Introduction

Pest control represents a critical factor and highly productive inputs for increasing crop yields and preventing crop losses before and after harvest. Till now chemical control has a main role in pest control programmers in both developed and developing countries. The great majority of pesticides employed in Egypt are used to protect cotton which is still the cash crop for exportation. The often and indiscriminate use of pesticides has led to several adverse consequence and the environmental quality has been deteriorated to a great extent.

The use of certain additives in pesticide formulations would improve their field performance and increase the bioactivity with consequent decrease in their rates of application, then reducing plant protection costs, there by, approaching close to the principle of integrated pest Management (IPM) by reducing the hazards to the environment. (1)

Adjuvants are substances without pesticidal properties but it increase the effectiveness of a pesticide when add to pesticide and can be used with pesticide only in accordance with approval of that pesticide as varied by lists of authorized Adjuvants published by ministers. (2)

Adjuvants change the physico-chemical properties of spray solution to be more effective, stable and protect it from degradation factors. Adjuvants are mixed with pesticides for many purposes such as reducing drift and increasing deposit in addition to increase the

adherence and improve wetting and spreading on the treated surface. (1)

Adjuvants are commonly used in agriculture to improve the performance of pesticides. Broadly defined, "an adjuvant is an ingredient that aids or modifies the action of the principal active ingredient." The use of adjuvants with agricultural chemicals generally falls into two categories:-

(1) Formulation adjuvants are present in the container when purchased by the dealer or grower.

(2) Spray adjuvants are added along with the formulated product to a carrier such as water. The liquid that is sprayed over the top of a crop, weeds, or insect pest often will contain both formulation and spray adjuvants.

One of the most widely used types of additives is the group of surfactants. They, like most additives, are chemically complicated materials which can improve spreading and wetting properties of liquids on foliage or pests. They are able to decrease the surface tension between the spray liquid and the sprayed surfaces. Surfactants cause spreading of water droplets in a relatively flat film over leaf surfaces rather than staying as oval droplets. They help to keep spray droplets from running-off from the leaf surface.

The study in this investigation consists of three principal categories:-

(1) Studying the physico-chemical properties of insecticide solutions and their combinations with different tested materials.

(2) Field evaluation of insecticidal efficiency of candidate insecticides and their combinations with chemical additives.

(3) Persistence of some insecticides on cotton leaves.

The aim of the present work is to investigate the effect of some local raw and product materials used as additives on the physico-chemical properties of some insecticides spray solution. The present work will extend to study the effect of additives in increasing the residual activity and reduce the dosage rate of pesticide to at least the lower limit of recommended concentration against the cotton leafworm ***Spodoptera littoralis,*** therefore minimize the hazards and cost of insecticides.

1. Effect of surfactants on physico-chemical properties of spray solution and pesticidal efficiency of pesticides.

The primary purpose of a surfactant or "surface active agent" is to reduce the surface tension of the spray solution to allow more intimate contact between the spray droplet and the plant surface. Any substance that brings a pesticide into closer contact with the leaf surface has the potential to aid energy in terms of force measured in dynes/cm. Water has a surface tension of 73 dynes/cm. Surfactants lower the surface tension of water to that of an oil or solvent, which spreads more readily than water on plant surface. Surfactants typically lower the surface tension of a solution to between 30 and 50 dynes/cm.

The influence of organic silicon surfactant Silwet 408, non-ionic surfactant OP10 and JFC on the efficiency of insecticide:

imidacloprid WP 2500 was studied against wheat aphids. In a field trials, adding 0.05% and 0.1% Silwet 408 into 10% insecticide, the surface tension and contact angle was decreased, therefore the efficacy of control against wheat aphids was increased. (3)

Greenhouse experiments were conducted to determine the effect of glyphosate on efficacy of bentazon for glyphosate-resistant (GR) rape (***Brassica napus***) control and of quizalofop for GR maize control. Efficacy of glyphosate plus bentazone enhanced by ammonium nitrate (AMN), ammonium sulfate (AMS), non- ionic surfactant (NIS) or silicon surfactant (Sis) but was slightly decreased by methylated seed oil, or petroleum oil concentrate for wheat control. Phytotoxicity of glyphosate plus quizalofop was enhanced by (NIS) to GR maize and velvetleaf, but it was less by Sis or (MSO) to GR maize and Sis or (AMS) to velvetleaf. (4)

Field experiments were conducted in Buenos Aires, Argentina to determine the efficacy of glyphosate with different concentration of surfactant for control of *Euphorbia dentate*. The addition of surfactants to the aspersion solution improved the overall efficacy of glyphosate with a high influence. (5)

The uptake of three pesticides in the presence of surfactants into the leaves of three plants: bentazone into *chenopodium album* and sinapis Alba, epoxiconazole and pyraclostrbin into *Triticum aestivum*. The Results have confirmed that, the initial dose of xenobiotic applied is strong, although the surfactant was found to have an effect. The lower surfactant concenteration showed a relationship between the amount of xenobiotic applied and uptake.

