COMPARATIVE EFFECTIVENESS OF DIFFERENT SPRAYERS AGAINST COTTON WHITEFLY (BEMISIA TABACI GENN.)

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ABSTRACT
The utmost essential and vital textile fiber throughout the world is Cotton (Gossypium hirsutum L.) that accounts in the world's total fiber production over 40%. Despite the fact that around the world about 80 countries produce cotton in which Pakistan is one of the ancient homes of cultivated cotton. Cotton is considered as “white gold” for Pakistan. Present research was conducted at Entomological Research Institute, Ayub Agricultural Research Institute, Faisalabad during 2018-19. A comparative evaluation of effect of tractor mounted boom spraying on droplet density and bio-efficacy were observed and comparison was made between different sprayers i.e. tractor mounted boom sprayer (TMB), battery operated knapsack sprayer (BOK), hand operated knapsack sprayer (HOP), power operated knapsack sprayer against whitefly on cotton crop. It was found that on an average droplet density by TMB sprayer was significantly high (p=0.00) 296, 256 and 244 droplets cm² by HOK, BOK and POK at top, middle and bottom, respectively. On an average bio-efficacy of tractor mounted boom sprayer was more (88.15, 84.47 and 55%) after 3, 7 and 15 days of spray, respectively than other three sprayers viz. HOK, BOK and POK. Tractor mounted boom and bio-efficacy was found efficient as compared to the other spraying techniques.

KEYWORDS: Whitefly; sprayers; efficacy; cotton; entomology; Pakistan.

INTRODUCTION
Globally cotton, (Gossypium hirsutum L.) is renowned as imperative commercial cash crop. Cotton always plays vital part in Pakistan’s economy because it is responsible for providing raw material for textile industries, ginneries and oil expelling factories (Iqbal et al., 2002). The excess lint cotton is also exported in addition providence of the raw materials for textiles industry. Cotton also arrange for fiber, edible oil and feed. It gives raw material to oil expellers, textile mills and to the ginning factories (Bakhsh et al., 2005). About 60 percent of Pakistan's overseas earnings are from its cotton and its by products. Pakistan’s economy is greatly dependent either on cotton or its derivatives (Bakhsh et al., 2009; Sial et al., 2014). In year 2019, cotton accounted for 5.2% of value added in Agriculture and around 1% GDP of Pakistan. The low production of cotton is mainly due to pest infestations and reduction in area sown under cotton crop (GoP, 2019). Sucking insect pests that include jassid, whitefly and thrips are extremely notorious to cotton and cause 40 to 50% crop damage (Naqvi, 2017).

The most commonly applied method for the protection of trees and crops against insects and diseases in agriculture is the use of pesticides (Abhilash and Singh, 2009; Mostafaie et al., 2009). The main tool and an integral part of Integrated Pest Management (IPM) program is the reduction of the losses caused by the cotton crop insect pests (Gogi et al., 2006). In an IPM program, selecting a correct plant protection appliance is as significant as the application of best recommended insecticide. Farmers strive for cost effective, versatile and reliable equipment for spray (Gowda et al., 2007). Several methods of spraying are available to protect the crops from insect pest. On the basis of volume application rate there are three types of sprays “HV spray, ULV spray and LV spray”. The high-volume sprayer leads to spray loss due to larger size of droplets and more volume application rate, and low volume sprayer considerably increases the bio-efficacy by better deposition but predominant to spray drift. The third method comes in optimum range of droplet size and bio-efficacy but there is no control over drift which leads to environmental pollution and chemical loss (Piche et al., 2000). The modern spraying concept is to spray target pests more proficiently with the selection of highly operative equipment having greater density of droplets for maximum coverage and retention. The droplet size reduction also improves overall coverage by increasing droplets number with same rate of
volume application as if there is no problem of drift than decrease in the droplets size increase coverage and retention (Patel et al., 2016). Ever since insufficient information is available on comparative effectiveness of various sprayers in the cotton therefore, current study obliged for evaluation of comparative performance of various sprayers.

