APPLICATION BOOM FOR CHEMICAL PROTECTION OF HOPS GROWN ON LOW TRELLIS SYSTEMS

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Abstract. The paper deals with a design for equipment used for chemical protection of hops grown on low trellis construction. This equipment is tightly fastened to a mistblower which is pulled by an energy means of transport – a tractor. In the experimental part, measurements dealing with irregularity of exit velocity of the air stream coming out of the application frame are described in detail.

Keywords: mistblower, chemical protection, hops.

Introduction

In the Czech Republic hops are grown in three main areas, the Žatec area being the largest, followed by the areas of Úštěcko and Tršicko. Hops are traditionally grown on high constructions, nevertheless, in recent years growers have been testing the usage of low trellis for hops growing. One of the reasons is a substantial decrease in costs of labour force necessary during the spring works. In the world, the low trellis system was adopted about twenty years ago, and nowadays this growing technology has been tested in Europe, too. In the Czech Republic, this low trellis technology has been known for about ten years.

At the present time the Czech Republic occupies the fourth rank as for hops growing acreage. The first rank in hops production is occupied by the USA, the second belonging to Germany, followed by China ranked the third. Hop fields in the Czech Republic cover the area of app. 5.305 hectares which were cultivated by approximately 135 growers in 2009. The trend in recent years is an effort to enlarge the areas with newly planted hops, which should continue in the future.

In the Czech Republic, the first low trellis construction was put up in 1991. At the present time, there are three hop fields with low trellis registered in the Czech Republic (they are the hop fields of Stekník, Hořesedly and Sedčice).

The height of a hop field is three metres. A hop field is planted with a spacing of 300 x 100 cm. Wooden poles are anchored in a depth of 1 metre, their diameter is 10 cm and they are placed in every row of plants. The upper ends of the poles are connected with a tight steal wire which is app. 5 mm in diameter. Another wire is tightened between poles in a height of 25-40 cm above the ground. Between both wires there are hop lines or guide net. In comparison with high trellis system, there is no annual hanging and sticking of hop lines, which can be carried out only app. once every five years with low trellis systems. Vines are self-guided, growing about hop lines, and when they reach the trellis top, they create an overhang. For hop growing on low trellis it is suitable to use specially cultivated species which run to shoots already from the ground and have a minimal overhang in the top part. However, temporarily it is possible to use also some species destined for high trellis systems [1].

For chemical protection of hops a special portal mistblower is developed, which runs between hop rows and in one passage, astride, it can spray one or possibly two neighbouring hop rows from both sides. Harvest is provided by a portal harvester. Hop-picking walls with rod-shaped fingers separate from vines their cones, leaves, and hop shoots. These are gathered in a container and taken to stationary line for separation of individual parts. The vine residues on the hop lines die back, or possibly they are mechanically removed [3].

In hop growing it very often happens that the hop field is infested with hop spider mite, hop aphid, hop mildew of the family Peronosporaceae, and mildew. In low hop fields there is more common the infestation with spider mite. This is due to leaving the vine residues just as they grew on the hop field. That is why there is a threat of hibernation of this plant pest. As for the other diseases there were discovered no differences in comparison with high trellis. It has been proved that the chemical protection of hops grown on low trellis is easier, there are smaller losses due to flight, and savings are achieved also by insecticides [5].

Table 1

Low trellis parameters [5, 6]

Parameter	Size, m
trellis height	2.5-3
pole height	4
pole rows spacing	3
plant spacing	3x1
number of wires for plants	1-2 pcs

Materials and methods

At the planned experiments, for hop chemical protection a pulled mistblower Monzun which was adjusted to conditions of low trellis in hop fields will be used. The chassis, tank, and pump were used from the former mist sprayer Monzun. Besides, for the new vehicle there was used a ventilator which conveys the air into the sleeves for application frames. A mistblower should provide a specific amount of 1000-1500 $l \cdot ha^{-1}$ and it should enable an application at the vehicle operational speed of up to 5 $km \cdot h^{-1}$.

