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EFFECT OF SOME HERBICIDES ON ANNUAL GRASS AND BROAD LEAVED WEEDS IN MAIZE CROP
2- Phytotoxic effect of some herbicides on maize crop

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ABSTRACT

Two trials were conducted during 2010 and 2011 summer seasons in Tahanoub area, Qualubia Governorate, Egypt, to evaluate the phytotoxic effect of different doses of the new selective herbicide Equip 22.5% OD (foramsulfuron + isoxadifen-ethyl) against annual grassy and broad leaved weeds in maize (*Zea mays* L.) fields compared to the recommended herbicide by the Egyptian Ministry of Agriculture; Starane 20% EC (fluroxypyr) and manual hoeing. The results showed that when Equip was applied at the recommended dose (750 cc/fed.), it increased chlorophyll a, b and the total chlorophyll content of the treated maize leaves significantly compared with the other treatments at 7, 14 and 21 days after treatment (DAT) during the two growing seasons. When Equip was tested at the double rate it showed a significant reduction in the total chlorophyll content compared to the other treatments.

Data showed that Equip at the recommended rate as well as hoeing treatment increased maize shoot dry weight significantly compared to Equip applied at the double dose and the untreated check. Also, Equip at the recommended rate increased cob weight significantly more than the other treatments and recorded the highest cob weight being 363 and 170.71 g/cob followed by hoeing (352.5 and 146 g/cob) and Starane (310 and 129.71 g/cob), at the 1st and the 2nd season, respectively, while Equip at the double dose showed the lowest significant effect.

Key words: *Equip 22.5% OD, phytotoxicity, maize (Zea mays L.).*

1. INTRODUCTION

Maize (*Zea mays* L.) is sensitive to weeds especially in the early growth stages. (Cheema *et al.,* 2004; Baghestani *et al.,* 2007). Indiscriminate use of chemicals for controlling weeds may pose environmental problems (Cheema & Khaliq, 2000). Although herbicides are very effective in controlling weeds, certain risks as environmental pollution and human health are involved in herbicide use.

Previously, many studies revealed that the phytotoxicity of sulfonylurea herbicide group increased with increasing the concentration in soil. (Eleni Kotoula *et al.,* 1993). Moreover, the phytotoxicity may occur to the susceptible species at levels as low as 0.1 g/h because of their great mobility in the soil and long persistence. Also, they can damage following crops for several growing seasons, (Cotterill (1992). Hollaway *et al.,* (2006), mentioned that sulfonylurea herbicides in alkaline soils (pH range 7.4 – 8.6) persisted for 3-5 years which is long enough to damage subsequent rotational crops.

Foramsulfuron is a new selective sulfonylurea herbicide that inhibits acetolactate syntheses key enzme in its branched chain amino acid synthesis (ALS or AHAS). Excellent crop safety was exhibited and crop response was minimal because of the proprietary safener isoxadifen-ethyl which is formulated with foramsulfuron. Previous research has shown that isoxadifen-ethyl reduces foramsulfuron phytotoxicity in maize by increasing the rate of foramsulfuron degradation (Chad *et al.*, 2001). Isoxadifen-ethyl has also been shown to reduce phytotoxicity of several broadleaf herbs. Also, the safener of isoxadifen-ethyl increased parent foramsulfuron selectivity by reducing its

translocation to the grown maize (Pesticide Manual, 2003-2004).

The present study aimed to evaluate the phytotoxicity of foramsulfuron to maize plants in comparison with the recommended maize herbicide under Egyptian field conditions.

2. MATERIAL AND METHODS

2.1. Field preparation and experiment design

Two trials were conducted during 2010 and 2011 summer season in Tahanoub area, Qualubia Governorate, Egypt, to evaluate the phytotoxic effect of the new herbicide foramsulfuron at different doses against maize (*Zea mays* L.) plants compared to Starane as the standard herbicide recommended by the Egyptian Ministry of Agriculture. All treatments were laid out in a randomized complete block design with three replications as well as the untreated check (control). The net plot size was 54 m^2. Hagen 2030 (hybrid) maize was planted. The analysis indicated that the soil was silty clay with particle size distribution 0.0% sand, 61% silt and 39% clay. Some of the physico-chemical characteristics and organic matter content (OM) of the used soil are presented in Table (1).

Table (1): Physico-chemical characteristics of the used soil.

pH	EC	Soluble cations (meq/l)				Soluble anions (meq/l)			O.M %	SP %*
(1:2.5) Suspen	dsm^{-1} at 25 C	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	HCO_3^-	Cl^-	SO_4^{--}		
7.2	6.9	37.84	20.3	1.6	21.74	4.25	26.56	50.67	1.96	53.33

* Saturation percentage.

