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APPLICATION OF DROPLEG TECHNOLOGY FOR PIPER SPRAYING

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Abstract

Pepper, as a vegetable crop grown primarily for nutritional purposes, is valued for its taste and content of vitamins and minerals. It is consumed both raw and processed. Weeding of vegetable crops leads to a decrease in yields, a deterioration in the nutritional quality of production, a decrease in the efficiency of operation of agricultural machinery and to financial losses of the farmer. There is currently no suitable herbicide that is effective against weeds from secondary weeding and is selective for the crop. There is also no data on the implementation of Dropleg pepper technology. This article addresses issues related to the biometrics of the piper plant and the application of Dropleg herbicide application technology with two types of TeeJet 15003 and TeeJet 11003 nozzles located 0.15 m, 0.20 m and 0.25 m from the soil surface. The optimum height at which there is no risk of treating the pepper leaf mass of the TeeJet 15003 is proven to be 0.20 m and for the TeeJet 11003 it is 0.25 m with a transverse irregularity of less than 5%.

***Key words**: biometrics, Dropleg technology, herbicide spraying, pepper.*

INTRODUCTION

Pepper is valued for the very high nutritional, dietary and taste qualities it possesses. They are determined by the content of sugars (glucose, fructose, sucrose), acids, mineral salts, vitamins and pectic substances. Vitamin C is ranked first among vegetables and even outnumbered 4-5 times by lemons. Practical studies and results show that weeds can cause a sharp decrease in vegetable yields of up to 70% and a deterioration in product quality (Velev B., 1984). In addition, weeds indirectly impair the mechanical cultivation and harvesting of these crops, reduce the productivity of the machines and impair the quality of their work. In peppers, secondary weeding with deciduous weeds is a major problem, as there is no suitable herbicide that is effective against weeds and at the same time is selective for the crop (Dospatliev L., 2012). Alternative spraying is possible with proper support of the spraying system parameters and selection of sprayers.

Such spraying is possible with the so-called Dropleg technology. The main difference from the conventional spraying method is that the Dropleg method allows spraying to be in the plant population rather than as usual from above. The idea is not new (Struck A., https://www.hofheld.de/kurz-erklaert-dropleg-system/). It was first applied in the 1950s in vegetable production. Today, technology is also applied to row and field crops (Hausmann J. et al., 2019; Heimbach U. et al., 2016).

The type and caliber of the nozzles for the Dropleg system can be selected according to the type of operation (Rüegg J., Total R., 2013). Deflector nozzles, for example, can be adjusted in such a way that fungicides and insecticides are sprayed on parts of plants that are difficult to spray, such as the lower leaves and shoots. The drop system can also be fitted with a wide-angle nozzle that points to the ground. This allows spraying of herbicides under the lowest layer of the leaves of the plants with minimal impact on the crop (eg maize, sugar beet, potatoes).

The authors (Kunz C. et al., 2015) observed the effect of herbicide sprays in sugar beet when applying various technical solutions. It has been found that the strip application of herbicides (Dropleg system) in combination with row spacing leads to a reduction in the amount of herbicide used by about 50 to 75%. Weed control efficiency with conventional herbicide treatments is 72%, with a combination of row spacing and band spraying up to 87% and 84% with precision plowing using RTK control.

The reason for the limited application of Dropleg so far is the large initial investment.

They are justified for farmers cultivating large areas. It becomes more interesting financially when the strengths of the technology are used in other crops - to combat weeds in sugar beet and corn. (https://www.iva.de/iva-magazin/forschung-technik/droplegs-applizieren-pflanzenschutzmittel-genauer).

Weed control is tolerable for these crops because the preparation does not fall on their leaves. Another added benefit of the Dropleg system is its low wind susceptibility. If the wind blows more than 5 m/s, conventional measures should be avoided as the drift is too large. Under these conditions, air movement is almost absent in the plant population. The time intervals for drug applications are increasing and machines may be better used.

