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Importance of Field Extension Training for Farmers of Alfalfa (*Medicago sativa* L.) to Adopt Weed Control Techniques

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Climate change may influence the survival and distribution of field crop weeds. Few investigations are available about the negative effect of noxious weeds on crop quality. Several studies were conducted to evaluate weed distribution of alfalfa fields. For eight years case studies through surveys, extension program, and questionnaires were carried out in two regions of Wadi Dlayl and Kherbeh Sides in the Zarqa River Basin of Jordan to study the distribution of weeds in alfalfa fields. Results indicated and reported that species of white top and dodder were the most common occurring species in Wadi Dlayl. However, amaranthus and common mallow were predominant in Kherbeh Sides region. The purpose of this paper is to highlight the most effective extension approaches to identification of weeds observed in alfalfa. Training will equip farmers with necessary competencies to become pioneers of knowledge about weed ecology, and growing habits to choose the most appropriate chemical management strategy with lower costs and time saving.

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1. INTRODUCTION

Alfalfa (*Medicago sativa*) is the oldest forage crop grown solely for forage purposes, which made a tremendous contribution to world food production. Alfalfa is one of the major hybrid crops grown in the world, along with rye, Sudan grass, silage corn, forage sorghum and barley [11] as well as triticale [10]. It appears to have originated in the mountainous regions of the Mediterranean in South-Western Asia. The great root depth, high seed production, and tolerance to heat under dry climatic conditions indicate that this crop must have originated in dry-hot regions. [12] Reported that forage growers admire alfalfa for its high yielding capacity, its wide adaptation to climatic conditions, its disease resistance and its powerful feeding quality. Alfalfa makes a tremendous contribution to world food production. It is one of the world's most versatile crops which can be grown in environments ranging from burning hot deserts to cool high mountain valleys, from the frozen continental climates to the Mediterranean valleys [12]. Alfalfa can grow on soils ranging from beach sands to heavy clays. It can be grazed, fed fresh as green chop, baled, cubed, pelleted, or ensiled.

However, weeds are serious economic pests of alfalfa and affect it during growth establishment and in the already established fields. They are the primary production pests of alfalfa, and can compete either directly or indirectly by serving as hosts for insect, disease, and nematode pests [7]. Since alfalfa is a perennial, some weeds are problems only during stand establishment and little threat during the subsequent years. A wide range of various weed species, including annuals and perennials, warm and cool season grasses, and parasitic and poisonous plants infest alfalfa [2]. [7] Reported that in a full, healthy stand, alfalfa will prevent establishment of common lambsquarters (*Chenopodium album*), redroot pigweed (*Amaranthus retroflexus*), foxtail barley (*Hordeum jubatum*), and dandelion (*Taraxacum officinale*). Other weeds, both annuals and perennials, including flixweed (*Descurainia sophia*), tumble mustard (*Sisymbrium altissimum*), shepherd's purse (*Capsella bursa-pastoris*), white campion (*Silene latifolia* Poir, or *Silene alba* Mill), and quackgrass (*Elytrigia repens*) may be present every year and must be managed. Grasses such as quackgrass, barnyardgrass (*Echinochloa crus-galli*), cheatgrass (*Bromus tectorum*), and wild oats (*Avena fatua*), and broadleaf weeds such as white campion, common groundsel (*Senecio vulgaris*), redroot pigweed, lambsquarters, dodder (*Cuscuta* spp), and various mustards including shepherd's purse compete for nutrient resources and damage the marketability of hay, reducing the crop value by 20 to 50%. Furthermore, noxious weeds presence in hay prevents export to foreign markets. [2] Concluded that alfalfa yields are sometimes reduced, but more often yield is higher when weeds are not controlled. Weeds affect alfalfa qualities since most weeds are less palatable with a lower feeding value. [15] Reported an outline of annuals and perennials that have an impact on alfalfa quality. The most serious annuals that have a negative impact on alfalfa are cocklebur (*Xanthium* spp), eastern black nightshade (*Solanum ptychanthum*), giant foxtail (*Setaria faberi*), giant ragweed (*Ambrosia trifida*) and yellow foxtails (*Setaria glauca*, or *Setaria pumila*). But, the perennials with high relative seriousness were curly dock (*Rumex crispus*), hoary alyssum (*Berteroa incana*) and yellow rocket (*Barbarea vulgaris*).

