

Weeds associated with garlic crops in southern Nuevo León

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Abstract

The state of Nuevo León ranks fifth in the national production of garlic with a production of 3 044 t and an average yield of 8.8 t ha⁻¹. Garlic crops are important to the south of the state for more than 150 producers. One of the main problems is the presence of weed plants. The purpose of this work was to record the main species of weeds present in garlic crops in the locality of La Ascensión, Aramberri, Nuevo León, Mexico. The size of the plot was 16 m², the species found were recorded, and the identity and their synonyms were verified. For the ecological characterization, the height, cover, and diameter of the individuals found in each of the sampling plots were evaluated. For each species, the following structural variables were calculated: abundance, dominance, frequency and importance value. A total of 21 species were found, which are cataloged in 12 families, among which Asteraceae (6) and Brassicaceae (3) predominate. The cluster analysis showed that there is similarity in terms of the number of individuals and species per farm in three of the units. The species *Argemone grandiflora* and *Centaurea rothrockii* presented the highest abundance, whereas the highest dominance and importance value is held by *Argemone grandiflora*.

Keywords:

Argemone grandiflora, competition, cultural practices, garlic, weeds.



Introduction

Mexico ranks 18th in garlic production with 6 783 ha year⁻¹, grown in 17 states of the country. The largest producing states are Zacatecas, Guanajuato, Puebla, Baja California and Sonora, contributing 87.1% of the national production. Other states have a lower production; in Nuevo León, in the 2019-2020 cycle, 344 ha were planted, with an average yield of 8.8 t ha⁻¹ (SIAP, 2022).

This vegetable is important for the South of the state of Nuevo León; 90% of which is grown in the locality of 'La Ascensión' in the municipality of Aramberri, with a significant economic capture for more than 150 producers (SEDAGRO, 2020). Nevertheless, one of the main problems is the presence of undesirable plants that compete with garlic for the availability of water, light, space and nutrients. *Allium sativum* crops, due to their slow germination, morphology, and low growth rate, are very sensitive to weed competition in early stages of development and combating them represents an economic expense (Rubin, 2018).

Wild plants that appear after an ecological succession and interfere with human activity in arable areas, damaging, reducing, and altering the production, quality, and profitability of agricultural products, are considered weeds (Díaz, 2015; Castillo, 2017; Guzmán, 2019). Worldwide, there are about eight thousand species of weeds, causing damage of around 13% (Torres, 2023). Of 23 000 plant species registered in Mexico, 12% are considered weeds, damaging the country's cash crops (CONABIO, 2024).

Due to the easy dispersal of their seeds through wind, water, agricultural machinery, and poorly cleaned farming tools, they attach to the skin of animals and crop loads, moving easily from one place to another. To date, there are few reports of weeds that are present in garlic crops; this information comes mainly from conversations with producers; the objective was to record the main species of weeds present in this crop in the main producing area of Nuevo León.

Materials and methods

Study area

The research was conducted in the locality of La Ascensión, Aramberri, Nuevo León (Figure 1), located at an altitude of 1 960 m, with coordinates 24° 19' 22" north latitude and 99° 54' 50" west longitude (Figure 1).



Figure 1. Location of the sampled farms, La Ascensión, Aramberri.



Site description

Soils

The analyses were carried out in the soil laboratory of the Faculty of Agronomy of the Autonomous University of Nuevo León (UANL), for its acronym in Spanish with soil samples at a depth of 30 cm and those soils that predominate in the locality, according to their characteristics, are classified as Rendzina (USDA, 2003; Platas, 2016). The profile is based on a body of colluvium on which a soil with a clayey texture develops, with a pH value of 8.3, 0.79 $\mu\text{S cm}^{-1}$ in electrical conductivity and 3.7% organic matter.

Climate

According to the Köppen classification, modified by García (1973), the climate is temperate; throughout the year of study, there was an average annual temperature of 9.5 °C, with an average maximum of 16.7 °C, an average minimum of 2.5 °C, and average rainfall of 425.5 mm, mainly in May, June, and September (AWN, 2025).

Methodology

Sampling was done randomly from a first square plot of 1 m x 1 m, with consecutive increases in area until reaching 16 m². In order to collect and record, a list of all the weed species present was drawn up in an orderly manner. The samplings were carried out from March to May 2024 due to the ease of identification due to the presence of flowers, six months after establishing the crop.

