Short communication

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Effect of herbicides on weed control and yield of sugarcane

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Weeds constitute one of the most important problems faced in crop cultivation because of its negative effect on the quality and quantity (Mehra *et al*. 1995). The competition between crop and weed is one of the important limiting factors in successful raising of plants of commercial value. Use of herbicides is one of the methods currently used to control weeds. The application of these herbicides at early stages of crop growth checks the competition between weeds and the crop during initial stages while weeds emerging later cause weak competition and do not cause any damage to crop plants.

Richard (1997) used paraquata 2.24 kg/ha in sugarcane to control Johnson grass (S*orghum halepense*), which led an increase in the yield to the extent of 16%. Agrawal *et al.* (1986) found that use of paraquat 600 g/ha led to killing of all weeds and continued to respond in controlling weeds until 4 weeks from the date of application. Fluazifop-butyl is used to control grass weeds in sugarcane. Like glyphosate and paraquat, it is applied by directed spray on weeds without making any contact with the crop plants. Chevalier, a herbicide mixture of mesosulfuron + iodosulfuron is also effective against broad-leaved annual weeds in grassy crops in Iraq (Anonymous 2001). However, it has not been tested in sugarcane in Iraq. This study was conducted to identify the most effective herbicides against weeds in sugarcane crop in Iraq.

A field experiment was conducted at the research farm of the General Company for industrial crops in province of Tikrit (Dhuluiya), Iraq. The experiment was laid out in randomized complete block design and replicated four times. The treatments included four herbicides, *viz.* fluazifop-butyl, Chevalier (mesosulfuron + iodosulfuron), glyphosate and paraquat, and weedy check (control). The soil of the experimental site was clay loam having low organic content (0.23%) and available N,P,K (157.4, 17.5 and 174.0 kg/ha, respectively) and slightly alkaline in reaction (pH 7.7). The experimental unit (plot) area was 36 m² and distance between the experimental units was 1.0 m. Application of 200 kg N/ha was made in the experimental field with urea (46% N) in two equal parts. One half of the urea was applied at the time of planting and the remaining half was applied after three months of planting. Triple superphosphate 120 kg P_2O_5/ha was applied once at the time of planting. Irrigation was provided upto mid October at an interval of 7-12 days. Sugarcane crop was harvested in the month of January. Herbicides glyphosate 5.76 kg/ha, paraquat 0.80 kg/ha and fluaziphop-butyl 0.75 kg/ha were sprayed directly on the weeds at the beginning of tillering stage in sugarcane, while Chevalier 0.30 kg/ha was sprayed as blanket spray.

A quadrant of one m² was thrown randomly in each experimental unit three times and green weed plants not affected by herbicides were counted and averaged for calculating weed density. Green weed plants were cut at the soil surface from the same site (quadrant) in the experimental unit. The weeds samples were air dried followed by oven dried at 65^0C for 48 h and weighed.

Ten sugarcane plants in two rows in the middle of each experimental unit were tagged used to record the number of green leaves, cane height and stem diameter. Stem diameter of cane was measured at five centimeters above the soil surface by using Vernier caliper. Number of millable and unmillable canes were sorted and counted from one line in midlle of the each plot.

Two leaves from middle of each tagged plant were taken to measure length and maximum width and single leaf area was calculated using the equation given by Tejera *et al.* (2007). The canes were collected from middle lines of each experimental unit and after topping, cane were weighed to obtain cane yield. The data recorded from the experiment were analyzed using standard methods of statistical analysis.

Weed species present in the sugarcane field were: *Aster tripolium* L, *Alhagi maurorum* Medic, *Convolvulus arvensis* L, *Sesbania aegyptica* Pers., *Sonchus oleraceus* L, *Imperata cylindrica* (L) P. Beauv and *Avena fatua* L.

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(Table 1). Among these, the prominent weed species were the broad-leaved annual weeds,*viz. Sesbania aegypticapers* and *Sonchus oleraceus* which occupied 51.1% share in total weed population (Table 2). The broad-leaved perennial weeds *i.e. Aster tripolium, Alhagi maurorum* and *Convolvulus arvensis* were few and constituted 7.5% of the total weed population. The grasses including perennial grasses like *Imperata cylindrica* and annual grasses such as *Avena fatua* constituted 41.4% of total weed density. The application of herbicides affected the weed type and density but the response of different types of weeds varied to different herbicides.

Application of paraquat controlled almost all types of weeds. The weed density was least under this treatment at all the growth stages of the crop till harvest. The effect of this herbicide in controlling weeds was quick because of its nature (contact herbicide). As a result the weed density decreased to 12.3 plant/m² compared with 24.5 and 67.2 plants/m² under glyphosate and fluaziphop-butyl, respectively. Weed growth was restored in the plots treated with glyphosate and fluaziphp-butyl led to a decrease in proportion of weed control compared to paraquat. The weed density under weedy check plot was 93.5 plants/m². Thus, in herbicide treatments, crop growth was better leading to higher number of millable cane at harvest.

