Small Grain Cereals and Dicotyledonous Weed Response to Herbicides Applied at Two Growth Stages in Chaouia (Semiarid Region of Morocco)

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Abstract

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From 1984 to 1987, nine trials on bread and durum wheat and barley were conducted using 16 different antidicotyledonous herbicides at Ben Ahmed and Sidi El Aydi Experimental Stations in Morocco. Herbicides applied at the 3 - 5 leaf stage of the crop reduced weed biomass by 90% and increased grain yield by 100% and straw yield by 44%, compared to the untreated check. Herbicides applied at the full-tillering stage of the crop reduced weed biomass by 81% and increased grain yield by 28% and straw yield by 10%, compared to the untreated check.

Key words: losses due to weeds, wheat, barley. Morocco.

Introduction

About 90% of the weed species infesting small grain cereals in Chaouia (Semiarid region of Morocco) are dicotyledonous (5, 14). To control these weeds, farmers usually hand-weed fields at grain heading when weeds are easily seen and large enough to feed livestock. Tanji (15) reported that hand weeding provided up to 2200 kg / ha of weed dry matter; however, there was an average loss of 0.43 kg of wheat grain for each kg of weed dry matter harvested. Relatively little chemical weed control is used in this region. Reasons that farmers hesitate to use herbicides include: 1) difficulty in obtaining sprayers, herbicides, and /or water; 2) habit of too late application of herbicides, when weeds are in bloom and tolerant to herbicides; and 3) need for weeds as forage.

In five experiments from 1984 - 87, early weed control together with Hessian fly *Mayetiola destructor* (Say)] control improved yields in Chaouia by 116% (12). Early weed control with chlorsulfuron (Glean) was almost three times as effective as later control with 2, 4 - D. Other improvements such as earlier planting, adequate fertilization, and more uniform stands resulting from better planting techniques could increase the advantages associated with early weed control.

This paper reports the results of nine experiments from 1984 - 87, involving most herbicides available in Morocco for control of broad - leaved weeds in small grains.

Materials and Methods

«Nesma» bread wheat, «Cocorit» durum wheat, or «905» barley were drilled in November-December at Ben Ahmed and Sidi El Aydi Experimental Stations, where average annual rainfall for the 3 years was between 204 and 342 mm (Table 1). A randomized complete block design was used, with four replications. Plot size was 2 m by 10 m, and herbicides were applied with a Co_2-powered plot sprayer delivering 225 L /ha at 207 kPa. Wheat was at the 3 - 5 leaf stage for the «early» treatments and full-tillering stage for «late» treatments. Herbicide formulations and rates are shown in table 2.

In one experiment, MCPA with clopyralid (Lontrel M 350) was applied at two growth stages over a range of rates to test for phytotoxicity to bread wheat. This herbicide is approved for use at the fulltillering stage at 1.75 L . /ha, but it may have potential for early application

Table 1. Monthly rainfall in millimeters, at Ben Ahmed and Sidi El Aydi Experimental Stations, Morocco, the year of the Experiments.

	Ben Ahmed		Sidi El Aydi	
Month	1984 - 85	1985 - 86	1985 - 86	1986 - 87
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	7	0	0	0
November	83	63	53	39
December	35	22	31	5
January	120	61	47	45
February	52	95	79	57
March	3	37	22	38
April	24	44	48	13
May	18	0	0	7
June	0	11	0	0
Total	342	333	280	204

Table 2. Herbicides used for dicotyledonous weed control in bread and durum wheat, and barley, in nine experiments from 1984 to 1987.

Timing[a] Trade name	Active ingredient	Rate (g /ha)[b]
Early		
1) Basagran DP	260 g /L bentazon + 340 g / L dichlorprop	2400
2) Brominal MR 4[c]	480 G / L bromoxynil ester	480
3) Certro H	120 g / L ioxynil + 360 g / L mecoprop (MCPP)	1440
4) Glean[c]	0.75 WDG chlorsulfuron	26
5) Lontrel M 350[c]	350 g /L 2,4-MCPA + 35 g /L clopyralid	674
6) U 46 DP	620 g / L dichlorprop	2480
Late		
7) Agroxone F	240 g /L 2,4-D amine + 240 g /L 2,4-MCPA amine	720
8) El Afrit	480 g /L 2,4-D ester	480
9) Lontrel M 350	350 g /L MCPA + 35 g /L clopyralid	674
10) Polymone 60	400 g /L mecoprop + 100 g /L 2, 4-D	750
11) Printazol 75	330 g /L 2, 4-D amine + 341 g /L MCPA	671
12) Printyl	400 g /L 2, 4-MCPA	600
13) Triotyl S	350 g /L 2,4-DP + 100 g /L 2, 4-MCPA + 150 g /L MCPP	1500
14) U 46 Super (= 13)		1500
15) U 46 KV combi-fluid	130 g /L 2, 4-D + 450 g /L MCPP	580
16) U 46 Fluid	480 g /L 2, 4-D amine	480

