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APPLICATOR EXPOSURE AND DRIFT PROBLEMS OF CYANOPHOS INSECTICIDE APPLIED ON COTTON FIELD USING TWO APPLICATION METHODS

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ABSTRACT

Two sprays of cyanophos were applied on cotton plants adjacent to maize field by two methods of application, i.e. micron ULVA and a motorized knapsack mistblower. Operator exposure during application, drift residues on maize plants and the toxicity of these residues on fish and honeybees were estimated. Fish and bees were located on the ground of maize field at different distances from the edge of the cotton field. Dermal exposure was determined by measuring cyanophos on pieces of clothing fitted to applicator overall within the time specified for application. Results show that the higher level of deposition of the insecticide on the total area of all cloth patches fitted on different body regions was observed for the micron ULVA (total deposition for the two sprays was 11.8 mg within exposure time of 9.5 min versus 3.82 mg for the mistblower at the same exposure time). Deposition on different body organs could be arranged descendingly as follows: hands> legs> knees> chest> elbows or shoulders. Deposition was more in 1st spray than in 2nd one, mainly due to the difference of wind speed. At the 1st spray, distances traveled by cyanophos residues were 24 and 33 m when using the mistblower and micron ULVA, respectively. At these distances, the corresponding values of mean deposits were 16.5, 11.6 µg/kg of maize leaves, respectively. At 2nd spray (lower wind velocity) the distances were 18 and 24 m corresponding to 19.3 and 10.6 µg/kg maize leaves, respectively. Drift of cyanophos released by each of the tested equipment caused 100% mortality of fish and honeybees placed at the distances 3 and 6 m, respectively. Zero mortality for both organisms were observed at distances 18 and 30 m for the mistblower and micron ULVA, respectively. It is obvious that levels of dermal exposure or drift to non-target sites were higher for micron ULVA than for the mistblower. These levels were markedly affected by wind speed.

INTRODUCTION

Application of foliar spray is a complex process that includes such events as spray atomization, transport to the plant, impaction on plant surfaces and retention by plants. Thus precision spray application appears to be a primary objective of both physical and biological-oriented scientists concerned with pesticide use allover the world. This concern has been expressed for better control by increasing target contact efficiency but not to increase the exposure of applicators or other non-target organisms appearing in a pesticide applicator area. The majority of pesticides continue to be applied as formulations diluted in water and sprayed under pressure through hydraulic nozzles. These sprays consist of very wide range of droplet size and in consequence, the larger droplets influenced by gravity are mostly deposited fairly close to the point of release (Mathews, 1995) and fail to attain the required coverage and distribution on the plant surfaces. As Cooke *et al.*

(1985) pointed out, hydraulic nozzles although biologically effective are wasteful because large droplets may bounce off foliage. Controlled droplet size application (CDA) is a familiar term for means of spraying a uniform cloud or droplets of the correct size to give effective control of a pest with the minimum amount of pesticide-carrying liquid (Mathews, 1979). Spinning disc or cup sprayers (e.g. micron ULVA) are designed especially for application of pesticides at ultra low volume rates of 1-5 L/ha (Oudejans, 1991) and introduced in Egypt for water-oil based application on cotton fields at a rate of 4 L/fed (Osman *et al.*, 1994). Another type of spraying systems applying reduced volumes is air assisting spraying. Air-assisted sprayers (e.g. the motorized knapsack mistblower) use air jets to carry pesticide droplets to the target position, to displace the air inside the crop canopy and also to assist a uniform deposition of the pesticide droplets on the target surface (Sidahmed and Brown, 2001; Delete *et al.*, 2005; Dasilva *et al.*, 2006). However, reduced spray volumes require smaller droplets which are prone to drift and subsequent operator and environmental contamination.

The current study was planned to evaluate operator exposure and drift of the organophosphate cyanophos insecticide onto maize plants grown adjacent to treated cotton fields beside estimating the toxicity of this drift to fish and honeybees. Two methods of application were used in this respect i.e. micron ULVA and a motorized knapsack mistblower. These methods produced a type of spray currently referred to as drift spraying.

