International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 12 No. 1, 2026
https://theaspd.com/index.php

The Relationship Between The Density Of Some Winter Grains Weeds And Durum Wheat Yield In Semi-Arid Area

Djamel Kholkhal*[1], Choukry Kazi Tani[2]
[1]Laboratory of Conservatory Management of Water, Soil and Forests and Sustainable Development of Mountainous Areas of the Tlemcen Region, Department of Forest Resources, Faculty of Nature and Life Sciences and Earth and Universe Sciences, Abou Bekr Belkaid University of Tlemcen, BP 119 13000, Tlemcen, (Algeria) ; ORCID : https://orcid.org/0000-0003-0529-7109.
[2]Department of Pharmacy, Faculty of Medicine, Abou Bekr Belkaïd University, B.P 123, 13 000 Tlemcen, (Algeria).
* Corresponding author, E-mail : *djamel_agro@yahoo.fr*

ABSTRACT
The aim of this study is, firstly, to demonstrate the decline in the yield of durum wheat (Vitron variety) in relation to the levels of infestation by some weed species, in this case : Papaver rhoeas L., Sinapis alba L. and Raphanus raphanustrum L. These species were selected according to their prevalence in the various crop plots within the study area. Secondly, the aim is to determine their respective damage thresholds, beyond which these weeds become a threat and it becomes economically necessary to control them.
The results show that the three weed species studied behave in the same way and appear to be more harmful to durum wheat crops. Where there were more than 5 weed/m^2, a significant decline in yield was observed, resulting in an average loss of around 45.90%. Yield components were also influenced by the increasing density of weeds, where a difference per square metre was recorded in the control plots compared with the infested plots of approximately 76 ; 83 and 89 in terms of the number of wheat plants, the number of tillers and the number of ears, respectively. This results in a loss of approximately 2817 seeds/m^2 and a decrease in total yield of around 10 Q/ha. A density of more than 5 weed/m^2 can be considered a level of infestation at which weed control becomes necessary against these three species in a durum wheat crop grown in a semi-arid area.
Keyword : *Weed Density, Winter grains, Durum Wheat, Yield component, Semi-Arid Areas.*

1. INTRODUCTION

The cereal sector plays a dominant role in Algerian agriculture, both in terms of the large area it covers, nearly 47.26% of the utilised agricultural area, or approximately 4.997 million hectares [1], and because it forms the basis of the local population's diet. Cereal crops such as soft wheat and durum wheat occupy a strategic place in the national economy and in the country's food system [2]. Couscous made from durum wheat or barley has a distinctive traditional character in this North African country.
Grain farming is regarded as a long-standing practice in Algerian agriculture ; numerous texts and archaeological remains indicate that the cultivation of barley and wheat in Numidia was well established before the 3rd century [3 ; 4].
At present, grain crops are grown across all bioclimatic zones, including the Saharan regions. This cultivation is concentrated in three main regions, which differ according to the levels of rainfall they receive : The region with high production potential in the northern Tell Atlas (Mitidja, Kabylie, Seybouse Valley, Soummam Valley, etc.), with rainfall exceeding 500 mm/year. Then, the region with moderate potential in the west of the country, characterised by a semi-arid climate and annual rainfall of between 400 and 500 mm (the Médéa Mountains, the hills of Tlemcen, the Chélif Valley, etc.). Finly, the region with low potential, situated in the high plateaus stretching from east to west (the Aurès Mountains, the plains of Annaba, Constantine, etc.), with an average annual rainfall of less than 350 mm [5 ; 6].
Since 2000, and despite the upward trend in production levels and the improvements achieved through the revitalisation of the agricultural sector following the implementation of various agricultural support programmes, as well as the promotion of highly profitable prices for grains, local production remains insufficient and exhibits inter-annual fluctuations [6].

To meet the enormous and ever-growing demand driven by strong demographic growth and an increase in livestock numbers, 70% of the country's grains consumption is imported from the international market to ensure food security. As a result, Algeria remains one of the world's largest wheat importers [7].

It is important to note that cereal cultivation in Algeria remains subject to various constraints, and that low yields are primarily related to climatic conditions, due to generally insufficient rainfall that is unevenly distributed both spatially and temporally, with late frosts and water stress at the end of the growing season constituting a major limiting factor on cereal productivity and resulting in a harvest from only two-thirds of the area sown annually. Furthermore, the incorrect application of soil preparation techniques and the use of unsuitable equipment make cereal production entirely unpredictable and insufficient.

