AGRICULTURAL SCIENCE AND TECHNOLOGY, VOL. 16, No 2, pp 54-59, 2024
Published by Faculty of Agriculture, Trakia University, Bulgaria
ISSN 1313-8820 (print)
ISSN 1314-412X (online)
http://www.agriscitech.eu
DOI: 10.15547/ast.2024.02.017

Production Systems

Analysis of the main parameters affecting the rate of consumption in sunflower spraying

G. Tihanov*

Department of Agricultural Engineering, Faculty of Agriculture, Trakia University, 6000 Stara Zagora, Bulgaria

(Manuscript received 6 February 2024; accepted for publication 15 May 2024)

Abstract. *Analysis of the consumption rate when spraying sunflower with a self-propelled sprayer Horsch Leeb 5.300 VN has been made. By using data from the Horsch Telematics system, data have been downloaded from which the actual operating speed of the self-propelled sprayer during spraying has been determined. The consumption rate per hectare of 200 l/ha has been studied and the factors that cause the fluctuation in the set consumption rate for spraying have been determined. The set spray pressure value has been found to vary from 1.53 to 4.57 bar. Analysis of the sprinkling height of the working solution onto the plants has been presented, which is quite small - 40 cm on average. This is quite possible because there is a 4-2 distribution of sprinklers, i.e. 4 /four/ sprinklers at a distance of 50 cm from each other and 2 /two/ intermediate sprinklers at a distance of 25 cm. This allows the boom wings to drop as low as possible to the plant during spraying. Analysis of the performance indicators of the self-propelled sprayer has been made. It can be seen that upon entering the field, the sprayer had been spraying at an operating speed of 11.57 km/h and the set pressure had been 4.76 bar, and at the time of visualization, it was lower - 4.43 bar. When spraying inside the field, the sprayer sprayed at 20-25 km/h, fully complying with the spraying consumption rate with 99% accuracy. We also have perfect consumption rate compliance and automatic pressure and sprinkler regulation.*

Keywords: spraying, telematic systems, self-propelled sprayer, consumption rate, deviation from the consumption rate, height of spraying to the plants

Introduction

Plant protection processes are applied mainly during the plant vegetation period and aim at creating more favourable conditions for plant growth and development (Kolev, 1999; Tihanov, 2021). According to other authors, mechanized plant protection technologies enhance labour productivity, decrease relative costs for carrying out the operations, improve the work conditions of the operators and contribute to reducing the adverse environmental impact (Dragoev and Stratiev, 2016; Nikov et al., 2017). The management of insects and diseases relies on chemical control capabilities (Derksen et al., 2007). Given the relatively low chemical capacity for pest management, it is crucial to make effective use of pesticides (Kehayov et al., 2020).

Modern agricultural machinery is equipped with telematics tools for data collection. Manufacturers continuously collect various indicators of machine operations, which are transmitted to centralized

---

*e-mail: galin.tihanov@trakia-uni.bg

databases wirelessly. A huge advantage of this system is that the data is transmitted automatically. Telematics can be broadly described as data measured and viewed remotely. Limited wireless internet connectivity hinders the full use and effectiveness of precision agriculture practices and subsequent big data systems in agriculture (Markov and Tihanov, 2023). In order to use the telematics data, access to the data collected from it should not be publicly available, such as login names and passwords. In many cases, a farmer has access to telematics data for his own farm machinery, but to analyse a broad sample a greater input complexity involving more than one fleet of farm machinery per owner is needed. There are several manufacturers of telematics systems on the market: AGCO Ag Command, John Deere JD Link, Claas Telematics, Raven Slingshot and Trimble Connected Farm. These systems are considered closed systems because each manufacturer has a connection between the machines they produce and the servers where the data are stored (Oksanen et al., 2016).

The telematics system stores various data sets, such as the exact location of the machine, the time, idle time and operator actions. Accordingly, the possibilities for data collection and analysis are promising (Van Hampton, 2015). In addition, the cumulative indicators of the machine, such as temperature of various fluids and critical engine errors, are critical (can destroy the engine, etc.). In fact, such data monitoring can directly affect the longevity of machinery as well as benefit the farmer. Obviously, the amount of data stored in the telematics systems (and the need for analysis) will increase significantly in the coming years, which will be especially relevant during inefficient agricultural years marked by unfavourable weather conditions and expensive fertilizers, pesticides, etc. Furthermore, the ever-increasing competition requires appropriate solutions to reduce the associated costs of agricultural production (Mark et al., 2016).

