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Assessing the phytosanitary protection of cereal crops in the Bouira region (Northern Algeria)

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Abstract

The Bouira region has a significant potential for cereal cultivation, covering 65.90% of the total agricultural area. Traditionally, cereal growers have relied on pesticides to control pests, but it is vital to evaluate how these practices align with the principles of cognitive sustainability. This study explores the phytosanitary practices used in cereal cultivation within the Bouira Region and assesses their impact on sustainable agricultural practices. Based on interviews with cereal growers in Bouira's central agricultural areas – El Asnam, El Hachimia, and Ain Bessam – the research was conducted during the 2023/2024 cereal season. The cereals grown include durum wheat, common wheat, barley, and oats, with routinely applied pesticides. Twenty-three pesticides protect these crops and enhance yields, herbicides being the most common, followed by fungicides and insecticides. However, the study found that protective measures were insufficient, as farmers often rely solely on masks and gloves when handling pesticides without fully understanding the associated risks. These findings underscore the urgent need for increased awareness and technical support to boost agricultural productivity and fully integrate cognitive sustainability principles, thereby fostering a more informed and sustainable approach to agriculture that safeguards both environmental and human health.

Keywords: Cereals, Pesticides, Phytosanitary, Cereal Growers, Bouira.

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1. Introduction

Cereals are vital and strategic in Algeria, accounting for around 80% of the country's utilised agricultural area (UAA), including fallow land. Every year, 3 and 3.5 million hectares are devoted to growing these cereals, underlining their crucial role in the country's agriculture and economy (Djermoun, 2009; Salim & Khã, 2021). In Algeria, most cereals are grown using traditional agricultural methods (Ait–Slimane-Ait-Kaki, 2008). Farmers use chemicals such as pesticides, which can have negative environmental impacts, including soil and water contamination. However, agricultural policy is important in supporting Sustainable Development Goals, which require adopting precision agriculture principles. These principles aim to reduce the use of pesticides, fertilisers, and water while improving soil productivity (Biró & Toldi, 2022).

The province of Bouira has made significant progress in quality and quantity in the agricultural sector. It has significant cereal-growing potential, with an agricultural area of 293,544 hectares, representing 65.90% of the total area of 445,434 hectares, according to ANIREF-Bouira (Lamri et al., 2022). This requires using various plant protection products to ensure optimum agricultural production.

However, the indiscriminate and massive use of pesticides represents an environmental and public health challenge on a global scale (Carvalho, 2017; Gressel et al., 2004). In Algeria, we still know very little about the phytosanitary protection methods used by farmers. The few surveys that have been carried out have revealed unusual practices and the use of various unauthorised pesticides in certain regions (Mebdoua et al., 2017; Soudani et al., 2020).

Our work aims to present the current state of pesticide use in cereal crops in the Bouira region. It focuses on aspects related to crops and cereal farmers, lists the products used, their methods and doses, and assesses farmers' understanding of and sensitivity to pesticide use's environmental and health risks.

2. Materials and methods

The study was conducted in the Bouira region, which was chosen for its important role in cereal production in Algeria. The specific areas selected for the survey include the provincial capital (Bouira) and the municipalities of El Asnam, El Hachimia, and Ain Bessam. These areas were chosen due to their diversity in terms of land dedicated to cereal crops, as shown in Figure 1. These sectors represent different agricultural contexts, providing an overview of agricultural practices in this region.