Weeds have a particularly detrimental effect on crops, partly due to the competition they exert for light, water and nutrients [8] and, on the other hand, by contaminating the crop and increasing the soil's seed potential (seed bank), thereby reducing crop quality through an increased percentage of impurities in the harvest, unpleasant taste and odour, and the presence of toxic seeds [9 ; 10 ; 11 ; 12 ; 13]. They create conditions conducive to the spread of diseases and pests, as well as causing complications in farming operations [14]. On a global scale, inadequate weed control results in estimated crop losses of 34% [15], for cereals, 20 to 30% [9 ; 16], For wheat, losses range from 10.2% to 37.1% [17]. In Africa, they can account for 50 to 60% in cereal-growing areas heavily infested with weeds [18]. In Algeria, they range from 20 et 50% [19 ; 20 ; 13].

However, having reached this point, the question that arises is this : at what density do weeds begin to cause yield losses ? Or, at what level of infestation is it necessary to take action to control weeds ?

The aim of this study is to determine the damage threshold for three winter grain weeds : *Papaver rhoeas* L. (Papaveraceae), *Sinapis alba* L. and *Raphanus raphanustrum* L. (Brassicaceae), the most common ones, in durum wheat fields located in a semi-arid bioclimatic area, as in the case of the Ain Fezza region, Tlemcen province, western Algeria.

2. MATERIALS AND METHODS

2.1. Study area

The region covered by our study is situated in the western part of Western Algeria ; it forms part of the Tlemcen Mountains and Tlemcen National Park. Located at an altitude of 850 m, it covers an area of 14,430 hectares. The municipality of Ain Fezza consists of mountainous areas interspersed with plains and depressions characterised by significant agricultural potential: Cereal farming, fruit tree cultivation, vegetable crops and livestock farming (sheep, cattle and goats). The latter constitutes a complementary activity to crop production.

This region belongs to the upper semi-arid bioclimatic zone with a temperate winter, characterised by an average annual rainfall of around 500 mm, distributed unevenly throughout the year. Winter and spring are the wettest seasons, autumn sees an average amount of rain, and summer is marked by a scarcity of rainfall. The average annual temperature is 15.6°C, with an average maximum temperature of 32.3°C in the hottest month (July) and an average minimum temperature of 3.8°C in the coldest month (January) [21].

The soil cover of the study area is characterised by a diverse mosaic of soils. It comprises three main types of soil formations : Reddened soils, calcimagnetic soils and underdeveloped soils [21].

2.2. Methodology

For this study, the cereal crop cultivated in the study area and consistently found in the analyzed plots was durum wheat (Vitron variety). The first aim is to demonstrate the decline in yield of this crop according to the infestation levels of several weed species, specifically : *Papaver rhoeas* L., *Sinapis alba* L., and *Raphanus raphanustrum* L. These species were chosen based on their prevalence in the different cultivated plots in this area.

Secondly, it is necessary to determine their respective threshold of harmfulness from which these weeds become a nuisance and it is economically necessary to remove them.

Methods for estimating cereal yields depend on the sowing method (row sowing, broadcast sowing). In this study, the plot under investigation was sown by broadcast sowing. Yield estimates can only be made

once the grains have fully ripened. It should be noted that this grain is grown using an extensive farming system relying entirely on rainwater.
One-square-meter frames were used and placed on test plots selected on the basis of the presence of the weeds under study. Within these plots, the following agronomic parameters were measured or calculated during the various trials : Wheat plant density, number of tillers, number of ears, number of grains per ear, a thousand-grain weight and number of weed plants. The same measurements were taken for the control plots, which is free from weeds.
On the same 20-hectare plot of durum wheat, this experiment was repeated 100 times. A true sample contains more small and medium-sized ears than large ones. To avoid skewing the statistical results, the edge rows (edge effect) and headlands (exceptional micro-site conditions) were excluded.