Several reasons reported the increase in weed pressure in alfalfa stands. Addition of nitrogen can increase weed pressure [5,6,8]. While the weeds are not often a problem after the first harvesting of the crop [13], growers should be prepared to address the potentially initial weed pressure with appropriate weed management tools [6,13]. In addition to supplying nitrogen that could stimulate weed growth of the establishment phase ([5,6,8]) manure can also be an important source of weed seeds [3,14].

The main goals of this research paper were to highlight the most effective extension approaches to identification of weeds observed in alfalfa. Training by a long-term survey, extension programs, and a questionnaire can foster target farmers to become as pioneer farmers in their areas with a full knowledge and skills about weed ecology, persistence, and growing habits in order to choose the most appropriate management strategy and, or to make a management in a well precise time, proper herbicides dosages, time saving, and lower costs.

2. METHODOLOGY

2.1 Extension Approaches in Wadi Dlayl Irrigation Project (WDIP)

Wadi Dlayl is located in Jordan, this area is the best for rearing livestock and mainly the dairy cows. In the year 2007 the total number of cattle was estimated at (42893) out of the total of the country (88215). This area is the most important for producing green forages like alfalfa [4]. Wadi Dlayl region is located in (E 36° N 32°) and it is about 581 meters above sea level. The most predominantly soil types of the region are clay soil.

2.1.1 Field survey

A field survey was conducted in 2008 for Wadi Dlayl Irrigation Project (WDIP) showed that the total current planted area of the project is about 55 hectares divided into growing land units, each one ranges between 2.5-3 ha. The major forage crop planted is Alfalfa (*Medicago sativa*).

A preliminary survey was conducted to evaluate field growers' strengths and weaknesses related to alfalfa production in the project. Random sampling of six growers covered an area of 19.15 hectares showed that alfalfa plant seeded at a rate of 53 kg per hectare. The most used cultivar of a perennial alfalfa was (cuf 101) irrigated by channels and surface irrigation of ground water, it was planted twice either in spring (March–April) or in fall (October-November). The plant was harvested at an average of nine times per year, each green harvest produced an average of 18 tons per hectare. The fertilizers were used in an average of 74 kg of Urea per hectare and 50 kg of Ammonium Sulfate per hectare, and 77 kg of organic cow manure per hectare. Alfalfa was irrigated by 90 m^3 per hectare in winter and 230 m^3 per hectare in summer months, the irrigation frequency was once a week.

2.1.2 Extension observation

In 2014 plots observations were conducted at a pioneer farmer field in the region to use herbicides controlling weeds in alfalfa. Four alfalfa plots, each of 25 m^2 were sprayed with an active ingredient called *Bromoxynil Octanoate* (28%) using two liters weed hand sprayer. The four treatments without replicates were (8, 10, 13, and 15 ml per two liters of water). In addition, one 25 m^2 plot was sprayed with an active ingredient of *Fluazifop-P-Butyl* (125 gm/L) in a rate of 10 ml per two liters of water. The pioneer farmer was trained for the ideal cultural practices of alfalfa production; seeding cultivar (cuf 101) during March of a rate of 60 kg per hectare, the seeds were fertilized with a 300 kg of Di-Ammonium Phosphate (DAP) per hectare at the planting time, 50 kgs of Urea per hectare were added after germination and after each harvest. Nine green forage harvests were expected each year, once every twenty one day's except in the winter season. The irrigation was 1000 m^3 per hectare after planting, then 600 m^3 per hectare every seven days. The yield on average was about 25 tons per hectare per harvest.

The same observation indicated that the herbicide *Bromoxynil Octanoate* (28%) is recommended being used at a rate of 4000 ml/ha before spring planting to control white top (*Cardaria draba*). However, *Fluazifop-P-Butyl* (125 gm/L) is recommended being used in a rate of 2000 ml per hectare to control such weeds after first alfalfa harvesting; common barnyard grass (*Echinochloa crusgalli*), bermuda grass (*Cynodon dactylon*), and common peganum *(Peganum harmala*). The dosage of 2800 ml per hectare of *Fluazifop-P-Butyl* (125 gm/L) is recommended being used to control dodder (*Cuscuta* spp) when alfalfa aged eighty six days.

