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## Study of the Effect of Different Types of Previous Crops on the Dynamics of the Weed Flora under No-Till Condition in Algeria

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THIS STUDY aims to evaluate the impact of crop rotations on weed dynamics under no-till conditions. Four crop rotations were tested:Wheat/Lentil/Wheat (W/L/W), Lentil/Wheat/Wheat (L/W/W), Triticale/forage Pea/Wheat (T/P/W) and forage Pea/Triticale/Wheat (P/T/W), during the 2016/17, 2017/18 and 2018/19 crop years. The experiment was conducted on the experimental site belonging to the ITGC-FEA of Setif (Algeria). The results indicate that the weed flora is composed of 13 species belonging to 09 families. Dicotyledons are mostly observed during the three campaigns, with proportions of 77.77%, 66.66%, 84.62%, respectively for the campaigns 2016/17, 2017/18 and 2018/19. Annual grasses (monocotyledons) consisted of *Avena sterilis* and *Bromus sterilis*. The Shannon and Simpson indices show controversial values depending on the treatments applied. The W/L/W crop rotation was distinguished by both specific diversity and low dominance, conversely the P/T/W treatment, shows high dominance accompanied by low diversity. The linear model relating to the evolution of monocots as a function of precipitation shows that they are negatively and significantly correlated with precipitation in January. The latter is as follows: Y= -0.251x + 34.461 with ($R^2$= 0.998).

**Keywords**: Crop rotation, No-till, Semi-arid, Shannon Entropy, Weed flora.

## Introduction

No-till was introduced in Algeria and in particular in the semi-arid zone of the high plains of Sétif during 2006, following the comforting results obtained elsewhere in Mediterranean countries (Zaghouane et al., 2006). This system was adopted and popularized by a group of farmers organized as an association called “Trait-d`union”, which has set itself the mission of developing conservation agriculture through direct seeding. The adoption of this system generates a strong proliferation of weeds, following the abandonment of tillage (Dorado & Lopez-Fando, 2006; Rahali et al., 2010; Ruisi et al., 2015). In the no-till system, weed management is an essential constraint in addition to the availability of an adapted seeder and other economic constraints in Algeria (Rouabhi et al., 2018). The adoption of this system induces both biological modifications of the soil and a new composition of weed communities. Thus, only the chemical option paired with the practice of rotation and the use of competitive varieties is possible.

Therefore, the study of the evolution of the weed flora under the effect of the rotations is of major interest. the weed flora management is an important aspect of culture systems since these foreign plants to culture can easily cause yield losses of up to 70% (Tanji, 2005). In the conventional system, many alternatives are available, including ploughing, shallow tillage, and false seeding (Rasmussen, 2004), which aim to reduce the seed bank by promoting the emergence of weeds (Hamadache, 1995; Gallandt, 2006). However, these techniques can

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have negative impacts on soil quality (lowering of fertility) and soil erosion (Dickey et al., 1983; Gallandt, 2004). In no-till, these tools offered are no longer available in the management of the weed flora and the system is confronted with the constraint of weed proliferation (Dorado et al., 1999; Fortas et al., 2013). In this regard, the optimization and mobilization of other levers are more than essential. Among, the alternatives offered, the use of the herbicide Glyphosate with a broad spectrum of action, possessing a major asset for the control of weeds before seeding.

It is in this context that our contribution aims, namely the study of the effect of the crop rotation on the temporal dynamics of the weed flora under no-till conditions management.

## Materials and Methods

The study was carried out during the 2016/17, 2017/18 and 2018/19 crop years at the experimental site of the Technical Institute of Field Crops (ITGC) of Setif, whose geographical coordinates are: 36° 15' N and 05° 37' E with an altitude of 975 m.a.s.l. The climate of the region is Mediterranean, continental, semi-arid, characterized by a hot and dry summer and a cold and wet winter (Chennafi et al., 2006). The soil physical and chemical analyses were carried out at the farm lab during the 2016/17 campaign. The results show that the soil texture is of loam type according to USDA textural triangle, the soil is shallow with poor drainage (presence of calcareous hardpan at 20 cm depth), and a high-water retention capacity. This soil type represents a risk of potassium retrogradation and a risk of phosphorus blockage due to pH (Alkaline), as well as root asphyxiation in extreme cases (Girard et al., 2011). The low carbon/nitrogen ratio indicates a rapid mineralization of the organic matter (Gobat et al., 2013). Some physical and chemical properties of this soil are shown in Table 1.