MATERIALS AND METHODS

1. Insecticide used:

Cyanophos: O-4 cyanophenyl O,O-dimethyl phosphorothioate, a formulated samples (Cyanox 50% EC, Kz Comp.) were used at a rate of 1 L/fed.

2. Test organisms:

2.1. Honey bees:

Honey bees, *Apis mellifera* L. (First hybrid Carniolan workers) were obtained from the Apiary of the Fact. of Agric., Kafrelsheikh Univ.

2.2. Fish

Fingerlings, 10-15 gm weight of Bolti, *Tilapia nilotica* species were obtained from El-Hamoul Fish Culture, Kafrelsheikh, Ministry of Agric., Egypt.

3. Application equipments and their technical specifications:

Two types of equipments each represented drift spraying were used, i.e. Micron ULVA and a motorized knapsack mistblower

3.1. Micron ULVA sprayer:

A hand-held spinning cup sprayer referred to as micron ULVA (micron sprayers Ltd., Herefordshire, UK) was used to apply the insecticide at 4 L dilute per feddan.

3.2. Motorised knapsack mistblower:

An air-carrier motor sprayer of single cylinder two stroke power HP, speed 6000 rpm and fuel 1.5 L/h (the trade mark, taral, 5125. Factory and

General Distribution: Multiple, Istanbul, Turkey) was used. Other technical specification are shown in Table (1).

Table (1): Technical parameters of the spraying techniques used.

Parameter	Micron ULVA	Mist- blower
Forces forming the droplets	Centrifugation	Air-assisting
Spray tank capacity (L.)	10	20
Volume of spray per fed. (L.)	4	20
Working speed (m/min.)	40	40
Flow rate (cm^3/min.)	960	960
Swath width (m)	5	5
Height of nozzle above plants (m)	1	0.5
Spraying time per fed. (min.)	20	20

4. Experimental and field studies:

Experiments were carried out during summer season 2005 in cotton fields (var. Giza 86) located at Dakalt in vicinity to Kafrelsheikh, Kafrelsheikh Governorate, Egypt. Six plots of cotton each of nearly 3 kirates (14 x 35 m) separated by non-treated strips of cotton cultivations each of (10 x 35 m) were designed to be adjacent to six corresponding plots each of about 4 kirates (14 x 50 m) grown with maize (var. SKH10) and positioned down-wind of the cotton field. The experimental plots of maize were also separated by strips of maize plants each of 10 x 50 m. Cyanophos was applied on cotton by two methods of application micron ULVA and the motorized knapsack mistblower. Two plots of cotton corresponding to two plots of maize were specified for each type of application. The rest of the plots were reserved as a control. Height of maize plants were 100-130 cm throughout the experimental period. Application of insecticides was done at the recommended rate proportionally to the sprayed area according to Mathews (1979) and as described by instructions of the Ministry of Agriculture, Egypt. Micron ULVA was held with hands across the front of the operator body. Operator started spraying and walked progressively upwind across the field through untreated plants. Measurement of operator exposure during application was done according to patch technique of Durham and Wolfe (1962) as described and adopted by Cowell *et al.* (1989); Stamper *et al.* (1989a), Bjugstad and Torgrimsen (1996) and El-Hamady *et al.* (1997). Before spraying, patches of clean white cotton cloth each of 10 x 10 cm were pinned outside on operator's suit at different locations. New suit and new patches were made for each treatment. The operator was instructed to follow the application procedures described before. Before spraying, samples of honeybees and fingerlings of fish were placed on the ground between maize plants at different distances from the end of the cotton field up to 50 m. Four screen wire cages each containing ten bees and four open plastic containers (20 cm width) each containing 1000 ml of canal water and ten fishes, were located at each distance. After application of pesticides, patches fixed on the operator were collected thoroughly handling by their outside perimeters only, wrapped in aluminum foil, transferred to the laboratory and kept in a deep freezer till analysis. For drift studies, samples of maize leaves (each of nearly 500 gm) were collected randomly from two rows of plants at each distance after each spray and transferred to the laboratory in plastic bags. Cages of bees or containers of fish were allowed to stand in their positions during pesticidal application and additional 24 hours, thereafter, mortality counts were recorded. Weather conditions obtained from Sakha station, Kafrelsheikh, are shown in Table (2).

