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EFFECT OF FIVE ADJUVANTS ON THE ACETOCHLOR ACTION ON PURSLAN *(Portulaca oleracea)* AND COCKLEBUR (*Xanthium brasilicum*) AND ITS PERSISTENCE IN SOIL .

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ABSTRACT

The results of studying the effect of acetochlor and its mixtures on the emergence of *Portulaca oleracea* weed revealed that in general the least effective treatments were acetochlor mixture with citric acid with 2.74 weeds/ m^2 as a mean, followed by acetochlor alone (2.30). While the most effective treatments resulting in low mean were acetochlor+ phosphoric acid (0.52), followed by the other treatments.
For *X. brasilicum* the mean values showed that acetochlor half dose with phosphoric acid, with palm oil and with capl 2 crude oil were the most effective mixtures with (0.19, 0.41 and 0.30 weed /m^2). The mixture with citric acid was the least effective (0.96 weeds /m^2) beside acetochlor alone with (1.96 weeds /m^2) comparing with 4.33 weeds / $m^{2.}$ While full dose of acetochlor was more effective on inhibiting the emergence of both tested weeds. Acetochlor mixture with phosphoric acid was the most effective mixture in suppressing both weeds emergence.

In general the fresh weight obtained from treatment with half recommended dose was higher than that obtained on treatment with full dose. Acetochlor alone and its mixture with citric acid resulted in fresh weight higher than all the other treatments as for the full dose and its half of the two tested weeds. There was very high % germination of the cucumber as a test plant in the treated soil layer 5 – 10 cm. This may be due to the effect of the tested adjuvants except for citric acid which didn't show the same effect.

The persistence of acetochlor with phosphoric acid was higher than all the other treatments during the experiment interval including acetochlor alone. The highest RL_{50} value was that of acetochlor with phosphoric acid (27.73 days), while the lowest was that of acetochlor with arabic gum (6.56 days).

INTRODUCTION

Portulaca oleracea L. (Common name purslane) and *Xanthium brasilicum* (Cocklebur) are annual summer weeds, which grow in maize fields. Maize is the third most important cereal grain after wheat and rice. Weed – crop competition is among the most important weeds management methods, which can lead to 35 – 79 % reduction in yield (Ford and Pleasant, 1994). Cultural, mechanical and chemical methods are also commonly used for controlling weeds. No doubt cultural methods are still useful tools but are expensive and time consuming, so chemical control is an important alternative (Tahir *et al.* 2011).

A large number of herbicides such as acetochlor are applied directly to the soil. (Huertas – Perez *et al.* 2006). Acetochlor is used as pre – emergence or pre- plant to control annual grasses, certain annual broad

leaved weeds and yellow nutsedge in soybeans. It is absorbed by the shoots (less so by the roots) of germinating plants and inhibits protein synthesis in susceptible plants (Anonymus 2004).

The use of adjuvant in combination with herbicide enhances the herbicide retention and thus increases the phytotoxicity of herbicide (Zadorozhny, 2004). Adjuvants are any substance either in a herbicide formulation or added to the spray tank, that modifies herbicidal activity or application characteristics. The interactions between herbicide formulation and adjuvants however are not simple and depend on many factors which include crop/weed, droplet characteristics, adjuvants type, chemical form of the herbicide and environmental conditions. Under standing the complexity of these interactions is essential for herbicide optimum utilization, particularly in prolonging, enhancing and improving the efficacy, reduction of the critical rain – free period , minimizing herbicide leaching into ground water and decreasing harmful effect to non- target plants (Pacanoski 2010).

A good review of different adjuvant terms and definitions can be found in Hazen (2000) or in Van Valkenburg (1982). Adjuvants were divided into two primary types based on their functions: activator adjuvants and utility adjuvants (Hess 1999, Kirkwood 1994). Activator adjuvants enhance the activity of the herbicide, often by increasing rates of absorption of the herbicide into the target plant. Utility adjuvants, which are sometimes called spray modifiers, alter the physical or chemical characteristics of the spray mixture making it easier to apply, increasing its adherence to plant surface so that it is less likely to roll off, or increasing its persistence in the environment.

The present experiment was carried out to study : 1- the action of five adjuvants namely , phosphoric acid , palm oil , capl 2 crude oil , arabic gum and citric acid on effectiveness of acetochlor with recommended dose and its half on two annual weeds *Portulaca oleracea* and *Xanthium brasilicum*. 2- Detection of acetochlor in soil using plant bioassay.3– Persistence of acetochlor in soil using GC.

MATERIALS AND METHODS

Field evaluation experiment

Field experiment was conducted at the Experimental station, Faculty of Agriculture, Cairo University to evaluate the effect of acetochlor alone or with several adjuvants at spray volume 200 L/fed. for the control of two annual weeds *Portulaca oleracea* and Xanthium *brasilicum* in corn *Zea mays* field. The experimental area was divided according to the randomized complete block design including three replicates for each treatment. Acetochlor was applied preemergence at the recommended rate (1.0 L/fed.) and its half (0.5 L/fed.). The tested adjuvants orthophosphoric acid, capl 2 crude oil, palm oil, arabic gum and citric acid were applied at 0.3% in mixtures with acetochlor. Five plants were randomly collected from each replicate and fresh weight was determined. Also, number of emerging plants from each replicate was counted. All data were subjected to analysis of

variance (ANOVA), and treatment means were separated using Duncan test, (Duncan 1955).

Detection of acetochlor in soil using plant bioassay:

Acetochlor residues in the soil were bioassayed using cucumber (*Cucumis sativus* L.Cv.) as test plant. The test plant was directly seeded into soil previously treated with acetochlor alone and or mixed with several adjuvants. Soil samples were collected randomly from each treatment on the 0, 3, 6, 14, 21, 28, 35 and 42 days after application. The soil samples were taken at two depths of 0 - 5 and 5 - 10 cm and each sample was replicated three times. Soil samples were placed in plastic pots and ten cucumber seeds were sowed in each pot and watered. The germination percentage of cucumber was recorded after two weeks.