Telemetry systems are some of the most innovative technologies in precision agriculture and represent a mechanism for automatic remote collection and analysis of information and transmission of control commands based on these data. It is known that incorrect sprinkler settings will result in significant underutilization of their capabilities. According to some authors, the optimal settings of the sprayer are: travel speed 5.9 km/h, system pressure of 7.0 and 13.0 bar and two types of sprinklers (Zahariev, 2023). The efficiency of agricultural machinery also depends on the human factor - the labour productivity of different operators under the same conditions can differ by up to 40 per 100. Telematics systems support the improvement of the result of machine operation, reduction of material and time costs for organizing control of the work, collection, processing and analysis of data on the progress of execution of technological processes. Today, they are offered by many manufacturers of agricultural machinery.

The objective of the present article is to analyse the cost rate of sunflower spraying by using the Horsch Telematics system.

Material and methods

The survey was carried out in May 2023 during spraying of sunflower (*NK Neoma* variety). The soil type is chernozem vertisol. The research was carried out with a *Horsch Leeb 5.300 VN* self-propelled sprayer shown on Figure 1 (https://www.agrotron.bg/bg/produkti/samohodna-pryskachka-leeb-vl/90).

Figure 1. Overview of the self-propelled sprayer

The study of field characteristics, agronomic data and performance indicators during sunflower spraying was carried out by employing the *Horsch Telematics* system. During the spraying of the sunflower crop, we accessed the *Horsch Telematics* system through the farm agronomist. The data were downloaded from the system, imported and merged into a database.

The tested areas were pre-measured and indicated in the tractor's navigation system. Together with the agronomist, a solution rate of 200 l/ha was determined. Spraying was carried out with 03, 04 blue and red Aixr teejet windproof sprinklers.

Observations were made via *Horsch Telematics* thanks to the *Horsch Connect* receiver. Through it, the data about the self-propelled sprayer have been consulted in *Horsch Connect Telematics*. To this end, we used the *Horsch Mobile Control* app via the mechanic's mobile device. Via integrated *WLAN* and *GPS* modem, the *SmartCan* hardware solution, the smartphone was connected to the self-propelled sprayer. The built-in memory card ensured we could save the data in case there was no internet coverage. Machine data visualization and documentation was done at telematics.horsch.com. Of great importance for the privacy protection of personal data, these were handled in compliance with all applicable data protection laws (BGSG, EU-DS-GVO).

Results and discussion

Figure 2 shows the actual operating speed of the self-propelled sprayer as it travelled from the farm to the field, and also the actual operating speed at which it sprayed inside the field. It is evident on the figure that the spraying speed is variable. This was due to the irregular shape of the field. In places it can be seen to be between 8 and 11 km/h.

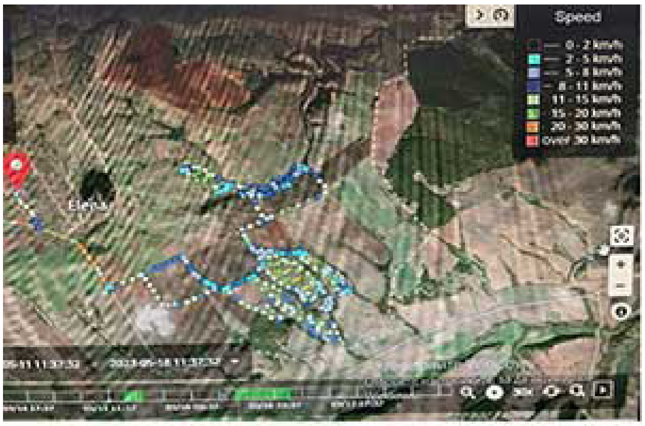

Figure. 2. Actual work speed movement of the self-propelled sprayer

Figure 3 shows the status of sprinklers. It is evident that during spraying there was no error and sprinklers were operable.

Figure 3. Status of sprinklers during spraying

Figure 4 shows the consumption rate per hectare. It is evident from the figure that it is 200 l/ha.

Figure 4. Set consumption rate for the working solution during spraying

Figure 5 shows the deviation from the consumption rate per hectare. One of the main drawbacks of most sprayers is the variation in the set spray rate, as is evident from Figure 5. This is due to a number of factors, one of which is the lack of sophisticated control systems to manage the working solution (flowmeters, velocity sensors, pressure sensors, etc.). Another reason may be due to not good GPS signal and missing ground station to the right signal. A third reason is the highly sloping terrain. A fourth cause is overdosing in the inner part of the turn or underdosing in the outer part of the turn. This problem increases as the length of the bars increases. Overdosing in the inner part should be considered critical as overdose levels of 150% are possible. On all modern sprayers there is now a solution to prevent this problem such as the individual nozzle control option and the active bar guidance option.