Table (2): Weather conditions during field application.

Date	Time of application	Air temperature (°C)	R.H. (%)	Wind velocity (km/h)
1st spray 25/7	16-18 p.m.	30-31	49	3.8
2nd spray, 9/8	16-18. p.m.	31-33	58	2.6

5. Analysis:

5.1. Initial drift deposits on maize:

Dislodgeabile drift deposits of Cyanophos on maize leaves were determined. Samples of maize leaves collected from the field were divided into 200 gm representative sub-samples, which were chopped to small pieces. The method of extraction and clean up of Cyanophos was as descried by Mukherjee and Gopal (1992) with some modifications. Each sub-sample was transferred to round-bottom flask containing 800 ml of acetone. Stoppered flasks were vigorously shaken by means of a mechanical shaker for one hour. The extracts were decanted into other clean flask and the chopped maize leaves were reextracted by the same procedure. The extracts were combined and evaporated under reduced pressure to 10 ml which were transferred along with a saturated solution of sodium chloride (150 ml) to a separating funnel. The resultant solution was extracted with hexane (3 x 50 ml). The combined hexane extract was passed on anhydrous sodium sulphate and concentrated to 5 ml then cleaned up via passing through a column prewashed with 50 ml of hexane + acetone (9: 1 v/v). The column was filled with acidic alumina (5 gm) + sodium sulphate (2 gm) and was eluated with 100 ml of a mixture of hexane + acetone (9: 1 v/v). The eluate was evaporated to near dryness and the residue was dissolved in 10 ml methanol and then analyzed by HPLC.

5.2. Patches of operator exposure:

The extraction of Cyanophos from the patches fixed on the operator during application was done according to Stamper *et al.* (1989b). The patches were placed in a 250 ml jar with 50 ml of hexane and shaken on a shaker for 5 min. The extract was decanted into a round-bottom flask and the pieces were reextracted by the same process. The extracts from the two steps were combined and evaporated on rotary evaporator at 40°C to dryness and the residue was dissolved in 10 ml methanol to be ready for HPLC analysis. The analysis results were corrected for recovery and were divided by the patch area and exposure time to give accumulation rate.

For recovery studies, samples of untreated maize leaves or cloth patches were fortified with a known amounts of Cyanophos (2 and 5 µg/gm sample for cloth and maize leaves, respectively), extracted, cleaned up as described before and percents of recoveries were calculated.

6. Chromatographic analysis:

Analysis was done using HPLC apparatus, Peckman, WL: 236, A.F. U.S.;I UV detector model Peckman 110b; the mobile phase: methanol, flow rate: 0.7 ml/min.

7. Statistical analysis:

Statistical analysis of variance of the data was carried out according to Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