High molecular mass surfactants produced lower uptake than expected from dose uptake equations in specific situation. [6]

An alkoxylate-based surfactant was increased the activity of herbicide when applied through air induction nozzles and was incorporated into several adjuvant formulation. When the surfactant incorporated into the adjuvant formulations increased its efficacy in approximately 25%, 40%, and 90% with glyphsate, clethodim and foramsulfuron respectively using air induction nozzles. [7]

Akzo Noble surface chemistry has synthesized complex alkoxylates of selected fatly amines for application with relatively hydrophobic pesticides and directed their evaluation as adjuvants for application enhancement of many pesticides in trials conducted around the world. Efficacy enhancing tank-max adjuvants for triazole fungicides and efficacy enhancers for strobilurin fungicides. [8]

Synthesized ethoxylated methyl and ethyl esters of fatty acids were used as adjuvants for herbicides. Greenhouse experiments indicated that, some ethoxylated alkyl esters of fatty acids at 0.25% (v/v) increased the activity of nicosulf uron, sulfosulfuron, flucarbazone-sodium and imazethapyr than the refrence methyl ester of fottyacids at 1% (v/v) and 0.25(v/v) for nonionic surfactant. [9]

Four surfactants, tween 20, Agral 90, Silwet L-77 and Break thru, were used as adjuvants for insecticides to evaluate their spray performance and dynamic surface tension. Results indicated that, the dynamic surface tension decreased with increasing surfactants concentration. While the volume fraction of the drift sensitive

droplets decreased when Silwet L-77 was used in both low and high concentration, regard less of the nozzles used. [10]

The effects of three types of adjuvant (mineral oil, higher aliphatic acid and non-ionic surfactant) on the penetration of beta cypermethrin through the Cabbage leaf surface were studied. The results showed that the penetration was positively correlated with both the concentration of adjuvant and the time after application in a given range of treatment. [11]

Tea Saponin is characterized as a natural surface active agent suitable for agricultural and industrial application, and can be used as follows:

(1)- In the formulation of wettable powder pesticides.

(2)- As asynergist or spreader in emulsion pesticides.

(3)- In soluble powder or liquid herbicides. [12]

Under greenhouse, the effect of surfactants on the efficacy of clodinafop-propagyl and/or tribenuron-methyl on wild oat and wild mustard were investigated, and it was noted that, the foliar activity of the tested herbicide rose with increasing the citofrigate surfactant concentrations and the synergistic effect in controlling wild mustard was greater than for wild oat. [13]

The phtostability of a herbicide, mesotrione on wax films is refer to the effect of a spreading adjuvant. Half-life of pure mesotrion on cuticular wax films was between 100 and 160 min. The phototransformation rate was multiplied by a factor 4.8. The

acceleration is due to the surfactants that allow a better spreading of the active ingredient on the leaf surface. (14)

Field studies were carried out to evaluate the efficacy of tribenuron-methyl 75% XP against broad leaf weeds of wheat. Results showed that, the addition of a non-ionic surfactant (0.2%) increased the efficacy of tribenuron compared to no surfactant. (15)

The efficiency of foliar spray application is influenced by the evaporation and residual of pesticide droplets on targets. Adding surfactant into spray mixtures increased droplet coverage area and decrease droplet evaporation time. For a 343 µ m droplet on a crab apple leaf, the evaporation time decreased from 70 to 50 second and the coverage area increased from 0.366 to 0.890 mm after adding the surfactant to insecticide. Whereas, the addition of retardant drift into the spray mixture slightly increase the evaporation time and decreased coverage area. In addition, changing the target surface from the hydrophilic slide to the hydrophobic slide greatly increased the droplet coverage area and decrease the droplet evaporation time. (16)

The effect of surfactant PEG 600 DL on the physical and biological efficacy of two pesticides, i.e. profenofos 72 % EC and fenpropathrin 20 % EC against the 4th instar larvae of ***S. littoralis*** was studied. The obtained data indicated that the surfactant was physically compatible with profenofos and fenopropathrin, and gave a slight change in the physical properties of pesticide spray solution; the effect of each pesticide on the 4th instar larvae of ***S. littoralis*** at

the half application ratio plus surfactant seemed to have similar effect as the complete rate without additives. (17)

The influence of wetting and spreading agent such as PEG 600 Di-laurate and Sisi-6 on physico-chemical properties of Merlene (EC), Sumialpha (5%EC) and Dursbane (48%EC) against 2th and 4th instar larvae of ***S. littoralis*** was studied. The obtained results indicated that all the additives were physically compatible with tested insecticides, where deposit increased as results of mixing with the adjuvants. (18)