2.2 Extension Approaches in Kherbeh Sides Region

Treated wastewater is a very important non-conventional water source of Zarqa River Basin. The main source is the effluent from Kherbeh Als-Samra wastewater treatment plant, which handles 70% of Jordan wastewater. It provides with 365000 m^3 per day of treated wastewater. The length of the treated wastewater effluent route from the plant until King Talal Dam (KTD) is 35 km sided with several types of plants covered 370 hectares. Alfalfa is the most widely planted green forage crop. This region is located in (E 36° N 32°) and it is about 550 meters above sea level. The most predominantly soils in this region are sand soil.

2.2.1 Field survey

A preliminary survey was conducted to evaluate ten growers points of strengths and weaknesses related to alfalfa production with a total area of about 56.4 hectares showed that alfalfa plant was seeded at a rate of 50 kg per hectare. The most used cultivar of a perennial alfalfa was (cuf 101) irrigated by surface irrigation of treated wastewater, the seeds were planted twice either in spring (March–April) or in fall (October-

November). The plant was harvested at an average of nine times per year, each green harvest produced an average of 15 tons per hectare. No fertilizers were used in this cropping. However, alfalfa was irrigated with about 1000 m^3 per hectare after planting, then 600 m^3 per hectare every seven days.

2.2.2 Extension observation

In 2014 field observations were conducted in cooperation with pioneer farmer field in the region to use herbicides controlling weeds in alfalfa field. 0.2 hectares of alfalfa field was sprayed with an active ingredient called *Bromoxynil Octanoate* (28%) and with an active ingredient of *Fluazifop-P-Butyl* (125 gm/L) using twenty liters weed back sprayer separately. The pioneer farmer was trained for the ideal cultural practices of alfalfa production; seeding cultivar (cuf 101) during March of a rate of 60 kg per hectare, the seeds were fertilized with a 300 kg of Di-Ammonium Phosphate (DAP) per hectare at the planting time, 50 kgs of Urea per hectare were added after germination and after each harvest. Nine green forage harvests were expected each year once every twenty one day's except in the winter season. The treated wastewater irrigation was 1000 m^3 per hectare after planting, then 600 m^3 per hectare every seven days. The yield on average was about 25 tons per hectare per harvest.

The same observations indicated that the herbicide *Bromoxynil Octanoate* (28%) is recommended being used in a rate of 5000 ml per hectare before spring planting to control such weeds like: London rocket (*Sysymbrium irio*), common mallow (*Malva sylvestris*), croton (*Chrozophora tinctoria*), and amaranthus (*Amaranthus gracilis* Desf). However, *Fluazifop-P-Butyl* (125 gm/L) is recommended being used at a rate of 2000 ml per hectare to control such weeds after first alfalfa harvesting; wild barley (*Hordeum spontaneum*), cat's tail (*Lopochloa phleoides*) (Vill.) Rchb, common barnyard grass (*Echinochloa crusgalli*), and Bermuda grass (*Cynodon dactylon*). Silverleaf nightshade (*Solanum elaeagnifolium* Cav) was not affected by *Bromoxynil Octanoate* (28%).

2.3 Two Regions Questionnaire for Targeted Farmers

Then, the results of the extension programs, field observations, and field visits to two regions were disseminated to growers through a well-colored extension booklet and field visits. A questionnaire in 2016 was conducted in the two regions targeted 22 farmers of alfalfa trainee growers, 11 of each region, to identify the weed types that have been infested their fields since 2010 till 2016, and the total areas of those farmers were 18.6 ha in Wadi Dlayl and was 56.4 ha in Kherbeh Sides.