1. Operator exposure:

Measurement of applicator exposure to pesticides gives the opportunity to evaluate the approaches to the reduction of exposure. Basically there are two approaches used. The first approach of Durham and Wolfe (1962) measures the external deposition or the amount of pesticide with which the worker's body comes into contact and also the second approach is the monitoring of the worker's body fluids (especially urine or blood) for levels of the pesticides, their metabolites or for changes in enzyme activity. In the present study, dermal exposure was determined by measuring the concentration of Cyanophos on pieces of clothing fitted on the applicator overall within the time specified for application. Generally average of percent recovery of cyanophos was found to be 94%. Results recorded in Tables (3-5) show that the highest level of deposition of Cyanophos on the total area of all cloth patches fitted on different body regions as a total for the two pesticidal applications was observed for the micron ULVA sprayer (11.8 mg within exposure time of 9.5 min). This was followed by the total deposition of the mistblower (deposition: 3.82 within 9.5 min). The total exposure on the twelve patches when using micron ULVA, and the mistblower expressed as accumulation rates was 248.98, 832.66 $\mu g/cm^2/hr$, respectively. For micron ULVA (1^{st} application), the amounts of Cyanophos deposited on different locations of the applicator body can be arranged descendingly as follows: hands > legs > knees > chest > elbows or shoulders. The same order and nearly the same quantities of Cyanophos deposits were observed in the second application. Also, the same trend was nearly observed for the mistblower sprayer.

Reports of some researchers may explain the higher level of operator exposure when using micron ULVA than using the mistblower. Oudejans (1991) reported that, a drawback of CDA (including micron ULVA) was that fine droplet spectrum and total dependence on air movements for distribution could easily contaminate the operator. Droplet-size seems to be very important in determining total exposure (Vidal *et al.,* 2002). Droplets of smaller sizes are subject to drift. Total operator contamination during spray operations on a mature cotton crop was found to be the highest for water-based very-low--volume (VLV) sprays applications (6-12 L/ha) e.g. micron ULVA. Cooper (1993) reported that operators suffered from the spray drift while applying pesticides. Locations of exposure on the body of applicators and its magnitude differs according to many factors, e.g. height and density of crops (Vidal, 2002), spraying period, weather and spraying conditions.

Table (3): Operator-dermal exposure to Cyanophos during application* as monitored by deposition on cloth patches fitted on different body regions (1st spray).

Body region	Micron ULVA		Knapsack mistblower	
	Deposition (µg/cm²) ± S.E.	Accumulation rate (µg/cm²/h)	Deposition (µg/cm²) ± S.E.	Accumulation rate (µg/cm²/h)
Right shoulder	1.2 ± 0.3	15.32	0.50 ± 0.01	6.39
Left shoulder	0.9 ± 0.2	11.49	0.18 ± 0.06	2.29
Right chest	3.4 ± 0.3	43.42	0.29 ± 0.05	3.70
Left chest	2.6 ± 0.1	33.20	0.16 ± 0.04	2.04
Right elbow	0.81 ± 0.06	10.34	0.11 ± 0.03	1.40
Left elbow	0.95 ± 0.1	11.52	0.66 ± 0.12	8.43
Right hand	18.2 ± 0.8	232.34	4.2 ± 0.4	53.63
Left hand	11.2 ± 1.3	143.02	3.9 ± 0.2	49.80
Right knee	5.4 ± 0.3	68.96	1.2 ± 0.1	15.32
Left knee	6.1 ± 0.5	7.89	2.6 ± 0.04	33.20
Right leg	7.6 ± 0.4	77.89	1.9 ± 0.05	24.26
Left leg	6.9 ± 0.6	88.11	3.8 ± 0.4	48.52

*** Exposure time was 9.4 min. for micron ULVA and mistblower**
S.E.: Standard error

Table (4): Operator-dermal exposure to Cyanophos during application* as monitored by deposition on cloth patches fitted on different body regions (2nd spray).

Body region	Micron ULVA		Knapsack mistblower	
	Deposition (µg/cm²) ± S.E.	Accumulation rate (µg/cm²/h)	Deposition (µg/cm²) ± S.E.	Accumulation rate (µg/cm²/h)
Right shoulder	0.81 ± 0.05	10.34	0.35 ± 0.008	4.47
Left shoulder	0.76 ± 0.2	9.71	0.12 ± 0.002	1.53
Right chest	0.93 ± 0.11	11.88	0.61 ± 0.006	7.79
Left chest	1.9 ± 0.13	24.26	0.92 ± 0.04	11.75
Right elbow	0.51 ± 0.16	6.51	0.43 ± 0.03	5.49
Left elbow	0.63 ± 0.02	8.05	0.33 ± 0.01	4.21
Right hand	7.2 ± 0.42	91.94	2.6 ± 0.29	33.20
Left hand	10.1 ± 0.65	128.98	3.5 ± 0.43	44.69
Right knee	3.2 ± 0.3	40.86	1.9 ± 0.21	24.26
Left knee	2.6 ± 0.4	33.20	1.7 ± 0.19	21.71
Right leg	5.3 ± 0.15	67.68	2.3 ± 0.09	29.37
Left leg	6.1 ± 0.38	77.89	3.9 ± 0.18	49.80

