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VALUES OF THE BINDING FORCE OF COMMON SEABUCKTHORN WITH A PLANT

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ABSTRACT

The aim of the study was to determine the effect of selected operating parameters of the two types of orchard sprayers on vertical distribution (expressed as spray percentage share in 50-cm segments) and quantitative changes in the vertical distribution of spray measured on the vertical separator of drops. The study included measurements of the vertical distribution of spray for two different ways of nozzles setting, two types of nozzles and two fan rotation speeds. The vertical distribution of spray depended significantly on spray emission system, the configuration and the type of nozzles and in the slightest degree on the fan rotation speed. The smallest share of liquid fell on the edge segments (≤ 5.22%) and the largest on the middle ones – 29.33%. The change in the configuration of nozzles significantly affected the change in the spray vertical distribution (by the spray displacement between the 50-cm segments). The greatest changes in the vertical distribution of spray – as affected by nozzle configuration change – was observed for the sprayer with the horizontal spray emission with maximum change in one segment of 14.0% (an average of 7 segments: 5.38%).

Introduction

Herbs cultivation in Poland has over a one-century tradition (Kozłowski, 2000). However, in the past, field crops included mainly herbs, while nowadays more and more growers reach for bushy medical plants. Common seabuckthorn (*Hippophae rhamnoides L.*) is one of them. It is a dioecious species which belongs to the oleaceae family, which can be met in the natural environment in Poland on the Baltic shore as well as in the cultivation on production plantations. Usually it occurs in the form of a highly branched bush, which with its habit and leaves resembles bushy forms of a willow tree. It has small soil requirements, a strong root system and the ability to bind atmospheric nitrogen. It is used as a pioneer species during soil erosion (Vescan et al., 2010). Its berries are rich in elements, in particular with vitamin C and E (Kallio et al., 2002; Zeb, 2004). Oil from seeds and berry pulp is particularly known (Zadernowski et al., 1997; Yang and Kallio, 2002; Cenkowski et al.,

2006). Common seabuckthorn has a great therapeutic potential (Yang et al., 2000; Suleyman et al.., 2001; Geetha et al., 2002; Cheng et al., 2003; Negi et al., 2005). Research carried out by Piłat et al. (2012) indicates high variability of the chemical composition of berries from various varieties. Interest in this plant in various countries is great (Vernet, 2006). According to the survey data (Niesteruk et al., 2013) in Poland it is still not popular. According to the quoted research, over half of the respondents have never heard of this plant and over 80% have never met the products, which contained common seabuckthorn berries. It results from the fact that fruit are undoubtedly hard to harvest due to thorns and density along branches. Thus, in order to popularize this unusually valuable plant, analysis of various possibilities of harvest mechanization is indispensable (Fu et al., 2014).

The objective of the paper was to determine and compare the bonding force of berries with a shoot for two varieties of common seabuckthorn. The obtained measuring data may be helpful for development of structural assumptions of working elements of a machine for harvesting common seabuckthorn berries.

Material and methodology of research

Berries of common seabuckthorn *Hippophae rhamnoides* L. constituted the research material. They came from the plantation located within the Department of Production Engineering and the Power Industry in Krakow. Two varieties Botaniczeskaja and Augustinka were covered by the analysis. The tests were carried out within 2012-2013. During the harvest maturity in the second half of August, common seabuckthorn branches were cut of with berries and then mounted in the attachment for extending biological material on the testing machine MTS Insight 2. Single berries were picked according to the agreed procedure recorded in the "Test Works 4' programme. Schematic representation of the picking device was presented in figure 1.