**TABLE 1. General soil properties at the ITGC station, conducted under No-till system in 2017**

| Properties | Values |
|---|---|
| Clays | 16% |
| Silt | 48% |
| Sand | 36% |
| Texture | Loam |
| pH | 8.85 |
| Organic matter | 1,68% |

The amounts of precipitation recorded during the three-crop campaigning (2016-17, 2017/2018 and 2018/19) from September to June are 187.9 mm, 442.10 mm, 346.6 mm, respectively (Fig. 1). Data reveal a large temporal variation for the three seasons. In the semi-arid zone, cereal cultivation is subject to a strong variation in precipitation, which induces a great fluctuation in yields and production. The 2016/17 season is the least favourable compared to the other two seasons; the difference compared to the next two seasons appears during the spring period, March-April, and May, with amounts of 0mm, 5.2mm, 9mm, respectively, which led to a deficit of 184.7mm, or 49.57% compared to the average rate received for the other two campaigns (Fig. 1). However, the 2017/18 crop year is relatively favourable, marked by a high monthly cumulative precipitation of 90.40mm in March and the lowest in October 10.70mm. The 2017/18 and 2018/19 crop years are characterized by a spring and a rainy end of cycle (months of April, May, and June) with a respective cumulative rate of 172.30mm, 102.40mm. This favourable period coincides with the meiosis-epiaison and grain filling phases. From the point of view of temperature analysis, whose distribution is high in summer and relatively low in winter, which limits the growth of the plant and does not allow the plant to valorise the winter precipitation. In this regard, Haddad (2017) suggests that selection should target genotypes that tolerate low temperatures during the vegetative phase and high temperatures during the reproductive phase.

*The experimental protocol and plant material*

The experiments are carried out according to a randomly completely block design with a single factor as previous crops (W/L/W, T/P/W, L/W/W, P/T/W) including four crops (Durum wheat (W), triticale (T), lentil (L), and forage pea (P)); the aftereffects of which we wanted to assess on the evolution of the weed flora. The block is composed by four elementary plots, each treatment is repeated three times. The experiment therefore comprises twelve plots, each one with 50 m long and 09 m wide. Plant material included: i) Bousselem (pedigree: Can2109 // jo / aa / 3 / s15 / cr) as durum wheat variety (*Triticum durum, Desf*), ii) triticale (*Triticosecale Wittm*), iii) Dahra lentil variety (*Lens culinaris* L.) and iv) Seffrou forage pea variety (*Pisum sativum* L). The sowing dates are carried out during the 3rd ten days of December of each year at doses: durum wheat at 300 seeds / m², triticale 250 seeds / m² and 200 seeds for lentil and forage peas. Previously, the seeds were treated with a fungicide Celest Extra 25g/L fludioxonil + 25g/L difenoconazole. The sowing operation was done with a commercial direct seeder (John Shearer) at a depth of 3cm. This drill allows for 23cm spacing between the seed rows. The plot was treated just before seeding with glyphosate [N-phosphonomethyl-glycine, $C_3H_8NO_5P$] at a rate of 360g/L of the commercial product at a rate of 3 l/ha in 250 liters of water per hectare. The control of weeds on cereals (durum wheat, triticale) is carried out chemically against dicotyledons with Zoom, dispersible granulated formulation (65.9% Dicamba + 4.1% Triasulfuron) at a rate of 150g/ha, and Topik 80 EC (80g/L of Clodinafop-propargyl), against grasses at a rate of 0.75L/ha The trial was fertilized with the MAP bottom dressing at 52% phosphorus, at a rate of 50kg/ha combined with the sowing (localized fertilization). Nitrogen fertilization was applied during the tillering phase at a rate of 46 U/ha of urea at 46%.

*Method of study of the weed flora*

*Species determination*

The monitoring of the dynamics of the weed flora is carried out over a period of 03 agricultural campaigns (2016/2017, 2017/2018 and 2018/2019), through four surveys during the cycles of the culture: a 1st sampling is carried out before sowing and weeding with glyphosate, followed by a 2nd after the total chemical treatment and a 3rd counting is carried out before catch-up weeding followed by a 4th after the last chemical treatment. A Quadra of 01m², chosen at random, is used for the follow-up and the counting of the various weed species. For the determination and identification of the species we used the " Guide to cereal weeds in Algeria " (ITGC; 1976) and the book: "Wheat and barley weeds in Morocco" (Tanji; 2005).