The authors' research (Byass J., Lake J., 1977) shows that drift increases rapidly with both wind speed and barbell height. It is concluded that it is possible to establish a safe distance from the peaks downwards for the application of a herbicide, without prejudice to the plants grown.

There are three options for maintaining the set height permanently: by fixing the hydraulic system of the spreader system - a disadvantage in this variant is that the irregularities in the length of the working stroke have a strong influence on the actual height of the rod system; the second option is by mounting limiters (with sliders or wheels) to the boom. Restraints copy the terrain and maintain the set height of the unit; the third option is the use of laser tracking systems for the height of the bar. They are integrated in the modern sprayers and allow very precise maintenance of the set height. Unfortunately, these extras make the whole sprayer expensive.

When the height of the bar is changed by 0.10 m due to the sprayer wheel being hit in a pit, on a stone or in a track when working with a pesticide in a field with a lower stem than when adjusting, the norm in the area of overlapping of the torches increases with to 40%, while in other zones it decreases by about 30% (Redkozubov I., Rotenberg Yu., Raskatova T., 2012). This fact leads to a decrease in yield due to insufficient weed control in the underweight areas and possible overdose toxicity. The height of the bar has a particularly strong influence when working with low or minimum standards of preparation. In addition, increasing the height of the bar over 0.10 m increases twice the loss of detergent due to drift, which further increases in high winds.

The transition from the 80-90º spreaders to the 110-120º spreaders allows the chancel height to be reduced by about 0.25 m and to reduce the loss of drift.

Another huge benefit of using the Dropleg system is the protection of bees and other pollinators from the harmful effects of pesticides (https://www.iva.de/iva-magazin/forschung-technik/droplegs-applizieren-pflanzenschutzmittel-genauer; https: //beecare.bayer.com/; Heimbach U. et al., 2016). The agricultural industry is constantly looking for ways in which bees can be effectively protected as farmers take advantage of the results of their pollination. In addition, a healthy bee is a symbol of a healthy environment. As a result, Dropleg technology has returned to the focus of plant protection and conservationists. The pesticides are not sprayed on top of the flowers, but approximately 0.40 m below the broad rapeseed color belt (https://www.lechler.com/de-en/products/product-highlights/dropleg/).

Thanks to the technology used, they are applied in this area by treating the leaves and stems of the plant. As a result, there is virtually no measurable pesticide residue in the honey studied, even with the best analytical techniques.

To sum up, the use of the Dropleg system in the field of crop and vegetable protection has a number of positives. There is no evidence of pepper treatment in the literature reviewed. The purpose of this development is to specify the parameters of a Dropleg herbicide treatment system in pepper plantations.

MATERIALS AND METHODS

In order to achieve this objective, it is necessary to specify the biometric characteristics of the pepper plants, the performance of the spreaders used and the parameters of the spreader system for the treatment of the observed plants. In solving the tasks assigned, a dimensional characteristic of the pepper plants is performed, observing the indicators determined according to the Figure 1.

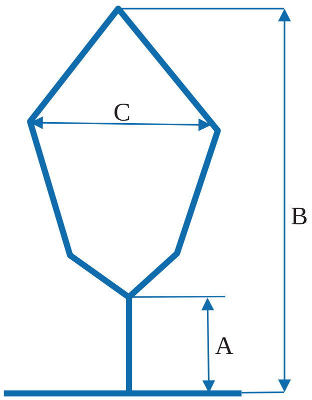

Figure 1. Schematic of a pepper plant:
A - height of the stem to the first branches, m;
B - total height of the plant, m;
C - maximum width of shrub, m

