Comparative Efficacy of the Most Widely Used Herbicides in Durum Wheat (*Triticum durum* Desf.) in Algeria

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Abstract

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Field chemical control trials of durum wheat (*Triticum durum* Desf.) weeds were conducted in the Sétif region (north-east of Algeria), with the most widely used herbicides in Algeria. The most abundant weeds were *Avena sterilis* L., *Convolvulus arvensis* L. and *Ranunculus arvensis* L.. The herbicides applied at the late-tillering stage of wheat were bromoxynil + diclofop–methyl, flamprop–isopropyl + MCPA, 2,4–D ester and diclofop–methyl, compared to the untreated control. The two first herbicides increased grain yield by more than 1200 kg ha^{-1} at sub-humid site, and 400 kg ha^{-1} at semi-arid site. These results showed the importance of chemical weed control in winter cereals.

Key words: Algeria, weeds, herbicides, semi-arid, sub-humid, wheat.

Introduction

In Algeria, a fallow-winter cereals rotation occupy every year more than 80% of cultivated land. The grain yield average is less than 700 kg ha^{-1}, and the production is not sufficient to meet local consumption. The low yield is partly due to the erratic and low rainfall and also to the use of unimproved production practices, which don't give attention to the control of weeds.

A total of 150 species belonging to 23 plant families were recorded in the cereals of the Sétif high plains (north-east of Algeria), from these, 87% are broad-leaved species (2). The wheat yield losses caused by this weed flora vary from 30 to 60% depending on weed density and environmental conditions. Relatively chemical weed control is not widely used in this region, and herbicides are applied only on less than 5% of the total surface of cereals. The main reasons that farmers hesitate to use herbicides are: the high price of sprayers and herbicides, need for weeds as fodder during the fallow and production risks inherent to the environment (mainly drought).

More than sixteen herbicides are registered for use in cereals fields in Algeria, of these the 2,4–D is the most applied, and the treatments with this herbicide, which have currently been conducted in Algeria for more than 25 years on large cereal areas, show an invasion by weed grasses, like *Avena sterilis* L., *Lolium* sp., *Bromus rigidus* Roth. and *B. rubens* L. (1). This research was carried out to compare the efficacy of the most widely used herbicides for weeds control in winter cereal, in Algeria.

Materials and Methods

Durum wheat (*Triticum durum* Desf.) cv. "Waha" was sown on January, 1998 at ITGC research station (5 km south of Sétif) and on November, 1997 at Chekhchoukh experimental station (12 km north of Sétif). The site characteristics, environmental conditions and agronomic details of the experiments are summarized in Table 1.

Table 1. Details of the location, climate, soil characteristics, crop agronomy and date of herbicide application for two experiments.

Particulars	South site	North site
Location	ITGC research station	Chekhchoukh experimental station
Altitude (m)	1000	1200
Climate		
Long- term mean seasonal rainfall (mm)	400	500
Average of min. of coldest month (°C)	0.4 (January)	
Average of max. of hottest month (°C)	32.5 (July)	
Climatic area	Semi-arid	Sub-humid
Soil characteristics		
Texture	Clay loam	Clay
OM%	0.40	1.85
pH (1:5 H2O)	7.9	7.2
Crop agronomy		
Preceding crop	Follow ploughed	Vetch - oat
Disc ploughing (September)	1	1
Cover crop before seeding	2	3
Seed rate (kg/ha)	120	120
Sowing date	28 November	12 November
Harvest	25 June	18 July
Time of herbicide application	26 March	16 April

The herbicides used in this experimentation were assigned to three groups for the purpose of comparison: broad-leaved / grass herbicides (Bromoxynil + diclofop–methyl and Flamprop–isopropyl + MCPA), broad-leaved herbicide (2,4–D ester) and selective graminicide (Diclofop–methyl). Herbicide formulations and rates are shown in Table 2. A randomised complete block design was used, with four replications. Plot size was 2 m by 10 m. Herbicides were applied at the late–tillering stage of wheat, with plot sprayer at pressure of 310 kPa. The weather during treatment at both sites was sunny and the temperature was about 20°C.

Weed densities were established at booting and inflorescence emergence stages of wheat (7), by using a quadrat of 0.5 m X 0.5 m randomly placed four times in each plot. Weed species collected from each plot were identified following the « Nouvelle flore d'Algérie » (4). Dominant weed species are reported on Table 3. Shoot biomass and density of wheat were determined at maturation stage on 0.5 m section of the middle four rows of each plot. Ear numbers were counted by m². Grain yields were weighed at harvest.