Determination of acetochlor residues in soil using GC:

Soil samples were randomly collected from each treatment at 0, 3, 6, 14, 21, 28, 35 and 42 days after spraying. Twenty grams soil sample was extracted with 60 ml. methanol for 2 hr. using a shaker. The extract was filtered and dried on sodium sulfate anhydrous, then evaporated to dryness at 50 ^{O}C using a rotary evaporator. The residues were redissolved in methanol for GLC determination. Quantitative analysis of acetochlor was performed by a Hewlett – Packard Series 6890 gas chromatography (GLC), equipped with electron capture detector (ECD) . The column was HPI (25 m x 0.32 mm x 0.17 um film thicknesses). Temperatures of the column, injector and detector were 200, 220 and 320, respectively. The flow rate of nitrogen was 1.0 ml/ min. Under these conditions, the retention time (R_t) of acetochlor was 3.5 min. Good linearity was obtained for the active ingredients with correlation coefficient between 0.97488–0.99781.

The recoveries of the active ingredients were determined by fortification of soil samples at concentrations 0.01, 0.1 and 0.2 mg /kg soil in three replicates, mixed well and extracted as described above. The average recoveries were 94 %. The rate of degradation of the tested herbicide alone and herbicide plus adjuvants and half–life periods (RL_{50}) in soil were calculated according to the equation of (Moye *et al*. 1987).

RL 50 = Ln2 / K = 0.6932/K

K = (1/ tx) X Ln (a/bx)

Where:

K = rate of decomposition tx = time in days

a = initial residue bx = residue at x time

RESULTS AND DISCUSSION

Field evaluation experiment:

Field experiments were conducted to determine the efficacy of acetochlor alone and its mixture with five different adjuvants on two annual weed species, namely *Portulaca oleracea* and *Xanthium brasilicum*. The effect of interaction of the herbicide, the type of adjuvant and the effect of mixing varied on the two tested weeds during the 56 days of the experiment .

1- Effect on the number of emerging weeds:

Table (1) show that the number of weeds/m^2 was affected by the applying acetochlor either with the recommended dose or its half, alone and or mixed with different adjuvants. As for treatment of *Portulaca oleracea* weed with acetochlor at half dose, the number of weeds/m^2 in control treatment were significantly different than all of the treatments. Data in Table (1) show that after 21 days post spraying there was significant difference in the numbers of weed /m^2 between acetochlor alone (t1) and with citric acid (t6) (1.7 and 1.7 weed/m^2) and the other treatments which ranged from 0.0 to 0.3 at half recommend dose. At 28 there was no difference between acetochlor alone (t1), with arabic gum (t5) and with citric acid (t6) weeds/m^2. Acetochlor with phosphoric acid (t 2), palm oil (t 3) and capl oil (t 4) completely inhibited the emerging weeds. Acetochlor alone and its mixture with citric acid at half the recommend dose had lowest effect on number of emerging weeds/m^2 (3.0 and 2.7), followed by t 5, t 3, t 2, t 4 after 35 days. In 42 days after the herbicide and adjuvants application there was a significant difference in the number of *P. oleracea* weeds/m^2 between acetochlor alone and all the other treatments whereas it reached 4.0 emerging weeds/m^2 for acetochlor alone followed by acetochlor + citric acid (3.3), then t 3 and t 5 were of the same emerging number (2.0), the least number of weeds/m^2 appeared in t2 and t4 (1.0 and 1.3), respectively. At 56 days post treatment acetochlor + phosphoric acid had the highest effect on suppressing the emergence of weed/m^2 (1.7) compared to (5.0) obtained with acetochlor alone treatment. Acetochlor alone and with its mixtures had effect on the emerging number of weeds compared to the control.

The most effective mixture was with phosphoric acid with a mean value of (0.52 weed/m^2), while the beast effect mixture was that of citric acid (2.74 weed /m^2) compared to 5.59 weed/m^2 for the control.

Application of adjuvants with full dose of the herbicide resulted in significantly lower number of P*. oleracea* weeds compared to treatment with half its dose. Results tabulated in Table (1) show that control was significantly different than all the other treatments, with highest number of emerging weeds/m^2 (3.3 – 16.7). At 21 days after spraying acetochlor alone and with citric acid were also significantly different than the other four mixture, which had no emerging weeds, while 28 days after application there was no significant difference between all the treatments (0.0 – 1.3 weed/m^2). 35 days results varied, where acetochlor had the highest emergence no (2.0) followed by acetochlor + citric acid (1.3), then acetochlor + palm oil (1.0) and acetochlor + arabic gum (1.0), while acetochlor + phosphoric and acetochlor +capl 2 crude oil (0.3) were more effective with the lowest number of emerging weed/m^2. Results of 42 and 49 days were of the same trend as 21 days but differed in the values.

Acetochlor alone and acetochlor+ citric acid resulted in less effect with higher number of weeds /m^2 at 42 and 49 days, respectively with significant differences than the other mixtures. At 56 days the same trend was obtained but with almost higher number of weeds/m^2 ranged from 1.0 to 6.0 for all treatments comparing with 16.7 weeds/m^2 for the control.

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Treatments with full dose had almost the same trend of results except for the number of emerging *P. oleracea* weeds were lower for the treatments. For example the acetochlor alone (t1) was 2.30 weeds/m^2 on treatment in the half dose compared to 1.41 weeds/m^2 on treatment with full dose.

For the second weed *Xanthium brasilicum*, on spraying 0.5 L/fed. (half recommended dose) there was a significant difference in the number of emerging weeds/m^2 between the control and all the treatments starting from the 21 day. Acetochlor alone was least effective than all the other treatments. Its values ranged from 1.7 to 6.0 weed/m^2 for the acetochlor alone treatment compared to control treatment, with highest number of weed/m^2 which ranged from 3.0 to 11.7. 28 days after application the acetochlor with phosphoric acid (t 2), and with capl oil (t4) inhibited completely emergence of weed, while t3, t5 and t6 had slight variation in their effect on emergence of *X. brasilicum* weeds. The results after 42 and 49 days were almost the same, where t 3 and t 4 had more effect on emergence of *X. brasilicum*. Mean values showed that acetochlor with phosphoric acid and two oils (palm and capl oil) were more effective in decreasing the number of emerging *X. brasilicum.*