*** Exposure time was 9.4 min. for micron ULVA and mistblower; S.E.: Standard error**

Table (5): Operator-dermal exposure to Cyanophos as monitored by deposition on total area of all cloth patches fitted on different body regions.

Methods of application	Deposition (mg)		
	1st spray	2nd spray	Total*
Micron ULVA	6.53	2.28	11.8
Mistblower	1.95	1.87	3.82
L.S.D.	2.11	0.37	-

*** Total exposure time for the two sprays is 9.4 min for each of the two spray application.**
L.S.D. = Least significance differences

The pattern of moving during application is also important. In general, the most exposed areas of the spray man body were the hands (Vercruysse *et al.,* 1999; Nilsson and Papantoni, 1996; El-Hamady, 1997). Hand exposure was usually the principal kind of exposure for the span sprayer (Stamper *et* *al.,* 1989a). Exposure for the hands and forearms has been found to account for approximately 70-90% or more of the total dermal exposure (Cowel *et al.,* 1989). On the other hand, legs and lower parts of the body receive considerable amounts of pesticides during application. Exposure to outside pads was primarily (84%) to the legs of the applicators in a commercial greenhouse (Stamper *et al.,* 1989b). After applying pesticides using knapsack sprayers, approximately, 61% of the total pesticide recovered was located in the legs of the applicator suit (Stevenson and Richardson, 1991). The majority of contamination (80-95%) occurred on the lower leg and feet irrespective of sprayer type (Thornhill *et al.,* 1995). Vidal *et al.* (2002) found that in greenhouses, the highest exposure by pesticides during field application occurs on the lower legs and front thighs of the applicator. The relatively high levels of deposits on the lower parts of the body especially thighs and knees may be due to wading in the treated area through wetted leaves during spraying operation (Bjustad and Torgsimsen, 1996).

Generally, there is a high variability in levels of pesticide dermal exposure and its distribution on the body (Vidal *et al.* 2002) and the potential dermal exposure to operator was found to be greater with the high volume application technique (e.g. hydraulic sprayers) than the reduced volume one. The rate of potential dermal exposure was greater with the higher volume technique by a factor of three.

2. Drift into adjacent maize plants:

The drift into adjacent maize plants during application of Cyanophos on cotton fields were determined as µg/kg maize leaves. Values were corrected according to recovery, (87%). The determinations were assayed on maize plant, positioned at various distances from the treated cotton fields (i.e. 3, 6, 9, 12, … up to 49 m). Results are recorded in Table (6).

Table (6):Drift of Cyanophos into adjacent maize plants during application on cotton field.

Method of application	No. of spray	Mean initial deposits (µg/kg maize leaves) at distances (m) from cotton field.											
		3	6	9	12	15	18	21	24	27	30	33	36*
Micron ULVA	1st	115.2	92.3	73.2	59.5	41.7	29.1	23.6	17.2	19.1	16.5	11.6	Nd
Micron ULVA	2nd	79.3	85.3	61.3	49.2	39.8	31.6	22.1	10.6	Nd	Nd	Nd	Nd
Mistblower	1st	107.1	78.3	61.5	39.7	43.6	29.1	21.3	16.5	Nd	Nd	Nd	Nd
Mistblower	2nd	116.2	62.5	42.3	21.9	17.8	19.3	Nd	Nd	Nd	Nd	Nd	Nd