Figures 1 and 2 demonstrate the operational position of the equipment. For transportation position, the moving parts of the frame 2 are inserted into the bearers 9. Thus the equipment transport is enabled.

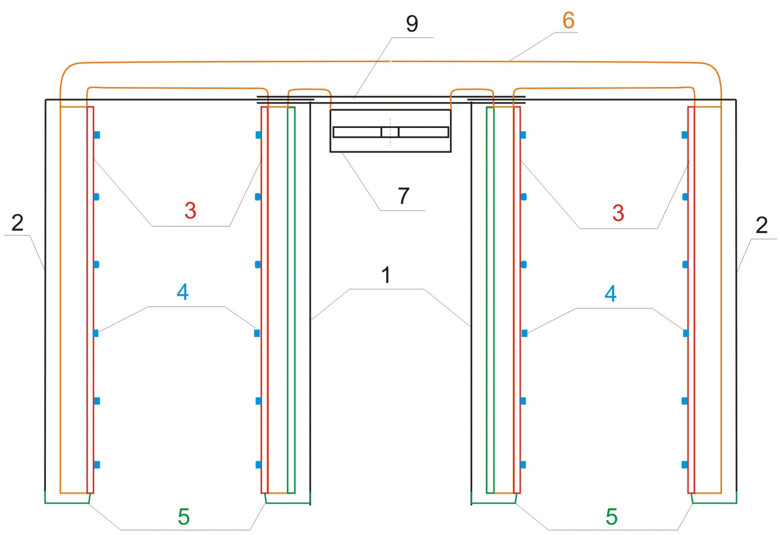

Fig. 1. **Operational position of the equipment – rear view**

The application frame (Figures 1 and 2) is formed by a fixed part 1 and moving parts 2. Between the bearers of the fixed frame parts 1 there is an axial ventilator 7. On both parts of the frame there are slats 3 placed which enable air outflow, next sets of nozzles 4, panels of collecting slats 8 and a reservoir 5 are placed. From the ventilator the air flows into the air outflow slat by means of a rubber-fabric sleeve 6. This way the air is conveyed to the set of nozzles. The hydraulic circuit is formed by a piston pump and a distributor, controlling and regulating components. Then the liquid is connected onto the circuit placed on the application frame.

The outflow of the protective substance from the nozzles together with the air flow from the slats is, as seen in Figure 2, placed on both frames in parallel opposite each other. This way the protective substance which did not stick on the hop growth could be caught. This substance then flows down into the reservoirs 5 and through a filter and auxiliary pump it is pumped into the tank [2].

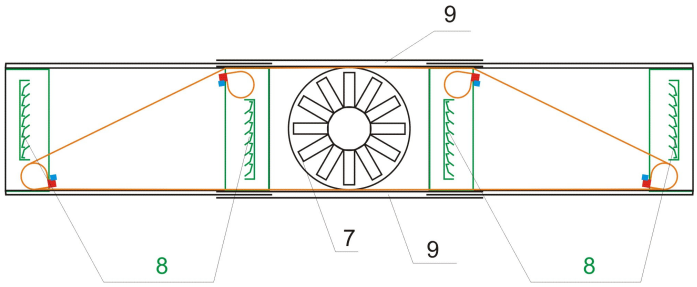

Fig. 2. **Operational position of the equipment – overhead view**

Experimental part

During the measurements it was discovered what the speed of the air outflow at different distances of the measuring instrument sensor from the slat outlet was. The measuring instrument was placed at 25 cm vertically, and horizontally the slat outlets were set for three values (0 mm, 300 mm and 500 mm). The rotation speed of the mistblower ventilator which has a hydraulic drive from the development shaft of the tractor was set for 30 s^{-1}. From the measured values it is possible to draw two types of graphs. On the one hand, it is possible to compare all horizontal values at the same time, within the fixed and the moving arm separately. Another possibility, which we chose for measurement assessment, is that we compare always both the fixed and the moving arm of the same heights.