The international organization (FAO and WHO) outlined the tests and specification that each pesticide must be pass in laboratory before field application. In this study tests were conducted to improve the physico-chemical properties of the IGR atabron 5% EC that was imported but failed in laboratory. Results obtained indicated that emulsifier (Tween 80) or its mixture with the polar solvent DMF highly improved the physico-chemical characteristic and insecticidal activity of the insecticide. (22)

The effect of ionic and nonionic surfactant PEG 600 ML and PEG 400 ML on the physico-chemical properties and pesticidal efficiency of pesticides: Dursban, Selecron and Lannate were studied. Obtained Results indicated that surfactants improved the physical properties of the spray solution by decreasing the surface tension and result in increasing the toxicity of insecticides against ***S. littoralis*.** (23)

The effect of surfactant PEG 600 DL on the physico-chemical properties of insecticides: dursban 48%, sumi-gold 20% and larvin 80% wp against ***S. littoralis*** was studied at 0.3 %. The obtained data

indicated that surfactant decreased the surface tension of all insecticides, then increase insecticidal efficiency. [21]

The influence of PEG 600 DL on the physico-chemical properties of insecticides: curacron 72 % EC and sumi-alpha 5 % were studied. Results obtained showed that additive decreased the value of both surface tension and pH of insecticides spray solution. [22]

The most physical compatible additives such as emulsifier/3 increased the toxicity and insecticidal activity of candidate insecticide spray solutions (deenate , carbaryl , thiodicarb and cyanophos) this synergistic effect could be attributed to the increase in toxicity and deposits of tested insecticides on the treated plant leaves as a result of the action of additives to improve their physico-chemical properties , such as increase of both viscosity and electric conductivity and decrease of both the pH value and surface tension .[23]

The effect of Triton CS-7 (0.25%) on chlorpyrifos for suppression of cotton aphid ***Aphis gossypii*** and penetrator (0.25%) adjuvants four parameters were studied. Spray deposit efficacy, spray droplet coverage, and spray droplet penetration and rate of disappearance of chlorpyrifos residues from cotton leaf surface. They reported that, insecticide-adjuvant combinations had positively affect deposit densities or persistence and might be a mechanism to reduce pesticide loads in agricultural ecosystems by reducing application rates as well application frequency. [24]

Studying the effect of mono-disperse ethoxylated alcohol on the mobility of 2,4-dichlorophenoxy acetic acid (2.4-D) in cuticular

membranes from bitter orange, pear, green pepper and tomatoes indicated that, the surfactant increase the mobility by time and was inversely proportional to the (2,4-D) in cuticles prior to surfactant treatment. As the molecular weight of surfactants increased their effects decreased and the time-dependence of effect becomes more pronounced. Susceptibility of cuticle to surfactant treatment varied among plant species. [25]

The influence of fatty acid esters on the foliar penetration of herbicides was studied.these compounds harbor a hydrophilic polyol and a lipophilic fatty acid chain in their structure, and belong to the family of non-ionic surfactants. the monoglycerides and the tetraethylene glycol esters showed a strong enhancing effect on the foliar penetration of herbicides.[26]

The effect of Tensiofix Do3 (non-ionic surfactant) 0.2% w/v, Break-thru S-240 (organo-silicones surfactant (trisiloxane) 0.15% w/v and Silwet L-77 (organosilicon surfactant (heptamethyltrisiloxane) 0.10% w/v on two formulations of phenmedipham (EC and SC) applied with three types of hydraulic nozzles (hollow cone, flat fan and air induction) was evaluated. Each tank mix adjuvant affected the volume median diameter (VMD) with Silwet giving a coarser spray, while Tensiofix and Break thru reduced the VMD. [27]

Trisiloxane surfactants are widely used in pesticide applications as adjuvants to promote spray drop spreading on leaves. The spreading behaviors of Silwet L-77 on dry and wet lotus leaves

were studied. It was found that the drop spreading on the wet surface was obviously easier than on the dry surface. [28]

The effect of commercially available surfactants tank-mix adjuvants on the retention and coverage of aqueous sprays on foliage were examined under track sprayer conditions, following application at their maximum recommended rates. Results obtained show that addition of the water-soluble tallow amine and nonylphenol surfactants gave the largest increase in retention, whereas there was little improvement in efficiency compared with water alone. [29]

The effect of different rates of bentazone alone or tank-mixed with ammonium sulfate, non-ionic (0.25% induce) or organosilicone (0.1% kinetic) adjuvants against cocklebur (*Xanthium strumarium*), black nightshade (*Solanium nigrum*), velvetleaf (*Abutilon theophrasti*), and stranglervine (*Morrenia odorata*) under greenhouse condition were studied. The results suggested that. Mixing adjuvant with bentazon generally enhanced common cocklebur and black nightshade control, while application of adjuvant to bentazone for controlling stranglervine did not cause any significant difference.among weeds, black nightshade weed is a difficult weed to control with bentazone. [30]