3. RESULTS AND DISCUSSION

The questionnaire was conducted in 2016 and results recorded in the Table 1 showing scientific names for twelve weed species which were observed by trained farmers in Zarqa River Basin, mainly in two regions of Wadi Dlayl and Kherbeh Sides. The five weed species of (*Sysymbrium irio*), (*Malva sylvestris*), (*Hordeum spontaneum*), (*Lopochloa phleoides* (Vill.) Rchb, and (*Echinochloa crusgalli*) were classified as winter annuals (A,W), while the two types of (*Chrozophora tinctoria*), and (*Amaranthus gracilis* Desf), were classified as summer annuals (A,S). Perennials observed were (*Cynodon dactylon*), (*Cardaria draba*), (*Peganum harmala*), and (*Solanum elaeagnifolium* Cav). The only annual parasitic weed was (*Cuscuta* spp).

Table 1. Summary of weed species: Scientific names and ecological classification observed in perennial alfalfa (*Medicago sativa*) fields in Zarqa River Basin (ZRB) survey two locations[1]

No.	Weed species	Ecological classification [2]
1	*Sysymbrium irio*	A, W
2	*Malva sylvestris*	A, W
3	*Hordeum spontaneum*	A, W
4	*Lopochloa phleoides* (Vill.) Rchb.	A, W
5	*Chrozophora tinctoria*	A, S
6	*Amaranthus gracilis* Desf	A, S
7	*Echinochloa crusgalli*	A, W
8	*Cynodon dactylon*	P
9	*Cardaria draba*	P
10	*Peganum harmala*	P
11	*Solanum elaeagnifolium* Cav.	P
12	*Cuscuta* spp	A

[1] *Summary consisted of 2 survey sites of 22 alfalfa fields representing 75 ha.*

[2] *P=Perennial, B=Biennial, A=Annual, S=Summer, W=Winter*.

Table 2 showed the frequency, which is the number of sites where specific weed type recorded. The total % is the frequency divided by the total number of sites in two regions. On the other hand, the total % in Table 3 indicated the frequency of the area measured in (ha) divided by the total area of all fields (75 ha) of both regions.

It can be stated from Table 4 that the most widely distributed weed in Wadi Dlayl was (*Cardaria draba*) of 15.8 ha with a 6.8% of increase than the second highest frequent weed type; (*Cuscuta* spp), which was observed in about 14.8 ha. However, (*Amaranthus gracilis* Desf) represented the highest frequent weed in Kherbeh Sides of about 34.6 ha with a 97.7% increase than (*Malva sylvestris*) which was observed in 17.5 ha in Kherbeh Sides (Table 5).

It was observed that the weed type of (*Echinochloa crusgalli*), was the only type which was observed in both two regions (Table 6) [7]. Indicated that (*Echinochloa crusgalli*) could be

Table 2. Summary of weed species and their frequency observed in 22 perennial alfalfa (*Medicago sativa*) fields in Wadi Dlayl and Kherbeh sides.[1]

No.	Weed species	Frequency [2]	% Total [3]
1	*Sysymbrium irio*	3	13.6 %
2	*Malva sylvestris*	5	22.7 %
3	*Hordeum spontaneum*	1	4.5 %
4	*Lopochloa phleoides* (Vill.) Rchb.	2	9 %
5	*Chrozophora tinctoria*	3	13.6 %
6	*Amaranthus gracilis* Desf	6	27 %
7	*Echinochloa crusgalli*	8	36 %
8	*Cynodon dactylon*	7	31.8 %
9	*Cardaria draba*	9	40.9 %
10	*Peganum harmala*	4	18 %
11	*Solanum elaeagnifolium* Cav.	1	4.5 %
12	*Cuscuta* spp	8	36 %

[1] Summary consisted of 2 survey sites within 22 alfalfa fields representing 75 ha.
[2] Frequency is the number of sites where weed species were observed.
[3] The percent is based on a total of 22 survey fields

Table 3. Summary of weed species and their frequency observed in 22 perennial alfalfa (*Medicago sativa*) fields in Wadi Dlayl and Kherbeh sides.[1]