2.3. Yield estimates

The method used to estimate the theoretical grain yield of wheat is that adopted by the Institute of Agricultural Engineering [22]. The average yield (g/m²) is calculated using the following equation :
Yield (g/m²) = Number of ears/m² × Number of grains/ear × Grain weight (g)
Where :

- Number of grains per/m² = Number of ears/m² × Number of grains/ear
- Number of grains/ear = $\frac{\text{Total number of grains counted}}{\text{Ntotal number of ears collected}}$
- Weight of a grain (g) = A thousand-grain weight /1000

Yield (q/ha) = $\frac{\text{Yield (g/m2) x 10 000}}{\text{100 000}}$
It refers to the theoretical yield ; account must be taken of losses due to deseeding and during harvesting, which can be estimated at 15%.
Expected yield (q/ha) = Theoretical yield (q/ha) x 0,85

2.4. Statistical analysis

All analyses were carried out using Excel 2016 and R 3.0.2. Analyses of variance for the mean values of the measured parameters were performed at a significance level of 5%. Where a significant difference was found, multiple comparisons of means were carried out using Tukey's test [23].

3. RESULTS AND DISCUSSION

The results in Table 1, relating to the effect of weed density on the various parameters measured per square metre, clearly show a marked difference between the averages recorded in the two plots (control and infested). Statistical analysis revealed a highly significant difference (p=0.000) in the number of wheat plants, the number of tillers and the number of ears, with a difference between the means of the two plots of 76 ; 83 and 89 respectively. Furthermore, in the infested plots, we observed a significant number of tillers without ears, which was three times as much than that recorded in the control plots.
Table 1, also shows the effect of weed presence on yield components. The ears from the control plots contain more seeds, resulting in an average difference of approximately 2817.4 g/m² and a gain of 9.4 g/m² in the weight of 1,000 seeds compared to plots with weeds, representing an average reduction in grain yield of approximately 45.90%.

Table 1. Effect of weed density on yield components

Measured parameters	Control plots			Infestated plots			Significant level
	Max.	Min.	Average	Max.	Min.	Average	
Wheat plants/m²	222.00	164.00	186.50	160.00	55.00	110.80	**
Tillers/m²	291.00	201.00	224.50	198.00	70.00	141.50	**
Ears of wheat/m²	221.00	185.00	200.00	179.00	52.00	110.60	**
Tillers without ears/m²	20.00	04.00	14.00	86.00	21.00	44.00	**
Grains/ear	49.40	44.00	46.60	42.20	24.50	34.30	*

Grains/m^2	8121.50	5705.00	6493.70	5552.00	1366.20	3676.30	**
Weight of 1000 grains	54.90	52.70	53.40	51.80	35.40	44.00	*
Theoretical grain yield g/m^2	287.50	203.50	244.30	190.00	95.00	132.30	**
Theoretical grain yield q/ha	28.70	20.30	24.40	19.00	09.50	13.20	**
Expected yield q/ha	24.40	17.20	20.70	16.10	08.00	11.20	**

** significant ; ** highly significant at $p\leq0.05$* (Source : Authors)

Table 2. Effect of Weed Density on durum wheat yield

Weed		Weed density /m^2)						Yield reduction from control %
		0	[1-5]	[6-10]	[11-15]	[16-20]	[21-25]	
S. alba	Average yield g/m^2	244.35	177.09	146.63	118.38	92.41	-	45.16
P. rhoeas			193.23	152.08	140.73	108.60	99.04	43.21
R. raphanistrum			199.58	146.56	133.46	93.36	90.83	45.66

(Source : Authors)

The results of the variation in wheat yield were classified into five categories for both species *P. rhoeas* et *R. raphanistrum* and only in four classes for *S. alba*. Analysis of Table 2 shows a gradual decline in yield (g/m^2) as the number of each weed species present in the sampled plots increases. The average yield reduction is approximately 45.16% for the four classes of *S. alba* and 43.21% and 45.66% for the five classes of *P. rhoeas* and *R. raphanistrum* respectively compared with the control.

The scale of the losses recorded in this study is confirmed by [24 ; 25 ; 26 ; 27 ; 28] in a number of studies on weed competition, such as : *Setaria viridis* and *Avena fatua* in wheat cultivation, *Echinochloa crus-galli* in rice and *Xanthium strumarium* for soybean cultivation.

