

## **Results and Discussion**

The physico-chemical properties of the additive materials were studied. Solubility in water and insecticides was considered as a limiting factor for mixing technique i.e. direct or tank- mix method. The free acidity or alkalinity, Critical Micell Concentration and Hydrophilic-Lipophylic Balance. The physical compatibility between different additive materials and candidate insecticides was studied. Also the effect of chemical additives on the physico-chemical properties of insecticides was investigated.

### **1. Determination of physico-chemical properties of chemical additives.**

#### **1.1. Solubility**

The physico-chemical properties of the tested additive materials are shown in Table (1). It was evident that kerosene, xylene and CABL1 were soluble with Dursban, Curacron, Axone and Superalpha at rate of 10%. on the other hand they were not soluble in water. On contrast, glue, Arabic gum, polyacryl amidee and HMC were soluble in water at concentration 0.5%, 0.5%, 0.1% and 0.25% respectively but they did not soluble in candidate insecticides . All surfactants Sisi6, DL600 and ML600 were soluble in water and insecticides at rate 0.5%. sulphonic acid soluble in water and insecticides, but citric acid, oxalic acid and tartaric acid soluble in water at rate 0.5%, but they did not soluble in insecticides.

## **1.2. Free alkalinity and acidity**

Results presented in Table (2) indicated that all acids have strongly acidic character, while ML600 is too weakly acidic. glue, Arabic gum and polyacryl amidee are very weak alkaline but DL600, Sisi6 and HMC are neutral. On the other hand, CAPL1 ,xylene are weak acids and kerosene is weak alkaline.

## **1.3. Hydrophilic-Lipophilic Balance (HLB)**

Results presented in Table ( 3 ) showed that, non ionic surfactants of poly ethylene glycol 600 dilurate and poly ethylene glycol 600 monolurate have the same HLB value (10-12) which they make translucent to clear dispersion, While anionic surfactant such as Sisi6 have HLB >13 which completely soluble in water.

## **1.4. Critical Micelle Concentration (CMC)**

CMC is the concentration of surfactants at which no more decrease in surface tension could be obtained by decreasing the surfactant concentration. The reduction in surface tension have been measured for determining the contact angle between the droplet and leaf surface enhance wetting, spreading and deposit of pesticide on the treated plant then improving control of target species. The result in Table (3) showed that surface tension of solution decreased by increasing surfactant concentration until CMC value there is no more decrease in surface tension could be obtained.

**Table (1): The solubility of chemical additives in water and pesticides**

<b>Chemical additives</b>	<b>Solubility in water at 0.5% (Wt. /V.)</b>	<b>Solubility in pesticides at 10%</b>			
	<b>Solubility in water</b>	<b>Dursban</b>	<b>Curacron</b>	<b>Axone</b>	<b>Super alpha</b>
<b>Citric acid</b>	soluble	insoluble	insoluble	insoluble	insoluble
<b>Sulphonic acid</b>	soluble	soluble	soluble	soluble	soluble
<b>Oxalic acid</b>	soluble	insoluble	insoluble	insoluble	insoluble
<b>Tartaric acid</b>	soluble	insoluble	insoluble	insoluble	insoluble
<b>DL 600</b>	soluble	soluble	soluble	soluble	soluble
<b>ML 600</b>	soluble	soluble	soluble	soluble	soluble
<b>Sisi6</b>	soluble	Gave emulsion	Gave emulsion	Gave emulsion	Gave emulsion
<b>Glue</b>	soluble	insoluble	insoluble	insoluble	insoluble
<b>Arabic gum</b>	soluble	insoluble	insoluble	insoluble	insoluble
<b>Polyacryl amide</b>	soluble	insoluble	insoluble	insoluble	insoluble
<b>HMC</b>	soluble	insoluble	insoluble	insoluble	insoluble
<b>Kerosene</b>	insoluble	soluble	soluble	soluble	soluble
<b>Xylene</b>	insoluble	soluble	soluble	soluble	soluble
<b>CAPL 1</b>	Gave emulsion	soluble	soluble	soluble	soluble

**Table (2): The free alkalinity and the free acidity of the locally chemical additives**

<b>Chemical additives</b>	<b>Free alkalinity % as NaOH</b>	<b>Free acidity % as H<sub>2</sub>SO<sub>4</sub></b>
<b>Citric acid</b>	-----	93.1
<b>Sulphonic acid</b>	-----	34.3
<b>Oxalic acid</b>	-----	88.2
<b>Tartaric acid</b>	-----	73.5
<b>DL 600</b>	-----	-----
<b>ML 600</b>	-----	0.98
<b>Sisi6</b>	-----	-----
<b>Glue</b>	0.32	-----
<b>Arabic gum</b>	0.16	-----
<b>Polyacryl amide</b>	1.36	-----
<b>HMC</b>	-----	-----
<b>Kerosene</b>	0.08	-----
<b>Xylene</b>	-----	0.098
<b>CAPL 1</b>	-----	0.0196

**Table (3): The CMC values correlated with surface tension of the locally chemical additives and HLB**

Surfactant	CMC % (wt/v)	Surface tension (dyne/cm)	HLB value
DL 600	0.9	40.2	10-12
ML 600	0.8	41.4	10-12
Sisi 6	0.5	26.8	>13

### 1.5. Physico-chemical properties of some certain additives in water

**Data in Table (4)** clearly indicated that, all tested adjuvants affected on the physico-chemical properties of water that will be used for dilution of insecticides when they added at rate 0.5% for all solublized additives except polyacryl amide at 0.25% and HMC at 0.1%. Sulphonic acid caused the highest decrease in surface tension followed by Sisi6 and ML600. While the others did not caused significant change except Polyacryl amide increased the surface tension. Polyacryl amide and HMC gave highest increase in viscosity but the others caused slightly increase except Oxalic acid and Tartaric acid have no effect. All chemical additives increased the electrical conductivity except DL600 and ML600. Oxalic acid gave highest increase in electrical conductivity followed by sulphonic acid, tartaric acid and citric acid. All adjuvants decreased the pH value where oxalic acid recorded a highest decrease followed by sulphonic acid, tartaric acid and citric acid.

**Table (4): Physico-chemical properties of some certain additives at mentioned concentration in water**

<b>Materials</b>	<b>Concentration</b>	<b>Surface tension Dyne/cm</b>	<b>Viscosity mps</b>	<b>Conductivity <math>\mu</math>MHOS</b>	<b>pH</b>
<b>Citric acid</b>	0.5%	72	11.3	1400	2.37
<b>Sulphonic acid</b>	0.5%	30.4	10.9	4200	2.1
<b>Oxalic acid</b>	0.5%	76	9.6	8000	1.94
<b>Tartaric acid</b>	0.5%	76	9.2	1800	2.19
<b>DL 600</b>	0.5%	68.4	10.00	335	6.4
<b>ML 600</b>	0.5%	38	10.43	305	5.78
<b>Sisi6</b>	0.5%	31.1	10.9	432	6.64
<b>Glue</b>	0.5%	68.4	12.2	490	6.35
<b>Arabic gum</b>	0.5%	76	11.3	430	6.83
<b>Polyacryl amide</b>	0.1%	80.5	56.5	400	6.52
<b>HMC</b>	0.25%	54.7	45.7	500	6.54
<b>Water</b>	-----	72	10.00	350	7.00

**HMC. Hydroxy methyl cellulose**

## 2. Physical compatibility between candidate insecticides and chemical additives.

### 2.1. tank-mix technique:-

It was carried out by determination of emulsion stability test for insecticides at field dilution rate and its tank mix with solublized additives

Emulsion stability test was considered as a limiting factor for the successful combination and would be an important guide for the physical compatibility of the mixed materials.