On applying the recommend dose (1.0 L/fed.), the results differed than those of half the dose except for the control. The results of 21 days after application revealed no significant differences between the six treatments (acetochlor alone and its five mixtures with different adjuvants as they all inhibited the emergence of *X. brasilicum*. While at 28 days after application acetochlor alone and its mixture with citric acid had the same number of emerging weeds/m^2, the other treatments still had high effect on the weed inhibition, as they prevented the emergence. The same results were nearly obtained at 35 days except for t5 (0.7 weed/m^2). 42 days post spraying, acetochlor was the least effective with 1.7 weeds/m^2 emerging. Acetochlor + capl 2 crude oil had highest effect on inhibiting the emergence (0.0 weed /m^2), while its mixture with palm oil, arabic gum and citric acid had different effects 0.67,1.0 and 1.33 weed/m^2, respectively. At 49 days from treatment acetochlor was still the least effective with 2.3 emerging weed/m^2 the other acetochlor mixtures, which ranged between 0.7 – 1.3 weed/m^2. The same results were obtained 56 days after spraying, t5 and t 6 were of less effectiveness on preventing the *X. brasilicum* emergence (2.3 weed/m^2). The mean values show that acetochlor with phosphoric acid (t2), palm oil (t3) and capl oil (t4) were the most effective mixtures on decreasing the number of emerging *X. brasilicum* with (0.19 , 0.22 and 0.22 weed/m^2) compared to (1.07) for acetochlor alone and 4.19 weeds/m^2 for control. From Table (1) it can be concluded that full dose of acetochlor was more effective on inhibiting the emergence of both tested weeds. Acetochlor mixture with phosphoric acid was the most effective mixture in suppressing both weeds emergence.

2- Effect on the fresh weight:

Table (2) shows the effect of acetochlor alone and with different adjuvants on fresh weight of the tested weeds. The results obtained for *Portulaca oleracea* when treated with acetochlor full dose and its half dose, were significantly different between control and all treatments throughout the

experiment. The fresh weight of the control was higher obviously than the treatments.

On treating *Portulaca oleracea* with half recommended dose, there was significant difference between control (11.3-30.3 gm/plant) and the other treatments on fresh weight. After 28 days from application the fresh weight, obtained, was (1.2 gm/plant) for acetochlor alone while there was no fresh weight obtained with the mixtures except for t6 whose fresh weight was 0.6 gm/plant. As for 35 days after application t3 resulted in highest fresh weight followed by t 1, t 6, t 2, t4 and then t5. The values of fresh weight obtained after 42, 49 and 56 days post spraying, increased than the previous intervals. The value obtained from acetochlor alone was higher in the 3 intervals, than that of the mixtures. The descending order of the mean fresh weight of *P. oleracea* obtained from the treatment with half dose was as follows: acetochlor alone, with palm oil, with citric acid, with phosphoric acid, with arabic gum and with capl oil and 2.15, 1.40, 1.37, 0.85, 0.80 and 0.79 gm/plant, respectively.

In the case of recommended dose, the values of fresh weight were lower in general than the treatments with half recommened dose of acetochlor and its mixture. 49 days after spraying gave fresh weights ranging from 0.7 for acetochlor with phosphoric acid to 2.7 gm/plant for acetochlor alone comparing with 26.7 for control. While 56 after spraying, the fresh weight ranging from (3.3) to (7.3) gm/plant.

For *Xanthium brasilicum* on spraying half recommended dose, significant differences were found between acetochlor alone and its 5 mixture with different adjuvants on fresh weight. Acetochlor alone and its mixture with citric acid gave highest fresh weight yield and no significant difference was observed between t 2 , t 3,t 4 and t 5 as they gave no fresh weight after 21 and 28 days. At 49 days post application t1 (8.1) and t6 (3.6) were significantly different than the other treatments which fresh weight higher than the other treatment, followed by t 3, t 2, t 5 and t 4 (0.8). The mean values of fresh weight obtained from treatments with half the dose of acetochlor were ascendingly ordered as follows t 4, t 5, t 3, t 2, t 6, t1 with o.27, 0.73, 0.88, 0.93, 1.83 and 4.25 gm/plant, respectively. It is clear that mixing of acetochlor with adjuvants decreased the fresh weight yield, significantly than the control and even than acetochlor alone, and their effect on fresh weight also differed.

On applying the full dose against fresh weight of the weed, the results show significant differences between the control and all the treatments following the same trend of results obtained previously. After 21, 28 and 35 days post application, acetochlor alone (t1) and its mixture with citric acid (t6) produced fresh weight, while t 2, t 3, t 4 and t 5 mostly resulted in no fresh weight yield.

The ascending order of the mean value of fresh weight of *X. brasilicum* treated with full dose of acetochlor and its mixtures was t4, t 2, t 3, t 5 and t1, t6 with values 0.14, 0.20, 0.23, 0.25, 0.73 and 1.42 gm/plant, respectively .

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It can be concluded from the Table (2) that values of control were higher than all those of treatment. In general the fresh weight obtained from treatment with half recommended dose was higher than that obtained on treatment with full dose. Acetochlor alone and its mixture with citric acid resulted in fresh weight higher than all the other treatments as for the full dose and its half of the two tested weeds.

Detection of acetochlor in soil using plant bioassay :

Cucumber (*Cucmis sativus* L.Cv.) seeds was used as sensitive plant for assaying the residues of acetochlor when used at the full or half the recommened dose . Data in Table (3) show the effect of acetochlor alone and its mixtures on % germination of cucumber at soil level of 0-5 cm. For example, it can be seen after 14 days of spraying the % germination in o.5 recommended dose of acetochlor alone treated soil was 33.3 compared to 20.0 in the full dose treated soil. Also, % germination with acetochlor + phosphoric acid was 20.0 and 6.7 at half and full doses of acetochlor, respectively.

Data in Table (3) indicate that the % germination increase as time after spraying pass in all of the treatments. Percent germination in acetochlor alone, treated soil was 10.0, 50.0 and 96.7 after 3, 21 and 42 days of application. The increase in % germination differed from one treatment to the other according to the used adjuvants. Acetochlor + phosphoric acid % germination was the least compared to all the other treatments. After 3, 21, 42 days from treatment, % germination of phosphoric mixture was 6.7, 26.7, 76.7 on testing half recommended dose, respectively. The corresponding values of % germination on testing full dose were 0, 13.3, and 63.3%. The highest mean values of % germination were obtained with acetochlor + capl oil, acetochlor + arabic gum and acetochlor alone treated soil. These values with half the recommended dose were 47.92, 46.67 and 44.17 and the corresponding values with the full dose were 36.67, 37.92 and 37.50, respectively.

While on studying the effect on % germination of cucumber at soil depth of (5 –10) the data in Table (4) showed that % germination was very high compared to data of Table (3).