**MATERIALS AND METHODS**

A trial for evaluation of four different sprayers viz: knapsack sprayer (Hand operated), knapsack sprayer (Battery operated), knapsack sprayer (Power operated) and tractor mounted boom sprayer were used for spraying on cotton crop at Entomological Research Institute Faisalabad, Pakistan during kharif season 2018-19. The crop geometry was as row to row and a plant to plant spacing was 75 and 30cm, respectively.

**Description of sprayers used in study**

The hand operated knapsack sprayer (HOK) is a manually operated equipped with water tank of capacity 15L and adjustable pump levers with a piston pump. The length of spray wand is about 50 cm. Battery operated knapsack sprayer (BOK) equipped with a rechargeable LED battery and 18 L water tank. The length of plastic spray wand is 50 cm and equipped with powerful 12 volts pump that is switchable to 2 steps with up to 3-4 bar pressure. The power operated knapsack sprayer (POK) is operated by a 2-stroke engine, equipped with 18 L water tank. Operational pressure of pull push piston pump extents up to 20 bar empowering this unit to provide finest spray with rate of flow up to 1.9 litre per minute. The length of spray wand is 50 cm. The tractor mounted boom sprayer (TMB) is equipped with a water tank of capacity 600 L, triple piston pump having discharge 70 litre per minute. It is equipped with a PTO shaft driven hydraulic pump.

**Field evaluation protocols**

Evaluation of sprayer was done at 75 days after sowing of the crop, when there was full coverage of the ground by plant canopy and it was ensured that the whitefly population was above Economic Threshold Level (ETL). Performance of tractor mounted boom sprayer was compared with of POK, BOK and HOK sprayers. After application of insecticide, the data regarding insect mortality was recorded by monitoring whitefly population from lower side of three fully formed leaves of the upper canopy before 10 am at interval of 3, 7, 15 days after spray (Shera et al., 2015). The % mortality that is stated as the percentage efficacy of sprayer was corrected with the help of Abbott’s (1925) formula.

\[
\text{Corrected mortality (\%)} = \left(1 - \frac{\text{Insect population after treatment}}{\text{Insect population in control}}\right) \times 100
\]

The percent mortality data was converted in square root transformation; as per transformation rule two (Gomez and Gomez, 1983). Data of mortality was subjected to statistics 8.1. Significant differences among means were separated by using Tukey’s HSD test (Steel et al., 1997)

**RESULTS AND DISCUSSION**

**Droplet density**

The results of droplet density by water sensitive paper are shown in (Figure 1). The droplet density measured in the laboratory on upper side of the top, middle and bottom leaves were 296, 256 and 244 droplets cm\(^{-2}\), respectively for the TMB. The droplet densities on top, middle and bottom canopy were 82.56, 74.6 and 56.25 droplets cm\(^{-2}\) for HOK sprayer, 100, 92 and 85 droplets cm\(^{-2}\) for BOK sprayer, 135, 114 and 101 droplets cm\(^{-2}\) for POK sprayer, respectively. The overall results revealed that on an average, droplet density on the canopy by TMB was significantly (p=0.00) higher than HOK (p=0.0003), BOK (p = 0.0048) and POK (p = 0.0071) sprayer, respectively at 5% level of significance.

**Bio-efficacy**

The noted population abundance of B. tabaci and percent efficacy of various sprayers have been presented in Table 1 and 2. After spray, mean population...
Effectiveness of different sprayers against whitefly 

of *B. tabaci* ranged from 6.67 to 7.07 and 5.20 to 6.00 plant⁻¹ during 2018 and 2019 respectively. After 3 days of the spray, lower most population plant⁻¹ (1.07) and uppermost mortality (87.51%) were documented with TMB sprayer which is significantly higher by HOK (77.03%), BOK (79.82%) and POK (83.65%) during 2018 and same trend was observed during 2019. After 7 days of spray, insects killed by TMB were significantly higher (82.96%) POK (79.28%), BOK (76.56%) and HOK (74.67%). After 15 days of spray, insects killed by TMB sprayer were significantly higher than insects killed by POK (44.76%), BOK (39.62%) and HOK (30.82%) during 2018 and similar trend was observed in 2019. Both sprayers (BOK, HOK) were statistically at par to each other at 15 days after spray.