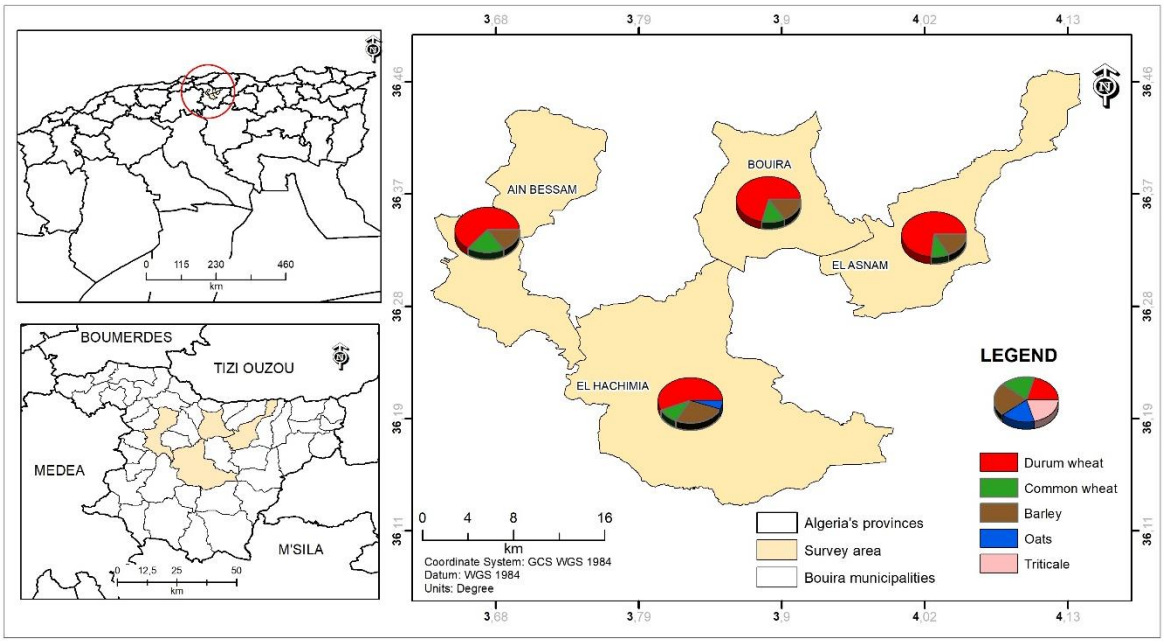

Figure 1 The survey area location and the different cereal acreages

The selection of respondents specifically targeted cereal farmers. Farmers were chosen based on their farms' size, access to pesticides, and level of involvement in cereal production. This choice ensures that the sample is representative of the overall agricultural practices in cereal cultivation in the studied region.

A total of 100 respondents participated in this study. These respondents are cereal producers who own or manage farms of various sizes and use pesticides. The diversity of respondents allows for a broad range of agricultural practices and approaches to the environmental and health challenges associated with pesticide use. The survey was conducted using a

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structured questionnaire designed to gather information on agricultural practices and the use of pesticides. This questionnaire included several key sections:

- Presentation of the farmer: general information about the owner, their area of study or agricultural training, and the size of the farm.
- Identification of the pesticides used: pesticides, fungicides, herbicides.
- Application methods and doses: information on product application methods and quantities used.
- Awareness and understanding of environmental and health risks associated with pesticide use: assessment of farmers' understanding of the potential impacts of pesticide use on the environment and health, as well as the management of empty packaging.

Data were collected in the field during the 2023/2024 cereal season through direct farm visits. During these visits, face-to-face interviews were conducted with the farmers. This allowed for more detailed responses and clarification of certain aspects of the questionnaire. Most farmers completed the questionnaires themselves, but in some cases, the researchers assisted them in ensuring a proper understanding of the questions.

The responses obtained from the questionnaires were analysed to extract trends regarding pesticide use and awareness of risks. The quantitative data concerning cultivated areas and the products used were compiled into tables, such as Table 1, allowing for comparison between the different study areas.

Table 1 Area under cereals in the area studied in 2023/2024

species	The area under cereal crops (Ha)			
	Bouira	El Asnam	El Hachimia	Ain Bessam
Durum wheat	3717.50	2560	5587	5159
Common wheat	747.25	387	1035	1834
Barley	792	550	2904	1207
Oats	31	3	500	60
Triticale	00	00	20	00
total	5287,75	3500	10046	8260

The data in Table 1 describe the distribution of cereal crops in the different studied areas (Central Bouira, El Asnam, El Hachimia, Ain Bessam), indicating the area of each type of crop (durum wheat, soft wheat, barley, oats). These figures provide a better understanding of agricultural activity and production in these regions and the emphasis placed on durum wheat production in the sector.

3. Results and discussion

Our results show a variable distribution of age groups and levels of education, with a predominance of middle-aged farmers and a high level of secondary education in some stations. As far as crops are concerned, durum wheat dominates in all localities, with regular use of pesticides to combat disease and pests. Herbicides dominate. However, there are shortcomings in the use of personal protective equipment and the management of empty packaging.

3.1. Age and level of education of farmers surveyed

In all the localities inspected, we found that all age categories were present, except for Ain Bessam, where the [21–30] and [61–70] age categories were not recorded. In fact, in this station, the age categories [31–40] and [41–50] dominate, with rates of 40% and 46.67% respectively. It is also worth mentioning that the [21–30] age group accounts for only 13.33% in El Asnam and El Hachimia (Fig. 2).

Similarly, various levels of education are present in all the localities, with varying proportions. In the localities of Ain Bessam and El Asnam, 40% of the surveyed farmers have a secondary education level. In Bouira Centre, the university education level is dominant, with a rate of 33.33%. In El Hachimia, farmers with no education have the highest rate (53.33%) (Fig. 3).