- **Data in Table (5)** showed the emulsion stability test of Dursban alone and its combination with additive materials. The results indicated that, there was a physical compatibility between chemical additives and Dursban. Where Dursban not gave Precipitation or separation with chemical additives except DL600 gave 0.1ml cream separation and Polyacryl amide gave 0.1 ml Precipitate.
- **Data in Table (6)** showed the emulsion stability test of Curacron alone and its combination with additive materials. The results indicated that, there was a physical compatibility between chemical additives and Curacron. Where Curacron not gave any cream separation and gave traces of precipitation with all acids, DL600, glue and Arabic gum.
- **Data in Table (7)** showed the emulsion stability test of Axone alone and its combination with additive materials. The results indicated that, there was a physical compatibility between chemical additives and Axone Where Axone gave 1 ml cream separation with tartaric acid and 0.1 ml precipitation with Arabic gum and Polyacryl amide.

- **Data in Table (8)** showed the emulsion stability test of Superalpha alone and its combination with additive materials. The results indicated that, there was a physical compatibility between chemical additives and Superalpha where Superalpha gave traces of precipitation with DL600 only.

**Table (5): Emulsion stability test for Dursban at field dilution rate and tank mixed with additives**

<b>Treatment</b>	<b>Concentration%(Wt./V.)</b>	<b>Cream Separation</b>	<b>MI Precipitation</b>
<b>Dursban</b>	0.5	-----	-----
<b>+Citric acid</b>	0.5	-----	-----
<b>+Sulphonic acid</b>	0.5	-----	-----
<b>+Oxalic acid</b>	0.5	-----	-----
<b>+Tartaric acid</b>	0.5	-----	-----
<b>+DL 600</b>	0.5	0.1 ML	-----
<b>+ML 600</b>	0.5	-----	-----
<b>+Sisi6</b>	0.5	-----	-----
<b>+Glue</b>	0.5	-----	-----
<b>+Arabic gum</b>	0.5	-----	-----
<b>+Polyacryl amide</b>	0.1	-----	0.1 ML
<b>+HMC</b>	0.25	-----	-----

**HMC. Hydroxy methyl cellulose**

**Table (6): Emulsion stability test for Curacron at field dilution rate and tank mixed with additives**

<b>Treatment</b>	<b>Concentration %(Wt./V.)</b>	<b>Cream Separation</b>	<b>MI Precipitation</b>
<b>Curacron</b>	0.5	-----	-----
<b>+Citric acid</b>	0.5	-----	T
<b>+Sulphonic acid</b>	0.5	-----	T
<b>+Oxalic acid</b>	0.5	-----	T
<b>+Tartaric acid</b>	0.5	-----	T
<b>+DL 600</b>	0.5	-----	T
<b>+ML 600</b>	0.5	-----	-----
<b>+Sisi6</b>	0.5	-----	-----
<b>+Glue</b>	0.5	-----	-----
<b>+Arabic gum</b>	0.5	-----	T
<b>+Polyacryl amide</b>	0.1	-----	T
<b>+HMC</b>	0.25	-----	-----

**HMC. Hydroxy methyl cellulose**

**T.Traces**

**Table (7): Emulsion stability test for Axone at field dilution rate and tank mixed with additives**

<b>Treatment</b>	<b>Concentration%(Wt./V.)</b>	<b>Cream Separation</b>	<b>MI Precipitation</b>
<b>Axone</b>	0.5	-----	-----
<b>+Citric acid</b>	0.5	-----	-----
<b>+Sulphonic acid</b>	0.5	-----	-----
<b>+Oxalic acid</b>	0.5	-----	-----
<b>+Tartaric acid</b>	0.5	0.1 ML	-----
<b>+DL 600</b>	0.5	-----	-----
<b>+ML 600</b>	0.5	-----	-----
<b>+Sisi6</b>	0.5	-----	-----
<b>+Glue</b>	0.5	-----	-----
<b>+Arabic gum</b>	0.5	-----	0.1 ML
<b>+Polyacryl amide</b>	0.1	-----	0.1 ML
<b>+HMC</b>	0.25	-----	-----

**HMC. Hydroxy methyl cellulose**

**Table (8): Emulsion stability test for Superalpha at field dilution rate and tank mixed with additives**

<b>Treatment</b>	<b>Concentration%(Wt./V.)</b>	<b>Cream Separation</b>	<b>MI Precipitation</b>
<b>Superalpha</b>	0.5	-----	-----
<b>+Citric acid</b>	0.5	-----	-----
<b>+Sulphonic acid</b>	0.5	-----	-----
<b>+Oxalic acid</b>	0.5	-----	-----
<b>+Tartaric acid</b>	0.5	-----	-----
<b>+DL 600</b>	0.5	T	-----
<b>+ML 600</b>	0.5	-----	-----
<b>+Sisi6</b>	0.5	-----	-----
<b>+Glue</b>	0.5	-----	-----
<b>+Arabic gum</b>	0.5	-----	-----
<b>+Polyacrylamid</b>	0.1	-----	-----
<b>+HMC</b>	0.25	-----	-----

**HMC. Hydroxy methyl cellulose**

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## 2.2. Direct-mix technique:-

Physico-chemical properties for Dursban alone and its direct mixed with tested additives were studied. The obtained data in Table (9) indicated that Dursban alone passed successfully in emulsion stability and cold test also it was acidic. Whereas it failed in accelerated storage test since it showed 4ml precipitation. On the other hand no changes in emulsion stability were found under direct mixed condition with all chemical additives except ML600 and Sulphonic acid which failed in this test also they were acidic. With another point of view there are an improvement was noted in precipitation of accelerated storage as a result to direct mixed with kerosene, Xylene, CAPL1 and DL600. The precipitation layer decreased from 4 ml in case of Dursban alone to 3 ml with other chemical additives.

Physico-chemical properties for Curacron alone and its direct mixed with tested additives were studied. The obtained data in Table (10) indicated that Curacron alone passed successfully in emulsion stability, cold test and accelerated storage where it gave traces of precipitate before cold test and accelerated storage also it was acidic. On the other hand Curacron under direct mixed condition with chemical additives passed successfully in emulsion stability, cold test and accelerated storage except DL600 and sulphonic acid which gave 3 ml and 2.5 ml respectively. With another point of view there are an improvement was noted in precipitate of accelerated storage as a result to direct mixed with chemical additives.

Physico-chemical properties for Axone alone and its direct mixed with tested additives were studied. The obtained data in Table (11) indicated that Axone alone passed successfully in emulsion stability and cold test also it was acidic. Whereas it failed in accelerated storage test since it showed

5ml cream separate. On the other hand no changes in emulsion stability were found under direct mixed condition with all chemical additives except ML600, and sulphonic acid failed in this test also they were acidic. With another point of view there are an improvement was noted in separation of accelerated storage as a result to direct mixed with kerosene, CAPL1, xylene and DL600.

Physico-chemical properties for Superalpha alone and its direct mixed with tested additives were studied. The obtained data in Table (12) indicated that Superalpha alone passed successfully in emulsion stability, cold test and accelerated storage also it was alkaline. On the other hand Superalpha under direct mixed condition with chemical additives passed successfully in emulsion stability, cold test and accelerated storage except ML600. With another point of view there are an improvement was noted in separation of accelerated storage as a result to direct mixed with all additives.