a) Early and late treatments applied at the 3-5 leaf and full-tillering stages of small grain cereals.
b) Grams active ingredient or acid equivalent.
c) Herbicide or application timing not approved for use in Morocco.

Table 3. Effects of herbicide and application timing on weed biomass and wheat yield in five experiments from 1984 to 1987, over a gradient of rainfall and weed density, in a semiarid region of Morocco.

Year	1984 - 85			1985 - 86			1985 - 86			1986 - 87			1986 - 87		
Site	Ben Ahmed			Ben Ahmed			Sidi El Aydi			Sidi El Aydi			Sidi El Aydi		
Weed density (# / m^2)	86			28			297			44			190		
Rainfall (mm)	342			333			267			204			204		
Preceeding crop	wheat			wheat			weedy fallow			tilled fallow			weedy fallow		
Timing Herbicide	WdDW[a]	Grain	Straw	WdDW	Grain	Straw	WdDW	Grain	Straw	WdDW	Grain	Straw	WdDW	Grain	Straw
Early Glean	47	1778	3101	1	3549	8558	54	1741	2829	195	964	1729	39	512	932
Late El-Afrit	52	1777	3229	2	3279	8752	139	925	1489	36	933	1852	80	191	609
Untreated	671	1316	2886	59	3553	8577	296	569	1071	719	789	1625	440	113	462
LSD (0.05)	204	200	320	19	ns	ns	97	291	465	167	116	148	73	44	72

a) WdDW = above-ground weed weight, oven-dried at 60°C, expressed in Kg /ha.

as well. All herbicides except bromoxynil (Brominal ME 4) and chlorsulfuron (Glean) are registered for use on small grains in Morocco.

Data obtained included grain and straw yields, and weed dry weights (Tables 3, 4 and 5) or weed control ratings (Table 6). Data were analyzed using the analysis of variance.

Results and Discussion

1. Treatment effects on weeds. All experiments showed significant reductions in weed biomass as a result of herbicide treatments (Tables 3, 4 and 5). Herbicide treatments applied at the full-tillering stage reduced weed biomass by 81% compared to the untreated checks; whereas early treatments caused a 90% reduction in weed dry weight. These results are consistent with Tanji and Regehr's (1988) findings that 2,4 - D applied to bread and durum wheat at the full-tillering stage on 20 farmers' fields in the region reduced weed dry weight by 82%. There were no significant differ-

Table 4. Effects of herbicide timing on weed biomass and durum wheat yields in one experiment at Sidi El Aydi Experimental Station, Morocco in 1985 – 86.

Timing[a] Herbicide	Weed dry weight	Durum wheat yields Grain	Straw
Early			
Basagran DP	53[b]	1661	1838
Certrol	31	1609	1708
Glean	214	1425	1627
Mean	99	1565	1724
Late			
El – Afrit	220	1025	1179
Lontrel M 350	210	1304	1458
Printazol 75	311	1155	1346
Mean	247	1161	1328
Untreated	1281	859	1506
LSD (0.05)	205	277	342

a) Early and late treatments applied at the 3 – 5 leaf and full – tillering stages of wheat, respectively.
b) All figures in the table are expressed in Kg / ha.

ences in the performance of the various late-applied herbicide treatments (Tables 4 and 5). Weed biomass remaining after herbicide application was due to partially controlled and / or late-germinating dicotyledonous weeds and to grasses not affected by these treatments.

All herbicides gave good to excellent full-season control of field marigold (*Calendula arvensis* L.), wall rocket (*Diplotaxis tenuisiliqua* Del.), Sweetclover (*Melilotus Sulcata* Desf.), charlock (*Sinapis arvensis* L.), and common vetch (*Vicia sativa* L.). Common poppy (*Papaver rhoeas* L.), the most important weed in Chaouia wheat (15), was adequately controlled by all herbicides, except early-applied bentazon with dichlorpropU (Basagran DB) (Table 7). Crown daisy (*Chrysanthemum coronarium* L.) and centaury (*Centaurea diluta* Aiton) were controlled by all approved early treatments but were much more resistant to late-applied herbicides.