The effects of the agricultural adjuvant Sylgard 309 and the insecticide pymetrozine on demographic parameters of the aphid parasitoid, *Diaeretiella rapae* were studied. The results showed that pymetrozine was not toxic to *D. rapae* at the concentration evaluated at (0.212 g ai/ha). Howevwr, Sylgard 309 alone was toxic and reduced rm by 18% compared to the control. The combination of

Sylgard 309 and pymetrozine acted synergistically, reducing *D. rapae* rm 39% compared to the control. When the mummy stage of *D. rapae* was exposed to a mixture of Sylgard 309 and pymetrozine, rm was reduced to 13% .thus; the mummy stage was less susceptible than the adult stage. (31)

The influence of Trend 90 is an isodecyl alcohol ethoxylate, Actirob is an esterified oil, Zipper is an organo modified trisiloxane and Softanol 70 is a mono-branched alcohol ethoxylate adjuvants on foliar fungicide residues was studied. For the tested adjuvants it can be concluded that their use in the tank mix shows a tendency towards a higher residue on both Tritical and Lettuce crops.(32)

In Poland spray adjuvants were introduced into plant protection programmes in 1967. Farmers frequently use adjuvants with atrazine, bentazone, glyphosate, phenmedipham and graminicides. (33)

2. Influence of sticking and thickening agents in controlling the spray drift

Stickers are those substances which are used to increase the retention or tenacity of spray deposit or to improve the adherence of the toxic chemical to the treated surface.

Sticker Adjuvants enhance adhesion of pesticide sprays to plant surfaces and increase their resistance to rain. The effect of two different sticker adjuvant types, organosilicone / latex and terpene based polymer on retention and rainfastness of aprotectant fungicide

was studied. It is noted that, the former sticker provided better spray retention than the later polymers. (34)

Addition of thickener and wetting agent in the dilution of triazophos, influence the deposition of triazophos on rice leaves. Results showed that, the combination of the wetting agent and thickener could increase the deposition significantly and resist the erosion of rain. The best combination was 0.025% of adjuvant 6501 and 0.02% of adjuvant PAAS in dilution of triazophos.(35)

Carboxy methyl cellulose is one of the most important compositions for the chemical composition of Sugarcane bagasse. It has several application one of them, it uses as a thickener in pesticide application. (36)

The effect of sticker adjuvant to improve the efficacy of permethrin and esfenvalerate against *Helicoverpa Zea* was studied. For permethrin, sticker was improved rainfastness and residual efficacy and did not alter the degredation. Therefore, the mortality increases after treatment.But in case of esfenvalerate, sticker increased the initial deposite of esfenvalerate resulted in total elimination of the pest. (37)

Field tests had shown the effect of adding a water thickener, Methocel J 75, on the performance of nematodes. The addition of 0.5% Methocel to nematodes, the mortality of *Eldana saccharina* insect pest of sugarcane was increased to a mean of 33%. While the addition to higher concentration of nematodes increased the mortality from 39% to 75 %.(38)

The evaporation time and maximum coverage area of pesticide droplets on hairy and waxy leaves were changed by adding adjuvants such as an alkyl polyoxyethylene surfactant, polymer drift retardant. Throughout the evaporation process the coverage area of pesticide droplet decrease on the waxy granium leaf surface, and completed on hairy leaf surface. [39]

An expermint was conducted in Colombia, on the late blight disease of celery which caused by fungus (*septoria apiicola*). Preventing fungicides were Copper oxychloride and chlrothalonil combined with three adjuvants namely Mixel (Wetting agent), Figo (Sticker) and Carrier (Carrier). Results showed that, the best adjuvant for the fungicides was Figo and the best treatment was the combination of Copper oxychloride with Figo. [40]

The effects of Beauveria bassiana mixed with compatible sticker/spreader were Tween 80 and Hamam on adults of *Dicladispa armigera*, and a pest of summer rice in Assam were determined. Percentages mortality were 96.3 and 93.26% resp, as compared with 10% in the control. [41]

A protocol has been established for examing the effects of adjuvants as wetting agent, spreaders, stickers, emulsifier, dispersing agents, drift control, foam control and penetrants. When used with pesticide, they can aid in determining drop size and size range, target plant contact and coverage, and losses of the pesticide to air transport and drift. [42]

The effect of stickers on the persistence of endosulfan on rice area of high rainfall was studied in Meghalaya. The addition of

Triton-AE sticker to endosulfan was increased the persistence by 7.8-20.8 days. (43)

The effect of natural glue (as thickening and sticking agent) on physical properties of pesticide spray solution and its pesticidal efficiency against the 4th instar larvae of *S.littoralis* was studied. Results showed that glue could be increased the pesticidal efficiency for pesticides at lower rates. (17)