To determine the number of samplings, the following formula was used: $n = (s^2 * t(n-1)) / (\bar{x} * E)$; n= statistically valid number of samples; s²= variance of stem diameters; t= tabular value of 't' with (n-1 degrees of freedom) at 0.05% error; $\bar{x}$ = average value of the data collected on the stem diameter; E= permissible error= 5%= 0.05. The study was conducted in six one-hectare sampling units with four replications per sampling unit.

The identity of the species was verified through bibliographic information from Correll and Johnston (1970), field visits, and collection of botanical specimens of the species. For the ecological characterization of weeds, the height, cover, and diameter of the individuals in each of the sampling plots were evaluated.

The following structural variables were calculated by species: abundance, dominance, frequency, and value of importance, following the methodology used by Rivera (2024), applying the following equations:

$$Ai = Ni / S$$

$$RAi = \left(Ai / \left(\sum Ai \right) \right)^n \times 100$$

Ai= relative abundance; RAi= relative abundance of species i with respect to the total; Ni= number of individuals of species i; S= sampling area (ha).

$$Di = \left(Ab(i) / \left(S(ha) \right) \right)$$

$$RDi = \left(Di / \left(\sum Di \right) \right)^n \times 100$$

Di= relative dominance; RDi= relative dominance of species i with respect to the total; Ab= crown area of species i; S= sampling area (ha).

$$Fi = Pi / NS$$

$$RFi = \left(Fi / \left(\sum Fi \right) \right)^n \times 100$$

Fi= relative frequency; RFi= relative frequency of species i with respect to the total; Pi= number of sites where species i is present; NS= total number of sampling units.

$$IVI = Ai + Di + Fi / 3$$

IVI= importance value index; Ai= relative abundance; Di= relative dominance; Fi= relative frequency.

The species richness and diversity of each sampling unit were determined by calculating the Shannon-Weiner, Margalef, and equitability indices, based on the recommendations by Alanís (2014); Müeller-Dombois (1974), and the equations:

$$DMg = (S - 1) / \ln(N)$$

DMg= Margalef index; S= total number of species present; N= total number of individuals.

$$H' = - \sum Pix \ln Pi$$

H'= Shannon-Wiener index; Pi= proportion of individuals of species i; Ln= natural logarithm.

$$E = H' / \ln(S)$$

H'= Shannon-Wiener index; S= total number of species present; Ln= natural logarithm.

A survey was applied during the garlic harvest stage (eight-month-old crop) to 20 producers in the study area with ten open-ended questions, including the main weeds present in the crop, the control methods they apply, application dates, and the species that are most difficult to eradicate.

Statistical analysis

Through the application of Past version 4.03, the cluster analysis was carried out with the species obtained in each of the farms in order to check if there was similarity in terms of the number of individuals or species per farm.