Nd = Not detected

*** Residues also were not detected up to the distance of 49 m.**

It is apparent that, in both methods of application, distances travelled by the drift in the first spray were farther than those of the second one. This result could be easily explained on the basis that wind speed in the first spray was higher than in the second one (3.8, 2.6 km/hr, respectively). Wind speed plays essential role for drift of pesticides (Briand *et al.,* 2002; Gil and Sinfort, 2005). The farther distance within maize field showing detectable residues was observed during application with micron ULVA followed by that of mistblower.. At the first spray, distances reached by drift residues of were 24 and 33 m when using the mistblower, micron ULVA, respectively. At the end of these distances, the corresponding values of mean deposits were 16.5, 11.6 µg/kg of maize leaves, respectively. At the second application, the distances were 18 and 24 m corresponding to 19.3 and 10.6 µg/kg maize leaves respectively. In the current study it is obvious that spraying with micron ULVA is a greater contributor to drift than spraying with the mistblower. This is something logical because micron ULVA releases smaller droplets liable to drift.

Levels of drift deposition on maize plants at farther distances might be underestimate since the nearer plants could capture the drift droplets preventing them to arrive to the inner and the terminal plants. However, the results of the present study are consistent with those of others. Ahmed (1989) indicated that up to 2.8% of the nominal dose of Fenvalerate were deposited as far as 32 m downwind on cabbage leaves. The same author found that measurable amount of Fenvalerate were detected 2.4 m above the ground level as close as 4 m from the spray boom. In general, drifting spray is a complex problem in which equipment design, application parameters, spray physical properties of the formulation used and meteorological conditions interact and influence drift (Gil and Sinfort 2005). Vegetation features e.g. the type of crops to be sprayed or those receiving drift, their height, and the uncontrolled variables such as discontinuities in the length of the vegetation, would affect spray drift as well (Gil and Sinfort, 2005). The term drift itself has to be defined from various views. According to the US Environmental Protection Agency, EPA (Miller and Stoughton, 2000), types of pesticide drift could be defined as follows. There are two types of drift: spray drift (direct) and post-application drift (indirect or socalled, secondary drift). Spray drift occurs during and immediately after a pesticide application. Post-application drift occurs after application is complete and up to seven days mainly due volatilization. Drift to maize plants in the present study concerns the first type (samples of maize leaves were collected directly after pesticidal application). However, when fish or honeybees were exposed to drift, the drift has to be dealt as a second type i.e. indirect drift where organisms were located downwind of the pesticidal application area and were let as they are up to 24 hours, and thus subjecting also to volatilization of the sprayed pesticides. Spray drift has been thoroughly studied over years and is now comprehensively considered in risk assessment as a relevant path of entry However, there are only few experimental data at present on exposure caused by short-range transport originating from pesticide volatilization (Siebers *et al.,* 2003). The proportion of entry attributable to spray drift and that attributable to volatilization is significantly influenced by the kind of crop treated i.e. whether it is an arable or a tall crop. It will be useful to perform case studies to gain better understanding of volatilization and deposition of air-borne substances in order to validate and optimize drift studies.

3. Toxicity of drift to non-target organisms:

3.1. Toxicity to bolti fish:

Results are recorded in Table (7). It is obvious that drift released by each of the tested equipments, caused 100% mortality of fish placed at the distances of 3 and 6 m. It is noticed that the toxicity against fish was generally observed at a longer distances in 1st spray than in 2nd one and this was mainly due to the differences of wind speed in the days of application. The potential of drift was more powerful for micron ULVA than for mistblower. Thus, the mistblower shows the least level of drift (in 1st spray, % mortality was 35% for fish placed at 15 m versus 17.5% at 21 m for micron ULVA. For the 1st spray, zero mortality was detected at the distance of 18 and 24 m for the mistblower and micron ULVA, versus to 15 and 21 m in the 2nd spray, respectively. The obtained results are of great importance. It could be extrapolated to the fact that pesticides applied in agricultural areas may also impact not only on the targeted species but also on non target organisms in and adjacent to the target area. Dabrowski *et al.* (2005) indicated that spray drift is one of the most important sources of non point source pesticide pollution in edge of field surface waters such as ditches, streams and ponds.

