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CONTROLLING RATE OF DELIVERY OF APPLICATORS AT THE HARVEST OF SUBSTRATES BIOGASWORKS - PRELIMINARY ISSUES.

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At the paper preliminary issues concerning applications of preparations preserving to silages were introduced. Such silages can be used as forage of animals and substrates of the bio-gasworks. During the harvest of green fodder to silages getting an end product of the better quality is one of more important problems. It is possible to obtain it using additions facilitating ensilage. Using them allows also for the improvement of the quality of the long preserved silage. One should aspire to it to get regular distributing preparation in the entire capacity of the silo. In the course of the application losses of preparation should be minimal.

Keywords: *additives, biogasworks, silage, substrates,*

1. Introduction

Achievement of the best quality products and application of high preservation technology and methods for loss reduction in each phase of production are of top priority in plant production. In order to achieve this goal it is necessary to implement agricultural-technical procedures consistent with the philosophy of precise agriculture whose main element is mapping of crops. It stimulates the development of technological solutions connected with recording and processing of data concerning the crops. Collected and analyzed in this way information allows to synchronize local and temporary land-soil properties with intensity of agricultural -technical processes.

In case of harvesting machines, definition of temporary volume of plant stream can not only be used for elaboration of a harvest map for a given area but also for determination of a precise dose of supporting preservatives applied during the harvest. In both cases the development of this technology involves improving precision of detection of changes occurring in the used machines which can be associated with a nonlinear rate of the plant stream flow. For this, purpose there are used different types of sensors, which properly sited, enable generation of signals which make it possible to define the plant material stream volume in a real time.

Application of additives during silage preparation reduces losses of energy contained in the substrate which are connected with lactic fermentation and further storage in silos. Thanks to additives it is also possible to obtain a higher level of the biogas yield [3, 2].

Nowadays, additives are dosed during the harvest or during loading and placing the plants into containers. Although the methods of application of preservatives into fodder plants undergo constant modification each of them allows to adjust the preparation dose to: field conditions, kind of the harvested plant, type of the additive and model of the harvesting machine or the machine loading the material to containers (silos). Methods of the applicator rate control can be divided into three basic groups, including: manual, semi-manual and automatic.

2. Rate of applicators

The rate of applicators can be referred to as volume or mass of the preservative , which is being applied into the plant material, during a given time This value can be characterized by the following formulas:.

$$Q_1 = \frac{V}{t}, (ml\ min^{-1}) \quad (1)$$

$$Q_2 = \frac{m}{t}, (g\ min^{-1}) \quad (2)$$

where:

Q_1 – rate of applicators dosing preservatives in the form of fluid, (ml min^{-1})
Q_2 – rate of applicators dosing solid preparations, (g min^{-1})
V – the preparation volume, (ml),
m – the preparation mass, (g),
t – time in which a given mass or volume is placed in the harvested material (min).

Control of the applicator rate enables to match the additive dose withthe applied fodder preservation technology, species of plants and recommendations of the preservative producer. One of the simplest methods enabling to change the dose of fluid additives is application of a system of exchange nozzles. It is the most common solution as it does not affect significantly the costs connected with construction of the application installations.

Another manual solution involves using chocking valves, by means of which, it is possible to control flow of the additive. This kind of control is used, among others, in a fluid applicator Junkkari HP5 of Finnish production, presented in figure 1. The rate is regulated by screw in the flow-meter.

Fig. 1. Picture of HP 100 dosing installation of Junkkari company: 1 – cords; 2 – membrane pumpwith a flow-meter; 3 – container with a preservative with an elastic conduit; 4 – controller; 5 – nozzle; 6 – leak protection valve

A popular solution is also a remote control of the rate by means of electronic controllers. This solution involves fixing a regulation device in the tractor cabin (self-propelled straw cutter)by means of which the machine operator can control the installation operation [10].