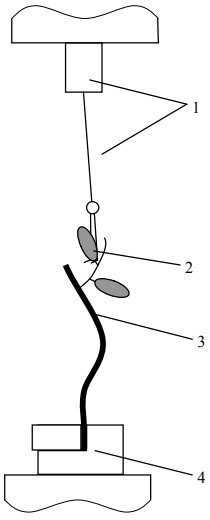


Figure 1. Schematic representation of the test rigs: 1– tensometric head of the testing machine along with a tie rod which picks berries, 2 – common seabuckthorn berry, 3 – seabuckthorn branch, 4 – attachment which mounts samples in the testing machine

In quasi-static tests for plant material, the speed is within 1 to 20 mm^{-1} (Stropek and Gołacki, 2005; Bochat and Zastempowski, 2009). Since, it is a first stage of research concerning the process of separating berries of seabuckthorn from a plant (in real conditions it is a dynamic process), the value of the test speed was determined in the upper applied range of the value and was 120 $mm \cdot min^{-1}$. Berries bonding force with a plant was tested in two zones of bushes, central and bottom, picking 100 berries from each zone.

Statistical analysis of the obtained results was carried out with the use of a computer program Statistica 9, analysis of variance was carried out and after showing differences between the considered variables – Duncan test at the significance level of p=0.05.

Results of the research

Figure 2 presents an exemplary characteristic of the course of changes of the value of the force separating berries from the central part of Botaniczeskaja variety. The A point means a critical force which separates berries from a plant.

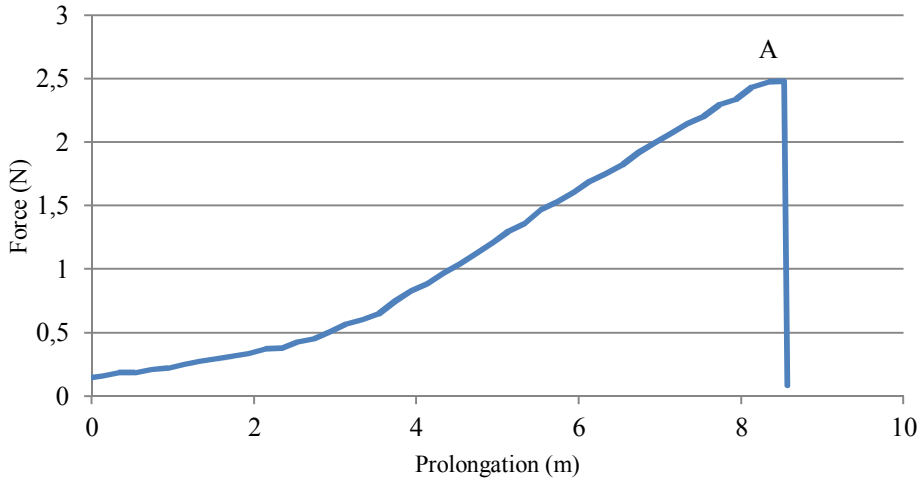
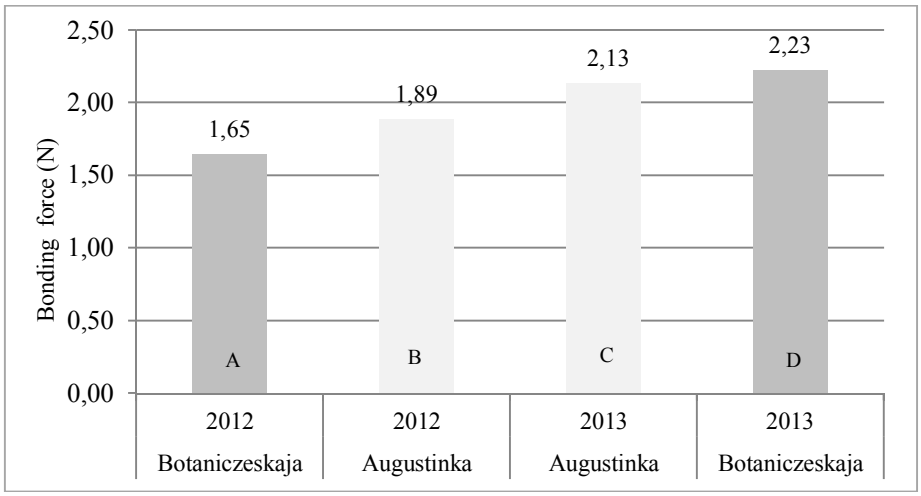


Figure 2. An exemplary course of changes of the bonding force value for Botaniczeskaja variety in the central zone

The research carried out on raspberries shows that the bonding force of berries is a varietal property and mainly depends on the size and shape of the receptacle, degree of berries maturity and the course of atmospheric conditions (Rybczyński et al., 2001). Thus one may assume that there has been a variability of this property over many years.

