

Measurement of the lengths of the roots and aerial parts

After determining the number of seeds that germinated in each box, we measured the lengths of the root part (LPR) and the aerial part (LPA). The LPR represents in durum wheat and barley the length of the coleorhize or the longest of the primary roots. LPA for durum wheat and barley is the length of the coleoptile or first leaf.

We followed a measurement method, by direct measurement of LPR and LPA on millimeter paper.

Data analysis

The percentage of seed germination for each Petri dish is determined according to the following formula:

$$PG\% = number\ of\ seeds\ that\ germinated \times 100/10$$

To compare the effects of the four weed species on durum wheat and barley, we converted the germination percentages and the LPR and LPA measurements to inhibition percentages. The conversions are carried out according to the following formula [5]:

$$\%I = \left[(Witness - CAd) / Witness \right] \times 100$$

$\%I$: the percentage of inhibition compared to the control; *Witness*: the average of the 5 repetitions of the witness; *CAd*: the percentage of germination or the length of the LPR or LPA of each box containing durum wheat (*C*) with an adventitious species (*Ad*) (Figure 1-4).

The %I of each species (germination, length of root and length of aerial part) is calculated separately, such as: % GI: The percentage of inhibition of germination (G).% ILR: Percentage inhibition of root length (LR), % ILPA: The percentage of inhibition of the length of the aerial part (LPA). The data obtained relate to the percentage of germination (% PG), the length of the root part (LPR), the length of the aerial part (LPA) of durum wheat. We presented for each species, the differences between mixing durum wheat with a weed and the control, the effect on the three variables (LR, LPA and PG).

RESULTS AND DISCUSSION

Effect of different weed species on durum wheat: effect on durum wheat: "Simeto" variety

The analysis of variance indicates that the percentage of germination (PG), the length of the root part (LPR) and the length of the aerial part (LPA) of durum wheat are significantly

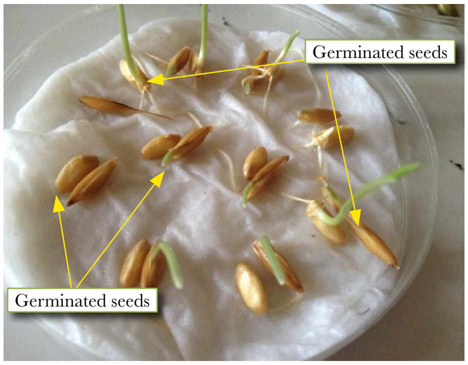

Figure 1. Durum wheat germination test with *Avena sterilis* L.

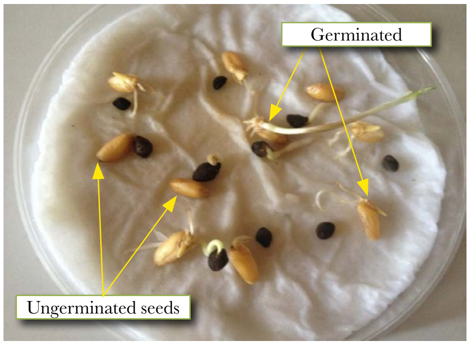

Figure 2. Durum wheat germination test with *Convolvulus arvensis* L.

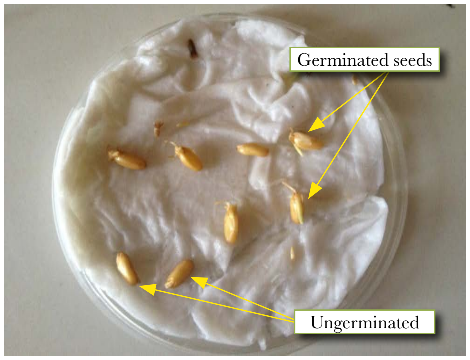

Figure 3. Durum wheat germination test with *Centaurea nicaeensis* All.

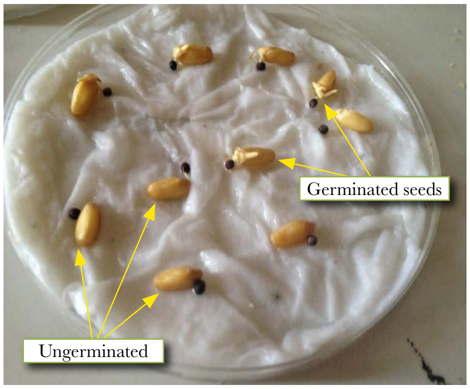

Figure 4. Durum wheat germination test with *Sinapia arvensis* L.

affected at P=0.95 and P=0.99 by the four weed species. The comparison of the means indicates that all the weed species significantly affect the length of the aerial part at P=0.95. For the length of the root, the means of the durum wheat and adventitious mixtures are significantly different in comparison with the control. For germination, wild mustard and wild oats did not have a significant effect in comparison with the control, on the other hand, wild bindweed (*Convolvulus arvensis* L.) and centaury (*Centaurea nicaeensis* All.) Are significant.