Data were analysed using the analysis of variance. The significance of difference between treatments was determined by Newman–Keuls test (3).

Results and Discussion

Treatment effects on weed densities

About 80% of the weed species collected at each site were dicotyledonous, grasses, were represented by *Bromus rigidus* Roth. at south site, and by *Avena sterilis* L., *Phalaris paradoxa* L. and *Bromus sterilis* L. at north site (Table 3). At wheat booting stage, average weed populations in the untreated control were 190 and 154 plants m^{-2} at south site and north site, respectively. They were at wheat heading 100 and 202 plants m^{-2}, respectively. Herbicide treatments showed significant reductions of weed densities. All the weed control treatments except diclofop–methyl gave good to excellent control of weed populations, but did not sufficiently control some species, particularly *Convolvulus arvensis* L. and *Fumaria densiflora* DC.

The herbicides bromoxynil + diclofop, flamprop + MCPA and 2,4–D reduced weed densities by half at two sites. The diclofop–methyl, selective graminicide, gave adequate control of *A sterilis* at north site, this result is consistent with (6), and reduced its density from 37 to 9 and from 32 to 4 plants m^{-2} at 28 DAT and 56 DAT, respectively. In Morocco, significant wheat yield losses were noted from 10 plants m^{-2} of *A. sterilis* (5) The bromoxynil + diclofop and flamprop + MCPA were the most efficient herbicides, they reduced weed densities by more than 80% at two sites.

Table 2. Herbicides and rates of their application.

Trade name	Active ingredient	Rates (g a.i.ha^{-1})
Illoxan B	110 g L^{-1} Bromoxynil + 245 g L^{-1} diclofop–methyl	440 + 980
Suffix double action	100 g L^{-1} L–Flamprop–isopropyl + 133 g L^{-1} MCPA	600 + 800
2,4–D	600 g L^{-1} 2,4–D ester	600
Illoxan CE	400 g L^{-1} Diclofop–methyl	1200

Table 3. Effect of herbicide treatments on weed densities (plants m^{-2}) at two wheat growth stages in the two experiments, recorded at different periods after treatment.

Site/ Weed species	Booting stage					Inflorescence emergence stage				
	Unt.[a]	4	3	2	1	Unt.	4	3	2	1
South site	23 days after treatment					49 days after treatment				
Veronica cymbalaria Bodard	77	75	53	51	55	0	0	0	0	0
Fumaria densiflora DC.	48	49	40	43	17	33	34	13	10	4
Vaccaria pyramidata Medik.	19	18	5	2	1	11	4	1	1	1
Galium tricorne Witth.	14	16	2	2	2	33	24	14	4	2
Papaver rhoeas L.	26	12	2	1	1	7	8	1	0	0
Carduus pycnocephalus L.	2	3	1	0	0	0	0	0	0	0
Bromus rigidus Roth.	2	1	1	0	0	1	0	0	0	0
Vicia sativa L.	1	1	0	0	0	15	8	1	1	0
Sonchus asper (L.)Vill.	1	0	0	0	0	0	0	0	0	0
Total (plants m^{-2})	190	175	104	99	76	100	78	30	16	7
Density reduction (%)[b]	-	08	45	48	60	-	22	70	84	93
North site	28 days after treatment					56 days after treatment				
Ranunculus arvensis L.	50	53	22	20	12	52	40	7	7	4
Avena sterilis L.	37	9	29	5	7	32	4	30	0	2
Galium tricorne Witth.	9	6	0	2	1	28	24	7	4	0
Convolvulus arvensis L.	38	27	10	12	5	74	69	24	24	17
Vicia sativa L.	15	11	1	1	0	12	16	16	0	0
Veronica cymbalaria Bodard	1	0	0	2	0	0	0	0	0	0
Phalaris paradoxa L.	2	1	1	0	0	4	0	0	2	0
Bromus sterilis L.	2	1	1	1	0	0	0	0	0	0
Total (plants m^{-2})	154	108	64	43	25	202	153	84	37	23
Density reduction (%)[b]	-	30	58	72	84	-	24	58	82	89

[a] Unt.= Untreated control, 1= Illoxan B, 2= Suffix double action, 3= 2,4–D, 4= Illoxan CE.
[b] Compared with untreated control.