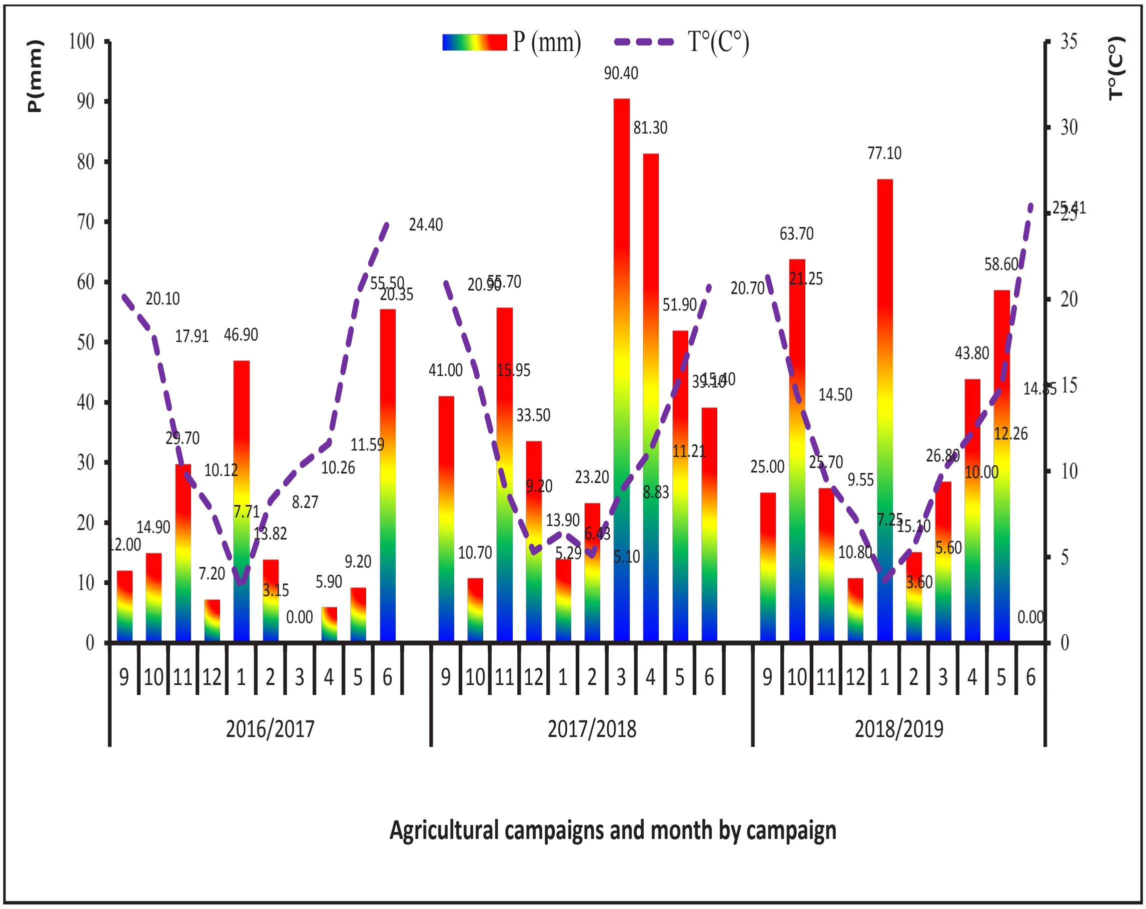


**Fig. 1. Monthly average precipitation and temperature of the 2016/17, 2017/18 and 2018/19 campaigns at the IITGC experimental site (ONM, 2019)**

*Study of the flora diversity*

The study of the diversity of the weed populations on the 03 campaigns of studies and for the various cultural rotations calls upon the calculation of the index of diversity of SHANON-WIENER and the equitability.

**A**/ SHANON-WIENER diversity index: The SHANON-WIENER diversity index (H') is the quantity of information provided by a sample on the structures of the stand from which the sample comes and on the way in which the individuals are distributed between various species (Dajet, 1976). According to Dajoz (1975), diversity is the function of the probability Pi of presence of each species *i* in relation to the total number of individuals:

$$H' = -\sum (ni/N) . \text{Log } 2\,(ni/N)$$

**H'**: specific diversity. **N**: sum of the number of species, **ni**: number of the population of the species **i**.

**B**/ Equitability (equipartition): The equitability constitutes a second fundamental dimension of diversity (Ramade, 1994). According to Dajoz (1996), it is expressed as follows:

$$E = H'/Hmax \quad \text{of which} \quad Hmax = Log2(s)$$

**S**: Is the number of species forming the population. Equitability allows comparison of population structures.

**C**/ Simpson's dominance index: This measure is also known in ecology as the probability of interspecific encounter (PIE) (Hurlbert, 1971) and the Gini-Simpson index (Jost, 2006). It can be expressed as a transformation of the true diversity of order 2:

$$\lambda = 1 - \frac{\sum ni(ni-1)}{N(N-1)}$$

*Statistical analysis*

The data processing was done with the software Past paleontological statistics software packaged for education and data analysis, Current version (May 2021): 4.06 b.

Another multidimensional descriptive analysis was performed; it is the Principal Component Analysis (PCA), whose purpose is to present and study the different variables selected for a system of components, this analysis is performed using Xlstat premium 2018.1 software.

## Results and Discussions

*Structure of the flora according to the agricultural season and crop rotations*

The qualitative floristic analysis allows to define the composition of the weed flora of the crops, while the quantitative floristic analysis allows to describe the agronomic importance of the species according to their relative frequency and abundance. The weed flora was diversified, of which 13 species belonging to 7 families were recorded across the 04 crop rotation types (W/L/W; L/W/W; T/P/W and P/T/W) and during the 03 study (Table 2). During the first campaign (2016/2017), the weeds recorded were divided into 03 groups. The dicotyledons with 77.77% of the weed population, are composed of annuals and perennials. The therophytes are formed of 04 families, counting five annual species, namely: *Sonchus asper, Polygonum aviculare, Papaver rhoeas*, *Raphanus raphanistrum* and *Sinapis arvensis*. The annual grasses identified are *Avena sterilis* and *Bromus sterilis* and account for about 22.22% (Table 2). The cryptophytes (perennials) are present with two families, namely the Brassicaceae and the Asteraceae, with respectively *Diplotaxis assurgens* and *Cirsium arvensis*. The second campaign has seen a reduction compared to the previous campaign; annual and perennial dicotyledons account for 66.66% and are represented by two families; Asteraceae and Brassicaceae and four species, namely *Sonchus asper, Raphanus raphanistrum* for annuals and *Cirsium arvensis* and *Diplotaxis assurgens* for perennials (Table 3), while the annual grasses formed by *Avena sterilis* and *Bromus sterilis* with 33.33% of the total population of weeds However, in the third campaign, all plots were sown with durum wheat, and the surveys carried out allowed to highlight the effect of the different treatments on the dynamics of the weed flora. On this subject, we note a qualitative and quantitative proliferation of the weed flora. The surveys indicate the presence of nine different families and thirteen species, 84.62% and 15.38%, respectively, for the dicotyledons and monocotyledons (Table 2). The recrudescence is located at the level of dicotyledons through the appearance of new annual species such as *Gallium aparine* and *Fumaria parviflora* Lam belonging to Rubiaceae and fumariaceae respectively. We also note the appearance of the biennial plant wild carrot of the Apiaceae family. However, the annual grasses are still represented by *Bromus sterilis* and *Avena sterilis*.

