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Chemical and Agronomical Weed Control in Chickpea (*Cicer arietinum* L. cv. Aziziye-94)

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Abstract: This study was conducted in order to investigate the effect of 9 herbicides (Linuron, Methabenzthiazuron, Terbutryne, Imazethapyr, Pluazifop-P-butyl, Terbutryne+Propyzamide, Methabenzthiazuron+Propyzamide, Linuron+Propyzamide, Terbutryne+Fluazifop-P-butyl) in comparison with a weedy control and hand weeding on seed and biomass yield of chickpeas (cv. Aziziye-94) under Erzurum's dry conditions in 1996 and 1997. Data were collected on the number and density of weed species, seed yield and total biomass yield in both years

Year x treatment interacion was significant with yields being generally lower in the dry year of 1996 than in the normal conditions of 1997. In both years Terbutryne+Fluazifop-P-butyl, Imazethapyr, Linuron+Propyzamide applications were more effective whereas Methabenzthiazuron was efficacious in the relatively wetter year of 1997 but a poor performer in the dry year of 1996. It was concluded that efficacious herbicides may provide yield increases compared with the control that may justify the use of these chemicals in chickpeas in Erzurum. However, hand weeding once could be equally effective in controlling weeds.

Nohutda (*Cicer arietinum* L. cv. Aziziye-94) Kimyasal ve Kültürel Yabancı Ot Kontrolü

Özet: Bu çalışmada, 1996 ve 1997 yıllarında Erzurum kuru şartlarında nohudun (cv. Aziziye-94) tohum ve toplam ürün verimi üzerine otlu kontrol ve elle ot alımı ile 9 herbisitin (Linuron, Methabenzthiazuron, Terbutryne, Imazethapyr, Fluazifop-P-butyl Terbutryne+Propyzamide, Methabenzthiazuron+Propyzamide, Linuron+Propyzamide, Terbutryne+Fluazifop-P-butyl) etkileri karşılaştırılmalı olarak araştırılmıştır. Her iki yılda da yabancı ot türlerinin yoğunlukları ile nohudun tohum ve toplam verimi belirlenmiştir.

Yıl ile uygulamalar arasındaki interaksiyon önemli bulunmuş ve 1996 yılında havaların kurak gitmesi nedeni ile daha az verim alınmıştır. Terbutryne+Fluazifop-P-butyl, Imazethapyr, Linuron+Propyzamide uygulamaları her iki yılda etkili olurken, Methabenzthiazuron yağışlı geçen 1997'de yeterli, ancak kurak geçen 1996 yılında ise zayıf etki göstermiştir.

Sonuç olarak, etkili herbisitlerin Erzurum şartlarında nohutta kullanılması ile otlu kontrole göre ürün artışı sağlanabileceği, bununla birlikte bir kez elle yabancı ot alımıyla da yabancı otların kontrol altına alınabileceği kanısına varılmıştır.

Introduction

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops in Turkey. Its acreage has increased from aproximately 270,000 ha in the 1980 s to 760,000 ha in 1994 (1), making Turkey a leading exporter of chickpea produce. With the recent introduction of cold and Ascochyta blight resistant cultivars (2), the acreage of chickpea is projected to increase steadily to 1,600,000 ha by the year 2005 (3).

Half of the production area of the crop is in the Mediterranean costal regions and Southeastern Anatolia whereas Eastern Anatolia occupies only 9 % of the national acreage (1). Recently, a high yielding and more adaptive chickpea cultivar (cv. Aziziye-94) was registered for Eastern Anatolia (4) which may increase its acreage in the region and may well replace approximately 1,400,000 ha fallow land in the traditional fallow-wheat system.

Experiments were carried out to investigate optimum sowing density and fertilizer doses for high yields from this cultivar (5). Production techniques such as optimum sowing date, sowing density, fertilizer, weed control etc.

for this cultivar must be developed and duly presented for use by farmers in order to increase chickpea production in the region. Several herbicides such as linuron, Methabenzthiazuron, terbutryne and imazethapyr have recently been registered and authorized for weed control in chickpea in Turkey (6). This study investigated the efficacy of the recently introduced chemicals in comparison with agronomical weed control under Erzurum conditions.