The influence of Glue on physico-chemical properties of Merlene (EC), Sumialpha (5% EC) and Dursban (48% EC) against 2nd and 4th instar larvae of ***S. littoralis*** was studied. Results indicated that the additive was physically compatible with tested insecticides where as viscosity and deposit increased as a result of mixing with glue, such change in insecticides properties led to increase their retention and insecticidal efficiency. (18)

The addition of 0.3 % Glue, Arabic gum (thickening and sticking agent) and sodium Lignosulfonate (spreading agent) on the physico-chemical properties of insecticides: dursban 48%, sumi-gold 20% and larvin 80% wp against ***S. littoralis*** were studied. Results obtained indicated that glue gave decrease in surface tension with all insecticides; Lignosulfonate gave decrease with dursban and sumi-gold. But Arabic gum had no effect. (21)

The addition of 0.3 % Glue, Arabic gum (thickening and sticking agent) and sodium lignosulfonate (spreading agent) on the physico-chemical properties of insecticides: curacron 72 % EC and sumi-alpha 5 % were studied. Results obtained indicated that additives decreased the value of both surface tension and pH but

increased the conductivity of spray solution, therefore increase the insecticidal efficeincy. [22]

The presence of glue in insecticide spray solution decrease the pH value, increase the viscosity and decrease the surface tension spray solution, also the glue increases the retention and adherence of insecticide and made them resist the wash off caused by spray irrigation. Also they found that, addition of glue to insecticide solution increase residual bioactivity of insecticides used under spray irrigation. [2]

Akesson *et al*. (1994) reported that Polysaccharides of naturally occurring gums, agars, and algin could serve as thickening or viscous adjuvants in water-based spray mixtures. Hazen (1996) found that the polysaccharide guar gum to have the ability to increase the viscosity of water-based spray mixtures and effectively reduce the percentage of the spray volume in droplets below 150 mm. however, it has been cautioned on the glyphosate registration that DCAs with certain glyphosate formulation may result in reduced efficacy (Anonymous 2005).[44]

Adjuvants used to control drift include viscosity-modifying polymer that combine with spray mixtures and increase spray droplet size, which reduce the movement of the spray mixture from the target plants. Among these drift control agents (DCA) are polysaccharides, with two of the most commonly used being guar and xanthan gums. [45]

The tenacity of bendiocarb 50% WP applied with and without adjuvants at a volume of 125 i/ha to the foliage of brassica plants

(*Brassica oleracea Germinifera*) was evaluated before and after simulated rain by biological assay with *Plutella xylostella* larvae. Results obtained indicate that the combination of Bond Super Sticker and Codacide oil adjuvants individually caused a significant level of improvement in the rainfastness of bendiocarb. (46)

The influence of additives on adhesion of Penicillium Frequentans Conidia to Peach Fruit surfaces was studied. Results showed that the maximal adhesions of fresh conidia, dried, and suspended in the additive solutions to the surfaces were observed with: 1.5% carboxymethyl celloulose, 1.3% Nu-film, 1.5% Sodium alginate, and 1.5% gelatin. Where in the case of fresh conidia suspended in the additive solution and dried, the maximal adhesions were obtained with 1.5% sodium alginate and 1.5% carboxymethyl celloulose. (47)

The effect of adjuvants on deposition efficiency of fenhexamid sprays applied to Chardonnay grapevine foliage was studied. Results showed that addition of Agral 90 (ethoxylated alkylphenol), BB5 (acidifier), Nu-film-p (terpene oil), and Solitaire (silicone / plant oil) significantly improved deposition on upper and lower leaf surfaces compared with the fenhexamid-only and water sprayed control.(48)

3. Role of oils in increasing the foliar deposition and bio-residual activity of insecticides

Suflufenacil is a new herbicide being developed for broadleaf weed control. Results showed that, Addition of adjuvants increases

the efficacy on fall-emerging weeds. For examples, non-ionic surfactant (NIS), crop oil concenteration (COC), and methylated seed oil (MSO). [49]

In glasshouse the effect of mixing different adjuvants such as non-ionic surfactant (NIS), crop oil concenteration, and organosilicon (OS) together with Tricloyer plus metsulfuron against *Hedyotis Verticillata* was studied. Results obtained indicated that, the addition of 0.25% NIS, 0.05% COC, or 0.05% OS, were effective in controlling *Hedyotis Verticillata.* [50]

Trifloxysulfuron was mixed with six adjuvants, non-ionic (0.25% induce and X-77), organosilicone (0.1% Kinetic and Silwet L-77) and crop oil concentrate (1.0% Agridex and Meth-N-oil) to evaluate bioefficacy. The lowest surface tension and contact angle were recoded with Silwet L-77 mixed with Trifloxysulfuron, but the highest recorded with Meth-N-Oil. [51]