**Table (9): Physico-chemical properties of Dursban alone and its direct mix with additives**

Treatment	Emulsion stability		Cold test	Free acidity as %H <sub>2</sub> SO <sub>4</sub>	Free alkalinity as %NaOH	Accelerated storage			
	ml Cream sep.	MI ppt				Emulsion stability		Free acidity as %H <sub>2</sub> SO <sub>4</sub>	Free alkalinity as %NaOH
						ml Cream sep.	MI ppt*		
<b>Dursban</b>	-----	-----	passed	0.196	-----	-----	4 ml	-----	-----
<b>+ Kerosene</b>	-----	-----	passed	0.196	-----	-----	3 ml	0.098	-----
<b>+ Xylene</b>	-----	-----	passed	0.196	-----	-----	3 ml	0.098	-----
<b>+ CAPL 1</b>	-----	-----	passed	0.196	-----	-----	-----	0.098	-----
<b>+ DI 600</b>	-----	-----	passed	0.196	-----	-----	3 ml	0.098	-----
<b>+ MI 600</b>	-----	3 ml	-----	-----	-----	-----	-----	-----	-----
<b>+ Sulphonic acid</b>	-----	3 ml	-----	-----	-----	-----	-----	-----	-----

\*Ppt=precipitation

**Table (10): Physico-chemical properties of Curacron alone and its direct mix with additives**

Treatment	Emulsion stability		Cold test	Free acidity as %H <sub>2</sub> SO <sub>4</sub>	Free alkalinity as %NaOH	Accelerated storage			
	ml Cream sep.	Ml ppt				Emulsion stability		Free acidity as %H <sub>2</sub> SO <sub>4</sub>	Free alkalinity as %NaOH
						ml Cream sep.	Ml ppt*		
<b>Curacron</b>	-----	T	passed	0.098	-----	-----	-----	0.882	-----
<b>+ Kerosene</b>	-----	1 ml	passed	0.098	-----	-----	-----	0.490	-----
<b>+ Xylene</b>	-----	1 ml	passed	0.098	-----	-----	-----	0.490	-----
<b>+ CAPL 1</b>	-----	1 ml	passed	0.098	-----	-----	-----	0.490	-----
<b>+ DI 600</b>	-----	3 ml	-----	-----	-----	-----	-----	-----	-----
<b>+ MI 600</b>	-----	-----	passed	0.098	-----	-----	-----	1.666	-----
<b>+ Sulphonic acid</b>	-----	2.5 ml	-----	-----	-----	-----	-----	-----	-----

\*Ppt=precipitation

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**Table (11): Physico-chemical properties of Axone alone and its direct mix with additives**

Treatment	Emulsion stability		Cold test	Free acidity as %H <sub>2</sub> SO <sub>4</sub>	Free alkalinity as %NaOH	Accelerated storage			
	ml Cream sep.	Ml ppt				Emulsion stability		Free acidity as %H <sub>2</sub> SO <sub>4</sub>	Free alkalinity as %NaOH
						ml Cream sep.	Ml ppt*		
<b>Axone</b>	-----	-----	passed	0.098	-----	5 ml	-----	-----	-----
<b>+ Kerosene</b>	-----	-----	passed	0.196	-----	-----	-----	0.098	-----
<b>+ Xylene</b>	-----	-----	passed	0.196	-----	3 ml	-----	0.098	-----
<b>+ CAPL 1</b>	-----	-----	passed	0.098	-----	-----	-----	0.098	-----
<b>+ D1 600</b>	-----	-----	passed	0.098	-----	-----	-----	0.098	-----
<b>+ Ml 600</b>	3 ml	-----	-----	-----	-----	-----	-----	-----	-----
<b>+ Sulphonic acid</b>	-----	5 ml	-----	-----	-----	-----	-----	-----	-----

\*Ppt=precipitation

**Table (12): Physico-chemical properties of Superalpha alone and its direct mix with additives**

Treatment	Emulsion stability		Cold test	Free acidity as %H <sub>2</sub> SO <sub>4</sub>	Free alkalinity as %NaOH	Accelerated storage			
	ml Cream sep.	MI ppt				Emulsion stability		Free acidity as %H <sub>2</sub> SO <sub>4</sub>	Free alkalinity as %NaOH
						ml Cream sep.	MI ppt*		
<b>Superalpha</b>	-----	-----	passed	-----	0.098	-----	-----	-----	-----
<b>+ Kerosene</b>	1 ml	-----	passed	-----	0.098	-----	-----	0.098	-----
<b>+ Xylene</b>	1 ml	-----	Passed	-----	0.098	-----	-----	0.098	-----
<b>+ CAPL 1</b>	1 ml	-----	Passed	-----	0.098	-----	-----	0.098	-----
<b>+ DI 600</b>	1 ml	-----	Passed	-----	0.098	-----	-----	0.098	-----
<b>+ MI 600</b>	3 ml	-----	-----	-----	-----	-----	-----	-----	-----
<b>+ Sulphonic acid</b>	-----	-----	Passed	3.300	-----	-----	-----	4.116	-----

\*Ppt=precipitation

### **3. Effect of certain chemical additives as adjuvant on physico-chemical properties of spray solution of candidate insecticides**

The effect of chemical additives on the physico-chemical properties of spray solution of insecticides was studied which was surface tension, viscosity; electrical conductivity and pH value were investigated.

#### **3.1. Tank-mix:-**

**Data in Table (13)** showed that, the physico-chemical properties of Dursban spray solution alone and its combinations with compatible additives. The results indicated that all tested additive materials decreased the surface tension of Dursban spray solution except citric acid, oxalic acid, tartaric acid and HMC. While Sisi6 and sulphonic acid gave the highest decrease in surface tension followed by DL600, ML600, glue and Arabic gum. This decrease in surface tension give a prediction that they will increase wettability, spreading and depositing of spray solution on treated surface with increasing of pesticidal efficiency (81). All tested compatibility materials increased the Viscosity except ML600. Polyacryl amide and HMC gave the highest increase in viscosity. The increase of viscosity of spray solution would increase the deposited on the treated plant leaves, then reduce the drift and increase the efficiency of insecticides. (82) All tested compatible materials increased the conductivity except DL600 and ML600 where Tartaric acid gave the highest increase in conductivity followed by oxalic acid, sulphonic acid and citric acid. On the other hand, all compatible materials decreased the pH value except DL600, Sisi6, Glue, Arabic gum, Polyacryl amide and HMC while oxalic acid recorded the highest decrease in pH value followed by sulphonic acid, tartaric acid and citric acid. This decrease in pH value of spray solution with increase electrical conductivity meant that acids decrease hydrolysis of the insecticide which is inversely correlated to alkaline media. (83) Also, reducing the pH value of spray solution might increase the attraction between sprayed solution and treated plants then increasing the insecticidal efficiency. (84)

**Data in Table (14)** showed that, the physico-chemical properties of Curacron spray solution alone and its combinations with compatible additives. The results indicated that all tested additive materials decreased the surface tension of Curacron spray solution except Arabic gum. Sulphonic acid gave the highest decrease in surface tension followed by Sisi6 and ML600. This decrease in surface tension gives a prediction that they will increase wettability, spreading and depositing of spray solution on treated surface with increasing of pesticidal efficiency (81). Polyacryl amide and HMC recorded the highest increase in viscosity while the other compatible materials have no change in viscosity. The increase of viscosity of spray solution would increase the deposited on the treated plant leaves, then reduce the drift and increase the efficiency of insecticides. (82) All the compatible materials showed a high increase in the electrical conductivity except DL600 and ML600 where oxalic acid gave the highest increase in electrical conductivity followed by sulphonic acid, citric acid and tartaric acid. Oxalic acid gave the highest decrease in pH value followed by Sulphonic acid, Tartaric acid, Citric acid and ML600, while the other compatible materials increased the pH value. This decrease in PH value of spray solution with increasing the electrical conductivity meant that acids decrease hydrolysis of the insecticide which is inversely correlated to alkaline media; (83) also; reducing the pH value of spray solution might increase the attraction between sprayed solution and treated plants then increasing the insecticidal efficiency. (84)