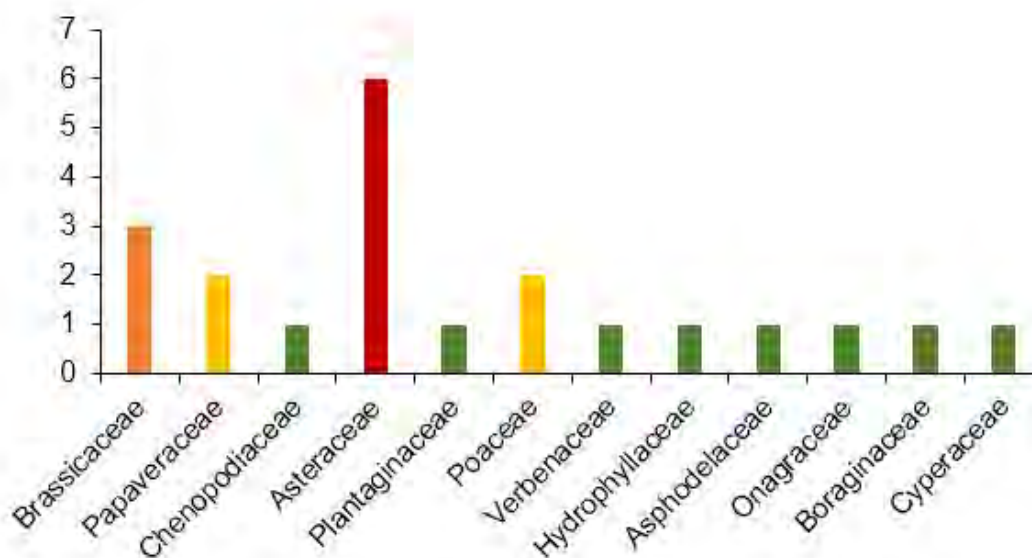
Results and discussion

In this research, it was possible to identify a total of 21 species of weeds associated with garlic crops in La Ascensión, Aramberri, Nuevo León (González, 2025) (Table 1). A total of 190 individuals were evaluated, which correspond to 12 families, with a high presence of the families Asteraceae (6) and Brassicaceae (3); in the rest of the families, only one to two species were identified (Figure 2). This is important to establish measures aimed at the control of broadleaf weeds.

Table 1. List of species identified in garlic cultivation sites.

Common name	Scientific name	Family
Mala mujer	<i>Argemone grandiflora</i> (Sweet.)	Papaveraceae
Cardo amarillo	<i>Argemone mexicana</i> (L.)	Papaveraceae
Gamoncillo/cebollín	<i>Asphodelus fistulosus</i> (L.)	Asphodelaceae
Zacate	<i>Avena fatua</i> (L.)	Poaceae
Girasolillo morado	<i>Centaurea rothrockii</i> (Greenm.)	Asteraceae
Quelite	<i>Chenopodium berlandieri</i> (Moq.)	Chenopodiaceae
Flor blanca de pelusa	<i>Cryptantha mexicana</i> (Brandegees)	Boraginaceae
Zacate pata de pollo	<i>Cynodon dactylon</i> (L.)	Poaceae
Cyperus	<i>Cyperus rotundus</i> (L.)	Cyperaceae
Roqueta de barda	<i>Diptotaxis muralis</i> (L.)	Brassicaceae
Roqueta blanca	<i>Eruca sativa</i> (Mill.)	Brassicaceae
Girasol rojo	<i>Gaillardia comosa</i> (A.)	Asteraceae
Alfombrilla /moradilla	<i>Glandularia bipinnatifida</i> (Nutt.)	Verbenaceae
Lechuga del monte	<i>Lactuca graminifolia</i> (Michx.)	Asteraceae
Onagra occidental	<i>Oenothera elata</i> (Kunth.)	Onagraceae
Espuelilla blanca	<i>Phacelia platycarpa</i> (Cav.)	Hydrophyllaceae
Abrojo	<i>Picris echioides</i> (L.)	Asteraceae
Llantén	<i>Plantago major</i> (L.)	Plantaginaceae
Sisibrium	<i>Sisymbrium officinale</i> (L.)	Brassicaceae
Lechuguilla espinuda	<i>Sonchus asper</i> (L.)	Asteraceae
Lechuguilla común	<i>Sonchus oleraceus</i> (L.)	Asteraceae

Figure 2. Number of species recorded by family.



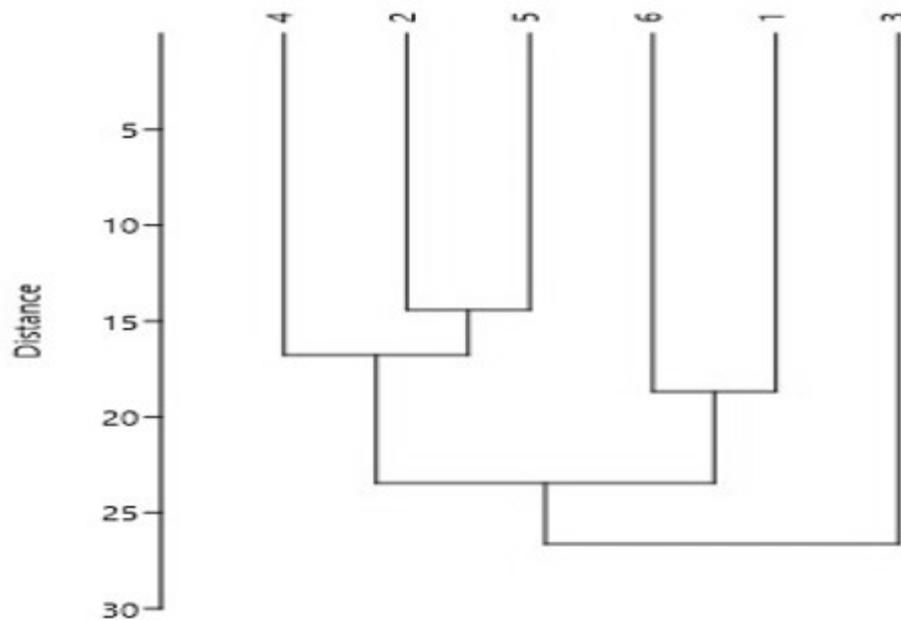
Sampling unit six has three species, whereas farm two has the highest value with eight species (Table 2). However, the cluster analysis showed a similarity in the number of individuals and species by farm in units four, two and five, while sampling unit three remains different from the rest (Figure 3).