Analysis of the influence of the independent variable (weed density) on the dependent variable (theoretical yield of durum wheat) reveals a high correlation coefficient of $r = -0.85$ and a negative regression coefficient, indicating that there is a strong negative correlation between the two variables. In this case, an increase in *S. alba* density leads to a significant reduction in yield (Fig. 1). The equation of the line of linear regression $y = -7.797x + 214.45$, The value of x obtained by substituting y (yield loss) into the equation represents the damage threshold for this weed, which is 5 plants/m^2. Our results are supported by several studies, notably those by [29 ; 30 ; 31 ; 32 ; 33], on this species, which has varying degrees of harmfulness : (i) a species that germinates early and grows very rapidly, (ii) several generations can be produced each year, (iii) a fairly substantial above-ground which forms a screen around the crops, (iv) a highly competitive species due to its particularly well-developed root system, (v) Allelopathy.

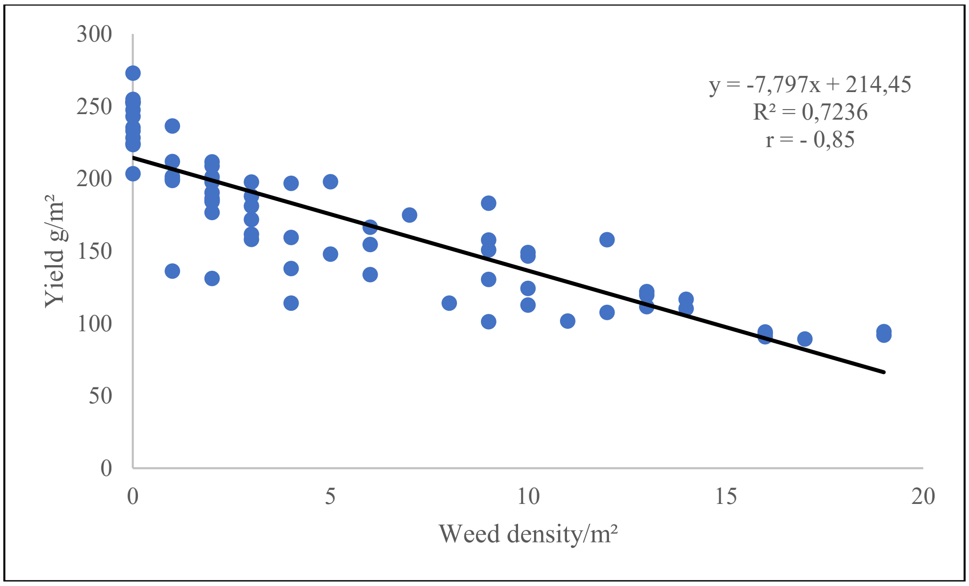

Figure 1. The line of a linear regression relationship depicting the effect of increasing density of *S. alba* on durum wheat yield

The scatter plot (Fig. 2) shows that high values of the density variable for *P. rhoeas* are associated with low values of the yield per m² variable, with a very high correlation coefficient of r = -0.88, indicating a very strong negative correlation between the two variables studied. This means that this weed can be classified as a harmful species for winter durum wheat cultivation [29 ; 34]. This harmful effect can be explained by [35 ; 36 ; 37] by its widespread presence, its very high seed production per plant around 50,000 seeds, the maximum viability of its seeds, which lasts around 40 to 60 years, and its allelopathic properties.