**Data in Table (15)** showed that, the physico-chemical properties of Axone spray solution alone and its combination with compatible additives. The results indicated that all tested additive materials decreased the surface tension of Axone spray solution except DL600. Sulphonic acid gave the highest decrease in surface tension followed by Sisi6, HMC. This decrease in surface tension gives a prediction that they will increase wettability, spreading and depositing of spray solution on treated surface with increasing of pesticidal efficiency. (81) Polyacryl amide and HMC recorded the highest increase in viscosity while the other compatible materials have slightly increase except oxalic acid and DL600. The increase of viscosity of spray solution would increase the deposited on

**Data in Table (16)** showed that, the physico-chemical properties of Superalpha spray solution alone and its combination with compatible additives. The results indicated that all tested additive materials decreased the surface tension of Superalpha spray solution. Sulphonic acid gave the highest decrease in surface tension followed by Sisi6, ML600 and DL600. This decrease in surface tension gives a prediction that they will increase wettability, spreading and depositing of spray solution on treated surface with increasing of pesticidal efficiency (81). Polyacryl amide and HMC recorded the highest increase in viscosity while the other compatible materials have slightly increase except Sisi6, DL600 and tartaric acid. The increase of viscosity of spray solution would increase the deposited on the treated plant leaves, then reduce the drift and increase the efficiency of insecticides. (82) Oxalic acid gave the highest decrease in pH value followed by Sulphonic acid; tartaric acid and citric acid while the other compatible materials gave slightly decrease in pH value except HMC, Arabic gum and Sisi6 which increased the pH value. This decrease in PH value of spray solution with increase electrical conductivity meant that acids decrease hydrolysis of the insecticide which is inversely correlated to alkaline media; (83) also; reducing the pH value of spray solution might increase the attraction between sprayed solution and treated plants then increasing the insecticidal efficiency. (84)

**Table (13): Physico-chemical properties of spray solution of Dursban alone and its tank mix with additives**

<b>Treatment</b>	<b>Surface tension Dyne/cm</b>	<b>Viscosity Mps</b>	<b>Conductivity μMHOS</b>	<b>pH</b>
<b>Dursban</b>	36.0	9.6	360	6.25
<b>+Citric acid</b>	45.6	10.0	1900	2.20
<b>+Sulphonic acid</b>	27.9	10.4	4500	1.97
<b>+Oxalic acid</b>	42.8	10.0	9500	1.83
<b>+Tartaric acid</b>	44.1	10.0	19000	2.09
<b>+DL 600</b>	32.6	10.0	360	6.24
<b>+ML 600</b>	35.1	9.6	335	5.74
<b>+Sisi6</b>	27.36	10.0	450	6.35
<b>+Glue</b>	33.4	10.0	490	6.33
<b>+Arabic gum</b>	35.1	10.0	430	6.53
<b>+Polyacryl amide</b>	36.9	42.6	460	6.48
<b>+HMC</b>	29.1	43.5	520	6.51
<b>H<sub>2</sub>O</b>	72	10	320	7

**HMC. Hydroxy methyl cellulose**

**Table (14): Physico-chemical properties of spray solution of Curacron alone and its tank mix with additives**

<b>Treatment</b>	<b>Surface tension Dyne/cm</b>	<b>Viscosity Mps</b>	<b>Conductivity <math>\mu</math>MHOS</b>	<b>pH</b>
<b>Curacron</b>	34.2	10.4	360	6.14
<b>+Citric acid</b>	32.6	10.4	1450	2.21
<b>+Sulphonic acid</b>	24.9	10.4	4000	1.96
<b>+Oxalic acid</b>	33.4	10.4	9000	1.83
<b>+Tartaric acid</b>	33.8	10.4	1400	2.08
<b>+DL 600</b>	31.1	10.4	360	6.24
<b>+ML 600</b>	30.4	10.4	350	5.78
<b>+Sisi6</b>	29.1	10.0	435	6.32
<b>+Glue</b>	30.4	10.9	500	6.32
<b>+Arabic gum</b>	35.1	10.9	420	6.39
<b>+Pol acryl amid</b>	33.4	43.5	450	6.36
<b>+HMC</b>	33.4	43.5	500	6.18
<b>H<sub>2</sub>O</b>	72	10	320	7

**HMC. Hydroxy methyl cellulose**

**Table (15): Physico-chemical properties of spray solution of Axone alone and its tank mix with additives**

<b>Treatment</b>	<b>Surface tension Dyne/cm</b>	<b>Viscosity Mps</b>	<b>Conductivity <math>\mu</math>MHOS</b>	<b>pH</b>
<b>Axone</b>	39.1	9.60	395	6.36
<b>+Citric acid</b>	36.0	10.43	1400	2.24
<b>+Sulphonic acid</b>	25.8	10.0	4400	2.0
<b>+Oxalic acid</b>	36.9	9.60	10000	1.91
<b>+Tartaric acid</b>	36.0	10.43	1500	2.16
<b>+DL 600</b>	39.1	9.60	400	6.41
<b>+ML 600</b>	34.2	10.43	315	5.92
<b>+Sisi6</b>	28.0	10.0	455	6.62
<b>+Glue</b>	35.1	10.0	600	6.36
<b>+Arabic gum</b>	40.1	10.43	460	6.66
<b>+Polyacryl amide</b>	36.9	39.0	470	6.51
<b>+HMC</b>	31.1	44.3	500	6.69
<b>H<sub>2</sub>O</b>	72	10	320	7

**HMC. Hydroxy methyl cellulose**

**Table (16): Physico-chemical properties of spray solution of Superalpha alone and its tank mix with additives**

<b>Treatment</b>	<b>Surface tension Dyne/cm</b>	<b>Viscosity Mps</b>	<b>Conductivity <math>\mu</math>MHOS</b>	<b>pH</b>
<b>Superalpha</b>	40.2	9.6	380	6.47
<b>+Citric acid</b>	36.0	10.0	1400	2.20
<b>+Sulphonic acid</b>	23.6	10.4	4400	1.96
<b>+Oxalic acid</b>	38.0	10.4	10000	1.80
<b>+Tartaric acid</b>	35.1	9.6	1850	2.07
<b>+DL 600</b>	32.6	9.1	375	6.35
<b>+ML 600</b>	31.8	11.3	330	5.77
<b>+Sisi6</b>	25.3	9.6	480	6.53
<b>+Glue</b>	36.9	10.4	500	6.32
<b>+Arabic gum</b>	35.1	10.9	438	6.53
<b>+Polyacryl amide</b>	39.1	43.5	420	6.35
<b>+HMC</b>	36.9	43.5	600	6.75
<b>H2O</b>	72	10	320	7

**HMC. Hydroxy methyl cellulose**

### 3.2. Direct-mix:-

**Data in Table (17)** shows the physico-chemical properties of Dursban spray solution alone and its direct mixed with chemical additives. The results indicated that all tested additive materials decreased the surface tension of Dursban spray solution and slightly decrease in viscosity. On contrast they increased the electrical conductivity and also showed increase in pH value.

**Data in Table (17)** shows the physico-chemical properties of Curacron spray solution alone and its direct mixed with chemical additives. The results indicated that all tested additive materials gave slightly decrease in the surface tension of Curacron spray solution but no change in viscosity. On the other hand they increased the electrical conductivity and pH value.

**Data in Table (17)** shows the physico-chemical properties of Axone spray solution alone and its direct mixed with chemical additives. The results indicated that all tested additive materials decreased the surface tension of Axone spray solution and viscosity. On the other hand they increased the electrical conductivity and also gave increase in pH value.

**Data in Table (17)** shows the physico-chemical properties of Superalpha spray solution alone and it's direct mixed with chemical additives. The results indicated that all tested additive materials decreased the surface tension of Superalpha spray solution but no change in viscosity. On the other hand they increased the electrical conductivity except sulphonic acid. Also they showed increase in pH value.