By means of a controller the operator can cut off the preservative inflow during manoeuvers. The controller has also an automatic summing meter of the flow, thanks to which, it is possible to read the actual amount of the pumped additive. Additionally, the system notifies of low amount of an additive in the container. If HP 1000 dosing system is equipped with a speed sensor it is possible to obtain a reading in the approximate area from which the plants have been harvested. Moreover, application of a the controller special mode of operation, after being preprogrammed, increases the amount of preservative in relation to the speed [10]. The operation principle of automatic dosing systems is based on defining temporary mass or volume of the harvestedgreen crop. Distribution of the preservatives can also depend on the harvested fodder plant quality. Such an innovative solution is offered by Harvest Tec (USA) in the harvest technology of green fodder for hay by means of both roll and cube balers. It is the most efficient method as it provides not only effective distribution of the preparation measured dose but also improves the operator's comfort. Additionally, application of such systems reduces losses of additives which contributes to decreasing costs of fodder production. It also leads to elimination of the environment degradation threat connected with the use of chemical compounds and prolongation of lifetime of the machine elements being in direct contact with them [11].

Optimal adjustment of the applicator rate has an influence on the level of the aditive losses The best solution is to control the dose which is to be adjusted to the plant stream flow changes during the harvest machine operation. It has a positive influence not only on improving the preservative distribution efficiency but also increases the comfort of work as well as reduces the phenomenon of corrosion of elements which are in contact with the preservation solution.

An assessment of dosing devices operation is based mainly on the degree of mixing uniformity of precisely measured preservative doses with the plant material, with regard to its potential losses. Factors which determine the quality of this procedure include: distribution of nozzles applying the substance in harvesting or cutting machines and the degree of the plant material fragmentation. A uniform distribution of the preservative in the harvested material is the only way to achieve good results [4, 5, 6, 7, 16, 8, 9].

3. Experiment

In order to establish the site for green fodder application in a roll baler the material used for the analysis was a mixture of meadow grass with moisture content 56%. 5% water solution of sodium chloride was used as an additive. The preparation of green fodder was added to green fodder during its harvest by means of Junkkari HP5 applicator which was mounted in the front part of the round baler (fig.1). The applicator was equipped with two vortex nozzles of Hardi with the inlet opening diameter Ø 0,025 mm, pressure was 0,5 MPa. The nozzles were placed in three different places (Fig. 2) in such a way that they could spray the additive on the whole width of the round baler.

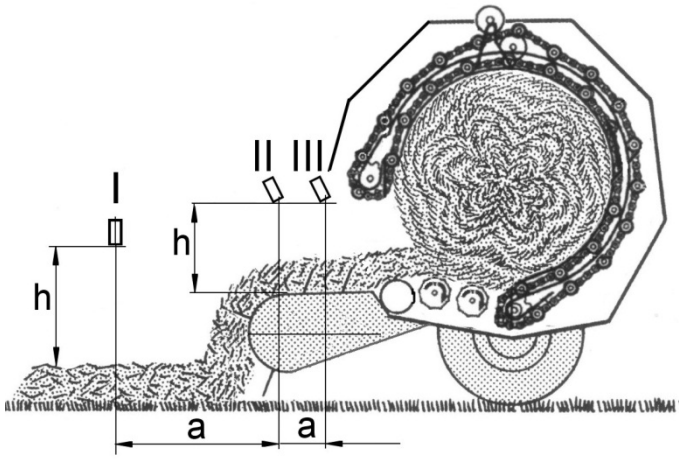

Fig. 2. Location of fastening the nozzle of applicator in round baler: I —ahead of the pick-up unit; II —over the pick-up; III —in the front part of the press chamber

The size of additive losses (water solution of NaCl) was determined basing on the marking of CL concentration of ions. The size of these losses is referred to as a ratio of the preparation amount left on measurement plates to the amount given according to dependence:

$$L = \frac{V_p}{V_z} \cdot 100\% \quad (3)$$

where:

L –losses of sodium chloride %
V_p–amount of sodium on measurement plates, dm^3/ton of green fodder
V_z–given amount of sodium chloride (control), dm^3/ton of green fodder

Measurement distances with length 100 m were determined by means of poles prior to the test. Rollers with plant material were manually arranged in such a way that they were characterized with equal height and width and uniform distribution of mass over the whole length.