Field studies were conducted in the USA to determine the effect of adjuvants on droplet deposition of Tracer Spinosad. It applied in water alone, or in water with the addition of one of the following adjuvants: crop oil concentrate (COC), wetter/spreader (X-77), or a combination product (an organo-silicon and methylated crop oil). Results indicated that, the addition of an adjuvant is not impotant, however in cases with low volumes,it affect the penetration, coverage or residual effect of Tracer.[52]

The following adjuvants, crop oil concenterate At Plus 411F, ortho X-77, surfactant polyglycol 59-13, and 26-2, Genamin T-050, T-DetDD-10, Brij 92 and sunspray 11N were used to the foliar

activity of an aryloxyphenoxy propionate herbicide. Results indicated that, the most effective non-ionic surfactant was polyglycol 26-2 and in combination with paraffinic oil gave nearly optimal transport. (53)

It is hypothesized that, the association between active ingredient and adjuvant in the leaf deposit resulted in higher uptake. For oil adjuvants to enhance uptake of a particulate active ingredient .Results showed that, low spray volumes showed increase in the uptake with decreasing deposit size, in contrast higher spray volumes produced larger deposits that consists of annuli. (54)

A newer group of vegetable oils, namely rape seed oils, namely rapeseed oil ethoxylates (RSO) are used to improve the biological efficacy of herbicides in weeds control. Rapeseed oil with 5 (RSO5), 10 (RSO10), 20(RSO20), 30(RSO30) and 60(RSO60) ethoxylation units were added to glyphosate spray solution and applies to different weed species. Chlorophyll fluorescence measurements showed a higher impact of glyphosate when rapeseed oils were used. (55)

Absorption and translocation of Clethodim was determined at 1, 4, 12, 24, 48, and 72 h after treatment with the addition of adjuvants. When either ammonium sulfate (AMS) or (AMS) plus crop oil concentrate (COC) was added as adjuvants to 0.12 kg / l formulation, absorption of Clethodim increase significantly at all harvest times 12 HAT compared to 0.12 kg / l formulation alone. Conversely, COC enhanced absorption at all harvest times when added to 0.24 kg / l formulation. (56)

In greenhouse of vegetable crops, abamectin (1.8%) and cyromazin (75%) were used to control of *leafminer*, *Liriomyza sativae* and *Blanchard* pests. The use of petroleum oil (EC, 90%) as adjuvant with insecticides, reduce the required rate to achieve acceptable control of this pests. Where LC_{50} of abamectin alone=1.5 ppm and with oil=0.5 ppm, LC_{50} of cyromazin alone=34.8 ppm and with oil=32.2 ppm. Also, the addition of plant oil (0.25%) to the insecticides increased the effectiveness of them to extent that normal dosage would be reduced. (57)

The effect of Kz oil on physical properties of pesticide spray solution and its pesticidal efficiency against the 4^{th} instar larvae of ***S. littoralis*** was studied. It's noted that Kz oil could be recommended for increasing profenofos and fenpropathrin pesticidal efficiency at lower rates and the initial deposits, residues for pesticides on cotton leafworm were increased. (17)

The influence of Mineral oils (Kz oil, CAPL-2) and plant oil: jojoba oil on physico-chemical properties of Merlene (EC), Sumialpha(5%) and Dursban (48%) were studied. Results indicated that the addition led to increase deposit efficiency on the foliage, also reduce pesticide evaporation and accelerate its absorbance inside plant cells. (18)

The effect of xylene (lypophilic agent) on the efficiency of the local mineral oil: CAPL-2 against sucking pests was determined. Results obtained indicated that CAPL-2 alone at concentration 1.5 % was suitable for controlling those pests, mixing of adjuvant with

CAPL-2 increased its initial and residual effect by reducing concentration to 1%.[58]

The addition of Castor bean oil and CAPL-2 (local mineral oil) at 0.3 % affect on the physico-chemical properties of insecticides: dursban 48%, sumi-gold 20% and larvin 80% WP against *S.littoralis* were studied. Results obtained showed that all additives decreased the surface tension of the spray solution of all insecticides. [21]

The effect of Castor bean oil and CAPL-2 (local mineral oil) at 0.3% on the physico-chemical properties and effectiveness of insecticides: curacron 72% EC and sumi-alpha 5% EC were studied. The obtained data showed that additives decreased pH value and surface tension of spray solution of insecticides and caused a highest increase in conductivity of sumi-alpha. [22]

The effect of Atplus 417 and Atplus 424 (mineral oil / surfactant mixtures) on the transport and retension of diflubenzuron in larvae of *S.littoralis* in laboratory was studied. The treatment of larvae with a mixture of Atplus 417 or Atplus 424 with diflubenzuron increased transport and retention of the insect growth regulator. [59]

Diflubenzuron was effective when applied as foliar spray diluted in 7.0 liters of cottonseed oil per ha, 9.4 liters of cottonseed oil per ha and 9.4 liters of sun oil 7n (R) (emulsifiable paraffinic oil) per ha against boll weevil. [60]

