Measuring Spray and Spray Deposition on Plant and Unwanted in Field Under Iraqi South Conditions

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Abstract

A field study was conducted in Al Qurnah city located in the south of Iraq to measure spray and spray deposition on a soil surface, corn plant, and unwanted to weed control using a herbicide product. A Knapsack sprayer utilized in this study with a Flat Fan nozzle mounted on the rod. Three blocks and three plant densities were carried out in this study. A completely randomized experiment was conducted using split plots. Spray applications were applied at 2 bar and nozzle height of 50 cm and with an average worker speed of 0.15 $m.s^{-1}$. Spray deposition was measured at three levels on both of plant and unwanted and with one location on the soil surface. The main results of this study showed that volume median diameter with ranging between 112.77 and 182.53 m. The results also appeared a sensitive spray deposition and spray impacted with plant and unwanted density. Higher spray deposition and spray impacted observed on the top and middle level of unwanted plant 0.029 and 0.021 $\mu L.cm^{-2}$ respectively compared to bottom level, corn plant and soil surface. In additions, maximum spray impacted on an unwanted plant was 12% with high unwanted plant density compared with small densities of 8.3%. Higher biological efficacy found with Prickly alhagi with no significant differences with al hali weed. Improving spray deposition and spray impacted can be attained by obtaining at a nozzle spray distance of 50 cm from the intended target. The results of this study will be contributing to knowledge and highlight amount of pesticides that deposit on different locations at the time of spraying applications to improve crop protection product.

Keywords: Spray deposits, spray impacted, volume median diameter, unwanted plant

Introduction

Crop protection product (CPP) is one of the fundamental measures agriculture production, and it is especially more important for quality and sufficient yields of crop. After planting crops, there are different problems found related to crop protection as pests, diseases, and unwanted plants. They attack intended plants and cause yield and quality losses (Aktar et al., 2009). During spraying application of crop protection using chemical products, there is an important point to study the exact amount and uniformity of spray that deposit on and off-intended area (Syngenta, 2017). At the last decades, agricultural sprayers already increased the efficiency of plant protection by improving spray application as electing a suitable nozzle height, operating pressure, and nozzle size to reduce the rate of pesticides that enter the soil and move away by air action. In

additions, to increase spray deposition on the site. Spray deposition on both of on plant and unwanted is considered a complex problem and it is an important issue to evaluate spray application methods (Fox et al., 2001). It is dependent on several factors as equipment design, properties of the leaves surface, wetting of leaves, application methods and metrological conditions. The main parameters related in spray deposition are spray quality as droplet size, volume median diameter, and both of unwanted and plant density (Nordbo et al., 1995; Breakman et al., 2009; Souza et al., 2017).

There are two methods for characterization spray deposition, firstly, by measuring the amount of liquid retained on the surface of the plant intended and, secondly. The percentage of deposit covered of plant surface. Spray deposition on the target area affected by the changes of spray quality. The finest droplet sprays in size are deposited in more efficiently on the surface of the plant intended than the largest droplet size. In additions, reducing in spray deposit on the target is with the low droplet number density per unit volume. Also, Spray impacted closed to spray deposition. Spray impacted on the target zone is more important issue especially for contact action herbicides and has a different impact on the performance of herbicide. Several studies have considered various ways to measure spray deposits and spray impacted on the collectors (Wolters et al., 2008; Foque and Nuyttens, 2011; Zhu et al., 2011). Quantity sprays deposition that is deposited on the collectors according to (ISO 24253-1, 2015). There are never studies in Iraq about pesticide applications to know portion of each part of the plant from pesticides applied are released to non-target. Also, most of the Iraqi farmers have not any information about nanoparticles spray during agricultural spraying.

Fig. 1 View side of knapsack sprayer

The objectives of this work were to:

1. Quantify spray droplet distribution that deposit on plant, unwanted, and soil surface at different locations.
2. Measure actual amount of spray impacted on the target site.
3. Maximize spray deposition on unwanted plant parts to determine best control.
4. Determine how plant and unwanted density can be affected in spray deposition and spray impacted.