When we set the lowest values of the distance between the sensor and frame, the higher values of air speed at the fixed frame part prevailed by 58 %. The balanced values of air flow speed at both frame parts are in this case 3, at a frame height of 100 cm, 225 cm, and 250 cm. 25 % irregularity is low, which corresponds with our intention to apply the substance on the plant as evenly as possible.

When we set a distance of 30 cm between the sensor and frame, the results were not as clear as in (Figure 3). In this case the air speed values equal at both arms in almost 42 %, with frame heights being 50 cm, 100 cm, 150 cm, 200 cm a 225 cm. In this case the irregularity is almost twice as better than in the first measurement.

When we set a distance of 50 cm between the sensor and frame, higher air speed prevails by 58 % at the moving part. The values are balanced only at two heights of the frame – 225 cm and 250 cm, while 17 % irregularity is insufficient. This (Figure 5) has a countertendency in comparison with (Figure 3) where higher values at the fixed frame prevailed.

If we compare the experimental results, the best values and the lowest irregularity can be measured at a distance of 30 cm between the sensor and frame. To improve the irregularity of air flow speed at fixed and moving frame it will be necessary to repeat the experiments and adjust the setting of the sensor and the frame.

Measurement of the air speed at the frame height of 0 cm was of no importance, as we suppose that when we apply the protective substance, this application will not proceed from the ground. It would not be technically possible anyway.

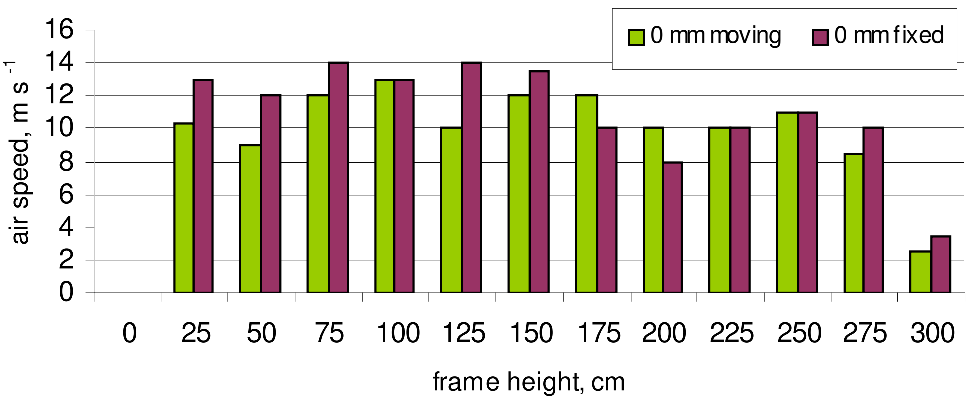

Fig. 3. **Comparison of values of moving and fixed arm at a distance of 0 mm between sensor and frame**