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Materials and Methods

This study was caried out on the experimental farm of the Faculty of Agriculture, Atatürk University in Erzurum in 1996 and 1997 using chickpea cv. Aziziye-94 (4). The experimental soil was clay loam with neutral pH, being poor in phosphorus and organic matter content but adequate in potassium content.

In the experiment 12 treatments (Table 1) were investigated in four completely randomized blocks. Seeds were sown in 3.6 x 4 m plots to give 40 seeds/m^2 (5). Each plot contained 6 rows (7, 8). Sowing was done with a hand drill on 6 May 1996 and on 10 May 1997 to an average depth of 5-6 cm following seed bed preparation as soon as the soil tilt was suitable in spring (5, 7). All herbicides were applied at the recommended doses (Table1). with a hand operated shoulder sprayer on 7 May 1996 and 13 May 1997 except Fluazifop-P-butyl which was applied on 12 June 1996 and 20 June 1997. No rain was recorded 2 days before or after the herbicide application. No irrigation or other chemical application was done during the plant growth until harvest. Harvesting was done by hand on 15 August 1996 and on 25 August 1997 excluding side rows and 50 cm from each end of the plots to give a 7.2 m^2 harvest area. Data on total biomass and seed yields and weed species in each plot were collected at the flowering stage of chickpea. Weeds were cut from ground level in each plot of 1/4m^2 area and taken to the laboratory for separation and dry weight determinations.

Results and Discussion

A total of 9 herbicides were tested for weed control in chickpeas (Table 1). The efficacy of herbicides tested was rated in comparison with the control as <40% is weak, 40-70% medium, 70-90% good, >90% excellent (9).Thus, Imazethapyr (84.6%), Terbutryne+Propyzamide (75.5%) and Terbutryne+Fluazifop-P-butyl (73.5%) were effective on broad-leaved weed species whereas Terbutryne (60.1%), Linuron (58.7%), Linuron+Propyzamide (57.4%), Methabenthiazuron+Propyzamide (56.6%) and Methabenzthiazuron (47.3%) were of relatively medium efficacy (Table 2). Fluazifop-P-butyl was ineffective on broad-leaved weeds. Imazethapyr, on the other hand, was effective on *Chenopodium album* (94.5%), *Amaranthus retroflexus* (98.0%) as was Terbutryne on *Equisetum arvense* (97.2%) (Table 2). Hand weeding once or twice provided on average weed control rates of 71.2-82.7% compared with the control.

Other species (Table 2) which were of comparatively less density in the plots included *Cirsium arvense* (L.) Scop., *Crambe orientalis* L., *Centaurea cyanus* L., *Centaurea depressa* Bieb., *Descurainia sophia* (L.) Webb

Table 1. Active ingredients, trade name, formulation, application doses and application periods of herbicides investiated

Active Ingredients/ Treatments	Trade Name	Formulation	Application Doses	Application Periods
Linuron	Linurex 50	WP	200 g/da	Pre-emergence
Methabenzthiazuron 70%	Tribunil 70	WP	250 g/da	"
Terbutryne 80%	Igran 80	WP	125 g/da	"
Imazethapyr	Pursuit 100	SL	20 cc/d	"
Fluazifop-P-butyl	Fusilade super	EC	100 cc/da	Post-emergence
Terbutryne +	Igran +	WP	125 g/da +	Pre-emergence
Propyzamide	Kerb 50	WP	50 g/da	"
Methabenzthiazuron +	Tribunil +	WP	250 g/d+	"
Propyzamide	Kerb	WP	50 g/da	"
Linuron +	Linurex +	WP	200 g/d+	"
Propyzamide	Kerb	WP	50 g/da	"
Terbutryne +	Igran +	WP	125 g/d+	Pre and Post-
Fluazifop-P-butyl	Fusilade	EC	100 cc/da	emergence
Hand weeded once	-	-	-	-
Hand weeded twice	-	-	-	-
Unweeded check	-	-	-	-

ex Prantl, *Fumaria officinalis* L., *Hyoscyamus niger* L., *Lactua serriola* L., *Lamium amplexicaule* L., *Melilotus officinalis* (L.) Desr., *Polygonum aviculare* L., *Polygonum bellardii* All., *Polygonum convolvulus* L., *Sideritis montana* L., *Sisymbrium altissimum* L., *Thlaspi arvense* L., *Tragopogon aureus* Boiss. and *Vicia cracca* L.