Materials and Methods

An experimental study was performed on a farm located in Al Qurnah city in the east of Basrah at 30.935467N and 47.457006E. The experiment was carried out in September 2017 on a corn plant. The spray deposition, droplet size, volume median diameter and spray impacted were quantified on the top, middle, and bottom of both of plant and unwanted and on the soil using white card papers. The tracer BSF is recommended for quantitative spraying on the target. The spraying applications were done when the corn plant with approximately 60-70 cm tall and of 17-20 cm an unwanted plant. The experimental design was set up in randomized blocks using spilt plots with three replications. The dimensions of each block were 3 × 3 m (width × length) respectively.

Herbicides applications are made within 35 days after emergence of corn plant. Each corn plant and unwanted, randomly selected within the spraying swath.

Corn Plant and Unwanted Density

The number of certain corn plant and unwanted in a particular area are determined by counting the number of individual both of corn plant and unwanted in a separate case in uniformly size sample growth per unit area (plant/ha). Corn plant was planted between two rows distance of 75 cm and the distance between plants in the same row was 15, 20, and 25 cm.

Knapsack Sprayer Settings

Spraying applications were used with knapsack sprayer 16 liters capacity as shown in **Fig. 1**.

Nozzle distance fixed at 50 cm height above the unwanted plant. A driving operater speed was of 0.15 $m.s^{-1}$.

Nozzle Characteristic

Flat Fan nozzle was used in this study to provide spray coverage and spray deposition. Nozzle flowrate was of 0.66 $L.min^{-1}$ at 2 bar of operating pressure. This nozzle was selected based on the application volume, within the recommended pressure range.

Metrological Conditions

Metrological conditions data including air temperature, relative humidity, wind speed, and wind direction was recorded at the test site. A summary of weather conditions during spray treatments was described in **Table 1**.

Table 1 Weather conditions at time of application

Time period	temperature		Relative humidity, %	Wind speed, $m.s^{-1}$	Wind direction
	Max °	Min °			
06:00-06:30 AM	38	32	25	2	North

Spray Deposition and Spray Impacted

Spray deposition and spray coverage at three different locations on the corn crop and unwanted plant (top, middle, and bottom) and on the soil surface using white card papers. WCPs have been used in many studies as a tool for quickly providing a cheap evaluation of both of spray deposition and spray impacted. After completion of spray drying, WCPs were gathered and scanned at 600 dpi.

Herbicides and Doses Tested

Two types of herbicides were applied in this study: Chevelier (Metsulfuron-methyl 1 $g.L^{-1}$) +Topek Janta (Clodinafop-propargyl 2.5 $ml.L^{-1}$)

Field Experimental Procedures

An experiment was conducted in corn field in September 2017 and involved randomly selected rows (approximately 0.032 ha). Corn plant had an average height of 65 cm, and an unwanted plant was 18.5 cm. Amount of spray deposition, spray impacted, droplet diameter and volume median diameter measured on white card papers. White cards papers dimensions were of (8.5 cm × 5 cm) length and width respectively. These papers were positioned horizontally on the ground for measuring ground deposit, and three locations on corn plant, unwanted on the top, middle and bottom **Fig. 2**. The collectors were placed at random plants and unwanted at three locations and on the ground. When the spraying application for any block is finished, the collectors were collected and placed inside of containers until scanner its.

Fig. 2 View picture of the test and spray deposition locations

Two types of herbicide were applied at the same volume for all blocks applications. Blocks were made with the same nozzle for this study. Spot sizes on the white card papers were measured with Image J software®. The number of spot size that recorded on each paper was varied depending on the location of a collector. The use of WCPs to collect spray droplets and spray deposition from the different locations on the soil, corn plant, and unwanted in the top, middle, and bottom using fluorescent dye to collect. The swath-width sprayed was at least 0.42 m. A minimum of 3 replications was made in time and place along of the blocks in the field during the spraying applications. This procedure produced a total of 72 white card papers. After the droplet that impacted on the collectors had dried, the collectors marked and saved in box until analysis. WCPs analyzed by using image j software® for measuring droplet size, spray deposition, and spray impacted. Biological efficacy of herbicide deposition on unwanted was evaluated after one month of spraying.

Statistical Analysis

Data of spray droplet sizes, spray deposition, and spray impacted were analyzed using ANOVA table ($p < 0.05$).