Table (7): Toxicity of Cyanophos drift against fingerlings of Bolti fish during and 24 h after application.

Method of application	No. of spray	% Mortality of fish placed at distances (m) from cotton field							
		3	6	9	12	15	18	21	24*
Micron ULVA	1st	100	100	85.0	70.0	42.5	40.0	17.5	0
Micron ULVA	2nd	100	100	100	62.5	22.5	12.5	0	0
Mistblower	1st	100	100	92.5	77.5	35.0	0	0	0
Mistblower	2nd	100	100	60.0	22.5	0	0	0	0
Control	1st	10	2.5	2.5	0	0	0	0	0
Control	2nd	5	0	2.5	0	0	0	0	0
L.S.D.		8.9	7.5	12.3	7.2	10.1	11.2	6.5	-

*** Zero mortality was also observed at distances up to 49 m.**

3.2. Toxicity to honeybees:

Results recorded in Table (8) show that drift caused by micron ULVA resulted in 100% mortality of bees at a distance of 12 m. At 21 m percent mortalities were 37.5 and 25 for 1st and 2nd sprays, respectively. Mistblower sprayer was less dangerous in this respect, especially in the 2nd spray (percent mortalities were 15 and 0 at a distance of 15 m for 1st and 2nd spray, respectively). It seems that wind speed (higher in the 1st spray) plays an important role as a contributor determining drift profile. The higher levels of drift observed for micron ULVA are simply explained basing on the production of smaller droplets that easily carried by winds. Death of bees may be caused by drift of chemicals on hives, crops or water. When drift occurs onto crops where bees are foraging the problems are similar to those for cases involving direct spraying. According to Peach (2006), drift occurs from nearly all spray or dust applications of pesticides from a short distance to miles downwind. Pesticides applied by plane usually drift farther than those applied by ground equipment. Based on the earlier discussion, data of the present study reveal that equipments like mistblower and especially for micron ULVA, inspite of being advantageous and efficient for insect control, it may pose deleterious effects on non-target organisms due to their emission of a potential drift onto field boundaries. To make full use of these equipments, buffer zones (no sprayed zones) have to be set downwind of the treated fields. A buffer zone (also known as no spray zone) is an area in which direct application of the pesticide is prohibited, this area is specified in distance between the closest point of direct pesticide application and the nearest boundary of a site to be protected. The obtained data in the present study are considered insufficient to suggest the specifications of these zones. No theoretical basis exists to justify buffer zone at a given field (De Schampheleire *et al.*, 2007). Buffers may be based on many variables e.g. type and quality of spray, release height and others such as wind speed. De Snoo and deWit (1998) reported that the creation of a 3 m wide buffer zone may lead to a 95% reduction in pesticide deposition on the adjacent ditch bank and ditch. A buffer zone of certain width along surface waters is given for each registered pesticide formulation. For field crops and grasslands the buffer zone is up to 20 m, for fruit orchards up to 30 m (DeSchampheleire *et al.,* 2007). Field margins with certain widths are sometimes left unsprayed to reduce the emission of drifting pesticides to the field surroundings (Tooby, 1999). These margins were referred to as conservation head lands or field boundaries (Longley *et al.,* 1997). In some cases there is an obligation to use buffer zones (or conservation headlands) in combinations with other drift mitigation measures.

Table (8): Toxicity of Cyanophos drift against honey bees during and 24 h after application.