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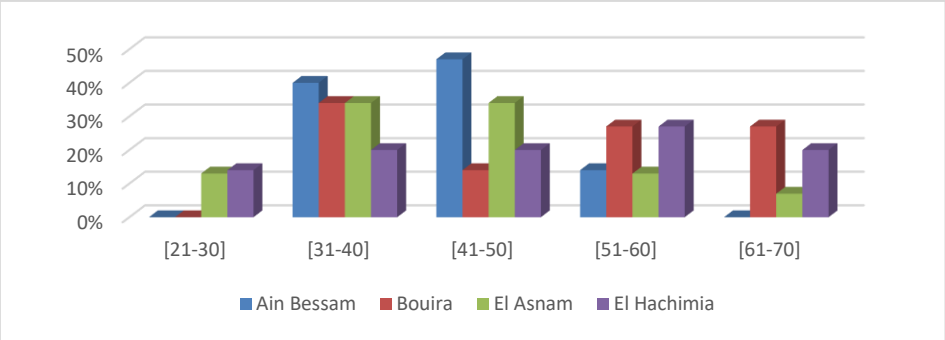

Figure 1 Age of farmers surveyed

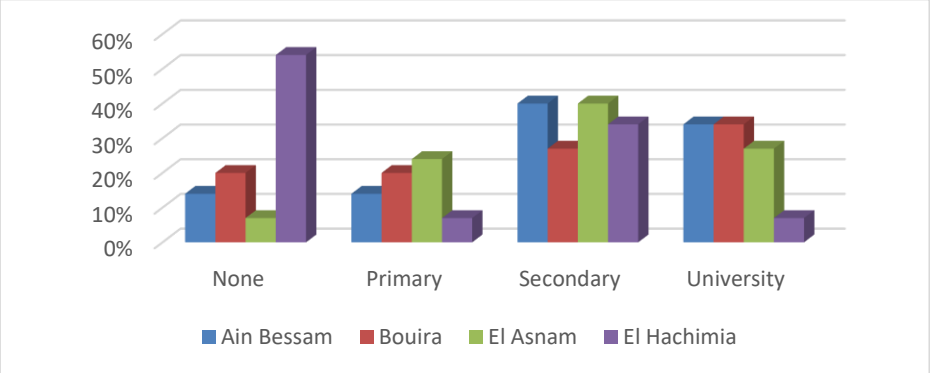

Figure 2 Level of education of farmers

Research by Soro et al. (2019) has shown that farmers' lack of education represents a major risk of poisoning both themselves and the environment, as they are unaware of the high toxicity of plant protection products.

3.2. Grown species

Durum wheat is the leading crop at all the study stations, with rates of 100% at Bouira centre, 86.67% at Ain Bessam and El Asnam, followed by common wheat and barley. By contrast, oat production at Ain Bessam did not exceed 33.33% (Fig. 4). According to the DSA, these crops are less sensitive to climatic and soil conditions and are intended for consumption or marketing.

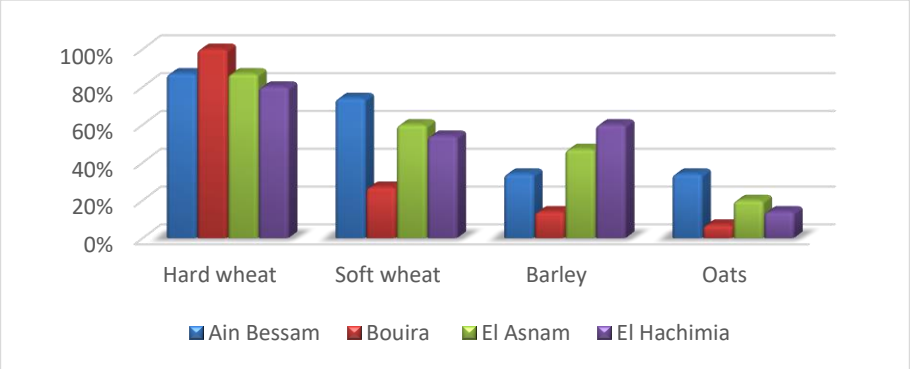

Figure 4 Species grown in the study areas

The dominance of durum wheat is a national trend; in fact, Chourghal et al. (2016) point out that this predominance reflects the overall orientation of agriculture. Similarly, since the economic changes and the end of input and equipment subsidies, durum wheat (43.61% of the area) has once again become the main product, ahead of barley and common wheat.

3.3. Use of pesticides on crops

Most cereal grower respondents regularly use pesticides to prevent and combat attacks by natural enemies. The use rates were 86.67% in El Asnam, 73.33% and 66.67% in Ain Bessam in central Bouira, respectively (Fig. 5 and 6). In El Asnam, all the farms have put preventive measures in place due to an outbreak of yellow rust *(Puccinia triformes)* on wheat. All the farmers interviewed opted for the liquid form of pesticides so that the plants could absorb them more easily.