Milkvetch (*Astragalus boeticus* L.) and spiny emex Emex *spinosa* (L.) Campd.] were stunted but not adequately controlled by most of these herbicide treatments (Table 7). Presently, neither species occurs with high frequency in the Chaouia (15), but both are a potential threat to cereal production and warrant further research on control methods.

Table 5. Effects of herbicide timing on weed biomass and barley yields in two experiments at Sidi El Aydi Experimental Station, Morocco in 1985 – 86 and 1986 – 87.

Timing[a]	1985 – 86			1986 – 87		
	Weed dry	Barley yield		Weed dry	Barley yield	
Herbicide[b]	weight	Grain	Straw	weight	Grain	Straw
Early						
Basagran DP	179[b]	4779	5396	9	550	1418
Brominal ME4	45	4768	5061	—	—	—
Certrol H	51	5068	5793	11	478	1246
Glean	130	4778	5338	—	—	—
U 46 DP	—	—	—	31	455	1068
Mean	101	4848	5397	17	494	1244
Late						
Agroxone F	—	—	—	167	224	905
El Afrit	737	4578	4969	156	333	945
Lontrel M 350	247	4014	4338	157	314	694
Polymone 60	—	—	—	270	261	745
Printazol 75	378	4206	4841	161	241	909
Printyl	—	—	—	273	238	739
Triotyl 5	—	—	—	175	285	650
U 46 Super (= 13)	—	—	—	269	211	745
U 46 KV combi-Fluid	—	—	—	261	239	795
U 46 Fluid	—	—	—	261	213	741
Mean	454	4266	4716	215	256	788
Untreated	2729	3473	4261	551	200	814
LSD (0.05)	851	736	909	134	148	285

a) Early and late treatments applied at the 3 – 5 leaf and full-tillering stages of barley, respectively.
b) All figures in the table are expressed in Kg /ha.

Table 6. The effect of MCPA with clopyralid(Lontrel M 350) applied at different wheat growth stages on weed control and wheat yield, at the Sidi El Aydi Station, Morocco 1986 – 87.

Timing[a]	Rate (g /ha)	Weed control[b] (%)			Wheat yield (kg /ha)	
		Cal.[c]	Cent.	Sin.	Grain	Straw
Early						
	385	95	100	100	528	1220
	674	100	100	100	520	1140
	1155	100	100	100	545	1145
	1925	100	100	100	545	1160
Mean					535	1166
Late						
	385	53	50	60	390	838
	674	78	80	87	425	940
	1155	95	98	98	435	985
	1925	100	100	100	385	1065
Mean					409	957
Untreated		0	0	0	473	975
	LSD (0.05)	9	6	6	113	177

a) MCPA with clopyralid applied early at the 3 – 5 leaf stage and late at the full-tillering stage.
b) Weed control determined three weeks after treatment, on a 0 – 100 scale, with 0 = no control and 100 = total control.
c) Weed species rated were *Calendula arvensis* L., *Centaurea diluta* Aiton, and *Sinapis arvensis* L.

Table 7. Comparative effectiveness of 16 herbicides on 10 common dicotyledonous weed species.

	Herbicides and Timing[a]															
	Early						Late									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Astragalus boeticus L.	P	—	P	P	—	—	P	P	P	P	P	P	P	P	P	P[b]
Calendula arvensis L.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Centaurea diluta Aiton	C	C	C	P	C	C	C	C	C	P	C	P	C	C	C	P
Chrysanthemum coronarium L.	C	C	C	C	C	C	P	C	C	P	C	P	P	P	P	P
Diplotaxis tenuisiliqua Del.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Emex spinosa (L.) Campd.	P	—	P	P	C	—	P	P	P	P	P	P	P	P	P	P
Melilotus sulcata Desf.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Papaver rhoeas L.	P	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Sinapis arvensis L.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Vicia sativa L.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C

a) Early and late treatments applied at the 3 – 5 leaf and full-tillering stages of cereals. Refer to Table 2 for corresponding herbicide names.
b) C = Total control, P = Partial control, — = No information.