Method of application	No. of spray	% Mortality of bees placed at distances (m) from cotton field									
		3	**6**	**9**	**12**	**15**	**18**	**21**	**24**	**27**	**30***
Micron ULVA	1st	100	100	100	100	87.5	67.5	37.5	15	2.5	0
Micron ULVA	2nd	100	100	100	100	65.0	45.0	25.0	0	0	0
Mistblower	1st	100	100	62.5	40.0	15.0	0	0	0	0	0
Mistblower	2nd	100	82.7	27.5	5.0	0	0	0	0	0	0
Control	1st	7.5	5.0	2.5	0	0	0	0	0	0	0
Control	2nd	2.5	2.5	0	0	0	0	0	0	0	0
L.S.D		8.3	11.7	16.5	18.3	16.3	19.6	6.8	5.9	1.7	-

(*) Zero mortalities were also observed at distances up to 49 m.

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تعرض عامل الرش ومشاكل الأنجراف لمبيد السيانوفوس المطبق بطريقتين على محصول القطن

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من المعروف أن آلات الرش الهيدروليكية مثل الرشاشات الظهرية والموتورات الأرضية العادية ذات معدل التخفيف العالى تؤدى إلى تشتيت سائل الرش وفقده وعدم توزيعه توزيعا جيدا على الأسطح المعاملة بالإضافة إلى أنها تستهلك وقتا كبيرا فى التطبيق. لذا فإن الإتجاه المفضل هو استخدام نظم آلات الرش ذات أحجام التخفيف الصغيرة مثل الرشاشة ميكرون أولفا أو الموتور الظهرى ذو الحامل الهوائى. وتهدف الدراسة الحالية إلى تقييم تعرض عامل الرش أثناء رش مبيد السيانوفوس عند تطبيقه (مرتين) على القطن بواسطة نظامى الرش المذكورين كما تهدف إلى تقييم مستوى انجراف رذاذ هذا المبيد إلى حقل منزرع بالذرة مجاور لحقل القطن المعامل وكذا سمية هذا الانجراف على سمك البلطى ونحل العسل الموضوعين تحت نباتات الذرة على مسافات مختلفة من الحقل المعامل. وبقياس تركيزات المبيد المتبقية على قطع من القماش موضوعة على أماكن مختلفة من جسم عامل الرش وجد أن مستوى تعرض عامل الرش كان أعلى عند استخدام الرشاشة ميكرون أولفا عما هو فى حالة الموتور الظهرى ذو الحامل الهوائى وفى كلا الحالتين وجد أن أكثر المناطق تعرضا للتلوث أثناء التطبيق هى الأيدى والأرجل والركبتين كما أن مستوى هذا التعرض يزداد بزيادة سرعة الرياح. وبدراسة انجراف المبيد إلى نباتات الأذرة تم اكتشاف متبقيات المبيد على مسافة 24 ، 33 متر بتركيزات 16.5 ، 11.6 ميكروجرام/كجم من أوراق الذرة فى حالتى الموتور الظهرى ذو الحامل الهوائى والرشاشة ميكرون أولفا على الترتيب. ولوحظ انخفاض مسافة ومستوى الانجراف فى الرشة الثانية عن المستويات المذكورة وربما يرجع ذلك إلى انخفاض سرعة الرياح. وفى كلا نظامى الرش وجد أن الانجراف أثناء التطبيق وبعد 24 ساعة منه يؤدى إلى 100% موت للسمك والنحل على مسافة 3 ، 6 متر ثم بعد ذلك تنخفض نسبة الموت إلى أن تنعدم بعد مسافة 18 ، 30 متر. باستخدام الموتور الظهرى ذو الحامل الهوائى والرشاشة ميكرون أولفا على التوالى وبصفة عامة تتوقف مسافات الانجراف على سرعة الرياح. ويقترح اتخاذ تدابير معينة للتقليل من مخاطر الانجراف منها ترك مناطق غير مرشوشة على حواف الحقول المعاملة. ويتوقف تحديد مواصفات هذه المناطق على عوامل عديدة مثل نوع آلة الرش المستخدمة ونوع المحصول المنزرع.

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