**TABLE 2. The contribution of mono and dicotyledons in the weeds listed**

| Agricultural campaigns | 2016/2017 | | | 2017/2018 | | | 2018/2019 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Classes | Dicots | | Monocots | Dicots | | Monocots | Dicots | | | Monocots |
| Biological types | Annual | Perennial | Annual | Annual | Perennial | Annual | Annual | Annual | Annual | Annual |
| N.Genus N. Species | 5 | 2 | 2 | 2 | 2 | 2 | 8 | 2 | 1 | 2 |
| Contribution % | 77,77 | | 22,22 | 66,66 | | 33,33 | 84,62 | | | 15,38 |

**TABLE 3. The observed weed species and their biological type during the three campaigns**

| Agricultural campaigns | Classes | Biological types | Family | Common name | Scientific name | EPPO code |
|---|---|---|---|---|---|---|
| 2016/2017 | Dicots | Annual | Asteraceae | Field milk thistle | *Sonchus asper* | SONAS |
| | | | Polygonaceae | Knotweed | *Polygonum aviculare* | POLAV |
| | | | Papaveraceae | Poppy | *Papaver rhoeas* | PAPRH |
| | | | Brassicaceae | Ravenelle | *Raphanus raphanistrum* | RAPRA |
| | | | Brassicaceae | Field mustard | *Sinapis arvensis* | SINAR |
| | | Perennial | Brassicaceae | Diplotaxis | *Diplotaxis assurgens* | DIPTE |
| | | | Asteraceae | Thistle | *Cirsium arvensis* | CIRAR |
| | Monocots | Annual | Poaceae | Brome | *Bromus sterilis* | BROST |
| | | | Poaceae | Wild oats | *Avena sterilis* | AVELU |
| 2017/2018 | Dicots | Annual | Asteraceae | Field milk thistle | *Sonchus asper* | SONAS |
| | | | Brassicaceae | Ravenelle | *Raphanus raphanistrum* | RAPRA |
| | | Perennial | Asteraceae | Thistle | *Cirsium arvensis* | CIRAR |
| | | | Brassicaceae | Diplotaxis | *Diplotaxis assurgens* | DIPTE |
| | Monocots | Annual | Poaceae | Brome | *Bromus sterilis* | BROST |
| | | | Poaceae | Wild oats | *Avena sterilis* | AVEFA |
| 2018/2019 | Dicots | Annual | Asteraceae | Field milk thistle | *Sonchus asper* | SONAS |
| | | | Brassicaceae | Ravenelle | *Raphanus raphanistrum* | RAPRA |
| | | | Rubiaceae | Cleavers | *Gallium aparine* | GALA |
| | | | Scrophulariaceae | Veronica | *Veronica hederifolia* | VERHE |
| | | | Fumariaceae | Fumitory | *Fumaria parviflora Lam* | FUMPA |
| | | | Polygonaceae | Knotweed | *Polygonum aviculare* | POLAV |
| | | | Papaveraceae | Poppy | *Papaver rhoeas* | PAPRH |
| | | | Brassicaceae | Field mustard | *Sinapis arvensis* | SINAR |
| | | Perennial | Asteraceae | Thistle | *Cirsium arvensis* | CIRAR |
| | | | Brassicaceae | Diplotaxis | *Diplotaxis assurgens* | DIPTE |
| | | Biennial or Perennial | Apiaceae | Wild carrot | *Daucus carota* | DAUCA |
| | Monocots | Annual | Poaceae | Brome | *Bromus sterilis* | BROST |
| | | | Poaceae | Wild oats | *Avena sterilis* | AVEFA |

Overall and in all treatments, there is a marked presence of dicotyledonous species compared to monocotyledons. This presence is greater in the legume rotations (forage pea and lens), compared to the previous cereals (durum wheat, triticale). This result seems to be linked to the combined effect of the early emergence of the grasses and the effect of the weed killer glyphosate (pre-sowing operation).

In terms of quantity, among the species encountered, we recorded the presence of *Avena sterilis, Bromus sterilis* and *Polygonum aviculare*, whose abundance is remarkable. However, other species such as *Sonchus arvensis* L., *Sinapis arvensis* and *Veronica hederifolia*, are present at lower densities but their ability to form dense populations make them critical for crops (Benniou et al., 2016) (Table 3). The competition between weed species and the crop is established at the beginning of the vegetative crop cycle; from the 2-3 leaf stage (Montegut, 1980). This competition effect is more important during the early stages of the crop, it seems to be attributed to the fact that weeds absorb water and nutrients more easily than the crop (Le Bourgois, 1993). This competition becomes very competitive during tillering, and even more when weed seeds germinate deeper (Caussanel, 1989).