Total weed dry weight mass was 231.04 g/m^2 in the control plots with no herbicide spraying or hand weeding compared with 91.24 g/m^2 in herbicide sprayed plants on average (Table 3). Thus, herbicidal control of weeds was 60.51% on average. In terms of dry weed mass Terbutryne+Propyzamide was more effective followed by Imazethapyr alone, Terbutryne+Fluazifop-P-butyl, Terbutryne alone and the others. In terms of weed intensity Imazethapyr was the most efficacious followed by Terbutryne+Propyzamide, Terbutryne+Fluazifop-P-butyl and the others. Hand weeding once and twice provided 89.8 and the 92.6% weed control respectively when compared with unweeded control. However, hand weeding once was almost as effective in controlling weeds as hand weeding twice.

The effect of herbicide application was significant on the total biomass and seed yiels (Table 4). The highest seed yield of the average of both was obtained from Terbutryne+Fluazifop-P-butyl, Imazethapyr and Linuron+Propyzamide applications which were equal to or better than hand weeding once or twice (Table 4). Total biomass yield was also the highest in

Table 2. The intensity of weeds (number m^{-2}) and the efficacy as an average of both years on weed species

Treatments	*C. arvensis*	*C. album*	*A. retroflexus*	*E. arvense*	Others	Average density	Control (%)
Linuron	27.5	8.3	25.5	10.8	0.08	72.18	58.67
Methabenzthiazuron	8.5	22.8	58.0	2.3	0.39	91.99	47.33
Terbutryne 80%	19.5	10.0	39.8	0.3	0.05	69.95	60.12
Imazethapyr	19.5	1.8	2.0	3.5	0.13	26.93	84.58
Fluazifop-P-butyl	-	-	-	-	-	97.79	-
Terbutryne + Propyzamide	12.3	2.8	21.3	6.3	0.09	42.79	75.50
Methabenzthiazuron +	14.5	7.3	48.8	5.0	0.13	75.73	56.64
Linuron + Propyzamide	18.5	6.8	37.0	12.0	0.03	74.33	57.44
Terbutryne + Fluazifop-P-butyl	16.8	5.8	23.5	0.0	0.14	46.24	73.52
Hand weeded once	4.8	4.3	14.5	5.8	0.11	29.51	82.73
Hand weeded twice	12.5	2.5	34.5	0.8	0.00	50.30	71.20
Unweeded check	28.0	32.8	102.8	10.8	0.26	174.66	-

Table 3. Efficacy of different herbicides and weeding by hand on the dry weight of broad-leaved weeds (g m^{-2})

Treatments	1996	1997	Average	Control (%)
Linuron	121.14	46.75	83.94	63.67
Methabenzthiazuron	152.71	26.02	89.36	61.32
Terbutryne 80%	140.49	8.60	74.54	67.74
Imazethapyr	74.53	51.84	63.18	72.65
Fluazifop-P-butyl	206.16	110.51	158.34	31.47
Terbutryne+Propyzamide	61.23	40.82	51.02	77.92
Methabenzthiazuron+Propyzamide	162.64	106.35	134.49	41.79
Linuron+Propyzamide	129.33	61.53	95.43	58.70
Terbutryne+Fluazifop-P-butyl	114.92	26.87	70.89	69.32
Average of herbicides	129.24	53.25	91.24	60.51
Hand weeded once	13.44	33.62	23.53	89.82
Hand weeded twice	28.84	5.16	17.00	92.64
Unweeded check	348.52	113.57	231.04	-
Standard Error (SE)	(SD 33) = 40.014	(SD 33) = 17.099	(SD 69) = 30.854	-

Terbutryne+Fluazifop-P-butyl, Imazethapyr, Terbutryne+ Propyzamide and Terbutryne applications as an average of both years (Table 4). However, year x treatment interaction was significant ($p<0.01$) and yields were lower in general in 1996 years possibly due to low levels of precipitation in that year. In 1996 the total monthly rainfall was 30.6, 39.7 and 17.2 mm in April, May and June respectively compared with 40.7, 66.1 and 32.0 mm in the same period in 1997 in spite of the lack of any discernable difference in average temperature in the both years. Long term total rainfall during the same period was 53.8, 73.0 and 52.8 mm for the period 1929-1995.