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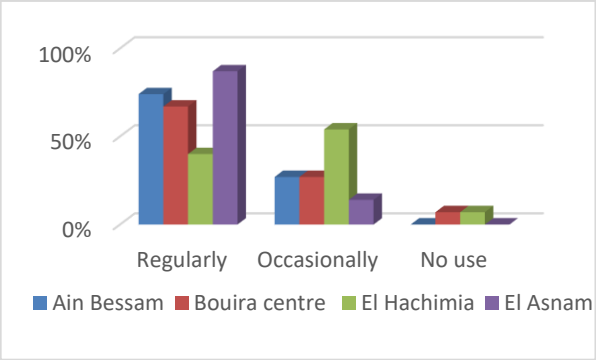


Figure 5 Frequency of pesticide use

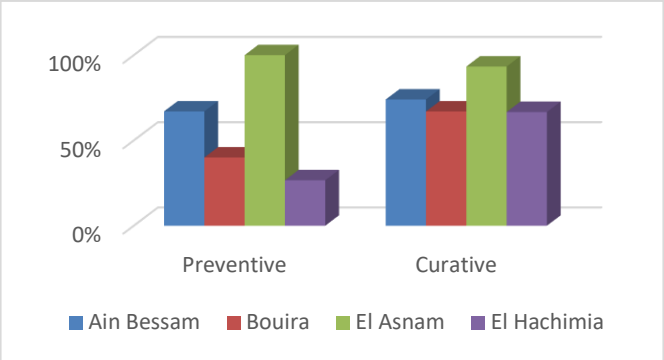


Figure 6 Treatment types.

3.4. Typology of pesticides used

Most cereal growers interviewed regularly use pesticides to prevent and combat attacks by natural enemies (Fig. 7). They acknowledge the use of various types of pesticide in different forms, sometimes mixing and alternating products to guarantee the effectiveness of the treatment methods. During our study, 24 commercial brands were identified, including 11 herbicides, seven insecticides and six fungicides (Fig. 8). All the people interviewed stated that they applied the same dose, one quintal per hectare (100 kg/ha).

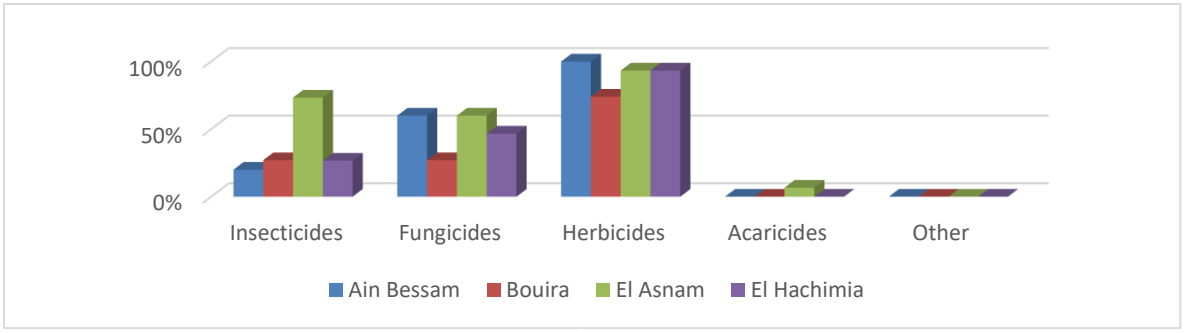
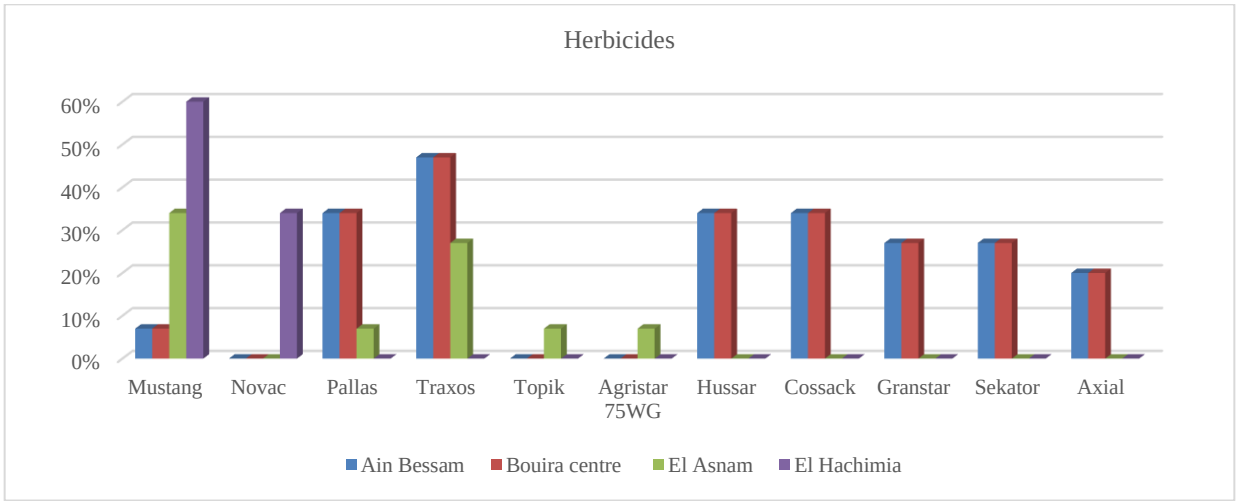