**Table (17): Physico-chemical properties of direct mixed insecticide-additives of spray solution**

Treatment		Surface tension Dyne/cm	Viscosity Mps	Conductivity $\mu$ MHOs	pH
Insecticide	Additives				
<b>Dursban</b>	<b>Alone</b>	36	9.6	360	6.25
	<b>Kerosene</b>	29.1	9.13	365	6.48
	<b>Xylene</b>	29.1	9.13	370	6.60
	<b>CAPL1</b>	35.1	8.7	370	6.64
	<b>DL600</b>	29.1	9.13	370	6.52
<b>Curacron</b>	<b>Alone</b>	35.1	8.7	365	6.24
	<b>Kerosene</b>	34.2	8.7	380	6.56
	<b>Xylene</b>	32.6	8.7	390	6.55
	<b>CAPL1</b>	33.4	8.7	390	6.63
	<b>ML600</b>	33.4	8.7	380	6.50
<b>Axone</b>	<b>Alone</b>	39.1	9.6	395	6.36
	<b>Kerosene</b>	35.1	8.7	380	6.81
	<b>Xylene</b>	30.4	9.13	365	6.63
	<b>CAPL1</b>	36.0	8.7	365	6.77
	<b>DL600</b>	33.4	8.7	365	6.81
<b>Superalpha</b>	<b>Alone</b>	38.0	8.7	365	6.70
	<b>Kerosene</b>	36.0	8.7	380	6.94
	<b>Xylene</b>	34.2	8.7	375	6.79
	<b>CAPL1</b>	32.6	8.7	375	6.78
	<b>DL600</b>	34.2	8.7	375	6.69
	<b>Sulphonic</b>	26.8	8.7	320	5.69

Generally, it could be concluded that the most tested chemical additives are physically compatible with the insecticides used; they improved the physico-chemical properties of insecticides spray solution which give a prediction of increasing both insecticides deposits and insecticidal efficiency. (82, 84, 85, 86)

#### **4. Efficacy of tested insecticides alone and its mixtures with the locally chemical additives on the Cotton leafworm larvae**

The initial and latent effect of the four insecticides, Dursban, Curacron, Axone and Superalpha at recommended ,  $\frac{3}{4}$  recommended rate and the combinations of  $\frac{3}{4}$  recommended rate with chemical additives as adjuvant against the 4th instar larvae of *S. littoralis*, then mean residual effect and mean general effect were calculated, results are illustrated in the next Tables.

##### **4.1. Toxicity of tested insecticides alone and its direct mix with different chemical additives on cotton leafworm**

###### **4.1.1. Dursban Treatment:**

**Data presented in Table (18)** cleared that; most of the additives improved the insecticidal action of the  $\frac{3}{4}$  recommended rate. Using Dursban at recommended and  $\frac{3}{4}$  of the recommended rate of application gave 100% initial larval mortality, while the addition of adjuvants to Dursban using  $\frac{3}{4}$  of the recommended rate of the application gave the same initial larval mortality. Regarding to the residual effect and general effect, it was noticed that all the adjuvants increased the percentage of larval mortality than that obtained with Dursban at  $\frac{3}{4}$  of the recommended rate except DL600 which gave 33.28%.CAPL1 gave the highest average residual effect when it combined with Dursban but less than recommended rate followed by xylene and kerosene (synergistic effect) but its combinations with DL600 gave antagonistic effect.

Based on the LT50 values, the results proved that the recommended rate of Dursban gave the greatest persistence (LT50 =7.46 days) whereas  $\frac{3}{4}$  recommended rate plus DL600 gave the smallest persistence (LT50 =5.2 days).CAPL1 and xylene increased the LT50 of  $\frac{3}{4}$  recommended rate from 5.39 days to 6.61 days and 6.00 days respectively .

#### **4.1.2. Curacron Treatment:**

**Data presented in Table (19)** cleared that; all the additives improved the insecticidal action of the  $\frac{3}{4}$  recommended rate. Using Curacron in recommended and  $\frac{3}{4}$  of the recommended rate gave 100% initial larval mortality, while the addition of adjuvants to Curacron using  $\frac{3}{4}$  of the recommended rate of the application gave the same initial larval mortality except ML600 which gave 95% of the mortality. Regarding to the mean residual effect and general effect, it was noticed that all the adjuvants decreased the percentage of larval mortality than that obtained with Curacron at  $\frac{3}{4}$  of the recommended rate (antagonistic effect). Kerosene gave the lowest average of residual effect when combined with Curacron followed by xylene, ML600 and CAPL1.

The LT50 values of the recommended rate and  $\frac{3}{4}$  recommended rate of Curacron were 9.17 days and 7.87days respectively. Where the combination of ML600 with  $\frac{3}{4}$  recommended rate increased the LT50 to 9.77 days. These agree with the results given by (Betana et al. 2004).

#### **4.1.3. Axone Treatment:**

**Data presented in Table (20)** cleared that; all the additives improved the insecticidal action of the  $\frac{3}{4}$  recommended rate. Using Axone in recommended and  $\frac{3}{4}$  of the recommended rate gave 45% and 42.5% initial larval mortality respectively, while the addition of adjuvants to Axone using  $\frac{3}{4}$  of the recommended rate of application increased the percentage of mortality to 60%, 57%, 57% and 55% for kerosene, xylene, DL600 and CAPL1 respectively. With respect to the mean of residual effect and general

effect, it was noticed that all the adjuvants increased the percentage of larval mortality than that obtained with Axone at 3/4 of the recommended rate (synergistic effect). CAPL1 gave the highest residual effect when it combined with Axone followed by kerosene, DL600 and xylene similar to recommended rate effect.

According to the LT50 values of recommended rate and 3/4 recommended rate of Axon were 0.024 days and 0.023 days respectively .all the chemical additives increased the LT50 to 0.305 ,0.231 , 0.181 and 0.121 days with respect to Kerosene , CAPL1, Xylene and DL600.

#### **4.1.4. Superalpha Treatment:**

**Data presented in Table (21)** cleared that; all the additives improved the insecticidal action of the 3/4 recommended rate. Using Superalpha in recommended and 3/4 of the recommended rate gave 85% and 72.5% initial larval mortality respectively, while the addition of adjuvants to Superalpha using 3/4 of the recommended rate of the application increased the percentage of mortality to 90%, 82%, 72%, 70% and 67.5% according to DL600, kerosene, CAPL1, xylene and sulphonic acid respectively. According to the mean residual effect and general effect, it was noticed that all the adjuvants increased the percentage of larval mortality than that obtained with Superalpha at 3/4 rate (synergistic effect). Kerosene and xylene gave the highest residual effect when combined with Superalpha similar to recommended rate effect followed by sulphonic acid, CAPL1 and DL600.

The LT50 values of recommended rate and 3/4 recommended rate of Superalpha were 1.224 and 0.313 days respectively .the combinations of kerosene, Dl600, CAPL1, xylene and sulphonic acid with 3/4 recommended rate increase the persistence from 0.313 days to 1.269, 0.508, 0.38 and 0.38 days respectively. These agree with the results given by (Betana et al. 2004). They found that, castor oil and acetic acid caused greater persistence on cotton plants than esfenvalerata alone at half-recommended rate.