The aggregate moved at the speed 4.58 km h^{-1} (1.27 m s^{-1}). Three plates with dimensions 1.0 m · 2.5 m were placed on the line of its pass under green fodder lying in the roller. The plates provided coverage of the aggregate whole working space. Plates were fixed to the ground by steel bolts in order to avoid pulling them up during the bale pass. Along the ride of the unit the plate was rinsed with the distilled water (100 ml).

The solution, obtained in result of rinsing the preparation which remained on the base (plate), was put into glass containers. Mrking of the concentration of CL ions was made by mercurymetric method **[1].**

Measurements of concentration of CL ions were made for all the locations of nozzles. Tests were performed three times. The obtained tests results were subjected to analysis of variance. Calculations were performed according to computer program ANAWAR 1.0. Significance of differences between experimental groups (different locations of nozzles) was examined by Tukey's range test.

3. Results

On the basis of the obtained results there was made a histogram of sodium chloride losses

distribution in dependence on its application to green fodder in roll baler which has been presented in figure 3. It shows that in relation to the quantity of the given amount (2.5 $dm^3 t^{-1}$ of green fodder), losses of the preparation in the amount 35.6% occurred while dosing it to green fodder placed in the roller. It was 12.8%. The smallest losses, in the amount 2.0%, were found for dosing it to green fodder lying in the baler. A distinct losses reduction occurred for dosing the solution into green fodder placed in the baler pickup. It was 12.8%. the smallest losses, in the amount of 2.0%, were found for dosing green fodder in the front part of the rolling chamber.

The carried out statistical analysis of tests results show that losses of sodium chloride differ statistically significantly between application sites – ahead of the pickup (watered roller of green fodder) and application sites above the pickup and in the front part of the prees chamber. Statistically significant differences occurred between the application site above the pickup and application site in the front part of the rolling chamber (fig.3).

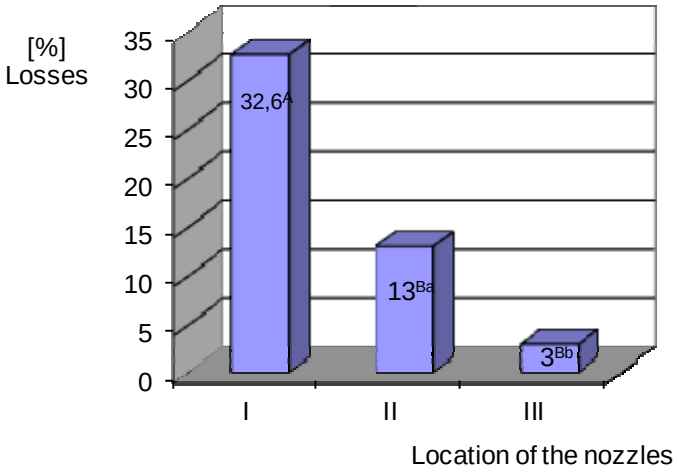

Fig. 3. Distribution histogram for the loss sodium chloride with respect to the location of the applicator in a forage harvester. Mounting locations for the applicator: I -ahead of the pick-up unit (the roll of crop sprinkled), II - over the pick-up unit, III - in the front part of the bale chamber. The values A and B (denoted by capital letters) are significantly different from one another ($p \leq 0.01$), whereas the values a and b (denoted by lower-case letters) are statistically significant ($p \leq 0.05$).

Results of markings of the number of lactic acid bacteria have been presented in table 1. It proves that the smallest amount of lactic acid bacteria was characteristic for green fodder of group I (without additives) with moisture content 81% (6.1% x 10^2 of units making up cells per one gram of green fodder).

4. Conclusions

The location of the applicator significantly affected the loss of additive. The smallest losses (about 2%) occurred of the applicators mounted in the front part of the bale chamber, whereas, the highest losses (up to 35.6%) occurred with the applications ahead of the pick-up unit.

For forage of moisture content up to 70% (wet and wilted forage), additive application produced silage of higher quality compared with forage without additive.

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