Data in Table (4) indicate that on testing half recommended dose of acetochlor values of % germination was close to those obtained in the control treatment, without differences between them. On the other hand on testing the recommended dose of acetochlor alone (85.83) and acetochlor + citric acid (79.58) % germination decreased significantly compared to 97.92 for control.

It on using cucumber as test plant for detecting the acetochlor can be concluded that there was very high % germination in the soil layer 5 – 10 cm due to the absence of herbicide leaching from the upper layer. This may be due to the effect of the tested adjuvants except for citric acid which didn't show the same effect. From results in Tables (1- 4), it appeared that the 5 tested adjuvants had an influence on different parameters on weeds from which are the number of emerged weeds and the fresh weight yield of weed .

And they also had effect on % germination of cucumber when planted in soil treated with the mixture acetochlor.

Adjuvant is any compound that can be added to a herbicide formulation to facilitate the mixing, application, or effectiveness of that herbicide. Adjuvants are chemically and biologically active compounds. A good review of different adjuvant terms and definitions can be found in Hazen (2000) or in Van Valkenburg (1982). Adjuvants were divided into two primary types based on their functions: activator adjuvants and utility adjuvants (Hess 1999 and Kirkwood 1994).

Table (3): Effect of acetochlor alone and its mixture with five different adjuvants on percent germination of cucumber (0- 5 cm).

Treatment	% Germination at different time intervals (days)								Mean
	0	3	6	14	21	28	35	42	
Half dose (0.5 L/ fed.)									
Acetochlor alone (t1)	0.0b	10.0b	26.7b	33.3c	50.0c	66.7b	70.0de	96.7a	44.17CD
Acetochlor + phosphoric acid(t2)	0.0b	6.7b	13.3cd	20.0d	26.7d	56.7bc	66.7e	76.7c	33.33EF
Acetochlor + palm oil(t3)	0.0b	3.3b	3.3d	36.7c	43.3c	50.0c	66.7e	93.3ab	37.08E
Acetochlor + capl oil(t4)	0.0b	3.3b	23.3bc	60.0b	63.3b	66.7b	80.0c	86.7ab	47.92BC
Acetochlor + arabic gum(t5)	0.0b	10.0b	20.0bc	40.0c	53.3bc	66.7b	90.0b	93.3ab	46.67BC
Acetochlor + citric acid(t6)	0.0b	6.7b	23.3bc	36.7c	43.3c	53.3bc	63.3cd	83.3bc	38.75DE
Control	100.0a	100.0a	96.7a	96.7a	100.0a	93.3a	100.0a	96.7a	97.92A
Recommended dose (1.0 L /fed.)									
Acetochlor alone (t1)	0.0b	6.7bc	13.3bc	20.0c	40.0bc	56.7b	76.7b	86.7b	37.50DE
Acetochlor + phosphoric acid(t2)	0.0b	0.0c	6.7c	6.7d	13.3e	33.3d	46.7d	63.3d	21.25G
Acetochlor + palm oil(t3)	0.0b	0.0c	6.6c	16.7d	26.6d	36.7d	46.7d	80.7bc	26.70B
Acetochlor + capl oil (t4)	0.0b	10.0b	13.3bc	43.3b	46.7b	50.0bc	63.3c	66.7d	36.67E
Acetohlor + arabic gum(t5))	0.0b	10.0b	20.0b	33.3b	43.3b	43.3cd	76.7b	76.7c	37.92DE
Acetochlor + citric acid(t6)	0.0b	3.3bc	16.7bc	20.0c	30.0cd	36.7d	46.7d	66.7d	27.50FG
Control	100.0a	100.0a	96.7a	96.7a	100.0a	93.3a	100.0a	96.7a	97.92A

Table (4): Effect of acetochlor alone and its mixture with five different adjuvants on percent germination of cucumber (5- 10 cm).

Treatment	% Germination at different time intervals (days)								Mean
	0	3	6	14	21	28	35	42	
Half dose (0.5L / fed.)									
Acetochlor alone (t1)	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	96.7a	100.0a	99.58A
Acetochlor + phosphoric acid(t2)	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	100.00A
Acetochlor + palm oil (t3)	100.0a	93.3b	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	99.17A
Acetochlor +capl oil (t4)	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	100.00A
Acetochlor + arabic gum(t5)	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	100.00A
Acetochlor + citricacid(t6)	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	100.0a	100.00A
Control	100.0a	100.0a	96.7a	96.67a	100.0a	93.3b	100.0a	96.7a	97.92AB
Recommended dose (1L /fed.)									
Acetochlor alone (t1)	86.7b	83.3c	86.7a	86.7ab	86.7b	80.0bc	83.3c	93.3a	85.83CD
Acetochlor + Phosphoric acid (t2)	86.7b	86.7bc	90.0a	93.3ab	93.3ab	86.7ab	96.7ab	96.7a	91.25BC
Acetochlor + palm oil (t3)	86.7b	90.0ab	96.7a	93.3ab	96.7a	93.3a	90.0bc	96.7a	92.92ABC
Acetochlor + capl oil (t4)	90.0ab	96.7ab	86.7a	90.0ab	96.7a	93.3a	86.7c	83.3c	90.42C
Acetochlor + arabic gum (t5)	93.3ab	96.7ab	96.7a	96.7a	96.7a	86.7ab	83.3c	86.7c	92.08BC
Acetochlor + citric acid(t6)	90.0ab	86.7bc	93.3a	80.0b	76.7c	73.3c	66.7d	70.0d	79.58DE
Control	100.0a	100.0a	96.7a	96.7a	100.0a	93.3a	100.0a	96.7a	97.92AB

Activator adjuvants enhance the activity of the herbicide, often by increasing rates of absorption of the herbicide into the target plant(s). Utility adjuvants, which are sometimes called spray modifiers , alter the physical or chemical characteristics of the spray mixture making it easier to apply, increasing its adherence to plant surface so that it is less likely to roll off, or increasing its activator adjuvants include surfactants, oil carriers such as phytobland oils, crop oils, crop oil concentrates, vegetable oils, methylated seed oils, petroleum oils , and silicone derivatives, as well as nitrogen fertilizers .