Figure 7 Typologies of pesticides used by locality



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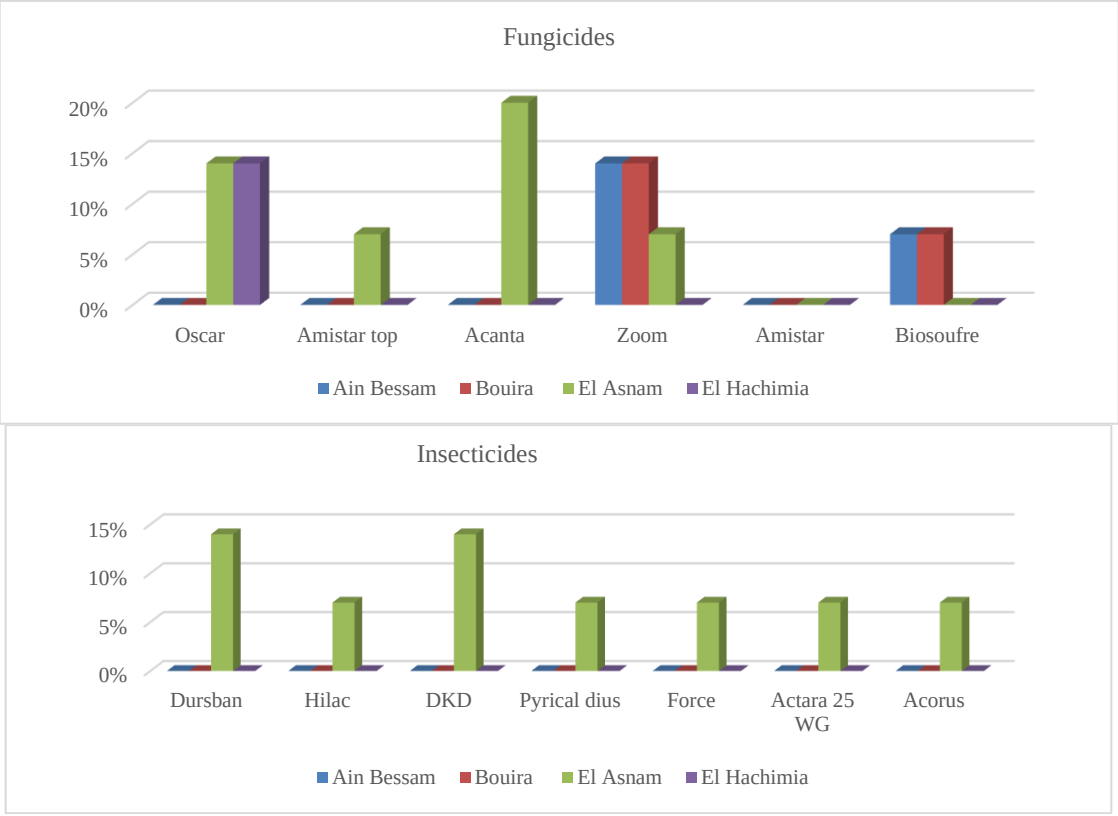

Figure 8 Types of pesticides used by cereal growers

The farmers interviewed regularly opt for pesticides, given their importance and necessity for cereal production in terms of quality and quantity. The use rates were 86.67% in El Asnam and 73.33% and 66.67% in Ain Bessam in central Bouira, respectively. The use of pesticides is a very important factor in plant protection (Ntalli & Menkissoglu-Spiroudi, 2011).

The farmers surveyed use large quantities of herbicides. This result is because natural weeding methods are no longer used, and farmers use all chemical products. The latter are more effective and easier to apply.