Effect on germination

We note that the highest inhibition is obtained by the bindweed (*Convolvulus arvensis* L) represents a percentage rate of 40%, and then the centaury (*Centaurea nicaeensis* All.) At 24.44%. On the contrary field mustard (*Sinapia arvensis* L.) and wild oats (*Avena sterilis* L.) can stimulate the germination of durum wheat variety “Simeto” (Figure 5).

Effect on the length of the root portion

The results obtained (Figure 6) show that the species most inhibiting the development of the root part is the bindweed (*Convolvulus arvensis* L.) per percentage of inhibition exceeds 35%. The inhibitory effect of the other three species is moderately weak and does not exceed 20%.

Effect on the length of the aerial part

The three species field mustard (*Sinapia arvensis* L.), centaury (*Centaurea nicaeensis* All.), And wild oats (*Avena sterilis* L.), show a moderately weak inhibitory effect on the length of the aerial part. They have values that do not reach 23% (Figure 7). In contrast, the inhibition percentage is relatively higher for the bindweed (*Convolvulus arvensis* L) at 48.05%. The results show that the species most inhibiting seed germination and seedling development is the bindweed (*Convolvulus arvensis* L). As well as wild oats has a positive effect which stimulates the germination of grains of the durum wheat variety “Simeto”. All species except wild oats (*Avena sterilis* L.) inhibit the length of the aerial part more than the length of the root.

The germination of a seed can only take place if certain favorable conditions are met, namely: oxygen, temperature, water. Furthermore, it is well known that natural substances produced by plants are capable of delaying or even inhibiting the germination of seeds and the growth of seedlings, this is the phenomenon of allelopathy.

This work determines the existence of an allelopathic phenomenon in experimental conditions, it provides proof that weeds contain toxic compounds whose action can potentially be exerted in natural conditions. In what follows, we will discuss the results presented in the 1st part of this chapter.

The results we obtained show that the four weed species: bindweed (*Convolvulus arvensis* L.), Centaury (*Centaurea nicaeensis* All.), Field mustard (*Sinapia arvensis* L.), and wild oats (*Avena sterilis* L.), affect durum wheat variety “Simeto” and barley variety “Saida” in different ways.

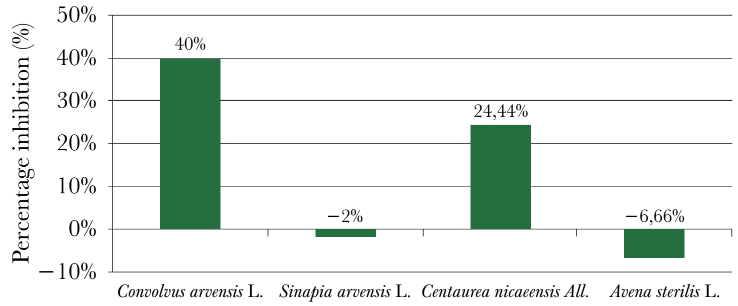

Figure 5. Percentage inhibition of weeds on germination (PG) of durum wheat (Simeto).

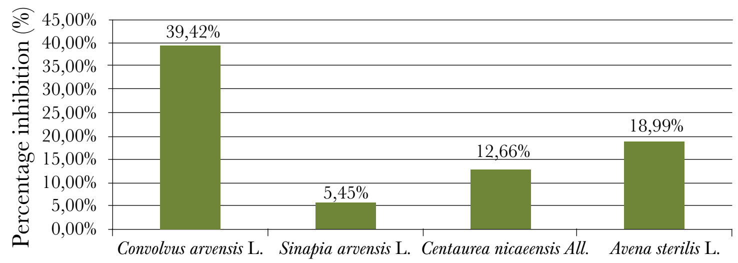

Figure 6. Percentage inhibition of weeds over the length of the root portion (LPR) of durum wheat (Simeto).

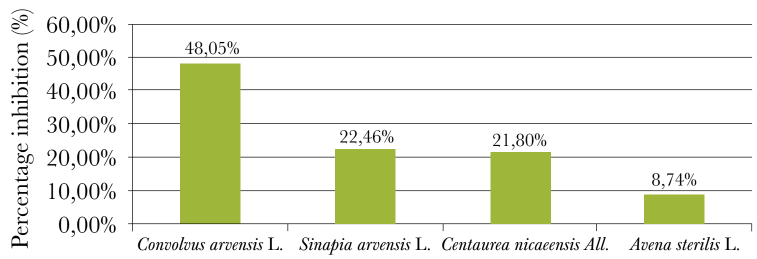

Figure 7. Percentage inhibition of weeds over the length of the aerial part (LPA) of durum wheat (Simeto).