Vegetable oils such as those from cottonseed or soybean were useful addition to ultra-low volume formulations for regulating the

number of drops and their volume median diameters, which were in many cases playing an important role for increasing the efficacy of insecticides in aerial application. (61)

The phytotoxicity and the ovicidal activity of some locally-prepared spray oils against both red mite and the cotton leafworm were studied. The results indicated that the candidate spray oils exhibited complete acaricidal and insecticidal efficiencies against the eggs of the red mite and the cotton leafworm. The oil had no phytotoxic effect against the cotton plants. (62)

The effect of highly purified paraffinic oil alone or in combination with triazophos 40% EC or dicofol-s (Kelthane S) (18.5% dicofol + 8% dimethoate) against *Thrips Tabaci* on cotton plants was studied. The results showed that the oil used separately at the rate of 7.5 L/ha significantly reduced the population of thrips, but oil / insecticide combinations were superior to oil or insecticides applied alone. The mineral oil increased the efficiency of insecticides used against both thrips and cotton leafworm two-fold or more. (63)

Fenvalerate (sumicidin) and cyanophos (cyanox) when mixed with any mineral oil at different lethal concentrate levels increased the ovicidal effect under filed conditions against the cotton leafworm, ***S. littoralis*** compared with insecticides or oil applied separately.(64)

Formulation containing mixtures of 1.5% crude cottonseed oil and microbial insecticide may be useful as bases of using Adjuvants to increase the effectiveness of pathogens used to control the tobacco budworm, ***Heliothis virescens*** and the bollworm, ***Heliothis zea***. (65)

Different oils as soybean, oleanol and diesel oils in combination with the insect growth regulators Dimilin (diflubenzuron) and alsystin (triflumuron) and with several preparations of *Bacillus thuringiensis*, for the control of *Thaumetopoes pityocampa* on Aleppo pine (*Pinus halepensis*) were studied. The results indicated that all the formulations gave complete Kill of 2nd instar larvae after 1.3 days and the insect growth regulators with all the oils also gave 100% mortality of 3rd instar larvae. However, preparation of *Bacillus thuringiensis* with sobbean and diesel oil gave over93% mortality of 3rd instar larvae, while with oleanol mortality was 83 %.[66]

The addition of 3%, 12%, and 50% paraffin oil (lipophilic agents) changed the physico-chemical properties of Kelthane under spraying dilution rate, such changes led to increase in its retention and acricidal effect. Also, increased deposit, reduced drift and improved spreading on the treated plant surfaces. [67]

The addition of the isoparaffinic oils to DDT and the *Heliothis polyhedral* virus increased the effectiveness of DDT and the virus compared with DDT or virus used alone. [68]

Mineral oil synergized the toxicity of cyfluthrin compared with water. Oil formulations, particularly mineral oil without water, increased the residual toxicity of cyfluthrin against boll weevils compared with the aqueous formulation. Mineral oil/cyfluthrin combinations also reduced boll weevil feeding injury to flower buds. [69]

Purple and yellow nutsedge control by imazapic and imazethapyr at 0.05 and 0.07 kg ai/ha applied alone or with crop oil concentration (Agri-Dex) paraffin-based petroleum oil (83%) and surfactant blend (17%) and methylated seed oil (sun-It) at 1.0% v/v were evaluated in field studies. Imazethapyr controlled Kochia (*Kochia scoparia* (L) Schrad) and green foxtail (*Setaria viridis* (L) Beauv) better when applied with various petroleum oil adjuvants (Manthey *et al*., 1992). Results obtained indicated that adjuvants enhance the efficacy of herbicides where the former gave high efficacy than the latter. [70]

Greenhouse and field studies were conducted to evaluate the activity of foramsulfuron with adjuvants combinations against annual weed species. The addition of methylated seed oil (MSO) provided the greatest control of these species followed by crop oil cocenteration.[71]

Captan (N-(trichloromethylthio)-4-cyclohexene-1,2-dicaboximide) is a micro-fine wettable powder for use in water as a spray for the control of certain fungal diseases such as scab, black rot, Botrytis blossom-end rot, sooty blotch, powdery mildew etc. when Captan and oil were applied together, the percentage of Captan that penetrated the cutical surface more than 50% over than the amount penetrated through control cuticales.[72]

The effect of mineral oil, vegetable oil and methylated vegetable oil adjuvants on the deposition efficiency of aqueous sprays on foliage pea leaves was studied. It was found that retention

of the three oil-based Adjuvants increased in the order methylated vegetable oil > vegetable oil > mineral oil on pea leaves. [28]

4. The role of acidifying agents in increasing retention and efficiency of insecticides

Acidifying agent is added to higher pH solution to prevent alkaline hydrolysis (a chemical reaction) of some organophosphate (OP) and carbamate insecticides. Also they are used to reduce problems with hard water. In particular, calcium and magnesium salts may interfere with the performance of certain pesticides.