Fungicides are also being applied at high rates (particularly in Ain Bessam and Al Asnam, at 60%), mainly due to climatic conditions that favour the appearance of fungal diseases (late seasonal rains). Se cereal crops have also suffered an insect attack (specifically the root aphid), especially in El Asnam. The drought at the start of this year's cereal season has encouraged this pest to take hold, leading to the widespread use of insecticides. Additionally, the DSA's services confirm that farmers producing crops for seed are obliged to follow a prescribed phytosanitary protocol, and the DSA will inspect them. Failure to comply will result in losing their multiplication premiums (consumption only).

According to Guehiliz et al. (2023), in the arid region, herbicides are used very highly (88.9%). In contrast, Oultaf (2022) in the Tizi-Ouzou region observed a rate of use of 50% for fungicides and 43% for insecticides, while herbicides were used for only 4%. These results show a clear correlation between climate, the type of natural enemy and the type of pesticide applied.

It is worth noting that the lack of stringent legislation contributes to the diversity of pesticides on the market. However, governments must enforce strict regulations to minimise environmental contamination and ensure safe handling practices. The agricultural industry can adopt sustainable methods like integrated pest management (IPM) and organic farming to reduce reliance on agrochemicals. Innovations such as precision agriculture, biological pest control, nanotechnology, and artificial intelligence for early risk detection are essential (Anjaria & Vaghela, 2024).

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3.5. Pesticide selection criteria

Most cereal growers interviewed chose pesticides based on their efficacy throughout the study area, i.e. 86.67% in El Hachimia and El Asnam and 80% in Ain Bessam. The other selection criteria were used in varying proportions (Fig. 9).

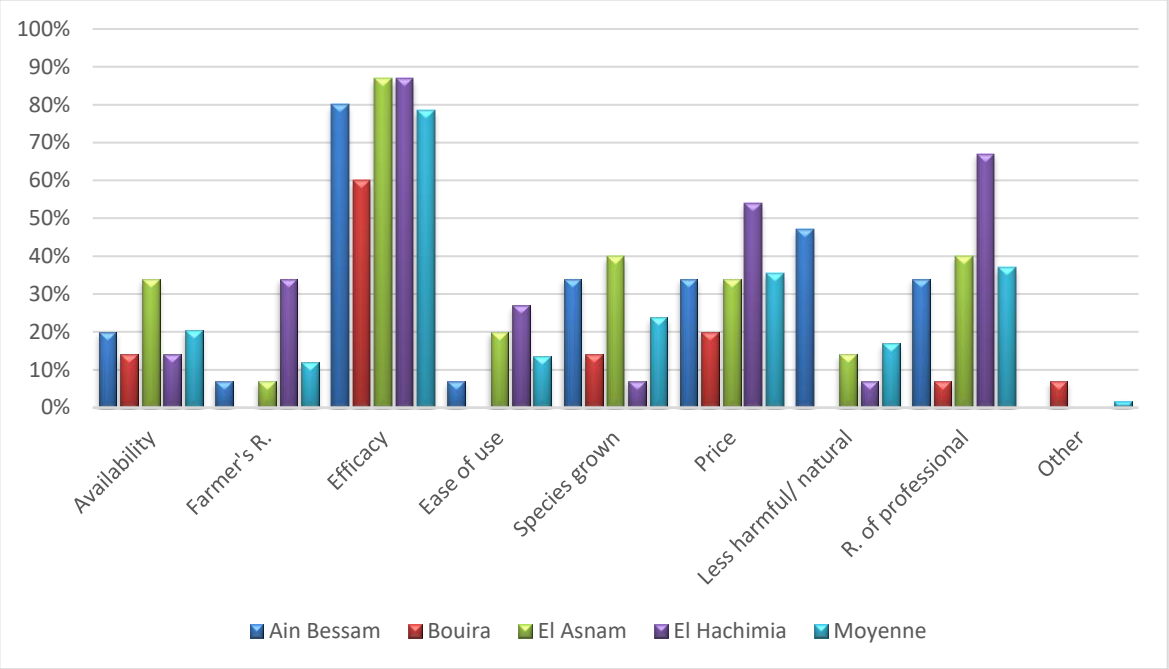

Figure 9. Criteria for selecting pesticides

3.6. Protective measures

Not all cereal growers use effective protective equipment when handling pesticides. In fact, for the complete kit, the figures recorded are low, ranging from 40% in Ain Bessam to 46.67% in El Asnam. The most commonly used means of protection are masks and gloves, with a rate of 80%. Gloves are used by 26%, while only 10% wear boots. Many farmers use other means, such as goggles (Fig.10).