Table 2. Species found by sampling site.

Sampling site	Scientific name	Number of individuals
1	<i>Sisymbrium officinale</i> (L.)	7
	<i>Argemone grandiflora</i> (Sweet.)	22
	<i>Diploaxis muralis</i> (L.)	2
	<i>Chenopodium berlandieri</i> (Moq.)	3
	<i>Picris echioides</i> (L.)	1
2	<i>Lactuca graminifolia</i> (Michx.)	4
	<i>Centaurea rothrockii</i> (Greenm.)	7
	<i>Sonchus oleraceus</i> (L.)	3
	<i>Plantago major</i> (L.)	6
	<i>Eruca sativa</i> (Mill.)	4
	<i>Avena fatua</i> (L.)	3
	<i>Sonchus asper</i> (L.)	3
	<i>Sisymbrium officinale</i> (L.)	2
3	<i>Argemone mexicana</i> (L.)	10
	<i>Glandularia bipinnatifida</i> (Nutt.)	15
	<i>Cynodon dactylon</i> (L.)	9
	<i>Phacelia platycarpa</i> (Cav.)	5
4	<i>Asphodelus fistulosus</i> (L.)	9
	<i>Oenothera elata</i> (Kunth)	4
	<i>Centaurea rothrockii</i> (Greenm.)	10
	<i>Gaillardia comosa</i> (A.)	3
	<i>Argemone grandiflora</i> (Sweet.)	6
	<i>Cynodon dactylon</i> (L.)	2
	<i>Cryptantha mexicana</i> (Brandeggee)	4
5	<i>Sonchus asper</i> (L.)	8
	<i>Oenothera elata</i> (Kunth)	6
	<i>Avena fatua</i> (L.)	2
6	<i>Cyperus rotundus</i> (L.)	14
	<i>Gaillardia comosa</i> (A.)	3
	<i>Argemone grandiflora</i> (Sweet.)	13



Figure 3. Clustering of the number of species by farm.



The *Argemone grandiflora* (Papaveraceae) with 41 individuals, followed by *Centaurea rothrockii* with 17 individuals, presented the highest abundance (Table 2). This differs from Patel *et al.* (2020), who reported the genus *Chenopodium* as the most abundant and from Usanmaz *et al.* (2025), in this research, the genera *Chenopodium* and *Amaranthus* were identified as the most common in the crop.

Argemone grandiflora had the highest above-ground cover (78.27%), while *Avena fatua* and *Sonchus asper* are the least dominant (0.09%) (Table 3). The most frequent species was *Argemone grandiflora*, present in three of six sampling units; in contrast, *Picris echioides* was only recorded on one of the sites (Table 3).

Table 3. Diversity of weeds found in the sampled farms.

Species	Abundance	Relative abundance	Frequency	Relative frequency	Cover	Dominance	Relative dominance	Importance value
<i>Argemone grandiflora</i> (Sweet)	41	21.58	3	50	25.5	0.78	78.27	49.9
<i>Argemone mexicana</i> (L.)	10	5.26	1	16.6	0.2	0.01	0.83	7.59
<i>Asphodelus fistulosus</i> (L.)	9	4.74	1	16.6	0.15	0	0.46	7.29
<i>Avena fatua</i> (L.)	5	2.63	2	33.3	0.68	0	0.09	12
<i>Centaurea rothrockii</i> (Greenm.)	17	8.95	2	33.3	0.73	0.02	2.23	14.8