MCPA with clopyralid (Lontrel M 350) gave significantly better control of centaury, charlock, and field marigold when applied early than when applied late (Table 6). There was no apparent injury to wheat even at application rates up to three times the recommended rate. If these results are substantiated by further research, early application of this herbicide at or below its presently labelled rate of 674 g /ha could be an economical early treatment to control spiny emex more effectively than other early-applied herbicides (Table 7).

Ioxynil with MCPP (Certrol H) applied early gave consistent control of a broad spectrum of dicotylendonous weeds, confirming previous results from Tunisia (6). Since dicotyledonous weeds are more susceptible to control at the seedling stage (1), we suggest that ioxynil with MCPP (Certrol H) and MCPA with clopyralid (Lontrel M 350) are especially promising for early, effective weed control in cereals in semiarid regions of Morocco.

2. Treatment effects on wheat and barley yields. In nine

experiments, total grain production was increased 41 and 16%, respectively, by early and late-applied herbicides. This yield advantage from early weed control is consistant with previous reports (1, 2, 4, 8, 9, 10, 13).

The effects of herbicides varied greatly from one experiment to another, with greatest yield increases occurring where weed densities were highest and precipitation was lowest. For example, at Sidi El Aydi in 1985 - 86 and 1986 - - 87, where yields were low because of high weed densities and severe moisture stress in wheat following weedy fallow (3rd and 5th experiments, Table 3), grain yields were increased nearly threefold by early weed control, whereas late weed control increased yields by only 66%. Conversely, at Ben Ahmed in 1985 - 86 (2nd experiment, Table 3), when weed pressure was low and rainfall was more adequate, weed control had no significant impact on wheat yields. The average effect of herbicides in the nine experiments was to increase grain yields by 100 and 28% respectively, for early and late treatments (Tables 3, 4, 5, and 6).

In Morocco, the value of cereal straw as animal fodder may equal the value of the grain (15). Weed competition in small grains reduces crop vigor and tillering in wheat and barley (3, 11). Total straw production increased 20 and 7% from early and late weed control, respectively (Tables 3, 4, 5 and 6). As with grain production, the percentage increases in straw yield from weed control were highest where weed and moisture stresses were greatest. For the nine experiments, average straw yield increases were 44 and 10% for early and late weed control, respectively.

Early weed control is especially effective in reducing interspecific competition for limited soil moisture, thus improving water-use efficiency (16). Under nonirrigated conditions in the semiarid prairies of North Dakota (USA) and Manitoba (Canada), wheat tolerated weed competition for only 2 weeks (7), whereas under less stressful conditions, wheat can tolerate 3 to 4 weeks of competition after emergence, without significant yield loss (18).

Rainfed cereal production in semiarid regions in characterized by large year-to-year fluctuations. These experiments demonstrated that weed control contributed most to grain and straw yield increases where weed density was greatest and soil moisture was most limiting. Cereal production in semiarid Morocco can be stabilized by early-season assessment of weed populations and early application of appropriate herbicides.

الملخص

طنجي، أ. و د.ل. ريجير. 1988. استجابة النجيليات ذات الحبوب الصغيرة والأعشاب ثنائية الفلقة لمبيدات الأعشاب المستخدمة عند مرحلتين من النمو فى منطقة الشاوية بالمغرب. مجلة وقاية النبات العربية 6: 124 - 119.

تمّ في الفترة الواقعة بين 1984 - 1987 في محطات تجارب بن أحمد وسيدي العايدي بالمغرب انفاذ تسع تجارب على قمح الخبز والقمح الصلب والشعير باستخدام 16 مبيداً عشبياً مختلفاً ضد الأعشاب ثنائية الفلقة. وقد أظهرت هذه الدراسة أن استخدام المبيدات العشبية في مرحلة الورقة 3 - 5أدت إلى تخفيض الكتلة الحيوية للأعشاب 90% وإلى زيادة الغلة الحبية بنسبة 100%. كما أدى استخدام هذه المبيدات في مرحلة الاشطاء الكامل للمحصول إلى تخفيض الكتلة الحيوية للأعشاب بنسبة 81% وإلى زيادة الغلة الحبية بنسبة 28% وغلة التبن بنسبة 10% وذلك مقارنة بالشاهد غير المعامل.

كلمات مفتاحية: الخسائر الناتجة عن الأعشاب الضارة، قمح، شعير، المغرب.

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