Figure 5. Deviation from the set consumption rate

Figure 6 shows the value of the set spray pressure. It is evident from the figure that it is variable, since the self-propelled sprayer automatically changes its pressure according to its actual operating speed. This is in order to maintain the set consumption rate during spraying. If it fails to reach the consumption rate, a sprinkler automatically switches on. It is clearly visible from Figure 6 that pressure varies between 1.53 to 4.57 bar.

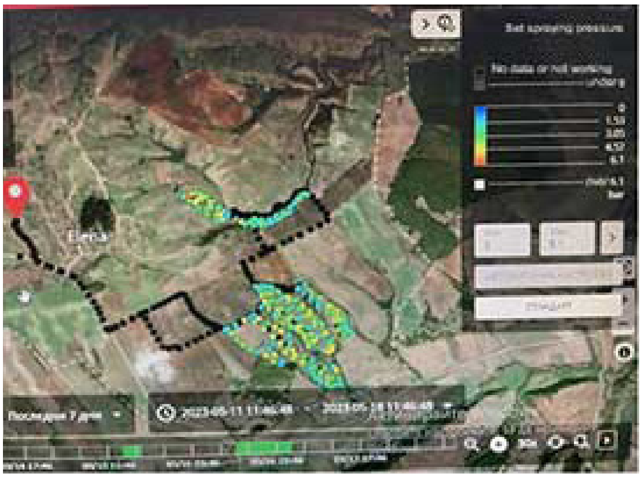

Figure 6. Set spraying pressure

Figure 7 presents an analysis of the spray height of the working solution next to the plant. It can be seen that it is quite small averaging 40 cm. This is absolutely logical because we have a 4-2 sprinkler distribution, i.e. 4 sprinklers 50 cm apart and 2 intermediate sprinklers 25 cm apart. This allows the wings of the bar to drop as low as possible to the plants during spraying. With standard sprayers the distance between the sprinklers is 50 cm and the minimum distance from the plant is 50 cm. In this way, higher precision is achieved during spraying, always aiming to achieve minimum deviations from the target height even with high sprayer operating speed, large bar working width and uneven ground. This is achieved by the sensors installed to monitor the bar height and the hydraulic system, which is highly sensitive.

Figure 7. Distance to the spraying site

Figure 8 presents analysis of the operation indicators of the self-propelled sprayer. It can be seen that the sprayer has an actual operating speed of 11.57 km/h upon entering the field. It can also be seen that the set pressure is 4.76 bar and at the time of visualization, it is lower 4.43 bar.

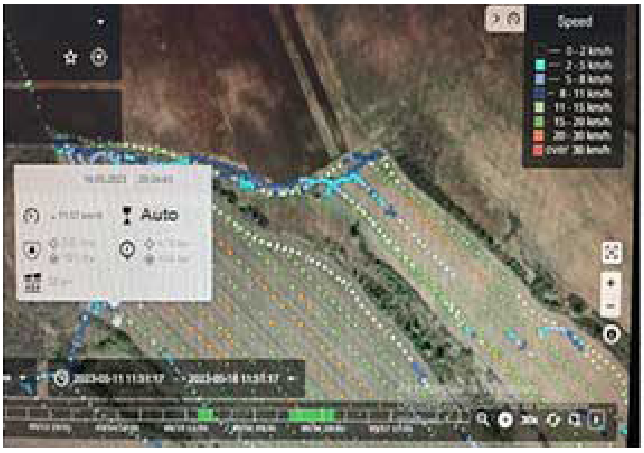

Figure 8. Analysis of the actual operating speed of the self-propelled sprayer upon entering the field

Figure 9 shows the analysis of the operating speed during spraying in the field. From the figure, it can be seen that the set pressure is 4.23 bar, and at the time of visualization here it is already higher

4.32 bar.

From the figure it can be seen that the sprayer can safely develop up to 20-25 km/h during spraying, fully complying with the spray rate with 99% accuracy. We also have perfect compliance with the consumption rate and automatic adjustment of pressure and sprinklers.