The weeds in paraquat treated plots belonged to seven plant species, five of them were broad-leaved species, *viz. Aster tripolium*, *Alhagi maurorum*, *Convolvulus arvensis*, *Sesbania aegyptica* and *Sonchus oleraceus* that formed 71.4% of total weeds, and two species of grasses weeds, *viz. Imperata cylindrica* and *Avena fatua* accounted for 28.6% of the total weeds. However, the ratio of weed control under paraquat was higher. The control of weeds in the early growth stage encouraged sugarcane plants to produce new tillers and provided the principle factors for composition of the tillers specially space and light followed by water and food.

Table 1. Major weed species in experimental field

Scientific name	Life cycle	Weed type	Population (no./m^2)
Aster tripolium	Perennial	Broad-leaved	2.8
Alhagi maurorum	Perennial	Broad-leaved	2.3
Convolvulus arvensis	Perennial	Broad-leaved	1.9
Sesbania aegyptica	Annual	Broad-leaved	4.9
Sonchus oleraceus	Annual	Broad-leaved	42.9
Imperata cylindrica	Perennial	Grass	13.6
Avena fatua	Annual	Grass	25.1
Total			93.5

The weeds in glyphosate treatment were of five plant species, all broad-leaved species, *viz. Aster tripolium, Alhagi maurorum, Convolvulus arvensis, Sesbania aegyptica* and *Sonchus oleraceus* formed 100% of the total weeds. Although glyphosate being non-selective kills all plant species, the ratio of weed control achieved by using glyphosate was less than paraquat. Glyphosate being systemic in nature, has ability to move and go to the underground parts, and the symptoms appear after a longer or shorter period depending on the conditions surrounding the plant. In this period, weeds compete with the crop for space and light as well as water, which negatively affected the growth of the tillers. As a result of high temperature that exceeds 30ºC until the start of boom growth stage of the crop, the physiological influence of herbicide

Table 2. Effect of herbicides on density and dry weight of weed species in sugarcane

Treatment	*Aster tripolium*	*Alhagi maurorum*	*Convolvulus arvensiss*	*Sesbania aegyptica*	*Sonchus oleraceus*	*Imperata cylindrica*	*Avena fatua*	Total
Weed density (no./m²)								
Glyphosate	3.0	2.2	2.0	6.0	11.3	0.0	0.0	24.5
Fluaziphop-butyl	18.6	16.3	0.0	0.0	24.2	0.0	6.1	65.2
Paraquat	1.9	1.4	1.3	1.2	3.8	1.5	1.2	12.3
Chevalier	1	0.0	0.0	1.3	1.7	21.7	15.6	41.3
Control	2.8	2.3	1.9	4.9	42.9	13.6	25.1	93.5
LSD (P=0.05)								16.0
Dry weight of weeds (g/m^2)								
Glyphosate	2.1	5	3.0	10	14	0.0	0.0	34.1
Fluaziphop-butyl	3.1	20.0	0.0	0.0	18.0	0.0	10.1	51.2
Paraquat	1.0	2.6	1.7	1.9	4.5	1.8	2.0	15.5
Chevalier	3.0	0.0	0.0	6.2	3.1	17.1	12.8	42.2
Control	5.4	4.2	4.7	9.7	60.2	22.0	20	126.2
LSD (P= 0.05)								22.2

may reduce dramatically in controlling weeds and might encourage emergence of new weeds later.

Weeds in fluaziphop-butyl treatment belonged to four plant species, including three species of broad-leaved, *viz. Aster tripolium*, *Alhagi maurorum* and *Sonchus oleraceus* collectively constituted 75% of the total density of weeds, and one species of grasses, *i.e Avena fatua* accounted for 25% of the total density of weeds. The control achieved by using fluaziphop-butyl was less than glyphosate due to the fact that fluaziphop-butyl is selective systemic herbicide that affects grasses (perennials and annuals) only.

All the herbicide treatments were found effective in significantly reducing the dry weight in weeds compared to the control (126.2 g/m²) (Table 2). The dry matter accumulation in weeds was lowest (15.5 g/m²) in paraquat treatment. The decrease in dry weight of green weeds under paraquate may be due to control of most types of weeds because of its use in the early stages of crop growth. The use of glyphosate in sugarcane significantly reduced the dry weight of green weed to the level of 34.1 g/m² compared to control (126.2 g/m²). The reduction in dry weight of green weeds in glyphosate may be due to low density of weed plants especially the weeds like *Sesbania aegyptica* and *Aster tripolium* that has profuse vegetative growth. The effect of paraquat and glyphosate was more pronounced as compared to fluaziphop-butyl in reducing the dry weight of green weeds. Fluaziphop-butyl being a selective herbicide controled grasses only and in the absence of grasses, the growth of broad-leaved weeds was higher, thus, recording higher dry weight of weeds compared to paraquat and glyphosate.