For this purpose, measurements of 100 randomly selected plants are made and the obtained results are statistically processed by determining the mean, variance and coefficient of variation for each of the indicators monitored (Mitkov A., Minkov D., 1989).
In the present work, observations are made with 2 spreaders, the first of which is the traditional LP TeeJet 11003 flat-jet spreader with a spreading angle of up to 110° - №3. The second is the TeeJet 15003 with 2 eccentric jets, with a spreading angle of 150° - also №3.
The following parameters are the width of the torch and the distribution of the working fluid along the width of the torch, depending on the height of the sprayer, at a pressure of 0.3 MPa.
The experiments are carried out at a stand in the Department of Mechanization at the Agricultural University - Plovdiv (Trifonov A., Petrov P., 2000). To determine the uniformity of the distribution of the working fluid, depending on the height, a series of experiments are performed, each in 3 repetitions. With the results of the bench tests of the working fluid distribution by width, histograms were constructed for the two dispensers in Excel media.
The distance between the individual boom spreaders is 0.50 m as standard. The work of the entire boom system is imitated. For this purpose, each histogram is shifted left and right by 0.50 m, and the newly received quantities are added together.
Once the size and shape of the torch have been determined for both spreaders, their height should be determined so that the leaves of the cultivated plants are not affected by spraying. For this purpose, the two figures (modeled-Figure 1) of the plants at the two-row band and the figures for the shape of the torch at the individual spreaders are superimposed on each other.
On the basis of the dimensional characteristics of the observed plants and the statistical characteristics of the distribution of the working fluid of the sprayers used, the height of the arrangement of the bar and the length of the extensions is determined so that spraying results in good work quality without affecting the leaf mass of the plants.

RESULTS AND DISCUSSIONS

Biometric indicators of the observed pepper plants (Table 1, Figure 1)
After observations were made regarding the dimensional characteristics of pepper plants, the data obtained were processed using the Statistica 7 software product and are presented in tables and graphs below.

Table 1. Biometric indicators

Descriptive Statistics				
Tracked metrics	Number of observations	Average value, cm	Dispersion	Coefficient of variation
A	100	22.90	2.23	9.74
B	100	65.50	7.28	11.11
C	100	34.60	4.50	13.01

The data shows that the average plant height is 0.655 m, with variation around this value being ± 0.0728 m. In this situation, the most developed plants are about 0.75 m high. In order not to injure the peaks and halt their development, the boom must be at least 0.30 m above them.

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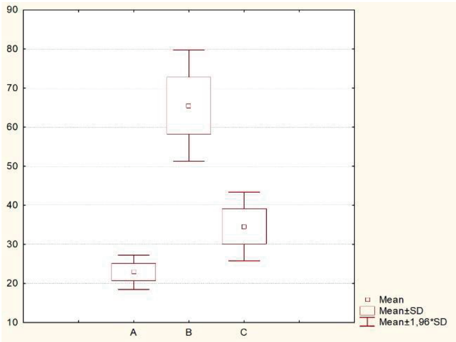

Figure 2. Graphic representation of the biometric indicators monitored

From what has been said here, it is necessary that the distance from the soil to the boom when under pepper treatment is approximately 1.00 m.

Torch width

This indicator is logically influenced by the height of the sprayer. The data from the bench tests for the two spreaders are shown in the Table 2.

Table 2. Torch width, m

Spreader height, m / Sprayer type	0.15	0.20	0.25
TeeJet 15003 (eccentric)	0.80	1.10	1.30
LP TeeJet 11003 (ordinary)	0.70	0.80	0.90

It is seen that as the height of the sprayer increases, the width of the torch or the area under cultivation increases.

The geometric representation of the torches of the two spreaders is shown in the Figure 3.

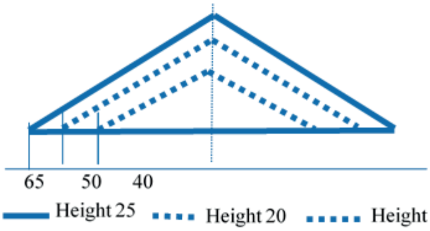

Figure 3. Torch size for TeeJet 15003 (eccentric)

The Figure 4 shows the torch of a conventional LP TeeJet 11003 slit sprayer.