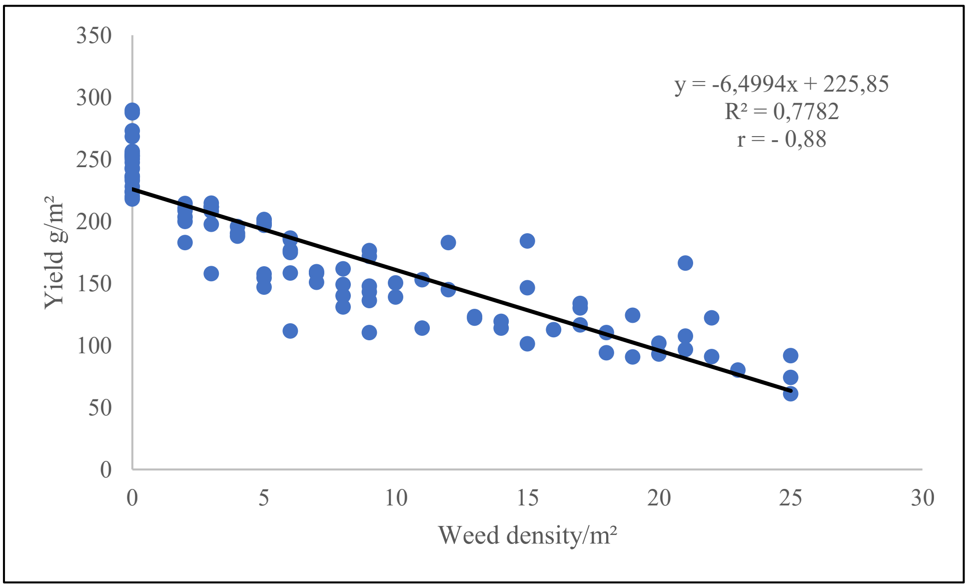

Figure 2. The line of a linear regression relationship depicting the effect of increasing density of *P. rhoeas* on durum wheat yield

Analysis of the linear regression graph, represented by a scatter plot with a fitted line (Fig. 3), provides a better understanding of the relationship between the two variables per square metre across the entire sampled plot ; in this case, we observe a steep downward trend as the explanatory variable (density of *R. Raphanistrum*) increases, the dependent variable (durum wheat yield) decreases rapidly beyond 5 plants/m². Statistically, the correlation coefficient r = −0.85 indicates a strong negative relationship,

and the high coefficient of determination $R^2 = 0.73$ indicates a better fit of the data to the regression line and a stronger relationship between the variables.
The results obtained show that wild radish affects yield in various ways, from germination through to growth, heading and seed maturation in durum wheat. This may be due to the allelopathic effect of this weed. These results are similar to those found by [38 ; 39]. Moreover, [40] point out that it harbours pathogenic bacteria, fungi and viruses that can infect contaminated crops.

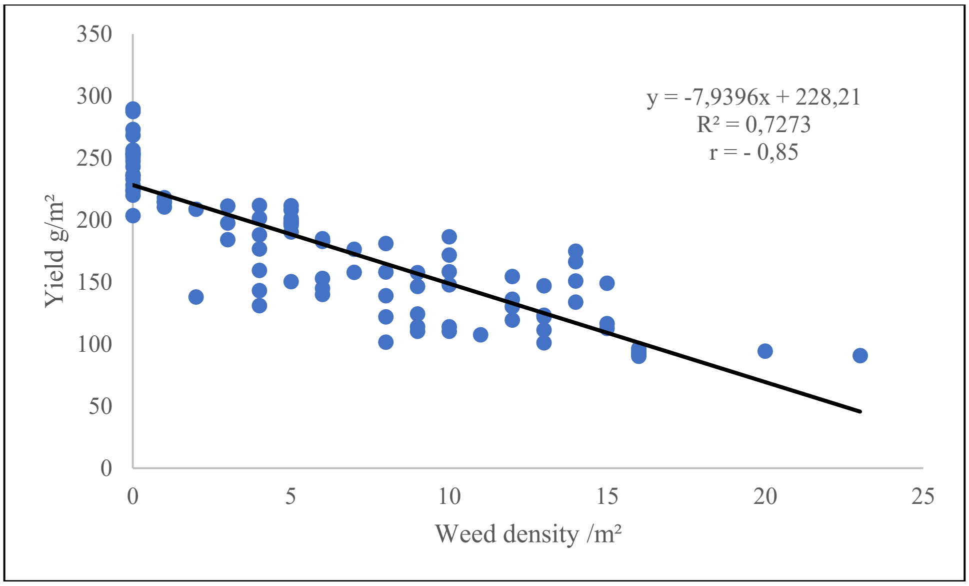

Figure 3. The line of a linear regression relationship depicting the effect of increasing density of *R. Raphanistrum* on durum wheat yield