Utility adjuvants are added to improve the application of the formulation to the target plants. By themselves, they do not directly enhance herbicidal activity (McMullan 2000). Instead, they change the physical or chemical properties of the tank mix in ways that make , it easier to apply to the target plant(s) , minimize unwanted effects, and broaden the range of conditions under which a given herbicide formulation can be . Some activator

adjuvants are also utility adjuvants and some even have herbicidal effects of their own.

The use of adjuvant in combination with herbicide enhances the herbicide retention, leaf surface penetration through cuticle, and thus increases the phytotoxicity of herbicide. (Zadorozhny, 2004). The type of adjuvant varies with crop, herbicide and weed species present. This explain our results , which stated that the mixture of acetochlor with phosphoric acid had the highest effect on the weeds by decreasing the number of emerging treated weeds, decreasing their fresh weight yield and % of germinating cucumber in soil previously treated with this mixture. The two oils (palm oil and capl 2 oil) and arabic gum followed phosphoric acid mixture in their effect.

While acetochlor + citric acid mixture was almost of the same effect on the tested weeds as acetochlor alone. In maize for controlling weeds urea fertilizer is the most effective adjuvant (Toloraya *et al.* 2001). Herbicide application in combination with urea gave 12-13.5% better results than herbicide alone (Getmanetz *et al.* 1991). At harvest minimum weed density and dry weight was recorded with full dose of herbicide along with urea as adjuvant.

Persistence of acetochlor in soil:

The level of residues of the tested herbicide was dependent on the type of adjuvants, time after application and depth of soil. Mixing with different adjuvants increased the persistence of acetochlor in top layer of the soil. The remaining amount of acetochlor alone and or mixed with adjuvants after different days of application to soil were tabulated in Table (5). The initial amount of acetochlor residues alone and with five different adjuvants ranged from 14.56 to 23.8 µg/gm The initial deposit of acetochlor extracted from soil depth 0 – 5 cm was 16.96 µg/gm. (Table 5 and Fig.1), followed by a rapid degradation having nearly the same results after 6 and 14 days with 35.91 and 35.85% recovered . Acetochlor residues decreased further with time to 2.97 µg/gm at 21 days after application representing a recovery of 17.5%. After 28 days there was a small decline to 2.27 µg/gm, which continued until 42 days reaching 1.44 µg/gm (8.49% recovered).

In the soil surface (0-5) the % recovered of acetochlor with different adjuvants was different. After 3 days from application of acetochlor mixture with phosphoric acid as adjuvant (t 2) represented high % recovered 90.59% followed by 87.11 and 81.34 % for the mixture with palm oil (t 3) and capl 2 crude oil (t 4), respectively.

As for the mixture with citric acid (t 6), the % recovered was nearly the same as acetochlor alone after 3 days, (74.20%) .While the acetochlor with arabic gum had lowest percent recovered (66.21) than all the other treatments. The percentage amount recovered from acetochlor and palm oil were from 87.11 to 41.20 %, from 3 to 14 days post application, respectively. There was a decline in percent recovered from acetochlor and capl 2 crude oil after 3 and 14 days to give 81.34 and 20.92%, respectively. After 42 days the percent loss of acetochlor with palm oil and capl 2 crude oil were 90.3 and 79.03% with % recovered 9.7 and 20.97 (Fig. 1.). The rapid degradation

continued for acetochlor plus citric acid until the 6 days from application reaching 50.11% (Table 5), then degradation became slower and gradual. After 42 days the percent recovered residues was 15.29%. Data in Table (5) indicated that the amount recovered from acetochlor and arabic gum was the lowest compared with the other treatments of acetochlor throughout the experiment. It decreased sharply from zero to 14 days after spraying, whereas the % recovered reached 18.75% and then gradually decreased to 17.17, 9.07 and 6.87% after 28, 35 and 42 days, respectively.

Phosphoric acid mixture with acetochlor increased the persistence of the herbicide compared with the other tested treatments. The percent recovered was 77.46%, 21 days from application, then decreased to 30.34% by the end of the experiment which is still the highest recovered value compared to the other treatments.

Movement of the acetochlor through the tested layers was studied. It was found that the leaching to layer 5 – 10 cm from surface showed different % recoveries for all of the tested treatment when calculated with reference to the total amount recovered from 0 – 10 cm.

The initial presence of the acetochlor in the six treatments in layers from 5–10 cm was different. For acetochlor alone and acetochlor plus different adjuvants the recovered amounts in this layer was ranged from 1.2 to 4.5% . The lowest percent which leached from L1 (0 – 5 cm) to L2 (5 – 10 cm) was 1.2 % compared to its presence in L 2 for the mixture with capl oil, while the highest leaching % was 4.5% for the mixture with citric acid compared to 3.7% for acetochlor alone.

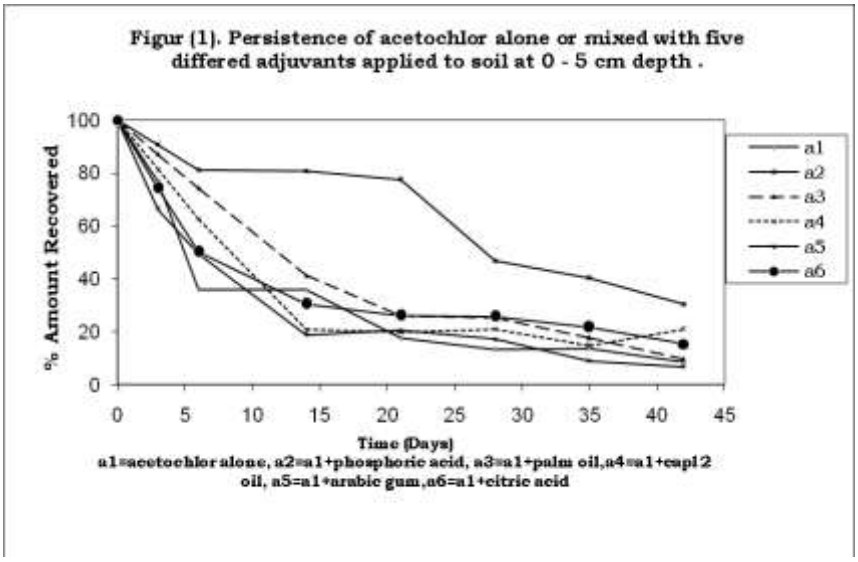
As for acetochlor the presence in L2 fluctuated throughout the whole experiment. It was almost stable until 14 days, then increased until 28 day of the experiment from 3.7 to 31.50%, then decreased until the end of the experiment reaching 17.7%. The presence increased gradually acetochlor and phosphoric acid in L2 till 28th day with 24.3% followed by a decrease until the end of the experiment with (7.9 %).