**Table (18): Toxicity of Dursban 44.5%EC alone and its direct mixed with physically chemical additives on cotton leafworm**

Treatments	Rate of application	Corrected % Mortality after Treatment (days)						General mean of% Mortalit	LT <sub>50</sub> (days) its limits at 95%	
		IK	Residual effect				Mean of % Residual effect			
			3	6	9	12				
<b>Alone</b>										
<b>Dursban</b>	1F	100.00	100.00	74.36	20.51	15.38	52.56	62.05	7.46 6.73	8.18
<b>Dursban</b>	3/4F	100.00	91.67	51.28	5.13	2.56	37.66	50.12	5.39 4.73	6.02
<b>Mixed</b>										
<b>Dursban+kerosene</b>	3/4F+10%	100.00	91.67	35.89	17.95	7.69	38.30	50.64	5.52 4.80	6.22
<b>+Xylene</b>	3/4F+10%	100.00	97.22	46.15	17.95	10.26	42.90	54.31	6.00 5.35	6.69
<b>+CAPL 1</b>	3/4F+10%	100.00	97.22	69.23	10.25	7.69	46.09	56.87	6.61 5.92	7.26
<b>+DL 600</b>	3/4F+10%	100.00	97.22	25.64	5.13	5.13	33.28	46.62	5.20 3.23	6.89

**F: Field dilution rate****IK: Initial Kill after one hour from application**

**Table (19): Toxicity of Curacron 72%EC alone and its direct mixed with physically chemical additives on cotton leafworm.**

Treatments	Rate of application	Corrected % Mortality after Treatment (days)					Mean of % Residual effect	General mean of% Mortalit	LT <sub>50</sub> (days) its limits at 95%
		IK	Residual effect						
			3	6	9	12			
<b>Alone</b>									
Curacron	1F	100.00	97.43	82.05	44.73	34.21	64.61	71.68	9.17 8.09 10.69
Curacron	3/4F	100.00	97.43	69.23	39.47	28.95	58.77	67.01	7.87 6.60 6.49
<b>Mixed</b>									
Curacron +kerosene	3/4F+10%	100.00	94.87	46.15	44.73	31.57	54.33	63.46	7.55 6.41 9.01
+Xylene	3/4F+10%	100.00	92.31	76.92	36.84	15.79	55.46	46.37	7.61 6.70 8.63
+CAPL 1	3/4F+10%	100.00	92.31	74.35	39.47	28.94	58.76	58.76	8.14 6.97 9.70
+ML 600	3/4F+10%	95.00	84.61	79.48	39.47	26.31	57.46	64.97	9.77 5.73 16.66

**F: Field dilution rate****IK: Initial Kill after one hour from application**

**Table (20): Toxicity of Axone 5%EC alone and its direct mixed with physically chemical additives on cotton leafworm.**

Treatments	Rate of application	Corrected % Mortality after Treatment (days)					Mean of % Residual effect	General mean of% Mortalit	LT <sub>50</sub> (days) its limits at 95%
		IK	Residual effect						
			3	6	9	12			
<b>Alone</b>									
Axone	1F	45.00	45.00	30.00	18.42	0.00	23.35	27.68	0.024 0.002 0.226
Axone	3/4F	42.00	42.50	27.50	2.63	0.00	18.15	23.02	0.023 0.005 0.112
<b>Mixed</b>									
Axone+kerosene	3/4F+10%	60.00	57.50	27.50	18.40	7.50	27.72	34.18	0.305 0.121 0.769
+Xylene	3/4F+10%	57.50	52.50	17.50	5.26	0.00	18.81	26.55	0.181 0.066 0.497
+CAPL 1	3/4F+10%	55.00	50.00	42.50	28.95	7.50	32.24	36.79	0.231 0.062 0.855
+DL 600	3/4F+10%	57.50	37.50	26.32	22.50	0.00	21.58	28.76	0.121 0.001 0.565

**F: Field dilution rate****IK: Initial Kill after one hour from application**

**Table (21): Toxicity of Superalpha 10%EC alone and its direct mixed with physically chemical additives on Cotton leafworm.**

Treatments	Rate of application	Corrected % Mortality after Treatment (days)					Mean of % Residual effect	General mean of% Mortalit	LT <sub>50</sub> (days) its limits at 95%
		IK	Residual effect						
			3	6	9	12			
<b>Alone</b>									
<b>Superalpha</b>	1F	85.00	53.85	52.50	5.13	2.50	28.49	39.79	1.224 0.704 2.199
<b>Superalpha</b>	3/4F	72.50	30.77	22.50	0.00	0.00	13.92	25.15	0.313 0.145 0.675
<b>Mixed</b>									
<b>Superalpha + kerosene</b>	3/4F+10%	82.50	71.80	22.50	15.39	12.50	30.54	40.93	1.269 0.679 2.371
<b>+Xylene</b>	3/4F+10%	67.50	46.15	20.00	17.95	17.50	25.40	33.81	0.38 0.09 0.89
<b>+CAPL 1</b>	3/4F+10%	72.50	51.28	22.50	12.50	10.25	24.13	33.82	0.508 0.261 0.987
<b>+DL 600</b>	3/4F+10%	90.00	53.84	15.38	12.50	12.50	23.55	36.84	1.138 0.643 2.015
<b>+Sulphonic Acid</b>	3/4F+10%	70.00	30.77	27.50	20.51	20.00	24.69	33.75	0.38 0.09 0.88

**F: Field dilution rate****IK: Initial Kill after one hour from application**

## **4.2. Toxicity of tested insecticides alone and its tank mix with different chemical additives on cotton leafworm**

### **4.2.1. Dursban Treatment:**

**Data presented in Table (22)** cleared that; all the additives improved the insecticidal action of the 3/4 recommended rate. Using Dursban in complete and 3/4 of the recommended rate of application gave 100% initial larval mortality, while the addition of adjuvants to Dursban using 3/4 of the recommended rate of the application gave the same initial larval mortality. Regarding to the mean of residual effect and mean of the general effect, it was noticed that all the adjuvants increased the percentage of larval mortality than that obtained with Dursban at 3/4 of the recommended rate except with sulphonic acid and polyacryl amide gave antagonistic effect. DL600 gave the highest average residual effect when it combined with Dursban followed by ML600, oxalic acid, Arabic gum, tartaric acid, HMC and citric acid similar to complete effect.

The LT50 values of recommended rate and 3/4 recommended rate of Dursban were 7.46 and 5.39 days. DL600 gave the highest persistence (LT50 =8.60 days) in combination with 3/4 recommended rate whereas sulphonic acid gave the smallest persistence (LT50 =3.1 days).

### **4.2.2. Curacron Treatment:**

**Data presented in Table (23)** cleared that; all the additives improved the insecticidal action of the 3/4 recommended rate. Using Curacron in complete and 3/4 of the recommended rate of application gave 100% initial larval mortality, while the addition of adjuvants to Curacron using 3/4 of the recommended rate of the application gave the same initial larval mortality except Sulphonic acid, DL600 and glue which gave 97.5% of initial larval mortality. According to the mean of residual effect and mean of the general effect, it was noticed that all the Adjuvants increased the percentage of larval mortality than that obtained with Curacron at 3/4 of the recommended rate (synergistic

effect) except sulphonic acid, ML600, Glue, HMC and polyacryl amide (antagonistic effect). Sisi6 gave the highest average residual effect when it combined with Curacron followed by DL600, tartaric acid, oxalic acid, citric acid and Arabic gum similar to complete rate.

According to LT50 the values of recommended rate and  $\frac{3}{4}$  recommended rate of Curacron were 9.17 and 7.87 days, the combination of Sisi6 gave the highest persistence LT50 =10.09 days on the other hand, HMC gave the smallest persistence (LT50 =5.46 days) .