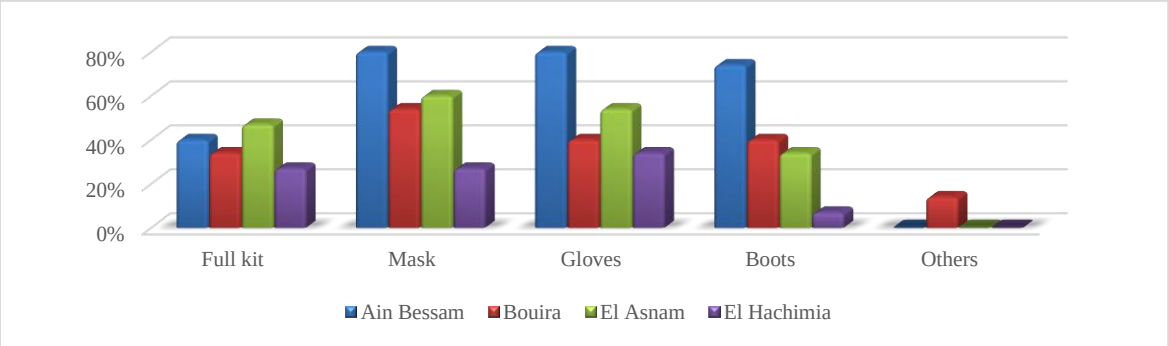

Figure 10. Protecting farmers from pesticides.

Pesticides are readily absorbed through oral, cutaneous and respiratory routes (Dayan et al., 2009). Pesticides include different substances that have different toxicities to humans (Levine, 2007).

Farmworkers and pesticide applicators face acute poisoning risks, with symptoms ranging from discomfort to severe illness or death. Chronic health effects include links to cancer, neurological disorders, and reproductive problems, raising concerns about food safety and worker well-being. Addressing agrochemical toxicity requires a multifaceted approach (Anjaria & Vaghela, 2024).

Pesticides are easily absorbed through oral, dermal, and respiratory routes (Dayan et al., 2009), posing significant risks to the health of agricultural workers and pesticide applicators. The toxic effects of these substances vary according to the type of chemical product, with some being more dangerous to human health than others (Levine, 2007). Acute exposure

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can lead to immediate poisoning, with symptoms ranging from discomfort to severe illness or even death. Even more concerning are the chronic effects associated with prolonged pesticide exposure. Studies have established a link between this exposure and diseases such as cancer, neurological disorders, reproductive issues, and other serious conditions.

These risks are not limited to workers handling pesticides but also concern the food chain, raising concerns about food safety for consumers. The widespread use of pesticides in agriculture necessitates strict adherence to safety protocols and the exploration of alternative pest management methods to reduce reliance on toxic chemical products. Ensuring the well-being of agricultural workers and the safety of food products requires a comprehensive and multifactorial approach. This includes better regulation of pesticide use, promoting protective equipment and safe handling practices, and encouraging the adoption of less harmful pest control strategies (Anjaria & Vaghela, 2024).

In cereal cultivation, where most farmers regularly use pesticides to prevent and combat natural enemies, the dangers associated with pesticide exposure become even more concerning. Farmers often mix and alternate different types of pesticides to ensure the effectiveness of treatments, but this practice increases the risks of chemical exposure for workers and the environment. Our study identified 24 commercial brands of pesticides used by these farmers, with herbicides, insecticides, and fungicides among the most commonly applied products. Despite the uniform application of pesticides at a rate of 1 quintal per hectare (100 kg/ha), it is essential to strengthen safety measures and raise awareness of the long-term health risks associated with pesticide use.

Addressing the toxicity of agrochemicals requires a balance between the need to effectively control pests and the protection of agricultural workers' health and the sustainability of agricultural ecosystems.

3.7. Waste disposal

Farmers incinerate their packaging, with the highest percentage recorded in El Hachimia (60%). In El Asnam, 40% of farmers dispose of their packaging on public landfill sites. However, 26.67% of the farmers questioned in Ain Bessam dump their waste in the countryside. Notably, 20% of farmers in Bouira dump their packaging in the ground uncontrolled, and only 6.67% of packaging is recovered by the health authorities (Fig. 11).