The presence of acetochlor and palm oil increased gradually with a maximum of 18.0% on the 35th day, followed by a decrease to 15.3% after 42 days. While the results of acetochlor and capl 2 crude oil were close to those of acetochlor and palm oil.

Acetochlor plus arabic gum results were different than all of the other treatments, where the increase was gradual until the 14 day, then it increased with the highest value (throughout the whole experiment) until the end of the experiment with (42 days) a value of 59.8% recovery in L2 layer, compared to its presence in (L1) layer . This may be due to its rapid degradation.

Acetochlor and citric acid results fluctuated through the 42 days of the experiment. The values increased gradually until 14 day, then decreased also gradually until leaching 10.9% at the end of the experiment. Although, the acetochlor remained in the top of the soil (5 cm) of soil, it was detected in the 5-10 layer on the second sampling date at seven days after application.

5



The appearance of the herbicide in the 5-10 cm layer could not be explained on the basis of the classic convection – dispersion equation using the measured rainfall. However, temperature had a significant influence on degradation of acetochlor, biodegradation was an important dissipation pathway for acetochlor, but biodegradation alone could not adequately describe dissipation of the acetochlor in the field, soil moisture had little effect on biodegradation of herbicide (Qing *et al.* 2000).

These results may agree with Norris (1982) who reported that other adjuvants can inhibit bacteria by disrupting their cell membranes. Kucharski (2004) also proved that the addition of adjuvants slowed down the degradation and increased the level of phenmedipham residue in the soil.

The statistical half- life times (RL_{50}) of acetochlor alone was 8.06 and 9.5 days at 0- 5 cm (L1) and 0- 10 cm (L 2), respectively. The RL_{50} values, for the mixtures varied. For acetochlor and phosphoric at 0- 5 cm acid, it was more stable (27.73 days) than the other treatments, followed by acetochlor plus palm oil (12.84days) and then acetochlor plus capl 2 crude oil (10.05 days). Acetochlor plus arabic gum (6.54 days) was less stable than acetochlor and citric acid (9.76 days).

These results agree with those of Dictor *et al.* (2008) who found that the half-lives (DT_{50}) of acetochlor varied from 1.4 to 14.9 days depending on the soil, temperature and applied concentration. While Zhen and Deng (2011) reported that half- life times (t1/2) for acetochlor in soil was 6.074 days. Ma *et al* .2004 found that the time for 50% (DT_{50}) of initial acetochlor loss was approximately 9 and 56 days, and 18 and 63 days at low and high application rates, respectively. They also stated that acetochlor loss in the Horotiu soil possibly resulted from the higher soil organic carbon content that retained more

acetochlor near the soil surface where higher temperature and photolysis accelerated the loss.

The phosphoric acid proved to be the most effective adjuvant on the biological aspects, suppressing the number of emerging weeds and the fresh weight yield. Its mixture was also the most persistent one compared to all the tested mixtures. The two tested oils (palm oil and capl oil) followed the phosphoric acid in its effectiveness and persistence. While citric acid mixture was almost close to the effect of acetochlor alone.

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تـأثير خمسـة اضـافات علـي فعاليـة مبيـد الاسـيتوكلورو علـي حشيشـيتي الرجلـه والشبيط وثباته في التربة .

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تم دراسة تأثير خمسة أنواع من الاضافات وهي حامض القوسفوريك – زيت النخيل ـ زيت كابل ـ الصمغ العربـي ـ حمض الستريك بتركيز 3و ٪ علي فاعلية مبيد الاسيتوكلورو بتركيزين هما 1لتر/ فدان (الجرعة الموصي بها)

& 5 ٫ لتر/فدان (نصف الجرعة الموصي بها) لمكافحة حشيشيتي الرجله والشبيط حيث تم رش هذه المعاملات علي التربة قبل الانبات .أخذت النتائج علي أعداد والوزن الطازج لكلا النباتين كما تم تقدير متبقيات الاسيتوكلورو منفردا ومخلوطا مع الاضافات السابقة في التربة علي فترات مختلفة حيويا باستعمال بذور الخيار وكيماويا بواسطة جهاز الغاز كروماتوجرافي

وقد أوضحت الدراسة النتائج التالية :

1ـ استعمال مبيد الاسيتوكلورو منفردا علي الحشائش السابقة بتركيز 1لتر/فدان أعطي مكافحة أفضل من استعمال نفس المبيد بتركيز 0,5 لتر/فدان. كذلك كان التأثير واضحا علي الوزن الطازج لحشيشة الشبيط (4,8 جم/نبات) مقارنة بالوزن الطازج لحشيشة الرجله (7,33 جم/نبات) بعد 56 يوم من المعاملة.

2 ـ يعتبر حمض الفوسفوريك أفضل الاضافات مع المبيد من حيث تأثيرها علي الحشائش المختبرة وثبات المبيد في التربة فوجد أن اضافة حمض الفوسفوريك بمعدل 0,3٪ الي مبيد الاسيتوكلورو أدي الي زيادة الفعالية عن بقية الاضافات حيث كان الوزن الطازج 1,03 جم/نبات في حشيشة الشبيط و 3,30 جم/ نبات في حشيشة الرجله .

3- زيت النخيل وزيت كابل والصمغ العربي كانوا في المرتبة الثانية بعد حمض القوسفوريك من حيث التأثير علي الحشائش ولم تظهر فروق معنوية بين تأثير كل من زيت النخيل وزيت كابل والصمغ العربي علي النباتات .

4- كان حمض الستريك أقل الاضافات تأثيرا علي فعالية وثبات مبيد الاسيتوكلورو في مكافحة كل من الرجله والشبيط.

5- عند تقدير متبقيات المعاملات السابقة في التربة حيويا بأخذ عينات من التربة علي مستوي من صفر – 5 سم علي انبات بذور الخيار وجد أن النسب المئوية للانبات هي 96,76 – 76,76 - 93,33 – 86,67 – 93,33 – 83,33٪ للمعاملات التالية الاسيتوكلورو منفردا بتركيز 0,5 لتر /فدان – الاسيتوكلورو مع حمض الفوسفوريك ، الاسيتوكلورو مع زيت النخيل ، الاسيتوكلورو مع زيت كابل ، الاسيتوكلورو مع الصمغ العربي ، الاسيتوكلورو مع حمض الستريك علي التوالي بعد 42 يوم من المعاملة .