*Correlation between the dynamics of weeds and the precipitation recorded in January during the 03 campaigns*

The emergence of weeds in crop fields is spread over practically the whole year. The seeds present in the soil profile are in a physiological state favourable to their germination. The non-dormant seeds are able to germinate as soon as the conditions become favourable (humidity, temperature, oxygen...). However, seeds are not always able to germinate and go through inhibition states (Jauzein, 1986; Popay et al., 1995). Seeds that fail to germinate under favourable conditions are considered dormant (Come & Thevenot, 1982). Dormancy is a characteristic governed by the nature of the morpho-physiological state of the seed (Khan, 1980-1981) and the environmental conditions to which it is subjected. Thus, dormancy would be an adaptive state that optimizes the distribution of germination through time. This is the case of many seeds belonging to annual plants (therophytes, dicotyledons), which require important cold requirements (low temperatures) for the dormancy to be lifted.

The humidity (through precipitation) is an important factor that participates in the germination-raising of seeds and at the same time the propagation of weed plants in crop fields. In this regard, our research was interested in studying the effect of precipitation recorded in January on the spread of weeds afterwards. Indeed, January rainfall often coincided with the second wave of the dicotyledons emergence. Under semi-arid environmental conditions, the temporal distribution of precipitation plays a major role in the germination of weed seeds, especially those in a dormant state. Figure 2 shows that there is a significant correlation between the volume of precipitation recorded in January over the three seasons covered by the study (Fig. 1) and the spread of weed plants.

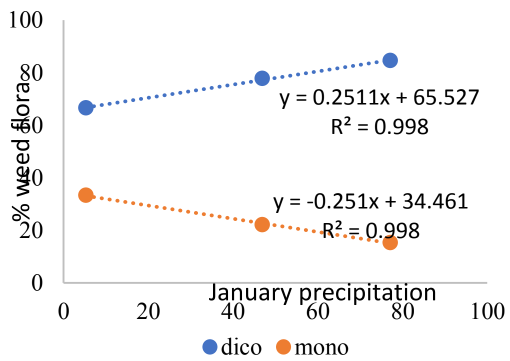


**Fig. 2. Relation ship between January precipitation and the evolution of weed flora during the 03 campaigns**.

The linear model concerning the evolution of the species number of dicotyledons weeds by plot as a function of precipitation recorded in January is Y = 0.2511X + 65.527

This model significantly predicts the presence of weeds ($R^2$=0,998), it indicates that the weed population increases with the increase of precipitation of this month (Fig. 2). However, the linear model related to the evolution of monocotyledons according to the precipitation of the same month shows that they are negatively and significantly correlated with the precipitation of the month of January (Fig. 3). The latter is as follows: Y =-0.251X+461 with ($R^2$ =0.998). The evolution of the weed flora in time is variable according to the campaigns and obeys relatively to the precipitations recorded during the month of January (Figus. 2 and 3). On this purpose, we note that the dicotyledonous species respond favourably to precipitation, this response seems to be attributed to the nature of these species, which are demanding in terms of low temperatures (conditionality of dormancy lifting), and whose germination-emergence occurs during this period (Fig. 3). Emberger (1971) pointed out that each type of climate affects the distribution of species and their development during the growing season through the precipitation and temperature regime.

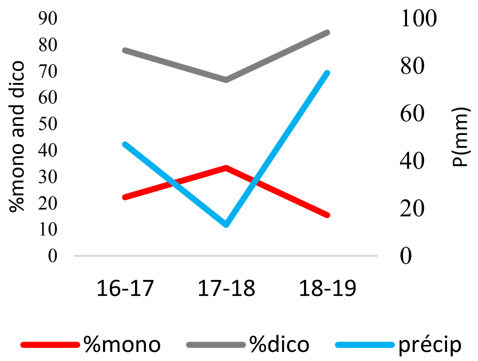


**Fig. 3. Temporal evolution of the weed flora (monocots and dicots) regarding the precipitation of January**

*Study of the diversity of the weed flora.*

The results showed a great variability in emergence from one season to another and within the same season, according to the type of weed plants (periods of appearance) and the cropping conditions (rotation and weed control). The Shannon-Weaver index (H') varied between 0.0265 bit and 1.781 bit (Table 4). Overall, the value of this index (H') is low, which implies that the environment is not very diverse (the case of specialized environments where we generally note the dominance of a single species or a small number of species over all the species in the community). The high values of this index (H') are observed before the glyphosate weeding operation, attesting to a fairly high presence of weed species on all observation stations. The highest score displayed in the first year of the study (1.781 bit) is noted within the forage pea crop in the previous is a barley crop (Table 4). This same value is shown in the 3rd season (2018/2019), at the W/L/W treatment, attesting, an increased presence of weeds within these treatments. However, the counts carried out after the catch-up treatment reveal rather low values of the Shannon index (H'), attesting a reduction of the weed population, under the effect of the chemical weeding operations. The most striking fact of the study is that in the third season (2018/2019), the indices (H') were high during the two counting observations and on all treatments (before and after weed control operations). This situation denotes not only the importance of the diversity of weed species; 07 species in the first count (before total weeding and seeding); and 06 species after the catch-up weeding and also the equitable repair of species at the observation stations (the treatments). This situation seems to be attributed to the non-control of weed management by the applied treatments within the no-till cropping system (Table 4).

