Mechanized Application of the Microbial Inoculants at Vegetable Plants Sowing

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Abstract. Agroinoculants are alternative products for the agrochemical products, their use reduces environmental pollution and contamination of food. The equipment for microbial inoculants application is designed to the modern technology of sowing and inoculating hoeing plants and vegetables, being used to apply a targeted suspension of bacteria inoculated in the best area for rhizosphere colonization for improve plants nutrition, protection, stimulation and soil structure. This paper presents the results obtained at the tests accomplished in laboratory conditions of the equipment for microbial inoculants application INOC, which has been designed, realized and tested at INMA Bucharest. Performing the laboratory tests it have been determined following qualitative working index: pump debit, nozzles debit, substance norms, stirring system efficiency.

Keywords: technology, equipment, bacteria, qualitative index.

INTRODUCTION

Bacterial agroinoculants are environment friendly products, having a multiple action on the crop plants (nutrition, protection, stimulation) and on soil (forming soil structure and the award of a natural resistance to erosion). Agroinoculants are alternative products for the agrochemical products; their use reduces environmental pollution and contamination of food. Using inoculants on determining the reduction of negative environmental phenomena (such as soil erosion) due to the complex effects which they have on soil structure and are the result of a high microbiological scale industrial (Industrial Microbiology as a platform for sustainable chemistry of the European Union).

Worldwide were obtained in high yields from the inoculants application by symbiotic offset by up to 85 – 90% of the nitrogen nutrient requirements for crop production in different vegetable plants (peas, beans, grain) and in first the soybean, species to specific symbiotic bacteria that inhabits soils more difficult, especially in temperate or continental zones. Operation of inoculation of seed can be achieved in two ways, as follows: (1) by hand, just before sowing, when the seeds are subject to the inoculation process in polyethylene bags; the process is simple and effective as the results, but has a disadvantage for a high operating time, knowing that time between bacterial treatment and placing the seed in the soil should be as low as possible; (2) mechanized sowing with, injecting from the device attached to the sowing aggregate inoculant suspension for the seeds placed in the furrows opened by the sowing machine shares.

INMA Bucharest has designed, developed and tested a technical equipment for modern technology of sowing and inoculated vegetable crops. The equipment is used to apply a targeted suspension of bacteria inoculated in the best area for rhizosphere colonization and allow work in a variety of sowing schemes and working conditions. Also, it requires maintenance and adjustments simple and easily performed by a single operator.
MATERIAL AND METHODS

The equipment for microbial inoculants application presented in Fig. 1 is generally composed from: two liquid tanks, a pump, a hydraulic engine, a filter, a distributor (pressure and debit controller), two hydraulic stirrers, connection pipes and nozzles for inoculant liquid application. The mounting and fixing support of the liquid tanks and the supports for sustaining and fixing the liquid pump, the hydraulic engine, the distributor and the filter are mounted on the sowing machine frame with some detachable and adjustable fasteners.

![Fig. 1. Equipment for microbial inoculants application attached to the sowing machine SPC 6](image)

**The kinematic and functional sketch** of the equipment for inoculants application is presented in Fig. 2, the main parts being figured symbolical.

![Fig. 2. Kinematic and functional sketch of the equipment for inoculants application: 1 - liquid tank; 2 - T joint; 3 - central valve; 4 - filter; 5 - liquid pump; 6 b - hydraulic engine; 7 - distributor (pressure and debit controller); 8 - hydraulic stirrer; 9,10 - connection pipes; 11 - nozzle](image)

The tests in laboratory conditions of the equipment for microbial inoculants application INOC have been made at INMA Bucharest location, using the testing stand presented in Fig. 3, which has in the main following equipments: 1 - frame, in welding structure, provided with slider and fixing system in bottom board; 2 - triphase electric engine
with the power of 7,5 kW and rotative speed of 1440 rot/min; 3 - reducing gear C212P P132 type, reduction ratio 2.6; 4 - cardan transmission.

Fig. 3. The testing stand used

RESULTS AND DISCUSSION

At tests in laboratory conditions of the equipment for microbial inoculants application INOC have been determined following working qualitative index: pump debit, nozzle debit, substance norms and the stirring system efficiency.

Pump debit has been determined through volumetric method, at the entrance rotative speed of 540 rot/min. Test have been made in 5 rehearsals (R1...R5), while pump operates at working pressures between 0 and 5 bar. In Tab. 1 there are presented the results obtained measuring the liquid debits at the chosen working pressures. The intermediary average values of the liquid debit are presented in Tab. 2, and the diagram of its variation in terms of pressure is presented in Fig. 4.