6- لوحظ أن استعمال المبيد المختبر بالجرعة الموصي بها (1لتر/فدان) مع نفس الاضافات السابقة علي مستوي من صفر – 5 سم كانت أعلي نسب لا نبات الخيار هي 80,67 ٪ عند اضافة حمض الفوسفوريك 63,33عند اضافة زيت النخيل.

7- لم تظهر أي فروق معنوية بين المعاملات السابقة مقارنة بالكنترول علي انبات بذور الخيار في مستوي التربة من 5 – 10 سم لكلا التركيزين من مبيد الاسيتوكلورو .

8- عند تقدير متبقيات مبيد الاسيتوكلورو منفردا ومخلوطا مع الاضافات السابقة باستخدام جهاز الغاز كروماتوجرافي علي نفس المستويين فى التربة أكدت النتائج أن اضافة حمض الفوسفوريك الي المبيد بالجرعة الموصي بها يزيد من ثباته في الطبقة السطحية للتربة. وأن فترة نصف العمر للمبيد منفردا هي 8,06 يوم بينما كانت للمبيد مع حمض الفوسفوريك 27,73 يوم ثم 12,84 ، 10,05 ، 6,54 و 9,76 يوم لباقي المعاملات علي التوالي (المبيد مع زيت النخيل ، المبيد مع زيت كابل ، المبيد مع الصمغ العربي ، المبيد مع حمض الستريك) .

قام بتحكيم البحث

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Table (1): Effect of recommended dose and its half of acetochlor alone or mixed with different adjuvants on the number of emerging weeds through different intervals after spraying.

Treatments	Number of emerging of *Portulaca oleracea*							Number of emerging of *Xanthium brasilicum*						
		Time (days)												
	21	28	35	42	49	56	Means	21	28	35	42	49	56	Means
Half dose (0.5 L/ fed.)														
Acetochlor alone (t1)	1.7b	2.3b	3.0b	4.0b	4.7b	5.0c	2.30C	1.7b	1.7b	2.0b	2.3b	4.0b	6.0b	1.96B
Acetochlor+ phosphoric acid (t2)	0.0c	0.0c	1.0d	1.0d	1.0d	1.7d	0.52GH	0.0c	0.0c	0.7cd	1.0cd	1.3d	1.7c	0.52FG
Acetochlor+ palm oil (t3)	0.3c	0.0c	1.7c	2.0d	2.7c	2.7d	1.04F	0.0c	0.3c	0.7cd	0.7d	1.0d	1.0c	0.41GH
Acetochlor+ capl oil (t4)	0.0c	0.0c	1.0d	1.3d	1.7cd	2.0d	0.67G	0.0c	0.0c	0.0d	0.7d	1.0d	1.0c	0.30GH
Acetochlor+ arabic gum (t5)	0.3c	2.0b	2.0c	2.0d	2.0cd	2.3d	1.19EF	0.0c	0.7bc	1.0c	1.0cd	1.3d	1.3c	0.59EF
Acetochlor+ citric acid (t6)	1.7b	2.0b	2.7b	3.3c	4.7b	10.0b	2.74B	0.3c	1.0bc	1.3bc	1.7bc	2.0cd	2.3c	0.96CD
Control	3.3a	4.7a	5.0a	5.7a	11.67a	16.7a	5.59A	3.0a	3.7a	4.3a	5.3a	8.3a	11.7a	4.33A
Recommended dose (1.0 L / fed.)														
Acetochlor alone (t1)	1.0b	1.0b	2.0b	2.0b	3.0b	3.7c	1.41DE	0.3b	1.0b	1.0b	1.7b	2.3b	3.3b	1.07C
Acetochlor+ phosphorica acid (t2)	0.0c	0.0b	0.3d	0.7c	1.0c	1.0d	0.33H	0.0b	0.0c	0.0c	0.3de	0.7c	0.7c	0.19H
Acetochlor+ palmoil (t3)	0.0c	0.0b	1.0cd	1.0c	1.0c	1.7d	0.52GH	0.0b	0.0c	0.0c	0.7cd	1.0c	0.7c	0.22H
Acetochlor+ capl oil (t4)	0.0c	0.0b	0.3d	1.0c	1.0c	1.0d	0.37H	0.0b	0.0c	0.0c	0.0e	1.0c	1.0c	0.22H
Acetochlor+ arabic gum (t5)	0.0c	1.0b	1.0cd	1.0c	1.3c	1.7d	0.67G	0.0b	0.0c	0.7bc	1.0bc	1.0c	2.3b	0.56EF
Acetochlor+ citric acid (t6)	0.7b	1.3b	1.3bc	2.0b	3.0b	6.0b	1.59D	0.0b	1.0b	1.3b	1.3bc	1.3c	2.3b	0.78DE
Control	3.3a	4.7a	4.7a	5.7a	11.7a	16.7a	5.56A	3.0a	3.67a	4.3a	5.33a	8.3a	11.7a	4.19A

Table (2): Effect of recommended dose and its half of acetochlor alone or mixed with different adjuvants on fresh weight of weed through different intervals after spraying .