On the other hand, Simpson's index varies between 21.11% and 100.00%, which shows that in some conditions there is a strong dominance, punctuated by low values of richness (R). Conversely, the treatments that show low values of Simpson's index are related to high values of richness (R) (Table 4). In the 2018/2019 crop year, the entire plot is sown by durum wheat variety. The crop rotations L/T/W and P/T/W revealed low values of Simpson dominance index, ranging from 0.2181 to 0.6124, respectively. At the beginning of the 3rd season (2018/2019), the observations made on the weed population and the scores given by the studied indices indicate low values of the Simpson dominance index, a high population of weed species, marked by a rather high index score (H'). The Wheat/lentil/wheat treatment has the values: R=8, H'=1.781 and D=23.62%).

For the comparison between the periods of application of the weed chemicals, the results obtained show that: For cereal crops, the catch-up weed control significantly decreases the richness, thus automatically decreases the diversity of the weed flora. However, by its nature as a non-remanent product, total weed control (glyphosate) only influences weed species that emerge early in the autumn.

*Impact of crop rotations on weed development.*

The response of the studied 04 rotations, under the explanatory effect of the Shannon (H') and Simpson (D) indices, (Fig. 4) was very variable according to the previous cereals and/or legumes. Thus, the W/L/W treatment was distinguished by both a high specific diversity and a low dominance, with the presence of 08 species. Conversely, the treatment symbolized by the P/T/W rotation is characterized by a high dominance accompanied by a low diversity, with the dominance of 02 species, namely *Polygonum aviculare* and *Papaver rhoeas* (Fig. 4). This controversial behaviour leads the farmer adopting direct seeding to undertake rotations that can favour dominance to the detriment of diversity, allowing him to manage with more ease the control of the weed flora. It is important to note that in the no-till farming is required to manage the surface layer, which constitutes the bulk of the weed seed stock (Essahat, 2015). The use of an integrated control based on herbicide (glyphosate), supported by diversified and long rotations, leads after 3-4 years to the depletion of the superficial seed stock (El brahli & Mrabet; 2000).

**TABLE 4. Study of the weed flora using some indices during three campaigns**

| Periods | Rotations | Richness $R = {}^0D$ | Shannon Entropy $H' = \ln({}^1D)$ | Shannon's equitability H'/Hmax | Simpson Dominance: λ |
|---|---|---|---|---|---|
| **2016/2017 agricultural Campaign** | | | | | |
| Before catch-up weeding | W | 5 | 1,069 | 0,6642 | 0,5743 |
| | T | 6 | 1,315 | 0,7339 | 0,3565 |
| | L | 5 | 0,847 | 0,5266 | 0,3565 |
| | P | 6 | 0,937 | 0,5229 | 0,4770 |
| After catch-up weeding | W | 2 | 0,0427 | 0,06172 | 0,9862 |
| | T | 3 | 0,0265 | 0,00241 | 0,9933 |
| | L | 2 | 0,0533 | 0,0769 | 0,9817 |
| | P | 2 | 0,0235 | 0,0339 | 0,9931 |
| **2017/2018 agricultural Campaign** | | | | | |
| Before applying glyphosate | W/L | 5 | 1,314 | 0,8167 | 0,3772 |
| | T/P | 5 | 1,781 | 1,107 | 0,2111 |
| | L/W | 3 | 0,2066 | 0,4131 | 0,8008 |
| | P/T | 5 | 1,6393 | 0,8055 | 0,3825 |
| After applying glyphosate | W/L | 2 | 0,5607 | 0,8089 | 0,6800 |
| | T/P | 2 | 0,4162 | 0,6005 | 0, |
| | L/W | 1 | 0 | / | 1 |
| | P/T | 1 | 0 | / | 1 |
| **2018/2019 agricultural Campaign** | | | | | |
| Before applying glyphosate | W/L/W | 8 | 1,781 | 0,8563 | 0,2362 |
| | T/P/W | 7 | 1,482 | 0,7618 | 0,3208 |
| | L/W/W | 6 | 1,404 | 0,7836 | 0,3238 |
| | P/T/W | 6 | 1,385 | 0,7731 | 0,3451 |
| Before catch-up weeding | W/L/W | 7 | 1,458 | 0,7491 | 0,2698 |
| | T/P/W | 7 | 1,501 | 0,7713 | 0,2688 |
| | L/W/W | 7 | 1,661 | 0,8538 | 0,2181 |
| | P/T/W | 7 | 1,558 | 0,8005 | 0,6124 |
| After catch-up weeding | W/L/W | 6 | 1.004 | 0,5604 | 0,4300 |
| | T/P/W | 6 | 1,358 | 0,7578 | 0,3909 |
| | L/W/W | 6 | 1,248 | 0,6967 | 0,4165 |
| | P/T/W | 6 | 1,262 | 0,7042 | 0,4079 |