On an average data explicitly showed that the insect mortality i.e % mortality that is stated as percent efficacy of sprayer, by TMB were significantly (p = 0.0008) higher 88.15, 84.47 and 55% with high no. of droplet density (296, 256 and 255 cm⁻²) and bio-efficacy (88.15, 84.47 and 55%) was more as compared to HOK, POK and BOK sprayers. Due to promising spraying effects and higher working efficiency, the boom sprayers are mostly used for crops of big farms. The density of droplets was narrowly correlated to percent efficiency of sprayer, as the droplet density increases the % mortality of insect also increases.

Table 1. Bio-efficacy of different sprayers against *Bemisia tabaci* on cotton during 2018.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Whitefly Population/Leaf</th>
<th>1DBA</th>
<th>3DAA</th>
<th>7DAA</th>
<th>15DAA</th>
<th>3DAA</th>
<th>7DAA</th>
<th>15DAA</th>
<th>3DAA</th>
<th>7DAA</th>
<th>15DAA</th>
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<tbody>
<tr>
<td>BOK Sprayer</td>
<td></td>
<td>7.07</td>
<td>1.71</td>
<td>2.67</td>
<td>6.23</td>
<td>79.82</td>
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<td>41.45</td>
<td>77.03</td>
<td>79.28</td>
<td>45.15</td>
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<td>POK Sprayer</td>
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<td>6.67</td>
<td>1.40</td>
<td>2.36</td>
<td>5.87</td>
<td>83.65</td>
<td>79.28</td>
<td>45.15</td>
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<td>79.28</td>
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<tr>
<td>Boom Sprayer</td>
<td></td>
<td>6.78</td>
<td>1.07</td>
<td>1.93</td>
<td>4.10</td>
<td>87.51</td>
<td>82.96</td>
<td>61.36</td>
<td>83.65</td>
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<td>61.36</td>
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<tr>
<td>Check</td>
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<td>6.39</td>
<td>8.53</td>
<td>11.36</td>
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<td>S. Em. ±</td>
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<td>0.5126</td>
<td>0.2220</td>
<td>0.1911</td>
<td>0.2966</td>
<td>0.0851</td>
<td>0.0579</td>
<td>0.1894</td>
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</table>

DBA- Day before application, DAA-Day after application, Figures in parenthesis are square root, transformed values, Means in same column show similar alphabets are on par.

Table 2. Bio-efficacy of different sprayers against whitefly (*B. tabaci*) on cotton during 2019

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Whitefly Population/Leaf</th>
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<th>3DAA</th>
<th>7DAA</th>
<th>15DAA</th>
<th>3DAA</th>
<th>7DAA</th>
<th>15DAA</th>
<th>3DAA</th>
<th>7DAA</th>
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<td>77.03</td>
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</tr>
<tr>
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<td>LSD (0.05)</td>
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<td>0.30</td>
<td>0.75</td>
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<td>0.17</td>
<td>0.58</td>
<td>0.17</td>
<td>0.17</td>
<td>0.58</td>
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</tbody>
</table>

DBA- Day before application, DAA-Day after application, Figures in parenthesis are square root transformed values, Means in same column show similar alphabets are on par.

Conclusion

Tractor mounted boom sprayer was efficient with droplets density (296, 256 and 255 cm⁻²) and bio-efficacy (88.15, 84.47 and 55%) was more as compared to HOK, POK and BOK sprayers. Due to promising spraying effects and higher working efficiency, the boom sprayers are mostly used for crops of big farms. The density of droplets was narrowly correlated to percent efficiency of sprayer, as the droplet density increases the % mortality of insect also increases.
Efficiency could be enhanced with decrease in the droplet size that increases droplet density: make the spray deposition better on the target.

REFERENCES

S. No. | Name of Author | Contribution | Signature
--- | --- | --- | ---
1. | Khawar Jawad Ahmed | Supervised in planning and execution of this study |
2. | Qurban Ali | Designed the structure of manuscript |
3. | Imran Nadeem | Provided technical assistance for the experiment |
4. | Muhammad Faheem Akhtar | Performed the experiment |
5. | Najuf Awais Anjum | Edited the manuscript |
6. | Aqsa Abbas | Collected and analysed the data |
7. | Muhammad Kashif Hanif | Critically reviewed the manuscript |