Results of the measurements of the liquid debits at the chosen working pressures

<table>
<thead>
<tr>
<th>Rotative speed [rot/min]</th>
<th>Pressure [bar]</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>Average [l/min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>540</td>
<td>0.5</td>
<td>14.5</td>
<td>14.8</td>
<td>14.5</td>
<td>14.9</td>
<td>15</td>
<td>14.7</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>12.9</td>
<td>13.3</td>
<td>13.7</td>
<td>13.5</td>
<td>13.5</td>
<td>13.3</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>11.7</td>
<td>11.1</td>
<td>12.0</td>
<td>11.5</td>
<td>11.8</td>
<td>11.6</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>9.8</td>
<td>10.2</td>
<td>10.6</td>
<td>9.9</td>
<td>10.4</td>
<td>10.1</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>7.2</td>
<td>7.5</td>
<td>7.6</td>
<td>7.1</td>
<td>7.9</td>
<td>7.4</td>
</tr>
<tr>
<td></td>
<td>3.0</td>
<td>4.8</td>
<td>5.0</td>
<td>4.9</td>
<td>5.1</td>
<td>5.0</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Intermediary average values of the liquid debit

<table>
<thead>
<tr>
<th>Working pressure [bar]</th>
<th>0.5</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
<th>2.5</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid debit [l/min]</td>
<td>14.7</td>
<td>13.3</td>
<td>11.6</td>
<td>10.1</td>
<td>7.4</td>
<td>4.9</td>
</tr>
</tbody>
</table>
Nozzles debit has been determined through volumetric method for every nozzle, by collecting the liquid dropped through each nozzle during 1 minute, at the pressure for which have been determined the pump debit, respectively 0,5; 1; 1,5; 2; 2,5 and 3 bar. For each pressure on made 3 measurements. The liquid quantity in liters, which flows through the nozzle during 1 minute, is the real debit through that nozzle.

The liquid debits through nozzles are between 0,463 l/min at pressure 0,5 bar and 1,233 l/min at pressure 3 bar. The diagram of the debit variation through nozzles in terms of pressure is presented in Fig. 5.

The liquid norms have been determined in terms of the liquid debit, working width and working speed using following relation:

\[
N = \frac{60 \times q}{0.1 \times L \times v} \quad \text{[l/ha]}
\]

where:

- \(N\) = liquid norm [l/ha];
- \(q\) = liquid debit [l/min];
- \(L\) = working width [m];
- \(v\) = working speed [km/h].
In laboratory on determined the flow, collecting substance that is leaking through the nozzles equipment for 1 minute. Determinations were made in 3 rehearsals, the results of measurements are presented in Tab. 3.

<table>
<thead>
<tr>
<th>Pressure [bar]</th>
<th>Measured values of debit [l/min]</th>
<th>Liquid norm [l/ha]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R1</td>
<td>R2</td>
</tr>
<tr>
<td>0.5</td>
<td>3.060</td>
<td>3.050</td>
</tr>
<tr>
<td>1</td>
<td>3.700</td>
<td>3.860</td>
</tr>
<tr>
<td>1.5</td>
<td>4.440</td>
<td>4.390</td>
</tr>
<tr>
<td>2.5</td>
<td>6.710</td>
<td>6.860</td>
</tr>
<tr>
<td>3</td>
<td>7.330</td>
<td>7.290</td>
</tr>
</tbody>
</table>

Provided with nozzles of Ø0.3, the equipment accomplishes liquid norms between 91.20 and 218.79 l/ha for working pressures between 0.5 and 3 bar, at the sowing aggregate average working speed of 7 km/h. The liquid norms values are presented in Tab. 3 and the diagram of its variation with pressure is presented in Fig. 5.

![Fig. 5. Graphic representation of the liquid norm variation in terms of pressure.](image)

Stirring system efficiency. For avoid the unallowable variations of the inoculant liquid density, the equipment is fitted with a stirring system made of two ejectors (Venturi tube), Fig. 6, situated inside liquid tanks, parallel with their longitudinal axis and feeded through a by-pass directly from the distributor.

![Fig. 6. Hydraulic stirrer](image)

Stirrers drill the liquid from tank, stirring it all time and maintaining a constant density over 85%. For the determination of the stirring system parameters it have been used a turdacupral suspension of 3% which rested inside tanks during 2 hours motionless, while the suspension settled down on the bottom of tanks. At the end of this period the stirring system start working for 3 minutes, after that the liquid has been collected through nozzles. The
density determined after the resting time and 3 minutes in operation of the stirring system didn’t exceed ± 5% from the start density.

CONCLUSIONS

Following tests accomplished with the equipment for microbial inoculants application INOC, the results are:

- The equipment is easy to work and accomplishes all agrotechnical requested imposed for the microbial inoculants application at hoeing crops and vegetables;
- The liquid pump realizes debits between 4.9 and 14.7 l/min at pressures of 0.5 – 3 bar and rotative speed of 540 rot/min, these values satisfy the functional requests of the equipment;
- The equipment has been fitted with nozzles of Ø0.3, the debit through these nozzles being between 0.463 l/min and 1.233 l/min at working pressures of 0.5 – 3 bar;
- Fitted with nozzles of Ø0.3, the equipment accomplishes liquid norms between 91.20 and 218.79 l/ha for working pressures of 0.5 – 3 bar, at an average working speed for the sowing aggregate of 7 km/h and fulfills the agrotechnical requests at all working regimes;
- The efficiency of the stirring system is over 85%.

The technical equipment accomplishes qualitative working parameters, safety in operation, it contains constructive solutions for the main assemblies at the same level with similar products on global plane and technological solutions for components which get to material saving and a low weight, in conclusion at a low cost.

REFERENCES