Treatment effects on ear number, shoot biomass and grain yield of wheat

The biggest ear number m^{-2} and biomass of wheat were gotten in plots treated by bromoxynil + diclofop and flamprop + MCPA herbicides, increases brought by these two herbicides were more than 48% (Table 4). Compared to the untreated control, diclofop–methyl treatments at south site don't showed a difference in ear number m^{-2} and wheat biomass, because the alone grass present at this site with low density was *B. rigidus*. At north site, where the density of *A. sterilis*. was more than 30 plants m^{-2}, the diclofop–methyl was efficient and better than 2,4–D, it increased ear number m^{-2} and biomass of wheat by 48 and 32%, respectively. The 2,4–D was classified in third position at south site, it increased this two wheat components by 36 and 41%, respectively.

All herbicides treatments increased significantly wheat yield when compared to the control. At north site, the bromoxynil + diclofop and flamprop + MCPA herbicides raised grain yield by more than twofold. They brought a gain of 416 kg ha^{-1} at south site.

The 2,4–D and diclofop–methyl were more efficient at north site, they increased grain yields by 100 and 70% respectively; these increases were only 18 and 14% at south site.

Grain yield differences between untreated control and herbicides treatments varied from 133 to 416 kg ha^{-1} at south site, and from 795 to 1280 kg ha^{-1} at north site, what demonstrates that the utilization of herbicides was more valorised in the sub-humid site.

Weed management has always been important in cereal production. The choice of adequate herbicides depends on type and the intensity of weed flora. The results of this study showed that bromoxynil + diclofop and flamprop + MCPA were more efficient that 2,4–D and diclofop–methyl. In the Sétif high plains, chemical control would be more effective by using other agronomic factors such as crop rotation (wheat/ broad–leaved crop or wheat/ fodder), adequate fertilization, application of better planting techniques and ploughed follow that reduce weeds, increase water infiltration and maximize moisture storage.

Table 4. Effect of herbicide treatments on ear number m^{-2}, shoot biomass (kg ha^{-1}) and grain yield (kg ha^{-1}) of wheat.

Site Treatments	Ear number m^{-2}	Gain %[a]	Biomass (kg ha^{-1})	Gain %	Grain yield (kg ha^{-1})	Gain %
South site						
Illoxan B	347 a	58.44	6040 b	48.40	1316 a	46.22
Suffix double action	350 a	59.81	6240 a	53.31	1316 a	46.22
2,4–D	298 b	36.00	5750 c	41.27	1066 b	18.44
Illoxan CE	229 c	4.56	4160 d	2.21	1033 b	14.77
Untreated control	219 c	-	4070 e	-	900 c	-
North site						
Illoxan B	289 b	52.10	5510 a	49.72	2407 a	113.57
Suffix double action	307 a	61.57	5470 a	48.67	2372 a	110.47
2,4–D	273 b	43.68	4760 b	29.34	2260 a	100.53
Illoxan CE	282 b	48.48	4860 b	32.06	1922 b	70.54
Untreated control	190 c	-	3680 c	-	1127 c	-

[a] Compared with untreated control

Means followed by the same letter in the same column are not significantly different according to Newman–Keuls test ($P \leq 0.05$).

الملخص

فني، محمد، أ.ن. شاكر و ج. مايبه. 2002. كفاءة بعض مبيدات الأعشاب الشائعة في مكافحة الأعشاب الضارة في حقول القمح الصلب (*Triticum durum* Desf.) في الجزائر. مجلة وقاية النبات العربية. 20: 55-58.

تم في منطقة سطيف (شمال شرق الجزائر) تنفيذ تجربتين حقليتين بهدف اختبار بعض المبيدات العشبية الشائعة لمكافحة الأعشاب الضارة في حقول القمح الصلب في الجزائر. أضيفت المبيدات التالية: بروموكسينيل + ديكلوفوب ميثيل (bromoxynil + diclofop–methyl)، فلمبروب إزوبروبيل + مسيبي (flamprop–isopropyl + MCPA)، 2,4 د أستر (2,4–D ester) وديكلوفوب ميثيل (diclofop–methyl) في أخر مرحلة تكون الإشطاءات في نباتات القمح الصلب. وتبين من النتائج أن المبيدان الأولان أديا إلى زيادة في حاصل الحبوب تعدت 1200 كغ/هـ في المنطقة الشبه رطبة و 400 كغ/هـ في المنطقة الشبه جافة. أكدت هذه النتائج أهمية المكافحة الكيميائية للأعشاب الضارة التي تنمو مع هذا المحصول.

كلمات مفتاحية: الجزائر، الأعشاب الضارة، مبيدات أعشاب، منطقة الشبه رطبة، منطقة الشبه الجافة.

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