**W**=Wheat, **T**= Triticale, **L**= Lentil, **P**=Peas.

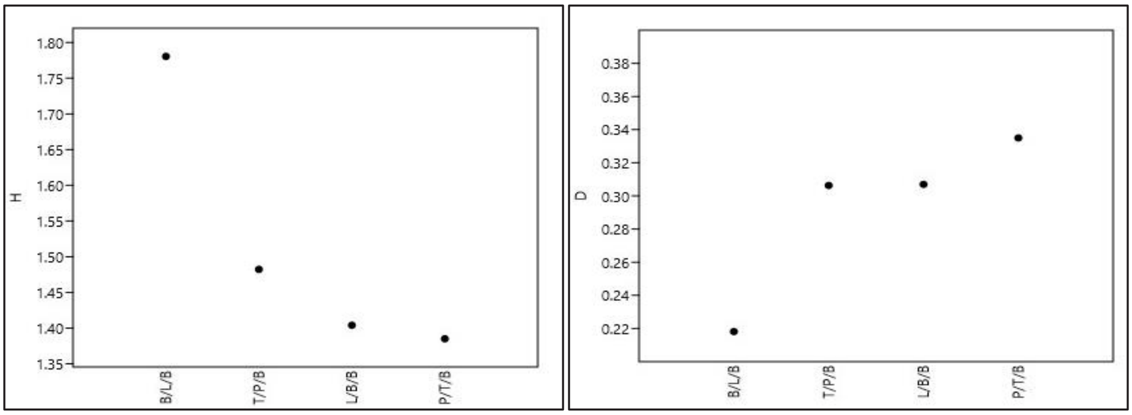


**Fig. 4. variation in Shannon diversity (H ') and Simpson abundance (D) (2017/2018 agricultural campaign)**

A principal component analysis (PCA) was performed to make a graphical checking and therefore verify the location of the measured variables in relation to the treatments, namely the previous crop (durum wheat, triticale, lens, and forage pea) (Fig. 5). The first two axes of the PCA explain 89.80% (2016/2017), 94.55% (2017/2018) and 92.35% (2018/2019) of the total variation. Thus axis 1, explains 56.34% (2016/2017), 64.80% (2017/2018) and 57.84% (2018/2019) (Fig. 5), while the second axis contains: 33.47% (2016/2017) 29.75% (2017/2018) and 34.51% (2018/2019). For the different treatments the reading of the values reported by the two axes indicates that the axis1 is positively related to the treatments whose previous is a cereal (durum wheat, triticale). On this same axis 1, is linked negatively the treatments whose previous is a leguminous (forage pea, lens).

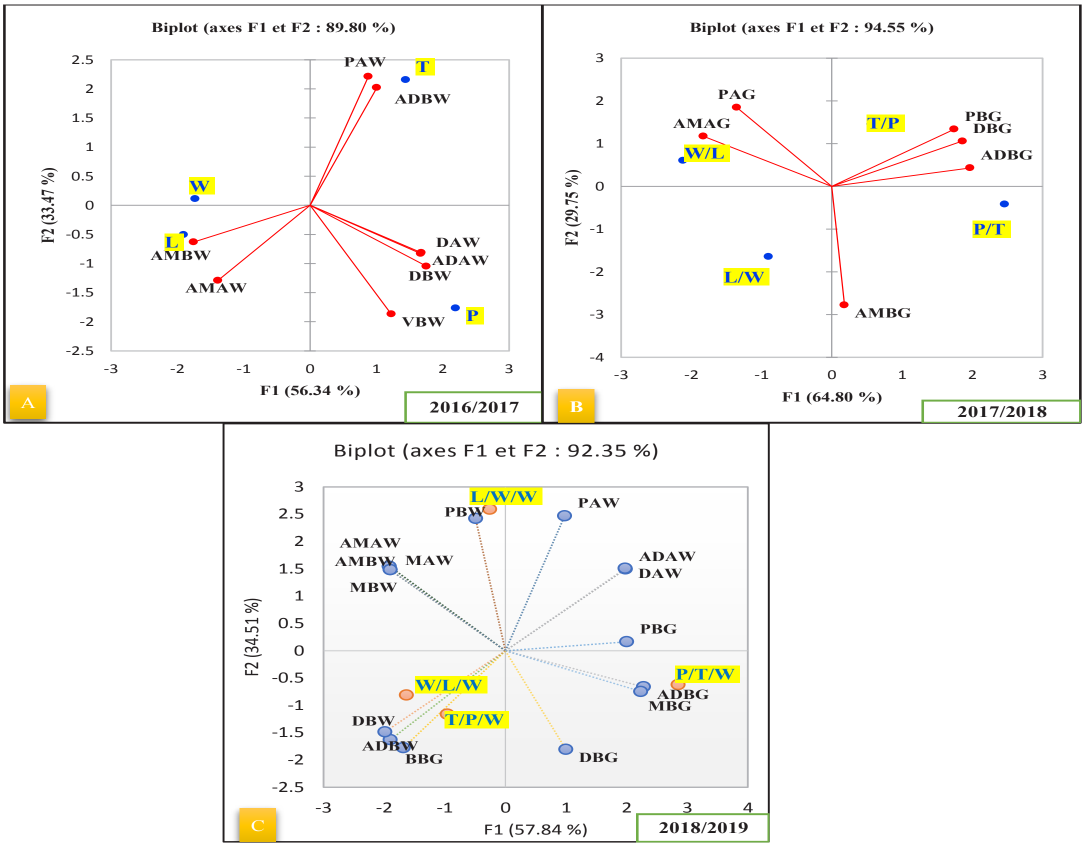


**Fig. 5. Evolutionary temporal representation of the measured variables, relative to the studied treatments (rotations) on the plane formed by axes 1 and 2 of the principal component analysis**