In reviewing the literature on the impact of weeds on cereal cultivation, and in particular on durum wheat, we found that the weed flora studied in this research consists of plants with an annual life cycle that coincides with that of the crop; they complete their life cycles within the agricultural year and reproduce via seeds [41]. Regarding interactions between weeds and the crop, [42, 43] argue that plants growing at the same time and those growing side by side in a given space, in most cases, compete for the light, nutrients and water available in that space; they do not compete for the space itself. This competition represents one of the major constraints on the growth of certain crops, particularly in areas with more extreme temperatures and low rainfall, especially in developing countries [44].
Furthermore, weeds reduce cereal yields by as much as 20 to 50% in heavily infested areas [19 ; 18] and in terms of quality, where most cereal producers are well aware of the problem of weed seeds, as well as the resulting losses during sorting and cleaning, as they are difficult to separate [28 ; 45]. Research into the allelopathic effects of weeds on wheat has been reported by several researchers [46 ; 47 ; 48]. The allelopathic properties of invasive weeds have also been investigated [49]. In another study [50] investigated the bioherbicidal activity of some winter weeds on soya, mung beans and maize.
According to [34 ; 51 ; 52], some weeds host the same pests and predators as cultivated plants, and so they act as potential breeding grounds for these pests. Furthermore, they create an environment conducive to the development of diseases.

4. CONCLUSION

The results of this study suggest that, in semi-arid areas, durum wheat cultivation is influenced by rainfall and in particular its distribution throughout the growing season and other adverse weather conditions (frosts and sirocco winds), as well as by the conditions under which the crop is established (cultivation practices). Furthermore, during a growing season, competition between wheat and weeds is evolving : at the start of the growing cycle, weeds are responsible for most of the competition with wheat, whereas, at the end of the cycle, they influence yield and its components, affect the difficulty and quality of harvesting, and increase the seed bank in the soil.

Indeed, it appears that *S. alba* L., *P. rhoeas* L. and *R. raphanistrum* L. seem to be more harmful to winter durum wheat. This has been well documented by the majority of weed science research conducted elsewhere. When the density of weed exceeds 5 plants/m^2, a significant drop in yield has been observed, with an average loss of around 45.90% compared to uninfested plots. This density can be regarded as the threshold at which weed control becomes necessary for these three species in a durum wheat grown in a semi-arid area.

Further, it is difficult to determine the exact damage threshold for each weed. This is because we do not have a sufficient understanding of how it behaves towards each crop, nor how this behaviour will manifest itself on different soil types, depending on the season and annual weather conditions, and also take into account cultivation practices and the presence of other weeds.

REFERENCES

[1] Recensement général de l'agriculture, RGA., 2001, Ministère de l'Agriculture et du Développement Rural, Alger (Algérie). Direction des Statistiques Agricoles et des Systèmes d'Information, 125 p.

[2] Djermoun, A., 2009, La production céréalière en Algérie : les principales caractéristiques. Nature et Technologie 1, 45-53.

[3] Bessaoud, O., 1999, L'Algérie agricole : de la construction du territoire à l'impossible émergence de la paysannerie. Insaniyet 3(1), 5-32.

[4] Rahal-Bouziane, H., 2015, L'orge en Algérie : passé, présent et importance pour la sécurité alimentaire, face aux nouveaux défis. Recherche Agronomique 17(27), 1-24.

[5] Chehat, F., 2007, Analyse macroéconomique des filières, la filière blés en Algérie. Projet PAMLIM « Perspectives agricoles et agroalimentaires Maghrébines Libéralisation et Mondialisation » Alger : 7-9 avril 2007.

[6] Chabane, M. and Boussard, J. M., 2012, La production céréalière en Algérie : Des réalités d'aujourd'hui aux perspectives stratégiques de demain. 20 pp. Hal-02804678.

[7] Sassi, Y., 2007, Transformation des céréales. Recueil des fiches sous sectorielles. Ed. PME Edition 47-76.

[8] Gazoyer, M., Aubinau, M., Bougler, J., Ney, B. and Roger-estrade, J., 2002, La rousse agricole. Ed. La Rousse, Canada, p. 23.

[9] Caussanel, J.P., Barralis, G., Vacher, C., Fabre, E., Morin, C. and Branthomf, X., 1986, La variation des seuils de nuisibilité des mauvaises herbes : résultats expérimentaux. Perspectives agricoles 109, 22-28.

[10] Caussanel J. P., 1989, Nuisibilité et seuils de nuisibilité des mauvaises herbes dans un système de culture annuelle : situation de concurrence bispécifique. Agronomie 9, 219-240.

[11] Araniti, F., Sorgonà A., Lupini, A. and Abenavoli, M.R., 2012, Screening of Mediterranean wild plant species for allelopathic activity and their use as bio- herbicides. Allelopathy Journal 29(1), 107-124.