No.	Weed species	Frequency [2]	% Total [3]
1	*Sysymbrium irio*	16.5	22 %
2	*Malva sylvestris*	17.5	23.3 %
3	*Hordeum spontaneum*	4	5.3 %
4	*Lopochloa phleoides* (Vill.) Rchb.	2.3	3.1 %
5	*Chrozophora tinctoria*	11.5	15.3 %
6	*Amaranthus gracilis* Desf	34.6	46 %
7	*Echinochloa crusgalli*	15.2	20.3 %
8	*Cynodon dactylon*	13.8	18.4 %
9	*Cardaria draba*	15.8	21.1 %
10	*Peganum harmala*	7.5	10 %
11	*Solanum elaeagnifolium* Cav.	1	1.33 %
12	*Cuscuta* spp	14.8	19.7 %

[1] Summary consisted of 2 survey sites within 22 alfalfa fields representing 75 ha.
[2] Frequency is the area of sites (ha) where weed species were observed.
[3] The percent is based on a total of 22 survey fields' area

Table 4. Comparison between the highest frequency weed species within the same location of Wadi Dlayl[1]

Highest Weed Freq	Freq (ha)	Freq (No.)
Cardaria draba	15.8	9
Cuscuta spp	14.8	8
% of Increase	6.8 %	12.5 %

[1] *Wadi Dlayl producing perennial alfalfa within Zarqa River Basin (ZRB)*

Table 5. Comparison between the highest frequency weed species within the same location of Kherbeh sides[1]

Highest WEED FREQ	Freq (ha)	Freq (No.)
Amaranthus gracilis Desf	34.6	6
Malva sylvestris	17.5	5
% of Increase	97.7%	20%

[1] *Kherbeh sides producing perennial alfalfa within Zarqa River Basin (ZRB)*

Table 6. Weeds species which was found among two regions within Zarqa River Basin (ZRB) [1]

ZRB	Survey AREA (ha)	Weed FREQ	Freq (ha)	Freq (No.)
Wadi Dlayl	18.6	*Echinochloa crusgalli*	6.3	3
Kherbeh sides	56.4	*Echinochloa crusgalli*	8.9	5
Total	75	% of decrease	29.2 %	40 %

[1] *Wadi Dlayl and Kherbeh sides are the two major locations producing perennial alfalfa within Zarqa River Basin (ZRB)*.

found in alfalfa fields and compete for nutrients. Both regions of this research have available nutrients in soils and water. Wadi Dlayl soils are rich in nutrients due to cow manure used, and Kherbeh Sides soil has accumulated salts originating from treated wastewater.

The most observed three types of weeds in Wadi Dlayl were (*Cardaria draba*, *Cuscuta* spp, and *Echinochloa crusgalli*).The wide distribution of perennials in Wadi Dlayl may be attributed to its ability to live for more than two years, as well as it may live almost indefinitely. Those weeds can reproduce by seed and many are able to spread by vegetative growth. Wadi Dlayl suffered from ground water over pumping, salinity, long irrigation periods, and little irrigation amounts. This is the main reason to consider Wadi Dlayl as a harsh climatic, environmental area in comparison to Kherbeh Sides. [2] Reported that although (*Cuscuta* spp) is an annual parasitic plant, but it seeds survived in soils for many years, and this plant development depends on sunlight to thrive. While, the other area, Kherbeh Sides, has a water sources effluent daily, this may promote the growing of annuals which completes their life cycle in less than one year. Similar description of annuals and perennials illustrated by [1].

4. CONCLUSION

Weed control plans typically consist of many methods which are divided into biological, chemical, cultural, and physical (mechanical) control. Physical methods include using coverings, manual weeding, tillage, flame, soil steam sterilization and soil solarization. Cultural methods mainly the crop rotation is used by rotating crops with ones that kill weeds by choking them out. It is a way to avoid the use of herbicides, and to gain the benefits of crop rotation. A biological weed control regiment can consist of biological control agents, bio herbicides, use of grazing animals, and protection of natural predators. However, the weed control can also be achieved by the use of herbicides. Selective herbicides kill certain targets while leaving the desired crop relatively unharmed. Some of these act by interfering with the growth of the weed and are often based on plant hormones. Herbicides are generally a fast and efficient method in terms of results and time saving.

Thus, extension activities must be directed towards innovation dissemination based on knowledge, research, and development [9]. Training can promote farmers to become pioneer farmers with knowledge about weed ecology, and growing habits to choose the most appropriate chemical management with lower costs and saving time.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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