DESIGN OF A LOCAL ROTARY ATOMIZER FOR ENVIRONMENTALLY – SAFE CONTROL OF CERTAIN VEGETABLE PESTS

By

Mahmoud Abu- Elmagd Abu-Elmagd

B. Sc. Agricultural Sciences (Agricultural Mechanization), Tanta University, 1995

M.Sc. Environmental Sciences (Department of Agricultural Sciences), Institute of Environmental Studies &Research,Ain Shams University,2003

A Thesis Submitted in Partial Fulfillment
Of
The Requirements for the Degree of
DOCTOR OF PHILOSOPHY
in
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Department of Agricultural Sciences
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APPROVAL SHEET

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المكافحة الآمنه بيئياً لبعض آفات الخضر بإستخدام وحدات رش دورانية محلية الصنع

رسالة مقدمه من الطالب

محمود أبو المجد أبو المجد

بكالوريوس فى العلوم الزراعية (ميكنة زراعية) جامعة طنطا ١٩٩٥

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جامعة عين شمس ٢٠٠٣

للاستكمال متطلبات الحصول على درجة دكتوراه الفلسفة

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جامعة عين شمس

٢٠١٢

إهـــــداء

أهدي ثمرة هذا الجهد الى :

روح....

<u>والدتى</u> ....

رحمها الله ...

واسكنها الله فسيح جناته...

المتوفية فى ٢٠١١/٥/٢١

شـــكر

إن الحمد والشكر لله ..ثم

- أتقدم بخالص الشكر والتقدير إلى كل من تفضل مشكوراً بمساعدتي في إنجاز هذه الدراسة وهم:-
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٣- الأستاذ الدكتور / محمد عبد العزيز محمد هندى
٤- الدكتور / احمد ابو اليزيد عبد الحافظ

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المكافحة الآمنه بيئياً لبعض آفات الخضر بإستخدام وحدات رش دورانية محلية الصنع

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موافقة مجلس المعهد **موافقة الجامعة**

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صفحة الموافقة على الرسالة

المكافحة الآمنه بيئياً لبعض آفات الخضر بإستخدام وحدات رش دورانية محلية الصنع

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Introduction

Consumption of natural pesticides is an important indicator for agricultural production. Food and Agricultural Organization (FAO) data indicated that the annual international loss of crop production caused by pests reached 33.8% where 12.3% of the loss was caused by insects, 11.8% by diseases and 9.7% because of weeds (FAO, 1987**)**.

High levels of environmental pollution have occurred due to the extensive use of toxic pesticides particularly by HV spray and improper application techniques.

The use of HV traditional motor-sprayer creates a very wide spectrum of droplets, which lead to uneven coverage of treated plants accompained by a distinctive loss of spray on ground. Also, it contaminates both the operator and the environment, [extremely inefficient destructive to the crop].

Vegetable production depends on the chemical control of piercing-sucking insects, i.e. aphid, jassid and whitefly. One of the major problems facing control of these insects is the difficulty of spraying the underside surface of leaves,where most insects live.

The department of Spraying Technology, Ministry of Agriculture exerts tremendous efforts towards the development and improvement of ground sprayer performance, both quantitatively and qualitatively, in order to increase their efficiency for controlling pests and minimize probable pollution.

The spinning disc atomizer the droplets by centrifugal forces are capable to produce a huge number of narrow-range droplet sizes which minimize the spray loss on soil or by drift . this generation of atomizer s could be considered as one of the closest atomizers/spinning disc acting within the Controlled Droplet Application (CDA) phenomenon (Matthews,1992) Standardization of spraying application of pesticides on

vegetable was realized in Egypt for the first time by (Salloum, 2004) ,as ESSAVP-2004. this standard should be activated and executed strictly in order to reach the international level in this respect.

This study spotlights to evaluate the modification of the present spraying techniques applied under Laboratory conditions and controlling aphids attacking Gorma watermelon, in order to improve the homogeneity on plant coverage and minimize lost spray on ground and drift spray on air for (1.0 and 4.0 meters) from plants. For a safety environment, trials were carried out to integrate with the commonly used chemical insecticide with safer biotic material. Realization of the best performance of the new spinning disc operationally (fed/hour), qualitatively (coverage on vegetables/pollution level) and biologically (pest mortality) ,taking into consideration the cost point of view. This cost provide to encouragement of national industry maximization of bioefficacy and minimization of environmental pollution.

With a comparison study with pneumatic atomizer Knapsack motor sprayer Agrimondo™ 20 l/fed and Conventional ground motor sprayer (hydraulic atomization) 400 l/fed to control the aphids on Gorma watermelon during summer season (2010).

Review of literature

1. Types of common used atomizer's:

Walton and Prewett (1949) found that high uniformity in droplet sizes form a spinning disc atomizer when operated at low uniform flow rates and report that a number of fine satellite droplets are formed in addition to the main homogeneous clouds.