Species	Abundance	Relative abundance	Frequency	Relative frequency	Cover	Dominance	Relative dominance	Importance value
<i>Chenopodium berlandieri</i> Moq	3	1.58	1	16.6	0.06	0	0.18	6.14
<i>Cryptantha mexicana</i> (Brandeggee)	4	2.11	1	16.6	0.14	0.93	93.33	37.3
<i>Cynodon dactylon</i> (L.)	11	5.79	2	33.3	0.22	0.01	0.67	13.2
<i>Cyperus rotundus</i> (L.)	14	7.37	1	16.6	0.15	0	0.46	8.16
<i>Diplotaxis muralis</i> (L.)	2	1.05	1	16.6	1.54	0.05	4.71	7.48
<i>Eruca sativa</i> (Mill.)	4	2.11	1	16.6	0.08	0	0.24	6.34
<i>Gaillardia comosa</i> (A.)	6	3.16	2	33.3	0.09	0	0.28	12.2
<i>Glandularia bipinnatifida</i> (Nutt.)	15	7.89	1	16.6	0.38	0.01	1.16	8.57
<i>Lactuca graminifolia</i> (Michx.)	4	2.11	1	16.6	0.28	0.01	0.86	6.54
<i>Oenothera elata</i> (Kunth)	10	5.26	2	33.3	1.09	0.03	3.34	13.9
<i>Phacelia platycarpa</i> (Cav.)	5	2.63	1	16.6	0.31	0.01	0.95	6.75
<i>Picris echinoides</i> (L.)	1	0.53	1	16.6	0.07	0	0.21	5.8
<i>Plantago major</i> (L.)	6	3.16	1	16.6	0.15	0	0.46	6.76
<i>Sisymbrium officinale</i> (L.)	9	4.74	2	33.3	0.54	0.02	1.65	13.2
<i>Sonchus asper</i> (L.)	11	5.79	2	33.3	0.03	0	0.09	13
<i>Sonchus oleraceus</i> (L.)	3	1.58	1	16.6	0.14	0	0.43	6.22

The species with the greatest influence are *Argemone grandiflora* (49.95%), *Cryptantha mexicana* (37.37%), and *Centaurea rothrockii* (14.84%). In contrast, those with the lowest IVI are *Picris echinoides* (5.8%) and *Chenopodium berlandieri* (6.14%) (Table 4). In farms 4 and 2, *Centaurea rothrockii* (Greenm.) appears with several individuals when the cultivator is used due to the removal of the seed in the soil; it did not represent risk problems since a subsequent manual weeding is done.

Table 4. Indices of richness and diversity of a sampling unit in the study farms.

	Dominance-D	Simpson-1-D	Shannon-H	Margalef	Equitability-J
Farm 1	0.446	0.553	1.089	1.125	0.677
farm 2	0.144	0.855	2.005	2.02	0.964
farm 3	0.283	0.716	1.318	0.818	0.951

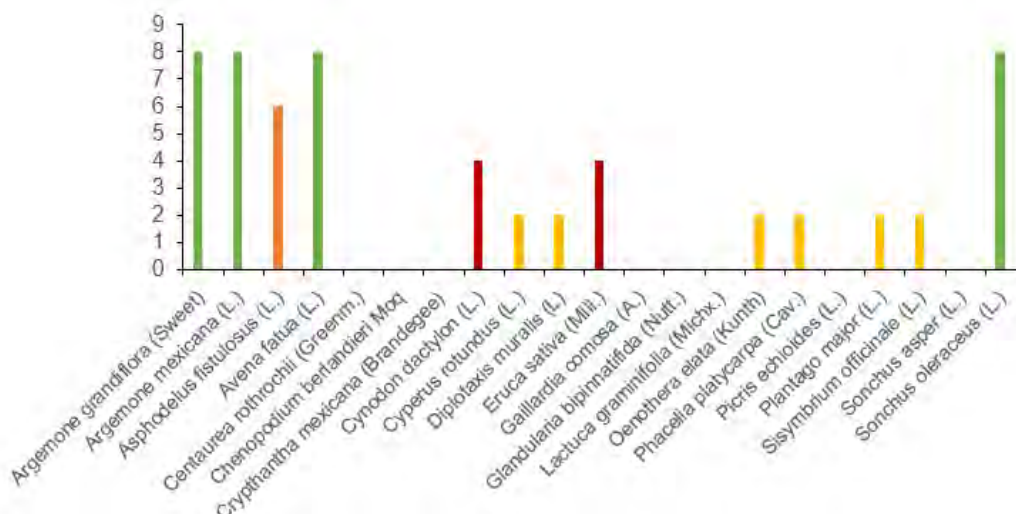
	Dominance-D	Simpson-1-D	Shannon-H	Margalef	Equitability-J
farm 4	0.213	0.787	1.651	1.418	0.921
farm 5	0.3	0.7	1.28	1.001	0.923
farm 6	0.415	0.584	0.948	0.588	0.863