Figure 5 c summarizes the situation of the weed flora for the 04 studied treatments, the L/W/W treatment is located on the positive side of axis 2 and is linked to the cryptophyte plants (perennials) before the catch-up weeding (PBW) and the perennials identified after the catch-up weeding (PAW). On the opposite side of this group and on the negative side of the same axis, we observe the positioning of the T/P/W and P/T/W treatments (treatments formed by legumes) forming a solid group together with the weed species of broadleaf types before the application of catch-up weed control (DBW), broadleaf annuals before the application of catch-up weed control (ADBW) and biennial species before the application of glyphosate (BBG). However, the P/T/W treatment falls on the positive side of axis 1 and is strongly linked to the species observed before the application of total glyphosate weed control of grass (*Bromus sterilis* and *Avena sterilis*) and broadleaf therophytes. This treatment is opposed to the other two rotations constituted by legumes (forage pea and lens) namely: W/L/W and T/P/W.

Overall, Figure 5c shows that the cereal-based treatments (triticale and durum wheat) were most effective in controlling perennial weed species (*Cirsium arvensis* and *Diplotaxis assurgens*), while the legume-based rotations (lentil and pea) appeared to have no effect on broadleaf weed control. This relative control of annual weed species by cereal-based rotations (*Bromus sterilis* and *Avena sterilis*), seems to be attributed to the effect of the catch-up treatment done on triticale and durum wheat during the tillering vegetative stage. The positive role played by the glyphosate weeding operation carried out after seeding should be noted for all the treatments.

## Conclusion

In the present study, different traits were evaluated by estimating various effects under no-till cropping systems, the proliferation of weeds is partly controlled by tillage (ploughing and shallow cultivation), combined with the use of herbicides. However, in no-till agriculture only the chemical option integrated with the adoption of rotations and competitive practices is possible. In this regard, this work was undertaken with the aim of knowing and understanding the evolution of the weed flora under no-till conditions and in parallel, testing a possible eco-friendly management effect of crop rotations on weeds. For this purpose, different rotations based on cereals and legumes were developed, namely: wheat/lentil/wheat, lentil/wheat/wheat, triticale/forage pea/wheat and forage pea/triticale/wheat and tested during 03 crop years 2016/17, 2017/18 and 2018/19. We believe that this work could be continued with longer and more diversified rotations by integrating crops that are sown in spring such as corn and spring chickpeas. In our study, the amounts of precipitation recorded in January contributed significantly to the emergence of the second wave of dicotyledon weeds. the management of the weed flora in no-till remains a major constraint and reading our results, we suggest that we should move towards long and diversifying crop rotations, by introducing crops which are sown in spring.

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## دراسة تأثير الأنواع المختلفة من المحاصيل السابقة على ديناميكيات الأعشاب الضارة تحت نظام البذر المباشر في الجزائر.

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تهدف هذه الدراسة إلى تقييم تأثير الدورات الزراعية على ديناميكيات الأعشاب الضارة في ظل ظروف تجريبية تحت نظام البذر المباشر. تم اختبار أربع دورات للمحاصيل: القمح / العدس / القمح (W / L / W)، العدس / القمح / القمح (L / W / W)، التريتيكال/علف البازلاء / القمح (T / P / W) والأعلاف البازلاء / التريتيكال/ قمح (P / T / W)، خلال المواسم الفلاحية 2016/17 و2017/18 و2018/19. أجريت التجربة في الموقع التجريبي التابع لـلمعه التقني للزراعات الكبرى في ولاية سطيف (الجزائر). تشير النتائج إلى أن الأعشاب الضارة تتكون من 13 نوعًا تنتمي إلى 09 عائلة. لوحظت ثنائية الفلقة في الغالببنسب 77.77٪، 66.66٪، 84.62٪ للمواسمالفلاحية 2016/17، 2017/18 و2018/19 على التوالي. تتكون الأعشاب السنوية (أحادية الفلقة) من Avena Sterilis وBromus Sterilis. تُظهر مؤشرات شانون وسيمبسون قيمًا مثيرة للجدل اعتمادًا على العلاجات المطبقة. تم تمييز تناوب المحاصيل W / L / W بكل من التنوع النوعي والهيمنة المنخفضة، وعلى العكس من ذلك، فإن معاملة P / T / W تظهر هيمنة عالية مصحوبة بتنوع منخفض. يوضح النموذج الخطي المتعلق بتطور الأحاديات كدالة لهطول الأمطار أنها مرتبطة سلبًا وبشكل كبير بهطول الأمطار في شهر جانفي كالتالي: $Y = -0.251x + 34.461$ مع ($R^2 = 0.998$).