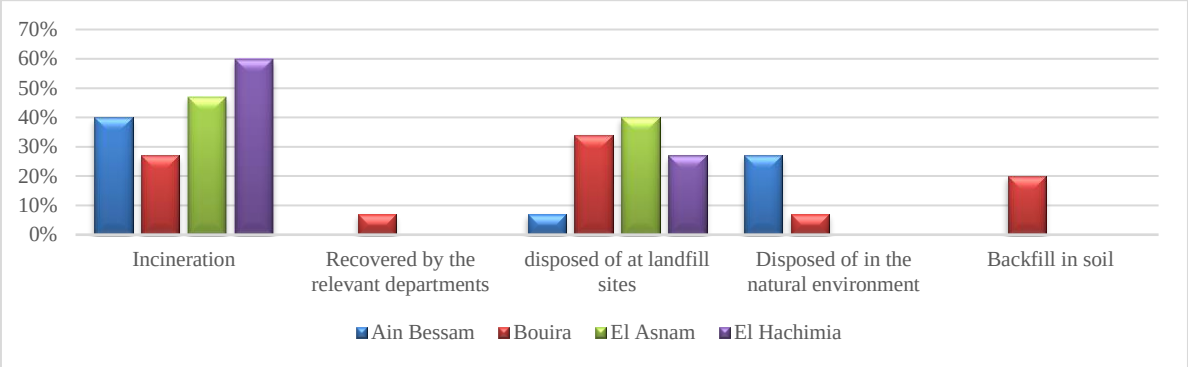

Figure 11 Packaging management

These results reveal the recklessness of most farmers who claim to have incinerated their waste or dumped it in public landfills. The most alarming finding of the survey was that in the two localities with the highest level of education (university) (Bouira and Ain Bessam), farmers either dumped their waste directly into the natural environment or poured it into the ground uncontrolled. According to Louchahi (2015), 50% of farmers abandon packaging in the fields (at the edge of the perimeters), while others throw it into rubbish dumps or watercourses (25%). Only 11.6% set fire to them, and 9% hid them. These results show that farmers' education level is not guaranteed by their actions. It should be pointed out that a recycling policy needs to be put in place to return packaging to the firms of origin.

4. Conclusion

This study sheds light on phytochemical protection practices for cereal crops in the Bouira region. We could interview cereal growers in the four agricultural zones of central Bouira, El Asnam, El Hachimia and Ain Bessam. Our survey was carried out during the 2023/2024 cereals season. The cereals grown are durum wheat, common wheat, barley and oats. Farmers use various pesticides to protect their crops and increase yields.

However, our data gives cause for concern: very few farmers are fully equipped and comply with all the protective measures. In their view, simply wearing masks and gloves when handling pesticides was more than enough protection. This attitude results from a lack of information about the real risk posed by exposure to pesticide residues.

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This study has also shown that the level of education does not guarantee farmers' actions in terms of waste management. Furthermore, our results reveal the lack of awareness of most farmers who claim to have incinerated their waste or disposed of it in public landfills and nature. This reflects farmers' ignorance and lack of awareness of the ecotoxicological risks of pesticides. These results underline the need for an increased awareness program and stricter regulations to ensure the safe and sustainable use of pesticides in cereal crops. Transitioning to more sustainable and innovative agricultural practices is essential to address modern challenges related to food security, resource management, and environmental protection.

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Annexe:

Questionnaire

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Series n°: ……

Date of the survey :……

Location of municipality/ district/ province: ……

GPS of the survey area: ……

Age of the respondents:

21-30……
31-40……
41-50……
51-60……
61-70……

Level of education/training:

- ☐ None (incomplete primary)
- ☐ Primary
- ☐ Secondary
- ☐ University

Are you the owner? yes No

Training on the application of pesticides: yes No

Awareness and dissemination day. yes No

If yes, specify the type of training…… The organization: ……

The total usable agricultural area of the farm……

What are the species of cultivated cereals?

- ☐ Durum wheat
- ☐ Soft wheat
- ☐ Barley
- ☐ Oats

Do you use pesticides on your crops?

- ☐ Regularly
- ☐ Occasionally
- ☐ No

Stades phénologiquestraités

E seed coating ☐

Stage 2/3 ☐ Leaf ☐ Tillering ☐

Stem elongation ☐ Ear formation ☐

Irrigation: before application of products ☐

After application of products ☐

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Typology of products used:

Pesticides	Form			Treatment		Treatment period in the year (months)
	Liquide	Solide	Gaz	Preventive		
Insecticides						
Fungicides						
Herbicides						
Acaricides						
Other						

List the commercial names of the products used

The applied doses and the number of applications

Date	Produit Product	Parcel area	Treated area	Dose applied to the treated area (specify the unit)

How do you choose the products?

	Pesticides	Fertilizers
Availability		
Recommendation by a farmer		
Effectiveness		
Ease of use		
According to the cultivated species		
Price		
Lower toxicity to nature		
Recommendation by a professional		
Other		

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What protective measures are used when handling the products?

Complete kit	
Mask	
Gloves	
Boots	
Other	

Where do you dispose of the packaging of the products used?

Other observations :