#### **4.2.3. Axone Treatment:**

**Data presented in Table (24)** cleared that; all the additives improved the insecticidal action of the  $\frac{3}{4}$  recommended rate. Using Axone in complete and  $\frac{3}{4}$  of the recommended rate gave 45% and 42.5% initial larval mortality respectively, while the addition of adjuvants to Axone using  $\frac{3}{4}$  of the recommended rate of the application increased the percentage of mortality except sulphonic acid, oxalic acid, Sisi6, glue, Arabic gum and Polyacryl amide. According to the mean of residual effect and mean of the general effect, it was noticed that, oxalic acid gave the highest residual effect when it combined with Axone followed by citric acid and DL600 similar to complete rate while combination with other additives gave antagonistic effect.

The LT50 values of recommended rate and  $\frac{3}{4}$  recommended rate were 0.024 and 0.023 days. HMC gave the greatest persistence (LT50 =0.098 days) in combination with  $\frac{3}{4}$  recommended rate whereas Arabic gum gave the smallest persistence (LT50 =1.6E-4 days).

#### **4.2.4. Superalpha Treatment:**

**Data presented in Table (25)** cleared that; all the additives improved the insecticidal action of the  $\frac{3}{4}$  recommended rate. Using Superalpha in complete and  $\frac{3}{4}$

of the recommended rate gave 85% and 72.5% initial larval mortality respectively, while the addition of adjuvants to Superalpha using 3/4 of the recommended rate of the application increased the percentage of mortality to 82.5%, 80%, 77.5%, and 3/4 for glue, HMC, DL600 and Arabic gum respectively. According to the mean of residual effect and mean of the general effect, it was noticed that all the adjuvants increased the percentage of larval mortality than that obtained with Superalpha at 3/4 of the rate except in case of its combination with ML600. Polyacryl amide and oxalic acid gave the highest residual effect when it combined with Superalpha similar to complete rate effect followed by citric acid, tartaric acid, Sisi6, HMC, Arabic gum, glue, sulphonic acid and DL600.

According to the LT50 values the recommended rate of Superalpha gave the greatest persistence (LT50 =1.224 days) while the 3/4 recommended rate with sulphonic acid gave the smallest persistence (LT50 =0.0513 days) Polyacryl amide gave the greatest persistence (LT50 =1.003 days) with 3/4 recommended rate (LT50 =0.313 days).

**Table (22): Toxicity of Dursban 44.5%EC alone and its tank mixed with chemical additives against 4<sup>th</sup> instars larvae of cotton leafworm.**

Treatments	Rate of application	Corrected % Mortality after Treatment (days)						General mean of % Mortality	LT <sub>50</sub> (days) its limits at 95%
		IK	Residual effect				Mean of % Residual effect		
			3	6	9	12			
<b>Alone</b>									
Dursban	1F	100.00	100.00	74.36	20.51	15.38	52.56	62.05	7.46 6.73 8.18
Dursban	3/4F	100.00	91.67	51.28	5.13	2.56	37.66	50.12	5.39 4.73 6.02
<b>Mixed</b>									
Dursban+ Citric acid	3/4F+0.5%	100.00	72.22	48.72	17.95	15.38	38.56	50.85	5.07 4.02 6.06
+Sulphonic acid	3/4F+0.5%	100.00	44.44	41.02	25.64	17.95	32.26	45.81	3.10 1.67 4.39
+Oxalic acid	3/4F+0.5%	100.00	100.00	56.41	51.28	17.95	56.41	65.13	7.84 6.94 8.86
+Tartaric acid	3/4F+0.5%	100.00	100.00	74.36	35.89	7.69	54.48	63.59	7.68 6.97 8.38
+DL 600	3/4F+0.5%	100.00	100.00	74.36	46.15	25.64	61.54	69.23	8.60 7.70 9.70
+ML 600	3/4F+0.5%	100.00	100.00	69.23	38.46	30.77	59.61	67.96	8.35 7.40 9.50
+Sisi 6	3/4F+0.5%	100.00	100.00	79.48	30.77	5.13	53.84	63.07	7.67 7.02 8.29
+Glue	3/4F+0.5%	100.00	100.00	79.48	7.69	0.00	46.79	57.43	6.95 6.51 7.42
+Arabic gum	3/4F+0.5%	100.00	100.00	71.79	28.20	20.51	55.13	64.10	7.73 6.93 8.56
+Poly acryl amid	3/4F+0.1%	100.00	100.00	28.20	5.13	5.13	34.62	47.69	5.44 4.89 6.04
+HMC	3/4F+0.25%	100.00	100.00	74.36	17.95	15.38	51.92	61.54	7.40 6.66 8.10

F: Field dilution rate

IK: Initial Kill after one hour from application

**Table (23): Toxicity of Curacron 72.5%EC alone and its tank mixed with chemical additives against 4<sup>th</sup> instars larvae of cotton leafworm.**

Treatments	Rate of application	Corrected % Mortality after Treatment (days)					Mean of % Residual effect	General mean of % Mortality	LT <sub>50</sub> (days) its limits at 95%
		IK	Residual effect						
			3	6	9	12			
<b>Alone</b>									
Curacron	1F	100.00	97.43	82.05	44.73	34.21	64.61	71.68	9.17 8.09 10.69
Curacron	3/4F	100.00	97.43	69.23	39.47	28.95	58.77	67.01	7.87 6.60 6.49
<b>Mixed</b>									
Curacron +Citric acid	3/4F+0.5%	100.00	100.00	94.87	34.21	18.42	61.87	69.50	8.73 8.06 9.43
+Sulphonic acid	3/4F+0.5%	97.50	84.62	71.80	7.90	5.26	42.40	53.42	5.88 5.07 6.82
+Oxalic acid	3/4F+0.5%	100.00	97.44	89.74	39.47	28.95	63.89	71.12	8.95 8.01 10.12
+Tartaric acid	3/4F+0.5%	100.00	94.87	84.61	47.36	39.47	66.58	73.26	9.75 8.43 11.94
+DL 600	3/4F+0.5%	97.50	97.44	94.87	57.90	21.05	67.82	73.75	9.46 8.57 10.44
+ML 600	3/4F+0.5%	100.00	87.17	87.17	26.31	23.68	56.08	64.86	7.71 6.57 9.05
+Sisi 6	3/4F+0.5%	100.00	100.00	97.43	78.94	15.79	73.04	78.43	10.09 9.46 10.78
+Glue	3/4F+0.5%	97.50	97.43	87.17	5.26	2.63	28.90	42.61	4.78 4.32 5.29
+Arabic gum	3/4F+0.5%	100.00	100.00	89.74	44.73	7.90	60.59	68.47	8.51 7.87 9.15
+Poly acryl amid	3/4F+0.1%	100.00	84.61	79.49	39.47	2.63	51.55	61.23	6.94 6.03 7.99
+HMC	3/4F+0.25%	100.00	92.30	30.76	15.78	13.15	37.99	50.39	5.46 4.70 6.19

F: Field dilution rate

IK: Initial Kill after one hour from application

**Table (24): Toxicity of Axone 5%EC alone and its tank mixed with chemical additives against 4<sup>th</sup> instars larvae of cotton leafworm.**