[12] Kouakou, J.N., Kouame, F.K., Ipou, J.I. and Gue, A., 2016, Importance relative des mauvaises herbes de la culture du maïs dans le département de M'Bahiakro. International Journal of Innovation and Applied Studies 17(3), 768-778.

[13] Zedam, A., 2022, La Malherbologie (Approches Ecologique, Scientifique et Agro-Technique). Collection scientifique de la Faculté des Sciences. Université Mohamed Boudiaf, M'Sila. 99 p.

[14] Alhaithloul, HA.S., 2019, Prevalence study of weeds in some economic orchards trees. Asian Journal of Agriculture and Biology 7(4), 512-518.

[15] Jabran, K., Mahajan, G., Sardana, V. and Chauhan, B.S., 2015, Alellopathy for weed control in agricultural systems. Crop Protection 72, 57-65.

[16] Moussaoui, K., Boucheref, A., Zekkari, I., Verdeguer, Sancho, M. et Djazouli, Z., 2017, Potentiel allélopathique de bioproduits formulés à base d'huiles essentielles de Pistacia lentiscus (L., 1753) et de Cupressus arizonica (Greene, 1882). Agrobiologia 7(2), 539-547.

[17] FAO., 2013, The State of Food and Agriculture. Food Systems for Better Nutrition. Food and Agriculture Organization of the United Nations. Rome.

[18] Labrada, R., 1992, Tropical Weeds: Status and trends for their control. 1st Intenational Weed Control Congress, Melbourne 17-21 February; 2, 263-276.

[19] Laddada M., 1979, Rôle des mauvaises herbes dans la production céréalière et les effets des différentes méthodes de lutte. Céréaliculture 11, 23-24.

[20] Hamadache, A., 1995, Les mauvaises herbes des grandes cultures. Biologie, écologie, moyens de lutte. ITGC, 40 p.

[21] Kholkhal, D., 2009, Contribution au développement agroforestier de la commune d'Ain fezza-Wilaya de Tlemcen (Algérie). Thèse de Magister, Faculté, SNV-STU, Département de Foresterie, Université de Tlemcen (Algérie), 147 p.

[22] ITGC., 2015, Institut Technique des Grandes Cultures, Méthode d'évaluation du rendement en grain des céréales au stade laiteux-pateux, 12 p.

[23] Tukey, J.W., 1949, Comparing individual means in the analysis of variance. Biometrics, 5, 99-114.

[24] Alex, J. F., 1967, Competition between Setaria viridis (green foxtail) and wheat at two fertilizer levels. Res. Rep., Can. Nat. Weed Comm., West Sect. 286–287.

[25] Bell, A.R. and Nalewaja, J. D., 1968, Competition of wild oat in wheat and barley. Weed Sci. 16, 505–508.

[26] Smith, R. J. JR., 1968, Weed competition in rice. Weed Sci. 16, 252–254.

[27] Barrentine, W. L., 1974, Common cocklebur competition in soybeans. Weed Sci. 22, 600–603.

[28] Zimdahl, R. L., 2007, Fundamentals of Weed Science 3th ed., Academic Press, 689 p.

[29] Bailly, R., Mamarot, J. et Psarski, P., 1977, Mauvaises herbes des grandes cultures. 69 espèces importantes présentées au stade plantule. ACTA, Paris.