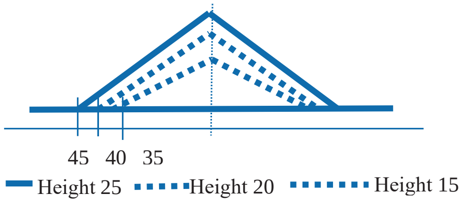

Figure 4. Torch size for LP TeeJet 11003

Height available for sprinklers

With a TeeJet 15003 sprayer, a height of 0.25 m is not appropriate because the jet passes very close to the sprayed plant and only a slight deviation from the ideal shape will cause damage to the cultivated crop. Therefore, a height of 0.20 m is more appropriate for this sprayer.

With the LP TeeJet 11003 sprayer at 0.25 m height there is no problem for the sprayed plants (Figure 5).

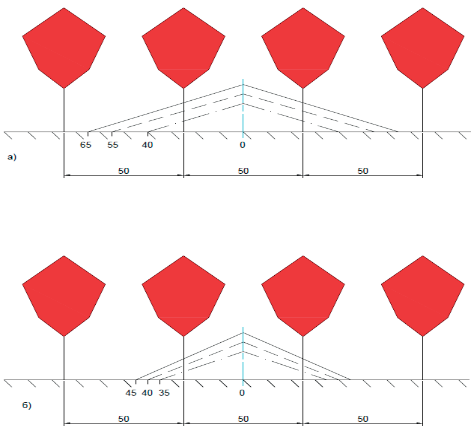

Figure 5 a, b. Arrangement of sprayer and sprayed plants

Even distribution of the working fluid

Under these conditions, the liquid distribution is as follows:

<u>- For TeeJet 15003 sprayer</u>

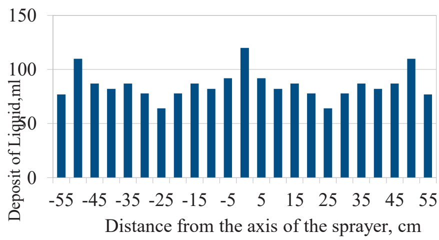

Figure 6. Transverse distribution of the fluid over the working width of the sprayer

The Figure 6 shows that there are no large peaks and drops in the distribution of the liquid. Only at the axis of the sprayer and 0.05 m there is a slightly larger amount of liquid, but this is logical since the largest spray occurs below the sprayer itself, and the next two adjacent sprayers are located at 0.50 m.

The observed statistical estimates have the following values: average value - 85.56; dispersion - 2.81; coefficient of variation - 3.29.

- For LP TeeJet 11003 sprayer

As can be seen from the Figure 7 there are no large peaks and drops in the distribution of the liquid. Only 0.05 and 0.45 m have a slightly larger amount of liquid.

The observed statistical estimates have the following values: - average - 93.26; dispersion - 3.34; coefficient of variation - 3.58.

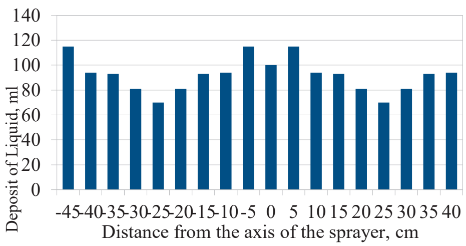

Figure 7. Transverse distribution of fluid over the working width of the sprayer

The results of monitoring the two spreaders give us reason to believe that there is a very good distribution of the working fluid across the width of the torch, which is a guarantee for good coverage of weeds with herbicides and their safe disposal.

CONCLUSIONS

The following conclusions and recommendations can be made on the basis of the experiments carried out, the processing of their results and analyzes:

The height of the pepper stem varies from 0.20 to 0.25 m and the total height of the plant varies from 0.55 to 0.75 m;

The width of the torch depends on the height of the spreader;

The optimum height at which there is no risk of treatment of the pepper leaf mass is 0.20 m for the Tee Jet 15003 and 0.25 m for the LP TeeJet 11003;

The transverse irregularity of both sprayers is below 5%, which is a guarantee for good herbicide coverage and weed control.

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