The effects of these weeds are observed on seed germination and seedling development. We have noticed that the germination of the seeds is delayed or it stops in an advanced stage or it does not occur.

When seed germination is not inhibited, we have observed other effects on seedling development (inhibition or stimulation). In the case of inhibition, we noted effects on the radicle (coleorrhize), on the tigella (coleoptile) or on both showed that when sensitive plants are exposed to allelopathy, the germination of seeds is delayed (Kheddam, 1998). With some seeds, germination stops in the swelling stage of the seed. Others believe that germination stops at the onset of the radicle.

According to Lamamra, 2007, the percentage of germination increases and the length of the root increases. Germination is accelerated and the development of the aerial part is important.

Some have an inhibitory effect on germination like bindweed (*Convolvulus arvensis* L.) on durum wheat variety "Simeto". Others cause an inhibiting effect on their growth such as field mustard (*Sinapia arvensis* L.), according to Rouimel, 2012, cruciferous plants often tend to be "toxic"; especially mustard, which should not be combined with cereals such as wheat and barley.

In the reality of the cultivated field, it seems that the growth inhibitions observed in the laboratory are much more difficult to explain (Sayoud, 1978). Summarize the reasons for these differences between controlled conditions and agricultural field. The first difficulty is linked to the multiple interactions between two species that coexist or succeed one another: how to distinguish allelopathy and competition for example. The second difficulty stems from the fact that, even if there is a production of compounds for which the depressive action on the biological functions of target species has been shown under controlled conditions, this does not mean that this effect is expressed field. For this, it would be necessary that at the appropriate time the quantities available of these molecules in the medium are sufficient, and that the target plant is in an adequate state of sensitivity. Finally, the third difficulty is linked to the intervention of other living organisms in the system: phytotoxic compounds can also have microbial origins, independent of the presence of a culture. Allelopathy is therefore, the chemical interference of one or more substances of a plant species with the germination, growth or development of other plant species, which covers both inhibition and stimulation effects. When susceptible plants are exposed to allelopathy, germination, growth and development can be affected.

CONCLUSION

The allelopathic effect of weeds, bindweed (*Convolvulus arvensis* L.), Centaury (*Centaurea nicaeensis* All.), Field mustard (*Sinapia arvensis* L.), and wild oats (*Avena sterilis* L.) vary according to the species. Some have an inhibiting effect on germination such as bindweed. The results obtained give that the majority of species significantly inhibit the germination of durum wheat. The highest inhibition is noted for the weed bindweed species. Agronomic solutions almost all have assumed and recognized consequences on the organization of work (shifting the sowing date, establishment of inter-crop or allelopathic precedent) or the energy used (tillage before sowing and mechanical weeding). These technical routes reducing the use of herbicides must therefore be evaluated on several criteria: economic performance of course, but also energy (efficiency, cost), working time (duration, site conflict), agronomic value (objective achieved, effects unwanted induced effects, long term effects on flora).

REFERENCES

Buhler S., G. Leroux D., 1997. Use of fall rye (Secale cereale) against weeds in pumpkin. Department of Phytology, Laval University, Quebec, G1K 7: 4 p.

CNCC, 2009. Cereal varieties bulletin, Algeria. April 2009: pp 74-16.

Hannachi A., 2010. Study of weeds of crops in the Batna region: systematics, biology and Ecology. Master thesis, Sétif 1 University (Algeria): 124 p. Hossain M.A., Young Ko S., Ju Yang C., 2016. Posttranscriptional Regulation of Gcr1 Expression and Activity Is Crucial for Metabolic Adjustment in Response to Glucose Availability. *Mol Cell 62*(3): pp 346-358.

Kheddam M., 1998. Biology and means of controlling parasitic plants presentation of the methods used against the spread of orobanches, dodder and strigas. Course on phytosanitary control (collection of communications). September 5-16, 1998: pp 136-163.

Lamamra S., 2007. Contribution to the morphological characterization of the parts: root and aerial of genotypes of barley (*Hordeum vulgare* L) and durum wheat (*Triticum durum* Desf). Thesis Engineer in Agronomy: phytotechnics: UNV August 20, 1955: Skikda (Algeria): 68 p.

Rouimel Z., 2012. Floristic and ecological study of citrus weeds in the Skikda region. Thesis Engineer in Agronomy: phytotechnics: UNV August 20, 1955: Skikda (Algeria): 71p.

Sayoud R., 1978. Cereal diseases. *Cereal review*. N = ° 17: pp 20-21.

Zaghouane O. and Bouziri S., 2013. Cereal production during the period 1876 to 2012: evolution and prospects. Agriculture and development: Information and extension review. November 2013, N ° 16: pp 14-21.