Johnsjone *et al.* (1977) tested three different atomizer sizes delivering low , medium and high flow rates. In performance tests wetting agents were found to be necessary to produce uniform droplet the volume distribution across the swath showed four (peaks and the flow rate), liquid and atomizer high examined the two major peaks was at 50 and 60 common either side of the line of the sprier, instigating peak – to – peak width of 110 cm of the collected spray, 75% settled within a control band of 120cm, 99% within 180cm and 100% within 195cm to present superimposition of peaks leading over dose, a swath of 150-160cm was suggested, such that over lap accurse at the outer position of half peak height to avoid excessive spray drift it was recommended that the sprayer be not used in any but very light wind. The authors expected that this machine should prone very useful for very low volume application between rows in bush crops and tree and for treating larger areas.

Trotsenko (1989) described a jet nozzle for fine spraying of liquid chemical and its schematic diagram liquid entering the nozzle under pressure caused rotation of the inner

cylinder with blades, passes through on opening to a dispersal disc rotating in the opposite direction and with finally dispersed by centrifugal forces in fine droplets. This nozzle was used in the Russon OM-630 sprayer.

JaJo and Shak (1991), descript the evaluation and design of two versions of a modified micro-ultra hand – held ULV sprayer this sprayer have resulted form the need by the Mali beast control project to develop equipment suitable for use by subsistence formats in the control of oedaleus Senegalensis and the noctuid heliocheilus albi punctella on millat, grassland and sorghum. A new design of rotary atomizer disc all – wed **Clayton *et al.* (1993)**, to crete efficient liquid atomizer over a wide rang of disc speeds and liquid flow rates. A hand – held sprayer incur operating this atomizer disc was already in widespread use in sup-Saharan Africa for cotton best control, using both oil based ultra – low volume formulations at 1 to 3 l/ha and traditional water based insect side formulations at total volume of around 10 l/ha. The sprayer has been designed to be robust and easy to maintain specially to meet the needs of small holders. Spray deposition trials on cotton. Cowpeas and groundnuts suggest the new sprayer will be suitable for protecting a wide range of corps.

Ripper (1955) reported that some workers claim that a charge may produce uneven deposits , charged particles may stand out on the insect integument like iron filings on a magnet , as **Wilson and Janes (1942)** found that charged particles may produce on uneven deposit on plants and may stand out on the insect integument like iron filing mangent ,thus not helping the different of the active ingredient in to the insect body .The speed of the droplet impinging on the foliage is caused by residual kinetic energy left over after the energy absorbed by the dispersion, or is just the terminal velocity, which the

droplets attain in free- fall. The first practical trial to apply electro statically charged to agricultural dusts in USA. Previous research had shown that dust deposition could be increased by electrically charging of the particles **(Bowen *et al* .,1952).**

According to **Sasser *et al.* (1967)** the electrostatic charging of agricultural dusts may be limited in application at high humidity's.**Bowen *et al.* (1952) and Hebblethwaite (1952)** found a decrease in deposit of charged dust with increase in relative humidity **. Splinter (1961)** found a 43% decrease in deposit of charged dust on aluminum spheres when relative humidity was increased from 40 to 90%.

2. Effect of Physical properties of liquid and droplet size:-

Fraser and Eisenklam (1956), Hedden (1960) and Dombrowski and Hooper (1962), stated that the VMD of droplets was decreased with increasing pressure and decreasing surface tension and viscosity.

Nordby and Skuterud (1975) reported that the droplet spectrum in crop spraying applications depended on nozzle type/size, operational pressure and liquid properties, such as surface tension, viscosity, and vapor pressure. They confirmed the positive correlation between flow rate and droplet size.

Kepner *et al*. **(1982)** reported that the degree of atomization of hydraulic nozzles depends on characteristics and operating conditions of the atomizer, as well on the properties of the atomized liquid. The principal properties affecting droplet size were surface tension and viscosity. Increasing surface tension and viscosity increases the droplet sizes. While reducing pressure increased droplet sizes. Increasing orifice size and

consequently flow rate increased the droplet volume mean diameter. Doubling the hole increased flow rate and VMD by 10% to 30%. Increasing the spray angle of the fan nozzle usually decreased the VMD, but with a hollow cone nozzle, no definite relationship occurred.

According to **Mcwhorter and Gebhardt (1988)** there were four basic factors affecting formation of spray droplet size: atomizer design, which determined the way in which liquid was discharged and droplets were formed; atomizer operation, which governed the energy dissipated in the droplet formation process; the physical properties of the spray and the ambient atmosphere, which affected droplet formation and evaporation.

The effects of nozzle type/size, formulation properties, air speed, and nozzle orientation on droplet size were investigated by **Akesson *et al*. (1989), Bouse and Carlton (1985)** and **Bouse *et al* . (1989)** after spraying vegetable oil mixed with water and with various solvents and pesticides. Droplet size distribution was affected by air speed, nozzle type & size, and by the physical properties of oil or spray mixture tested.

Matthews (1992) mentioned the role played by physical properties of liquid and ambient conditions in the development of spray sheet and formation of droplets. He stated that a minimum pressure was essential to provide sufficient velocity with hydraulic nozzles to overcome the contacting force of surface tension and to obtain full development of the spray pattern. The minimum pressure should be at least one bar, but usually 2-3 bar was required. An increase in pressure opened the spray sheet and increased flow rate in proportion to the square root of operational pressure.