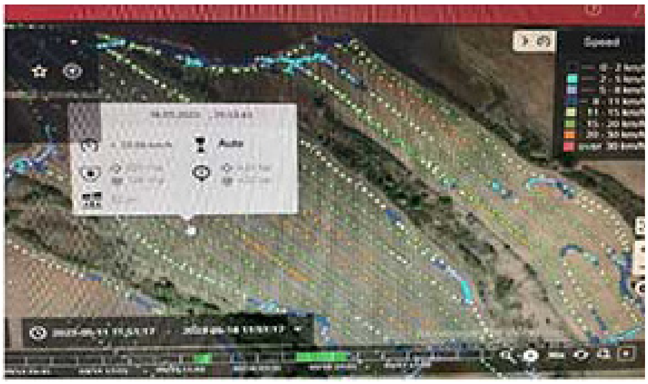

Figure 9. Analysis of the actual operating speed of the self-propelled sprayer upon spraying in the field

Conclusion

It has been established that: (i) The actual speed of the self-propelled sprayer when spraying was found to be variable between 8 and 11 km/h, which was due to the irregular shape of the field. (ii) The consumption rate per hectare of 200 l/ha was investigated and the factors affecting the fluctuation in the set spray rate were identified. (iii) The value of set spray pressure which is variable and varies from 1.53 bar to 4.57 bar has been established. This is quite normal, since the self-propelled sprayer automatically changes pressure according to its actual operating speed. This is in order to maintain the set consumption rate during spraying and if it fails to reach the consumption rate, a sprinkler is to switch on automatically. (iv) An analysis of the spray height of the working solution to the plant has been presented, which is quite small averaging 40 cm. This is quite possible because there is a 4-2 sprinkler distribution, i.e. 4 /four/ sprinklers 50 cm apart and 2 /two/ intermediate sprinklers 25 cm apart. This allows the wings of the bar to go as low as possible to the plant during spraying. (v) An analysis of the operating indicators of the self-propelled sprayer has been carried out. It can be seen that upon entering the field, the sprayer was spraying at an operating speed of 11.57 km/h and the set pressure was 4.76 bar, while at the time of visualization, it was lower 4.43 bar. When spraying in the field, the sprayer was spraying at 20-25 km/h, fully complying with the consumption rate for spraying with accuracy of 99 %. We also have an ideal compliance with the consumption rate and automatic control of pressure and the sprinklers.

References

Derksen R, Vitanza S, Welty C, Miller S, Bennett M and Zhu H, 2007. Field Evaluation of Application Variables and Plant Density for Bell Pepper Pest Management. Transactions of the ASABE, 50, 1945-1953.

Dragoev D and Stratiev N, 2016. Problems of technology in growing wheat, XXV International Scientific Conference „Management and Quality“ for young scientists, 11-12 May 2016, Collection of reports, 24-31 (Bg).

Kehayov D, Palagacheva N and Zahariev I, 2020. Determination the degree of coverage when treating pepper with different types of nozzles. Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering, IX, 266-272, ISSN 2285-6064.

Kolev K, 1999. Operation of the machine-tractor fleet. Dionis Publishing house, Sofia (Bg).

Mark TB, Griffin TW and Whitacre BE, 2016. The role of wireless broadband connectivity on ‘Big Data’ and the agricultural industry in the United States and Australia. International Food and Agribusiness Management Review, 19, A, 43-56.

Markov N and Tihanov G, 2023. Assessing the opportunities to increase economic efficiency through the use of Telematic systems for analysis and control. SHS Web of Conferences, Seventh International Scientific Conference “Business and Regional Development” (BRD, 2023), 176, 03004, 1-7. https://doi.org/10.1051/shsconf/202317603004

Nikov I, Gencheva S, Baeva M and Duchev P, 2017. Analysis of basic technical parameters of boom sprayers. Student Scientific Session of RU “Angel Kanchev”, Ruse, Collection of reports, 59-63, ISSN 1311-3321.

Oksanen T, Linkolehto R and Seilonen I, 2016.

Adapting an industrial automation protocol to remote monitoring of mobile agricultural machinery: a combine harvester with IoT. IFAC-PapersOnLine, 49, 127-131.

Tihanov G, 2021. Study on the productivity of a bar sprayer when spraying wheat. Scientific Atlas – Association: “Perperek Valley”, 3, 86-91, ISSN 2738-7518 (Bg).

Van Hampton T, 2015. Moving Data and Dirt. ENR: Engineering News-Record 274, no. 10: 21. Accessed November 13.

Zahariev I, 2023. Studying the effect of the work on a fan sprayer with two types of nozzles in a hops plantation. Youth forums “Science, Technology, Innovation, Business“, Collection of reports, 128-132, ISSN 2367-8569 (Bg).

https://www.agrotron.bg/bg/produkti/samohodna-pryskachka-leeb-vl/90.