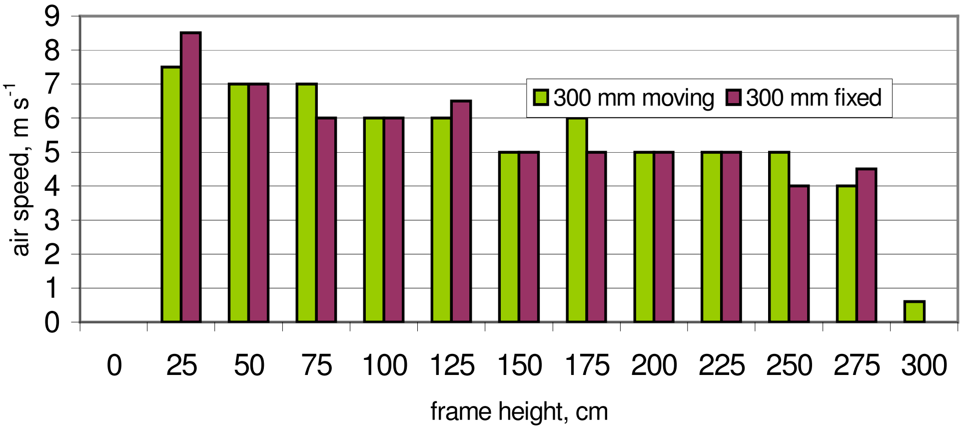

Fig. 4. **Comparison of values of moving and fixed arm at a distance of 300 mm between sensor and frame**

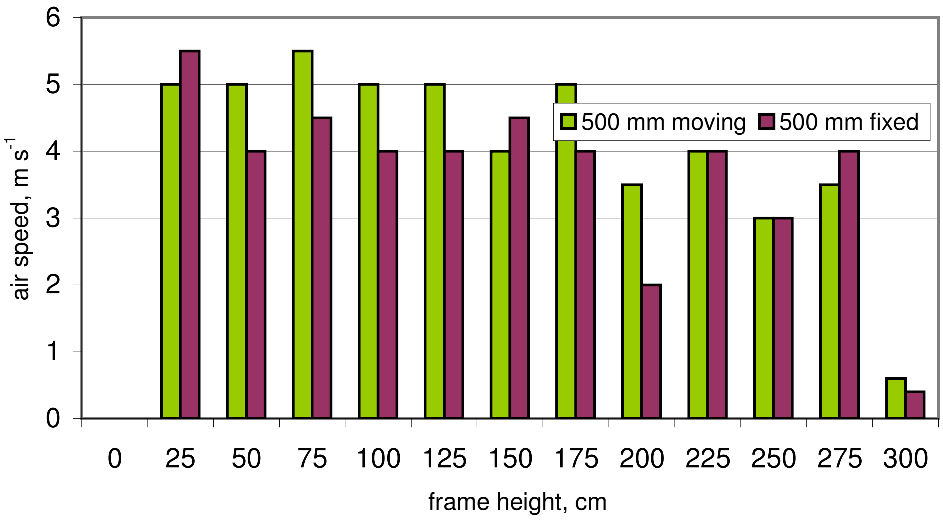

Fig. 5. **Comparison of values of moving and fixed arm at a distance of 500 mm between sensor and frame**

Discussion

The advantage of the designed equipment lies in that from the central ventilator the air flows into the air outflow slats. The current of air helps to penetration of the protective substance into the growth wall. In the collecting slat panels the protective substance which did not stick on the hop growth was caught and flew into the collecting tanks. This way the flight into the air is eliminated and the soil contamination with chemical agents is decreased. Another advantage is also the possibility to apply the protective substance at stronger wind when classical mist sprayer with an arc frame cannot be used. Another advantage is also the reduction in emissions of energetic means of transport combustion gas, because during the application the tractor goes only in every second row, thus lowering the environmental burden and the costs of fuel for energetic means of transport.

Conclusions

The rubber-fabric sleeve, which conveys air from the ventilator to the slats with nozzles and was used for the experiments, was 200 mm in diameter. At a constant sleeve cross-section the distribution of air penetration was not effective, that is why a change in cross-section was necessary. The sleeve was adjusted both for the moving and fixed arm. On the moving arm at the bottom of the sleeve the largest cross-section reduction occurred, by 150 mm in total, and on the top part a cross-section reduction by 60 mm occurred. On the fixed arm the bottom cross-section was reduced by 120 mm and the top one by 54 mm. This reduction was secured by clips.

During the installation of the application frame a problem concerning excessive burden of a frame part behind the mistblower axle occurred. That will be eliminated by two possible means – by axle shift on the bearer frame itself, or by placing a weight on the front part of the mistblower. Which way will be used is for the time being a subject for testing trellis stiffness, pad load, and other possible influences.

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