Treatments	Rate of application	Corrected % Mortality after Treatment (days)					Mean of % Residual effect	General mean of% Mortality	LT <sub>50</sub> (days) its limits at 95%
		IK	Residual effect						
			3	6	9	12			
<b>Alone</b>									
Axone	1F	45.00	45.00	30.00	18.42	0.00	23.35	27.68	0.024 0.002 0.226
Axone	3/4F	42.00	42.50	27.50	2.63	0.00	18.15	23.02	0.023 0.005 0.112
<b>Mixed</b>									
Axone +Citric acid	3/4F+0.5%	50.00	42.50	35.00	5.26	0.00	20.69	26.55	0.067 0.018 0.331
+Sulphonic acid	3/4F+0.5%	37.50	37.50	17.50	15.78	0.00	17.69	21.65	0.003 0.001 0.016
+Oxalic acid	3/4F+0.5%	42.50	42.50	42.50	15.78	0.00	25.19	28.65	0.001 3.2E-5 0.012
+Tartaric acid	3/4F+0.5%	50.00	32.50	27.50	5.26	0.00	16.31	23.05	0.059 0.018 0.199
+DL 600	3/4F+0.5%	45.00	45.00	30.00	5.26	0.00	20.06	25.05	0.035 0.007 0.185
+ML 600	3/4F+0.5%	55.000	10.00	7.50	5.26	0.00	5.69	15.55	0.061 0.014 0.154
+Sisi 6	3/4F+0.5%	37.50	35.00	10.00	2.63	0.00	11.91	16.93	0.012 0.002 0.068
+Glue	3/4F+0.5%	40.00	22.50	17.50	13.15	0.00	13.16	18.53	0.008 2.3E-6 0.083
+Arabic gum	3/4F+0.5%	27.50	17.50	17.50	7.89	2.50	11.34	14.57	1.6E-4 8.2E-6 3.1E-3
+Poly acryl amid	3/4F+0.1%	37.50	35.00	17.50	7.50	5.26	16.31	20.55	0.008 0.002 0.038
+HMC	3/4F+0.25%	60.00	17.50	7.89	7.50	0.00	8.22	18.57	0.098 0.024 0.236

F: Field dilution rate

IK: Initial Kill after one hour from application

**Table (25) Toxicity of Superalpha 10%EC alone and its tank mixed with chemical additives against 4<sup>th</sup> instars larvae of cotton leafworm.**

Treatments	Rate of application	Corrected % Mortality after Treatment (days)						General mean of % Mortalit	LT <sub>50</sub> (days) its limits at 95%
		IK	Residual effect				Mean of % Residual effect		
			3	6	9	12			
<b>Alone</b>									
Superalpha	1F	85.00	53.85	52.50	5.13	2.50	28.49	39.79	1.224 0.704 2.199
Superalpha	3/4F	72.50	30.77	22.50	0.00	0.00	13.92	25.15	0.313 0.145 0.675
<b>Mixed</b>									
Superalpha+Citric acid	3/4F+0.5%	67.50	41.02	32.50	5.12	0.00	19.66	29.23	0.359 0.150 0.862
+Sulphonic acid	3/4F+0.5%	47.50	33.33	20.00	7.69	2.50	15.88	22.26	0.0513 0.016 0.163
+Oxalic acid	3/4F+0.5%	57.50	51.28	30.00	7.50	5.12	23.47	30.28	0.2 0.084 0.475
+Tartaric acid	3/4F+0.5%	55.00	41.02	30.00	5.12	0.00	19.03	26.22	0.128 0.040 0.410
+DL 600	3/4F+0.5%	77.50	35.89	22.50	5.12	0.00	15.87	28.20	0.467 0.189 0.910
+ML 600	3/4F+0.5%	65.00	10.25	7.69	2.50	0.00	5.11	17.09	0.111 0.039 0.231
+Sisi 6	3/4F+0.5%	50.00	48.71	17.50	7.69	0.00	18.47	24.78	0.079 0.019 0.334
+Glue	3/4F+0.5%	82.50	30.76	27.50	7.50	7.50	17.72	30.67	0.554 0.253 0.986
+Arabic gum	3/4F+0.5%	75.00	35.89	30.00	5.12	2.50	18.37	29.70	0.414 0.201 0.852
+Poly acryl amid	3/4F+0.1%	70.00	58.97	52.50	2.56	0.00	28.51	36.81	1.003 0.354 2.838
+HMC	3/4F+0.25%	80.00	38.46	30.00	5.12	0.00	18.39	30.71	0.633 0.301 1.330

F: Field dilution rate

IK: Initial Kill after one hour from application.

## 5. Persistence of Dursban and Axone on cotton leaves.

The insecticides Dursban and Axone were sprayed alone with recommended rate, 3/4 of the recommended rate and 3/4 of the recommended rate with additives on cotton leaves under normal field condition at the recommended rate of 1L/fed and 375ml /fed respectively. DL600 added to Dursban in case of tank-mix while CAPL1 added to Axone in case of direct-mix technique. The samples were taken at different intervals, 1 hour after application and 6 days post treatment. The samples were analyzed for determination of insecticides residues. The results in Table (26) show the residues of Dursban in recommended rate, 3/4 of recommended rate and its combination with DL600 on cotton leaves were 96.04, 51.43 and 65.49 ppm according to Fig (1, 2 and 3) respectively after one hour from application. On the other hand, the listed data show the residue in Axone samples are 24.95, 7.18 and 7.63 ppm according to Fig (7, 8, and 9) for recommended rate, 3/4 of recommended rate and its combination with CAPL1. After 6 day of insecticides application, the amount of residue reduced to 9.65, 4.14 and 5.63 ppm for Dursban according to Fig ( 4 , 5 and 6) and 6.19, 3.44 and 5.23 ppm according to Fig ( 10 ,11 and 12) for Axone. It is evident that, there is an improvement in the amount of residue as a resulting from the combination of 3/4 recommended rate of both Dursban with DL600 and Axone with CAPL1.

**Table (26): Dursban and Axone residues in cotton leaves**

Treatment	Rate of Application	Residues (ppm) after Application	
		Initial	6 Days
Dursban	1F	96.04	9.65
	3/4F	51.43	4.14
	3/4F + DL600	65.49	5.36
Axone	1F	24.95	6.19
	3/4F	7.18	3.44
	3/4F + CAPL1	7.63	5.23

**F: Field dilution rate****Initial: Samples taken immediately after insecticide application**

**Data in Table (26)** showed the residue of Dursban and Axone pesticides on cotton plant for the complete rate, 3/4 recommended rate, 3/4 recommended rate plus polyethylene glycol 600 dilurate (DL600) and CAPL1 after one hour and 6 days from application. It's cleared that, the addition of DL600 to Dursban increase the residue of 3/4 recommended rate than 3/4 recommended rate alone after one hour and 6 days from application. This increase is due to the increase of wettability and spreading on the surface of treated plant, therefore lengthened the activity of pesticide. (81) On the other hand CAPL1 showed significant increase in the amount of residue for Axone after 6 days, this increase is due to the increase of retention of pesticide on the surface of treated plant then increase its residual effect. (82)

Field experimental was carried out to study the effect of chemical additives on the efficiency of some insecticidal spray solution used for control cotton leafworm.

In general, we can conclude that the addition of these chemical additives to the candidate insecticide changes the physico-chemical properties of insecticidal spray solution. These changes gave prediction of increasing field performance and insecticidal efficiency then reducing the field application rate to 3/4 of recommended rate in some cases while gave antagonistic effect in other cases which may be due to chemical reaction between chemical additives and insecticides. Increasing the effect is due to one or more of the following things.

The reduction of surface tension of the insecticidal spray solution would increase its wettability and spreading on treated surface, then increase insecticidal activity. (85)

The increase of electrical conductivity of insecticidal spray solution would lead to deionization of insecticides and increase its deposit and penetration in treated plant surface, then increase the insecticidal efficiency. (86)

On the other hand, the decrease in pH value of insecticide spray solution indicates an increase in positive charge of spray solution leading to increasing in attraction between spray solution and treated plant leaves surface, which have negative charges, then increase the insecticidal efficiency. (84)

The increase of viscosity of spray solution would increase the deposited on the treated plant leaves, then reduce the drift and increase the efficiency of insecticides. (95)

It can be concluded that the uses of these chemical additives in combination with insecticide spray solutions for the control of cotton leafworm is an important and useful approach. These additives lengthened the residual activity of the insecticides and reduced their rates of application to about 25% thus reducing the hazards and costs. (87)