The species *Glandularia bipinnatifida* (Nutt.), although it was present in large numbers in farm 3, did not represent a problem since it is a species found on the ground offering a beautiful visual spectacle with its purple flowers, which are frequently visited by butterflies. The highest dominance is for farms 1 and 6, which corresponds to the farms with the presence of broadleaf weed species that cover a large area of the soil and to the scarce practices of mechanical control due to their high costs. For its part, in farm 2, a pre-emergent herbicide is applied at the beginning of the crop (end of September) and the agricultural cultivator is used as many times as necessary during the production cycle, so there is less weed cover.

For the Shannon-Wiener index, sampling unit 2 has the highest value of $H' = 2$, since it brings together the best combination of density, frequency, and cover. Margalef Index. The richness value (DMg) shows ranges from 0.58 to 2.02. Simpson's index. The figures calculated were from $D = 0.55$ to $D = 0.85$; this index is not always higher due to the number of species, due to the absence of a dominant species, such as in unit one, although it has a high dominance, it has low species richness. Equitability. When comparing the plant species present, there is a closely similar equitability between units two to five.

Surveys of producers indicated that 61% of weed species coincide with those with the highest presence (Figure 4). Producers were concerned about the abundance of *Argemone grandiflora*, *Argemone mexicana*, *Avena fatua*, and *Sonchus oleraceus*, the control of which represents a problem in the crop.

Figure 4. Weeds are most difficult to control in garlic crops.



The genus *Argemone* was present in five of the farms; its absence in farm 5 is due to the use of more mechanical practices, four manual control activities since February. Garlic is a slow-growing, shallow-rooted crop, planted at high densities, so mechanical cultivation is often limited and manual weeding can be expensive. Twenty-five percent of the population of producers have had to implement preventive and mechanical control at the beginning of the cycle, increasing the ease and effectiveness of management; according to Sanjay *et al.* (2019), manual weeding resulted in higher net yields due to lower weed density. For their part, 57% opt for chemical control; according to Qasem (1996); Khokhar (2006); Guerra (2020), the application of oxyfluorfen and oxadiazon at

the 3-4 leaf stage after emergence achieves a yield similar to a weed-free crop, while the application of both herbicides before planting reduced weed biomass by 55%.

Therefore, in garlic crops, it is recommended to apply a comprehensive management (Singh, 2023) that consists of preventive mechanical management with an implement at the beginning of the cycle and repeating it every two months, as well as using pre-emergent control (Rubin, 2018) together with three or four manual weedings (Usanmaz, 2025) in February when the change from leaf to grain occurs and the rotation of the crop for corn or beans after the garlic harvest.

Conclusions

In garlic crops in the state of Nuevo León, there are at least 21 species of weeds that represented a risk to production. With few abundant species and a large proportion of low-abundant species and a dominance of *Argemone grandiflora*. Due to their abundance, easy dispersal, and the large presence of thorns, it is difficult to control *Argemone grandiflora* and *Argemone mexicana*. Likewise, *Avena fatua* is often present. In order to prevent the expansion of these species and to avoid the exchange of genetic material, comprehensive management is recommended.

The species have useful characteristics for producers, *Avena fatua* and *Cynodon dactylon* contribute as food for animals, *Sonchus asper* and *Sonchus oleraceus* are for medicinal use; *Cryptantha mexicana* combats soil erosion, whereas *Centaurea rothrockii*, *Gaillardia comosa* and *Oenothera elata* are ornamental plants.

The study will be a source for producers in the southern region of the state in the identification of the main weeds and a basis for future research and proposals for comprehensive weed management. It is suggested to carry out studies on the morphology and ecology of the predominant weeds, the technically effective, economically visible and environmentally safe control methods.

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