Treatments	Fresh weight (gm / plant) of *Portulaca oleracea*							Fresh weight (gm. / plant) of *Xanthium brasilicum*						
	Time (days)													
	21	28	35	42	49	56	Mean	21	28	35	42	49	56	Mean
Half dose (0.5 L /fed.)														
Acetochlor alone (t1)	0.6b	1.2b	2.0b	3.1b	5.1b	7.3b	2.15B	2.47b	2.7b	5.8b	6.9b	8.1b	12.3b	4.25B
Acetochlor+ phosphoric acid (t2)	0.0b	0.0c	0.6c	1.3bc	2.4cd	3.3d	0.85D	0.00c	0.0c	0.6d	1.2d	2.4d	4.3d	0.93E
Acetochlor+ palm oil (t3)	0.3b	0.0c	2.0b	2.5bc	3.5bc	4.3d	1.40C	0.00c	0.0c	1.0d	1.3d	2.2d	3.3e	0.88E
Acetochlor+ capl oil (t4)	0.0b	0.0c	0.6c	1.1c	1.8cd	3.6d	0.79DE	0.00c	0.0c	0.0d	0.2d	0.8e	1.4f	0.27F
Acetochlor+ arabic gum (t5)	0.2b	0.1b	0.2c	0.7c	1.4d	3.8d	0.80DE	0.00c	o.8c	0.7d	1.3d	1.4de	2.3f	0.73E
Acetochlor+ citric acid (t6)	0.5b	0.6bc	1.0bc	1.6bc	2.7cd	5.4c	1.37C	0.10c	0.7c	2.7c	3.6c	3.6c	5.8c	1.83C
Control	11.3a	12.7a	16.3a	22.7a	26.7a	30.3a	14.1A	5.3a	6.9a	12.9a	16.5a	21.1a	24.6a	10.31A
Recommended dose (1.0 L /fed.)														
Acetochlor alone (t1)	0.2b	0.5b	1.0b	1.8b	2.7b	7.3b	1.07CD	0.3b	0.5b	1.3b	1.9b	3.6b	4.8b	1.42C
Acetochlor+ phosphoric acid (**t2**)	0.0b	0.0b	0.1b	0.3b	0.7c	3.3d	0.31F	0.0b	0.0b	0.0c	0.1d	0.7cd	1.0d	0.20F
Acetochlor+ Palmoil (t3)	0.0b	0.0b	0.5b	0.8b	1.2bc	4.3d	0.51EF	0.0b	0.0b	0.0c	0.3cd	0.7cd	1.0d	0.23F
Acetochlor+ capl oil (t4)	0.0b	0.0b	0.1b	0.5b	1.1bc	3.6d	0.36F	0.0b	0.0b	0.0c	0.0d	0.5d	0.8d	0.14F
Acetochlor+ arabic gum (t5)	0.0b	0.4b	0.5b	0.7b	0.7c	3.8d	0.47EF	0.0b	0.0b	0.3c	0.6cd	0.5cd	0.8d	0.25F
Acetochlor+ citric acid (t6)	0.8b	0.8b	1.2b	0.8b	1.6bc	5.4c	1.02D	0.0b	0.5b	0.8b	1.3bc	1.4c	2.5c	0.73E
Control	11.3a	12.7a	16.3a	22.7a	26.7a	30.3a	14.06A	5.3a	6.9a	12.9a	16.5a	21.1a	24.6a	10.31A

Table (5) : Persistence of acetochlor alone or mixed with five different adjuvants applied to soil at two different depths .

Treatment	Soil depth (cm)	Acetochlor remained after days of application (ug / gm.)																
		0		3		6		14		21		28		35		42		
		amount	Rec.%	amount	Rec.%	Amount	Rec.%	amount	Rec.%	amount	Rec.%	Amount	%Rec	Amount	Rec.%	amount	Rec.%	RL_{50} day
Acetochlor alone (t1)	0-5	16.96	100	13.02	76.76	6.09	35.91	6.08	35.85	2.97	17.51	2.27	13.38	2.34	13.80	1.44	8.49	8.06
	5-10	0.66	3.7	1.06	7.5	1.55	20.3	1.08	15.1	1.55	34.3	1.03	31.5	0.53	18.5	0.31	17.7	--
	0-10	17.62	100	19.08	79.9	7.64	38.2	7.16	35.8	4.52	22.6	3.27	16.5	2.87	14.35	1.75	8.75	9.5
Acetochlor+ phosphoric Acid(t2)	0-5	18.59	100	16.84	90.59	15.09	81.17	15.0	80.69	14.4	77.46	8.70	46.80	7.49	40.29	5.64	30.34	27.73
	5-10	0.66	3.4	1.00	5.6	0.57	3.6	1.36	8.3	1.56	3.8	2.79	24.3	1.55	17.1	0.49	7.9	--
	0-10	19.25	100	17.84	92.68	15.66	72.40	16.36	75.64	15.96	73.79	11.49	53.12	9.04	41.79	6.13	28.34	33.01
Acetochlor+ palm oil (t3)	0-5	21.65	100	18.86	87.11	16.06	74.18	8.92	41.20	5.65	26.10	5.45	25.17	3.83	17.69	2.10	9.70	12.84
	5-10	0.92	4.1	1.61	7.9	1.85	10.3	1.44	13.9	0.93	14.1	0.93	14.6	0.84	18.0	0.38	15.3	--
	0-10	22.57	100	20.47	90.70	17.91	79.35	10.36	45.90	6.58	29.15	6.38	28.27	4.67	20.69	2.48	10.99	14.75
Acetochlor+ capl oil (t4)	0-5	23.8	100	19.36	81.34	14.9	62.61	4.98	20.92	4.7	19.75	5.0	21.01	3.51	14.75	4.99	20.97	10.05
	5-10	0.29	1.2	0.89	4.4	0.23	1.5	0.55	9.9	0.82	14.5	0.82	14.1	0.50	12.5	0.34	6.3	--
	0-10	24.09	100	20.25	84.06	15.13	62.81	5.53	22.96	5.52	22.91	5.82	24.16	4.01	16.65	5.33	22.13	10.8
Acetochlor+ arabic gum(t5)	0-5	14.56	100	9.64	66.21	7.2	49.45	2.73	18.75	2.97	20.40	2.50	17.17	1.32	9.07	1.0	6.87	6.54
	5-10	0.37	2.5	0.51	5.0	0.61	7.8	0.31	10.2	0.95	24.2	1.78	41.6	1.67	55.9	1.49	59.8	--
	0-10	14.93	100	10.15	67.98	7.81	52.31	3.04	20.36	3.92	26.26	4.28	28.67	2.99	20.03	2.49	16.68	7.62
Acetochlor+ citric acid(t6)	0-5	22.95	100	17.03	74.20	11.5	50.11	7.0	30.50	6.0	26.14	5.91	25.75	5.0	21.79	3.51	15.29	9.76
	5-10	1.09	4.5	1.13	6.2	0.78	6.4	2.55	26.7	1.71	22.2	1.36	18.7	0.52	9.4	0.43	10.9	--
	0-10	24.04	100	18.16	75.54	12.28	51.08	9.55	17.61	7.71	13.11	7.27	11.57	5.52	8.18	3.94	5.30	10.66

In (0-5) the % recovered is calculated on the basis that the amount recovered at the initial time is 100% .
In (5-10) layer the % recovered is calculated on the basis that amount recovered from 5-10 cm is retension to the total (0-10) layer .
%Rec. : % recovered

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