Herbicides application in sugarcane to control weeds registered significant effect on cane height (Table 3). Application of glyphosate increased the cane height to the highest level of 153.7 cm, but did not differ significantly from fluaziphop-butyl treatment (149.0 cm). Chevalier could not exert its significant effect on cane height compared to control (145.3 cm). While, the use of paraquat decreased the cane height amounted to 138.4 cm because it being a contact herbicide, killed green tissues of weeds after a few hours from the time of spray causing wilting and drying quickly in the weeds, which might helped suffcient light to reach sugarcane in early tillering stage, causing retardant in elongation of crop plants. Reziq and Ali (1981) showed that sugarcane plants in appropriate lighting conditions reduce concentration or activity of certain growth regulators of polar motion to bottom of the plants causing retardant in stem elongation.

There was significant increase in number of canes by using paraquat and glyphosate over control. Chevalier and fluaziphop-butyl did not significantly influence number of canes. The increase in number of tillers by use of paraquat at the beginning of tillering stage was due to light penetration resulting in high density of tillers. Abdul *et al.* (1982) indicated that there was a relationship between light intensity and activity of growth substances in plants. In the case of increasing light intensity, the speed of movement of growth regulators from the top of the plant to the base becomes less causing an increase in number of tillers on the one hand and reduced weed density on the other hand with high percentage of weed control.

Cane stem diameter (Table 3) was not significantly affected by use of various herbicides. There was significant effect of herbicide application on average number of green leaves in sugarcane. Paraquat registered the highest increase of green leaves per cane (11 leaves/cane) that didn't differ significantly from glyphosate and fluazifop-butyl treatment (9 leaves/cane in both the treatments). However, all the herbicides helped to produce significantly higher number of green leaves per plant compared to control (7 leaves/cane).

The use of herbicides helped sugarcane to produce significantly higher leaf area over control (Table 3). The highest leaf area (57.4 cm²) was recorded with paraquat treatment followed by glyphosate (50.8 cm²) while, other herbicides could not have a significant influence on leaf

Table 3. Effect of herbicides on growth and yield of sugarcane

Treatment	Cane height (cm)	Canes/5 m row length	Stem diameter (mm)	Leaves/ plant	Single leaf area (cm^2)	Cane yield (t/ha)
Glyphosate	153.7	58.5	33.8	9.2	527	50.8
Fluaziphop-butyl	149.0	56.1	34.1	9.6	500	46.9
Paraquat	138.4	62.3	35.3	11.2	574	54.5
Chevalier	146.7	54.9	34.3	8.8	469	41.1
Control	145.3	51.7	35.0	7.6	483	37.6
LSD (P= 0.05)	2.81	5.33	NS	1.18	26.1	3.24

area over control (48.3 cm^2). The increase in leaf area by using paraquat and glyphosate may be due to the positive role of these herbicides to increase light interception by controlling a large proportion of weeds in early stages of crop growth.

Use of herbicides to control weeds in sugarcane significantly enhanced the cane yield. Paraquat registered the highest cane yield (54.5 t/ha) which was significantly higher (44.9%) over control. Glyphosate and fluazifop-butyl also proved significantly superior to control in respect of cane yield, which was 50.8 and 46.0 t/ha, respectively. The increase in cane yield by use of glyphosate and fluazifop-butyl was 35.2 and 24.9%, respectively. The increase in cane yield with Chevalier did not reach the level of significance, which registered cane yield of 41.0 t/ha compared to control (37.6 t/ha). The increase in sugarcane yield by using paraquat might be due to increase in number of tillers in the early stages of crop growth and production of high amount of photosynthetic products. Also the improved sink capacity on account of increase in number of canes may be related to weakened growth of weeds under herbicide treatment. Therefore, the stage of tillers composition must be accompanied by absence of weeds that compete with crop (Thakur *et al*. 1996). These results are consistent with findings of Agrawal *et al.* (1986).

SUMMARY

A field experiment was conducted at the research farm of the General Company for industrial crops in the province of Tikrit (Dhuluiya), Iraq to evaluate chemical herbicides, *viz*. fluazifop-butyl, glyphosate, paraquat and Chevalier in sugarcane variety '*QD12*'. Results showed that use of paraquat helped in controlling weeds to the extent of 86.8% over weedy check. As a result, weed density was very less and reduction in dry weight of green weeds was up to 87.7%. The number of canes increased by 20.5%, green leaves by 56% and leaf area by 45%, which was reflected in the highest increase in cane yield (44.9%). Cane length and diameter were not significantly affected by herbicide application.

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