2.2.Herbicide treatment

The herbicides were sprayed 3 weeks after planting using knapsack hand sprayer with flat fan nozzle at field capacity condition. Hand hoeing was conducted twice after the 1^{st} and the 2^{nd} irrigation. All other agricultural practices were kept as used for all treatments.

Equip 22.5% OD (foramsulfuron + isoxadifen-ethyl) at the recommended rate (750 cc/fed.), and at the double rate (1500 cc/ fed.), and Starane 20% EC (fluroxypyr) were applied at the rate of 200 cc/fed. The treated and untreated check were replicated 3 times distributed in completely randomized plots.

2.3. Measurements of phytotoxic action

The phytotoxic effect of the treated herbicide was carried out according to FAO, (2006). One week after spraying, the visual phytotoxic symptoms *i.e.,* yellowing, stunting, malformation, burning, necrosis and leaf curl were observed in all treated plots. Also, chlorophyll a (Chl_a), Chlorophyll b (Chl_b) and the total chlorophyll (Chl_t) were determined periodically 7 days after application.

Chlorophyll a, Chl_b and Chl_t were calculated using Arnon equation (1949).

Chl. $_a$ = 12.7 x O.D 662 – 2.69 x O.D 644 mg/l

Chl. $_b$ = 22.9 x O.D 644 – 2.69 x O.D 662 mg/l

Chl. $_t$ = 20.2 x O.D 644 + 8.02 x O.D 662 mg/l

At the harvest stage, maize plant height, dry and fresh weight (g/plant) were oven dried at 72 °C for 48 h., cob number/plant and cob weight for each treatment was recorded.

2.4. Statistical analysis: The crop parameters were analyzed statistically by using SPSS analysis of variance technique and least significant difference test was applied at 5% probability level to compare treatment means.

3. RESULTS AND DISCUSSION

3.1. Phytotoxicity symptoms

Over all the experiment time, the visual phytotoxic symptoms, *i.e.* yellowing, stunting, malformation, burning, necrosis and leaf curl were observed at the different herbicide types/rates treatments.

3.2.Chlorophyll content

Data presented in Table (2) showed that Equip at the recommended rate (750 cc/fed.), increased the average of Chl_a, Chl_b, and Chl_t content significantly compared to the other treatments after 7, 14, 21 days from application during the two seasons.

3.3.Chlorophyll a contents

The present results showed that maize leaf Chl_a varied significantly according to the applied treatment and the application rate of herbicides during the two growing seasons.

The data showed that Equip at the recommended dose increased Chl_a significantly than the other treatments followed by hoeing and recorded the

highest content after 7, 14 and 21 days from application (DAT), being 5.99, 4.66 and 5.65 mg/g fresh weight, and 2.88, 3.06 and 2.92 mg/g fresh weight at the 1st and the 2nd season, respectively.

However, when the recommended dose was doubled, Chl_a decreased significantly compared to Equip at the recommended rate recording the lowest content after 7 and 21 DAT being 3.16 and 2.59 mg/g fresh weight, and 2.88 and 2.92 mg/g fresh weight, at the 1st and the 2nd season, respectively.

Starane treatment significantly decreased Chl_a compared to Equip at the recommended rate after 7 and 21 DAT during the 1st and 2nd season reaching 4.3 and 3.373 mg/g fresh weight, or 2.06 and 1.85 mg/g fresh weight, respectively.

Equip at the double rate, Starane and hoeing treatments showed inconsistent un-uniform response after 14 DAT.

3.4. Chlorophyll b contents

The data presented in Table (2) showed a correlation between the change of Chl_a and Chl_b contents in maize leaves.

The data showed that Equip at the recommended dose increased Chl_b significantly compared to the other treatments after 7, 14 and 21 DAT, reaching 1.08, 0.9 and 0.97 mg/g fresh weight, and 2.52, 2.64 and 2.42 mg/g fresh weight during the 1st and the 2nd season, respectively.

When Equip dose was doubled, it showed significant decrease in Chl_b content compared to the other treatments after 7 and 21 DAT, recording the lowest content being 0.36, and 0.37 mg/g fresh weight or 1.71 and 1.69 mg/g fresh weight, during the first and the second growing seasons, respectively.

Hoeing treatment showed no significant effect compared with Equip at the recommended dose after 7 and 21 DAT, while Starane showed fluctuated effect on Chl_b content compared to the other treatments during the two seasons.