Results and Discussions

Effect of volume median diameter

As shown in **Figs. 3, 4**, and **5** volume median diameter on white card papers has affected significantly for all sampling that located on soil, plant and unwanted at different locations. Higher volume median diameter values were found in the top collectors that located on an unwanted plant of 186 µm compared to other locations. Lower volume median diameter values were measured on the bottom of plant and soil 132.4 and 1132 µm respectively.

Also, as shown in the figures above, The results demonstrated

Fig. 3 Effect of plant density on volume median diameter at different blocks- soil surface

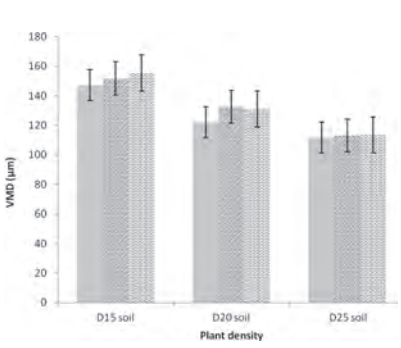


Fig. 4 Effect of plant density on volume median diameter at different blocks-corn plant

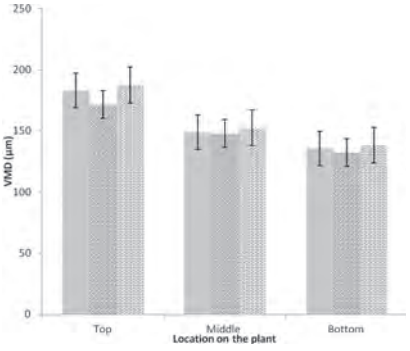


Fig. 5 Effect of plant density on volume median diameter at different blocks-unwanted plant

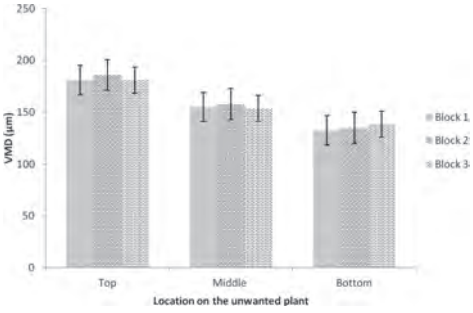


Fig. 6 Effect of plant density on spray impacted at different blocks- soil surface

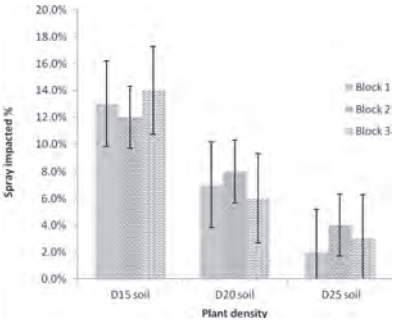


Fig. 7 Effect of plant density on spray impacted at different blocks- corn plant

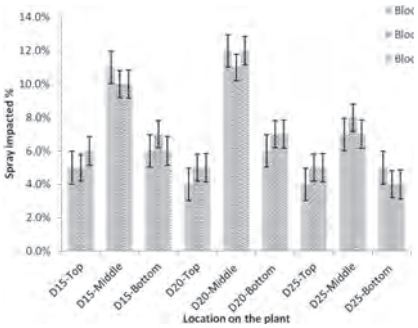
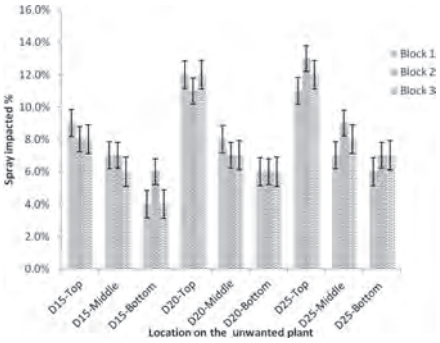


Fig. 8 Effect of plant density on unwanted spray impacted at different blocks



there are no significant differences between blocks in volume median diameters for all data that collected from the soil surface, plant, and unwanted at different locations.

Effect of Spray Impacted:

Spray impacted results in % for different locations on soil, plant intended and unwanted plant are presented in **Figs. 6, 7**, and **8**. Results showed significant differences in spray impacted. Higher spray impacted observed on unwanted plant on the top location of 12% than other treatments. Also, results indicated spray impacted inside both of plant and unwanted showed that the spray impacted decreased with plant and unwanted density. The decreased in spray impacted of white card papers was shown at each block with increasing plant and unwanted plant density. Results also indicated no significant differences in the blocks in spray impacted values for all data collected from soil, plant, and unwanted at different locations.