Biological activity of nicosulfuron can be enhanced by using adjuvants that increase the pH of the spray mixture and solubility. The most effective pH adjusters are tribasic potassium phosphate, sodium carbonate, and triethanolamine. They make the spray mixture alkaline and enhance the activity of nicosulfuron. Alkaline condition rapidly dissolves the sulfonyl urea particles and enhances activity with the addition of crop oil concentrate, modified seed oil, and non ionic surfactants. [73]

Water conditioner adjuvants can be used to evaluate efficacy of glyphosate herbicide. The herbicide was applied with soft and hard water without adjuvants, and with hard water plus water conditioner adjuvants (ammonium sulfate, Niagra, pro Aqua, As 500 SL).And (experimental product ZW-10-0807) or with hard water plus organosilicon surfactant Silwet L-77 840 AL only. Results showed that adjuvants not only over came negative effect of minerals in spray water but also increased glyphosate efficacy to the higher level than from glyphosate applied wiyh soft water only.[74]

The hydrolysis of azadirachtin was studied in aqueous buffers and natural water. It followed simple pseudo-first-order kinetics. The rate constants ranged from 2.48 to 67.7 and were faster in basic than acidic pH. On the basis of rate constants, azadirachtin was susceptible to hydrolysis than synthetic organophosphate, or carbamates. (75)

The chemical stability of cypermethrin was affected by water collected from The King Abdallah Canal in Jordan. Farmers use phosphoric acid to adjust the pH to 6.00 before mixing with Cypermethrin. These is refer to the pH value of water where (pH > 6.00) which reduce the stability of cypermethrin. (76)

The influence of surfactants and carrier pH on the foliar uptake of bentazone, was studied using bean and mustared that, all surfactants improved uptake more when bentazone was applied at low concentration. Both bentazone and carrier pH (5.7and 9) was applied as unformulated acid and as so divmsalt. Lower carrier pH did not provide greater uptake for bentazone sodium salt and was only beneficial for the uptake of bentazone acid at very low concentration. (77)

The degradation of ethiofencarb in aqueous solutions was observed at pH=12 at three temperatures, 4, 12, and 50 (+ or -) degree C. It also was completely degraded at pH=9 at 20 and 50 degrees C while in pure water at pH=6 degredation took place at 50 at 20 degrees C. (78)

The local mineral oil: CAPL-2 was formulated by Central Agricultural Pesticides Laboratory, mixed with acetic acid, and ascorbic acid (acidity modifiers) and acetone (polarizing agent) to

increase its pesticidal efficiency for controlling aphid, cotton leafworm egg masses, and sucking pests. Results obtained indicated that,the presence of acetic and ascorbic acid caused decreasing of pH value of spray solution that increased the attraction between spray solution and treated plants, with increasing the retention and pesticidal efficiency. (79)

BB5 is an alkyl phenoxy polyethylene ethanol is acidic buffer, added as adjuvants to various pesticides to potentiate their activity aganits the white fly (***Bemisia tabaci***) nymphs on cotton seedlings. Addition of 0.25 BBs to thiamethoxam resulted increase in the toxicity of the pesticide on (***B. tabaci***) higher than that thiamethoxam alone. (80)

Kz oil is mineral oil, its spray solution with Arish water have been used for controlling ***Saissetia oleae***. Arish water was higher in alkalinity than Nile water; the alkaline water decreased the retention and insecticidal efficiency of Kz oil, mixing acetic acid (6%) with Arish water at rate (0.2%) in tank-mix caused decreasing of pH value of Kz oil spray solution and increasing its pesticidal efficiency than untreated water, Kz oil concentration decreased from 1.5 to 1.25 % (v/v).(17)

The influence of Acetic acid 60 % (Acidulate agent) on physico-chemical properties of Merlene (EC) was studied. Resulted obtained indicated that reducing the pH value of spray solution led to increased in the retention and insecticidal efficiency therefore the initial mortality rate was greater than the insecticide alone. (18)

The effect of acetic acid and phosphoric acid (acidity modifier agent) on the physico-chemical properties and insecticidal efficiency of insecticides: dursban 48%, sumi-gold 20% and larvin 80% wp against *S.littoralis* were studied at 0.3 % adjuvants. Results obtained indicated that all additives used decreased pH value of spray solution of all tested insecticides, therefore increase the insecticidal efficiency. (21)

The effect of acidifying agents: phosphoric acid 6.6 N and Acetic acid 6% at 0.3% on the physico-chemical properties and effectiveness of insecticides: curacron 72 % EC and simi-alpha 5 % EC were studied.Results obtained indicated that additives decreased pH value of spray solution for all insecticides and increased the conductivity of sumi-alpha (22)