3.5. Total chlorophyll contents

The data presented in Table (2) showed that the change of the total chlorophyll of maize leaves synchronizes with the variation in Chl_a and Chl_b according to applied treatment during the growing two seasons.

The results showed that Equip applied at the recommended dose, significantly increased Chl_t content comported to the other treatments reaching, 7.07, 5.56 and 6.62 mg/g fresh weight, or 5.40, 5.70 and 5.33 mg/g fresh weight after 7, 14 and 21 DAT during the 1st and 2nd growing seasons, respectively.

Equip applied at the double rate significantly decreased Chl_t after 7 and 21 DAT and it was less than all other treatments being, 3.52 and 2.96 mg/g fresh weight and 4.17 and 3.95 mg/g fresh weight at the 1st and 2nd growing seasons, respectively.

Hoeing treatment showed no significant effect on Chl_t compared to Equip at the recommended dose. It increased the total chlorophyll content after 7 and 14 DAT, reaching 5.84 and 6.40 mg/g fresh weight at the 1st season, and 5.07 and 4.95 mg/g fresh weight at the 2nd season, respectively.

3.6. Chlorophyll a/b ratio

The results in Table (2) indicated that chlorophyll a/b ratio showed no marked differences between the different treatments during the two growing seasons, except Equip treatments when applied at the double dose which increased chlorophyll a/b ratio markedly comparing to the other treatments after 7 and 21 DAT.

3.7. Shoot weight and height

3.7.1. Shoot height

The data in Tables (3 and 4) revealed that hoeing increased maize height significantly (250 cm) compared with Equip applied at the double dose (221.5 cm) and the untreated check (216 cm) at the 1st season, while there was no significant difference between the other treatments.

All treatments and the untreated control showed no significant effect on maize plant height during the 2nd season.

3.7.2. Fresh weight

The results in Tables (3 and 4) illustrated that all treatments showed no significant differences in shoot fresh weight, while it was significantly increased in the 1st and the 2nd seasons compared with the untreated check.

3.7.3. Dry weight

Data presented in Tables (3 and 4), showed no significant differences between Equip at the recommended rate and hoeing treatment being 320.83g and 320.0g at the 1st season and 165.42 and 156.42 g at the 2nd season, respectively. When Equip was applied at the double rate it showed no significant effect on shoot dry weight (260 g) compared to the untreated control (265 g) in the 1st season, or 119.64 and 125 g in the 2nd season, respectively. There was no significant differences between Starane and hoeing treatment during the two growing seasons.

3.7.4. Fresh/dry weight ratio

Table (2): Effect of Equip 22.5 OD at two doses and Starane on maize leaf chlorophyll Content (mg/g fw).

Days after treatment	Treatment		First season				Second season			
	Herbicide	Rate of Appl. CC /fed.	Chl a	Chl b	Chl t	Chl a/b	Chl a	Chl b	Chl t	Chl a/b
7	Equip22.5 OD	750	5.99 a	1.08 a	7.07 a	5.55	2.88 a	2.52 a	5.40 a	1.14
	Equip 22.5 OD	1500	3.16 c	0.36 c	3.52 c	8.78	2.46 b	1.71 c	4.17 b	1.44
	Starane 20% EC	200	4.30 b	0.70 b	5.00 b	6.14	2.47 b	2.06 b	4.53 b	1.20
	Manual hoeing	Twice	5.0 ab	0.84 ab	5.84 ab	5.95	2.62 ab	2.45 a	5.07 a	1.07
	Control	-----	3.82 c	0.70 b	4.52 bc	5.46	2.48 b	2.16 b	4.64 b	1.15
	LSD		1.08	0.3	1.52		0.29	0.29	0.41	
14	Equip22.5 OD	750	4.66 a	0.90 a	5.56 a	5.18	3.06 a	2.64 a	5.70 a	1.16
	Equip 22.5 OD	1500	3.82 ab	0.58 b	4.40 a	6.59	2.16 b	1.66 b	3.82 b	1.30
	Starane 20% EC	200	4.35 a	0.79 ab	5.14 a	5.51	2.79 a	2.31 a	5.10 a	1.21
	Manual hoeing	Twice	2.75 b	0.35 c	3.10 b	7.86	2.12 b	1.73 b	3.85 b	1.23
	Control	-----	2.39 b	0.37 c	2.76 b	6.46	1.60 c	1.39 b	2.99 c	1.15
	LSD		1.08	0.25	1.18		0.36	0.35	0.7	
21	Equip22.5 OD	750	5.65 a	0.97 a	6.62 a	5.82	2.92 a	2.41 a	5.33 a	1.21
	Equip 22.5 OD	1500	2.59 b	0.37 c	2.96 c	7.00	2.26 b	1.69 b	3.95 b	1.34
	Starane 20% EC	200	3.37 b	0.63 b	4.00 b	5.35	2.36 b	1.85 b	4.21 b	1.28
	Manual hoeing	Twice	5.52 a	0.88 a	6.40 a	6.27	2.74 a	2.21 a	4.95 a	1.24
	Control	-----	4.90 a	0.90 a	5.80 a	5.44	2.43 b	1.88 b	4.31 b	1.29
	LSD		0.79	0.17	0.89		0.23	0.27	0.46	