Effect of Spray Deposition

As shown in **Figs. 9, 10**, and **11** the results for herbicide spray deposition showed significant differences among spray deposition on soil surface, plant, and unwanted plant densities. Results also induced reduce in ground deposition when increasing in the density of both of plant and unwanted. More herbicide deposition observed on the top of unwanted plant 0.029 $\mu L.cm^{-2}$ than the other locations of plant and soil surface. The portion of Spray deposition was also compared between different parts of the plant and unwanted plant, while spray deposition did not appear any differences in the blocks for soil surface, plant, and unwanted plant.

Relation Between Spray Deposition and Biological Efficacy

As shown in **Fig. 12** biological efficacy of herbicide treatment to kill different types of unwanted plant found with corn plant. Higher biological efficacy observed with Prickly alhagi with no significant differences with al hali weed. On the other hand, a reduction in biological efficacy was appeared in some type of weed types.

Fig. 9 Effect of plant density on soil spray deposition at different blocks

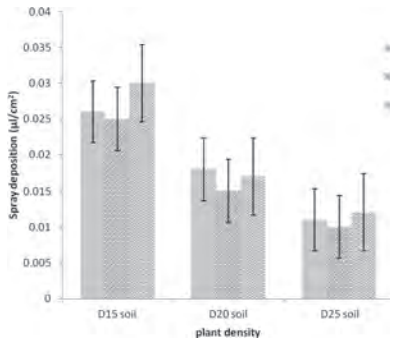


Fig. 10 Effect of plant density on corn plant spray deposition at different blocks

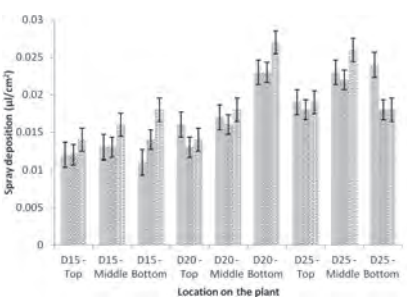


Fig. 11 Effect of plant density on unwanted spray deposition at different blocks

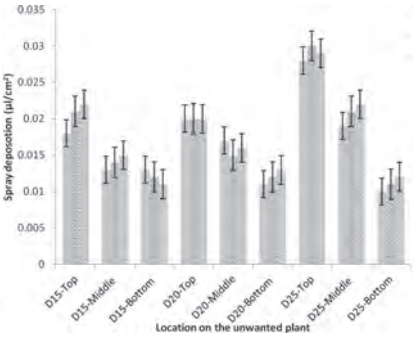
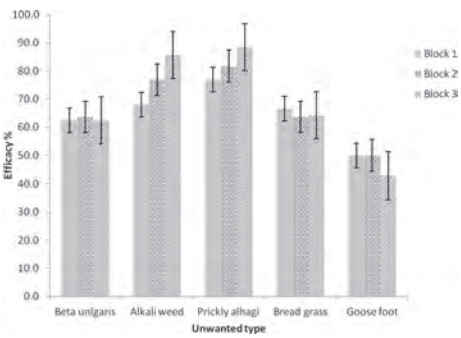


Fig. 12 Biological efficacy of herbicide on unwanted plant types at different blocks



Conclusions

In this study, three parameters were studied as volume median diameter, spray deposition, and spray impact collected on the white card papers from three locations on soil surface, corn plant, and unwanted. Larger values of volume median diameter, spray deposition, and spray impacted observed on the top of unwanted location than other treatments. Increasing of the variation in spot droplet diameter showed with increasing in the size of large spot. Increasing understanding of spray quality as droplet size, volume median diameter involved in the different stages on both of plant intended and unwanted plants and has delivery results in significant differences in herbicides applications. Higher spray deposition and spray impacted observed on the top of unwanted than other locations. Also, lower spray deposition and spray impacted of herbicide amount measured on the top of corn plant and soil surface especially with increasing of plant and unwanted density. According to above mentions, it is an important point to orient nozzle spray on the target for improving spray deposition, spray impacted, and volume median diameter. The results also showed higher biological efficacy with Prickly alhagi with no significant differences with al hali weed. On the other hand, a reduction in biological efficacy was appeared in some type of weed types like goose foot.

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