In the dry conditions of 1996 Imazethapyr and Linuron+Propyzamide applications gave relatively high yields while Methabenzthiazuron was a poor performer (Table 4). Biomass yields were also in line with the seed yields in that year. In the relatively normal conditions of 1997 Terbutryne+Fluazifop-P-butyl and Methabenzthiazuron gave comparatively high yields, indicating that environmental conditions, notably soil moisture may influence the efficacy of herbicides. Moreover, as an average of both years Terbutryne+Fluazifop-P-butyl and Imazethapyr applications gave 40-50 kg/da higher yields than the unweeded control (Table 4) being comparable with or better than hand weeding twice. Fluzifop-P-butyl application as a supplement to Terbutryne appeared to provide an increase in seed yield of 12.93 kg/da on average in the two years. However, this increase amounted to 22.29 kg in 1997 which may justify extra supplemental application of Fluazifop-P-butyl.

In other studies Terbutryne and Methabenzthiazuron alone or in combination with other herbicides controlled weeds in chickpea better (10, 11). With Terbutryne application in chickpea seed yields increased from 102.7 to 156.5 kg/da with Methabenzthiazuron application giving even higher yields up to 170.1 kg/da in India (12). Terbutryne and Methabenzthiazuron were reported to effectively control broad leaved annual weed species (13). Under Syria's dry conditions the best results were obtained using Terbutryne, Chlorbromuron and Cyanazine with Pronamide combinations depending on the locations (14). These trials indicated that Methabenzthiazuron and Terbutryne were effective in relatively wetter conditions (14) in line with the data in our experiments.

In studies conducted at ICARDA, seed yield o chickpea increased from 99 kg/da in the weedy control to 185 kg/da when Igran+Kerb was applied (15). In Sicily, seed yield was 81 kg/da in weedy control plots but increased to 150 kg/da and 155 kg/da when hand weeded once and Propyzamide+Simazine was applied (16). In Pakistan, seed yield increased from 84 kg/da in weedy control plots to 112 kg/da in weeded plots, 114 kg/da in Igran (Terbutryne) applied plots and 95 kg/da in Tribunil (Methabenzthiazuron) treated plots (17).

Table 4. The effect of herbicides and hand weeding on seed and biomass yields of chickpea (kg/da)

	1996		1997		Average	
Treatments	Seed	Biomass Seed+Straw	Seed	Biomas Seed+Straw	Seed	Biomas Seed+Straw
Linuron	65.80	168.30	122.88	246.53	94.34	207.41
Methabenzthiazuron	21.49	66.58	145.94	295.14	83.71	180.86
Terbutryne 80%	47.16	136.81	132.85	309.03	90.00	222.92
Imazethapyr	83.36	197.29	125.28	277.78	104.32	237.54
Fluazifop-P-butyl	32.37	94.48	89.27	222.22	60.83	158.35
Terbutryne+Propyzamide	59.34	166.81	135.56	288.19	97.45	227.50
Methabenzthiazuron+Propyzamide	38.46	112.22	110.97	232.64	74.72	172.43
Linuron+Propyzamide	72.84	169.36	128.96	256.94	100.90	213.44
Terbutryne+Fluazifop-P-butyl	70.73	192.36	155.14	305.56	112.93	248.96
Hand weeded once	26.42	106.43	126.42	295.14	76.42	200.78
Hand weeded twice	31.77	96.70	132.81	270.83	82.29	183.77
Unweeded check	24.24	86.74	103.26	201.39	63.75	144.06
Standard Error (SE)	10.162 (SD 33)	22.914 (SD 33)	13.042 (SD 33)	19.104 (SD 33)	11.743 (SD 69)	21.536 (SD 69)

In conclusion, two years of trials showed that herbicide application considerably increased chickpea yields compared with the unweeded control under Erzurum's dry conditions. Of the herbicides tested Terbutryne+Fluazifop-P-butyl, Imazethapyr, Linuron+ Propyzamide were the most effective. However, further trials should be conducted involving higher plant densities, locations, soil types and supplemental weed control using Fluazifop-P-butyl in conjunction with other pre-emergence herbicides. Hand weeding once may equally be effective in controlling weeds subject to economical availability of labour.

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