[30] Liebman, M. & Davis, A. S., 2000, Integration of soil, crop, and weed management in low-external-input farming systems. Weed Research, 40(1), 27-47.
[31] Inderjit C. & Duke S. O., 2003, Ecophysiological aspect of allelopathy, Planta, 217(4), 529-539.
[32] Lebreton, G., Le Bourgeois, T. (2005). Analyse de la flore adventice de la lentille à Cilaos – Réunion. CIRAD, 20 p.
[33] Morra, M. J., Popova I. E. & Boydston R. A., 2018, Bioherbicidal activity of Sinapis alba seed meal extracts. Industrial crops and products 115, 174–181. doi : 10.1016/j.indcrop.2018.02.027.
[34] Pousset, J., 2003, Agriculture sans herbicides : principes et méthodes. Éditions la France Agricole, 704 p.
[35] Michel – Michez, J., 1980, Les semences d'adventices dans le sol - Qu'est qu'une adventice, Cultivar - spécial désherbage, 15-16.
[36] Melakhessou, Z., Demnati F. & Boubaker, Z., 2020, Diagnostic de la diversité des plantes adventices dans les agrosystèmes : cas des champs de blé dans les Aurès, Bulletin de la Société Royale des Sciences de Liège, 89, 39-54.
[37] Kazi Tani, C., Grard, P., Le Bourgeois, T., (2021), AdvenAlg 1.0 Identification et connaissance des principales adventices d'Algérie méditerranéenne. Al Yasmina, 2 (3), 184 p.
[38] Dias, L.S. and Dias, A.S., (2005). Allelopathic effects of Raphanus raphanistrum and interactions of effects on wheat and oat. X Congresso Brasileiro de Fisiologia Vegetal, XII Congresso Latino Americano de Fisiologia Vegetal, 5 p.
[39] Dali, A., Touiri, M., Abbad, M., et Snoussi, S., (2023), Evaluation de l'effet allélopathique du radis sauvage (Raphanus raphanistrum) sur la gérmination du blé dur (Triticum durum) en condition controlée, Agrobiologia 13(1) : 3508-3513.
[40] Warwick, S. I. and Francis, A., 2005, The biology of Canadian weeds. 132. Raphanus raphanistrum. Canadian Journal of Plant Science 85, 709-733.
[41] Reynier, A., 2000, Manuel de Viticulture - Guide technique du viticulteur 8em édition. Ed. TEC & Doc, 514 p.
[42] Booth, B.D., S.D. Murphy, and C.J. Swanton. 2003, Weed Ecology in Natural and Agricultural Systems. CABI Pub., Wallingford, Oxon, UK. 303 pp.
[43] Quillet, M., 2010 - Maitriser la flore adventice : Etude des Stratégies de désherbage mécanique auprès des agriculteurs biologiques. Mém. Ing. Ecole Supérieure d'Agriculture d'Angers, France. 151p.
[44] FAO., 2016, La situation mondiale de l'alimentation et de l'agriculture. Changement climatique, agriculture et sécurité alimentaire. Organisation des Nations Unies pour l'alimentation et l'agriculture, Rome. 190 p.
[45] Valantin-Morison M., Guichard L. et Jeuffroy M-H., 2008, Comment maîtriser la flore adventice des grandes cultures à travers les éléments de l'itinéraire technique ? Innovations Agronomiques, INRAE, 3, 27-41.
[46] Gella, D., Ashagre, H., & Negewo, T., 2013, Allelopathic effect of aqueous extracts of major weed species plant parts on germination and growth of wheat. Journal of Agricultural and Crop Research, 1(3), 30-35.
[47] Afridi, R.A., & Khan, M.A., 2015, Comparative Effect of Water Extract of Parthenium hysterophorus, Datura alba, Phragmites australis and Oryza sativa on Weeds and Wheat. Sains Malaysiana, 44 (5), 693–699.
[48] Zohaib, A., Tabassum, T., Anjum, S. A., Abbas, T., & Nazir, U., 2017, Efeito alelopático de algumas plantas daninhas do trigo associadas na germinabilidade e produção de biomassa de plântulas do trigo. Planta Daninha, 35. https://doi.org/10.1590/S0100-83582017350100089
[49] Ben-ghabrit, S., Bouhache, M., & Akkif, M., 2017, Effets allélopathiques d'une adventice envahissante (Verbisina encelioides (Cav)Benth. &Hook.f.) sur la germination et la croissance de blé dur. Revue Marocaines de protection des plantes, 11, 17-28.
[50] Khan, I.A., Khan, R. and Zarin, S., 2011., Allelopathic effects of Parthenium hysterophorus L. on seed germination and growth of soy bean, mung bean and maize. Herbologia 12, 129-136.
[51] Kouakou, J.N., Kouame F.K., Ipou J.I. et Gue A., 2016, Importance relative des mauvaises herbes de la culture du maïs dans le département de M'Bahiakro. International Journal of Innovation and Applied Studies, 17(3), 768-778.
[52] Alhaithloul, H.A.S., 2019, Prevalence study of weeds in some economic orchards trees. Asian Journal of Agriculture and Biology, 7(4), 512-518.