The figures followed by the same letters are insignificant.

Table (3): Effect of Equip 22.5 OD at two doses and Starane on maize plant characteristics at the first season.

Treatment		Plant height (cm)	Shoot Weight		Fw / Dw ratio	Cobs	
Herbicide	Rate of Appl. CC /fed.		fw (g)	dw (g)		Cob No./ plant	Weight/Cob (g)
Equip22.5 OD	750	226.0 ab	480.0 ab	320.83 a	1.5	2.2 a	363.0 a
Equip 22.5 OD	1500	221.5 b	535.0 a	260.0 b	2.1	2.1 a	235.0 b
Starane 20% EC	200	235.5 ab	580.0 a	300.0 ab	1.9	2.1 a	310.0 a
Manual hoeing	Twice	250.0 a	590.0 a	320.00 a	1.8	2.2 a	352.5 a
Control		216.0 b	390.0 b	265.0 b	1.5	2.1 a	232.5 b
LSD		23.45	113.36	42.02		0.33	70.23

The figures followed by the same letters are insignificant .

Table (4): Effect of Equip 22.5 OD at two doses and Starane on maize plant characteristics at the second season.

Treatment		Plant height (cm)	Shoot Weight		Fw / Dw ratio	Cobs	
Herbicide	Rate of Appl. CC /fed.		fw (g)	dw (g)		Cob No./ plant	Weight/Cob (g)
Equip22.5 OD	750	146.4 a	219 bc	165.42 a	1.3	2.3 a	170.71 a
Equip 22.5 OD	1500	140.6 a	247.0 b	119.64 c	2.1	1.6 b	95.57 c
Starane 20% EC	200	159.2 a	249.0 b	144.78 b	1.7	1.9 ab	129.71 b
Manual hoeing	Twice	161.8 a	308.6 a	156.42 ab	2.0	2.0 ab	146.00 ab
Control		136.6 a	192.0 c	123.3 c	1.6	1.2 b	89.00 c
LSD (0.05)		42.5036	42.412	13.3071		0.6076	30.4608

The figures followed by the same letters are insignificant .

Data presented in Tables (3 and 4) indicated that all treatments showed no major differences in fresh/dry weight ratio between the different treatments during the two growing seasons. Equip at the double dose, Starane and the hoeing treatment increased fresh weight/dry weight ratio remarkably compared to the other treatments reaching 2.1, 1.9 and 1.8 % at the 1st season, and 2.1, 1.7 and 2.0% at the 2nd season, respectively. In contiast, Equip at the recommended dose showed the lowest ratio being 1.5 and 1.3% during the 1st and the 2nd season, respectively.

3.8.Cob number and weight

Results in Tables (3 and 4) showed that all treatments revealed no significant effect on cob No./plant during the 1st season. At the 2nd season, Equip at the recommended rate increased cob No./plant significantly being 2.3 followed by the hoeing treatment (2 cobs/plant) and Starane treatment (1.9 cobs/plant). Cob number was significantly reduced in Equip double rate treatment (1.6) and the untreated check (1.2).

Equip at the recommended rate, Starane and hoeing significantly increased cob weight being 363, 310 and 352.5 g/cob at the 1st season, respectively. Equip at the double rate and the untreated control significantly decreased cob weight in the 1st season. In the 2nd season, Equip, hoeing and Starane treatments significantly increased cob weight being 170.71, 146, and 129.71 g/cob, compared to 95.57, 89 g/cob when Equip dose was doubled and the untreated control, respectively.

No visual phytotoxicity symptoms over all the experiment time and increasing of Ch_a, Ch_b and Ch_t in Equip treatments could be attributed to the proprietary safener isoxadifen-ethyl that is formulated with foramsulfuron. Previous research showed that isoxadifen-ethyl reduced foramsulfuron phytotoxicity in corn by increasing the rate of foramsulfuron degradation (Chad *et al.*, 2001). Isoxadifen-ethyl has also been shown to reduce phytotoxicity of several broadleaf herbicides.

Arnold *et al.*, 2005, indicated that when nicosulfuron plus rimsulfuron, DPX 79406, and foramsulfuron were applied in combination with diflufenzopyr plus dicamba, dicamba plus atrazine, mesotrione, or dicamba, broadleaf weed control increased significantly without field corn injury or yield reductions.

Application of foramsulfuron caused injury to Corn at 7 DAT but did not exceed a rating of 10%; by 14 and 28 DAT no corn injury was recorded, (Nurse *et al*., 2007).

Decreasing of maize height, dry weight, cob number and cob weight in the untreated control treatment comparing to the herbicide treatments could be attributed to the weed infestation which could reduce maize yield by approximately 77 and 64% (Zaremohazabieh and Ghadiri, 2011). Also, Evans *et al*. (2001) reported that early season weed competition reduced kernel number. In contrast, Equip herbicide treatments showed that the high significant results comparing to the untreated control may be due to that foramsulfuron was the most effective herbicide for reducing weed density significantly in maize fields (Lotfi *et al*., 2012).

Latifil and Jamshidi (2011), showed that foramsulfuron significantly increased corn plant height, stem diameter, ear length, seed number per raw in the ear, seed number per ear, thousand kernel weight, seed yield, biological yield and chlorophyll content than the untreated check.

The above mentioned results are in agreement with Zaremohazabieh and Ghadiri,(2011), who indicated that herbicide treatments had significant effect on maize grain yield and the highest maize grain yield were obtained with foramsulfuron at two applied rates (0.03 and 0.06 kg *a.i.* / ha^{-1}) as a result of herbicide reducing weed density and increased grain yield.

From the above mentioned results it could be concluded that foramsulfuron herbicide product formulated with the safener of isoxadifen-ethyl could be used safely at the recommended rate to protect maize field from weed infestation.

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تأثير بعض مبيدات الحشائش على الحشائش الحولية النجيلية وعريضة الاوراق فى محصول الذرة
2- التأثير السام لبعض مبيدات الحشائش على محصول الذرة

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قسم سمية المبيدات للنباتات – المعمل المركزى للمبيدات – مركز البحوث الزراعية – جيزة – مصر

ملخص

تم إجراء هذه التجربة خلال الموسم الزراعى الصيفى 2011 ، 2012 بمنطقة طحانوب، بمحافظة القليوبية، مصر، لتقييم مقدرة الجرعات المختلفة من مبيد الحشائش الجديد الأختيارى إيكويب 22,5% مستحضر زيتى قابل للأنتشار فى الماء (فورامسلفيورون + أيزوكسادايفين إيثيل) على مكافحة الحشائش الحولية العريضة وضيقة الأوراق النامية بحقول الذرة الشامية ومقارنة تأثيرها بالعزيق اليدوى ومبيد الحشائش الموصى به من وزارة الزراعة المصرية، ستارين 20% مركز قابل للأستحلاب (فلوروكسيباير).

أوضحت النتائج أن معاملة مبيد الإيكويب بالجرعة الموصى بها (750 سم^3/فدان) أدى إلى زيادة الكلوروفيل أ، ب والكلوروفيل الكلى بأوراق الذرة المعاملة معنوياً بعد 7، 14، 21 يوم من المعاملة مقارنة بجميع المعاملات الأخرى خلال موسمى النمو. وعلى العكس من ذلك أدت معاملة مبيد الإيكويب بضعف الجرعة الموصى بها إلى إنخفاض تركيز الكلوروفيل معنوياً مقارنة بالمعاملات الأخرى.

أيضاً أدى معاملة مبيد إيكويب بالجرعة الموصى بها وكذلك العزيق إلى زيادة الوزن الجاف لسوق الذرة معنوياً مقارنة بمعاملة الأيكويب المعامل بضعف الجرعة والكنترول. كما أدت المعاملة بمبيد الإيكويب بالجرعة الموصى بها إلى زيادة عدد كيزان الذرة، ووزنها معنوياً مقارنه بالمعاملات الأخرى مسجلاً 363جم، 170جم، يليه معاملة العزيق (325,5جم، 146 جم)، ثم مبيد الستارين (310جم، 129,71جم) خلال موسم النمو الأول والثانى على التوالى، بينما كانت المعاملة بمبيد الإيكويب بضعف الجرعة الأقل معنوياً.