Results of the presented research confirm the thesis that the analysis of variance (ANOVA, MANOVA) proved relation of the bonding force of berries of particular varieties to the years of research. Berries of Botaniczeskaja variety had the weakest bonding in 2012; however in the following year of research, at the average by 0.58 N higher values were reported for this variety, thus these results were in the different uniform group (fig. 3).

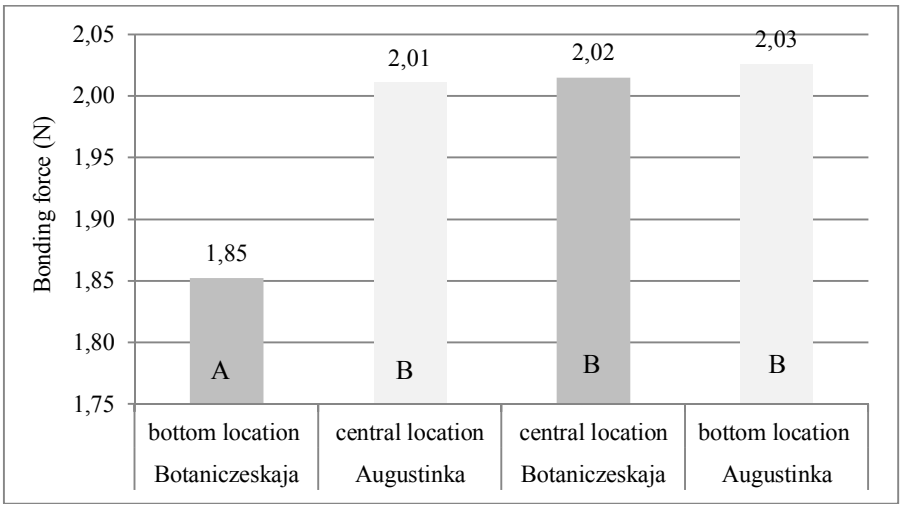


A, B, C, D – uniform groups acc. to Duncan test

Figure 3. Mean values of the bonding force of berries of the investigated varieties of common seabuckthorn in particular years

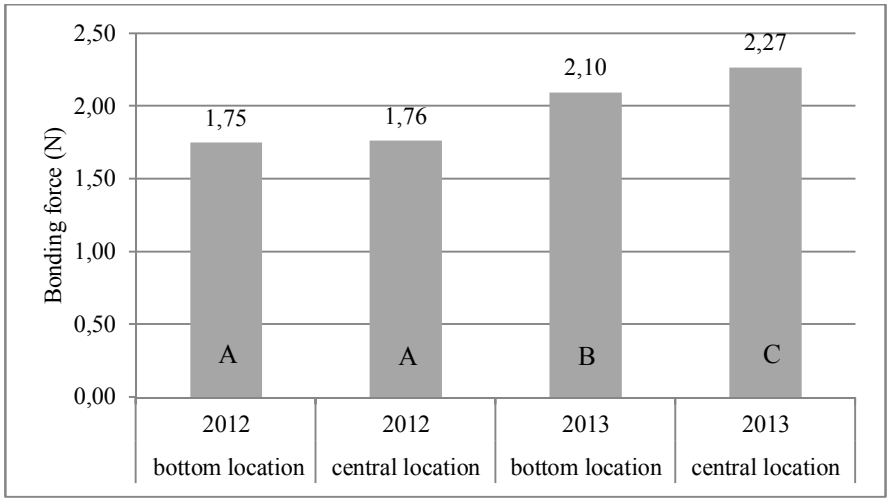
The statistical analysis which was carried out proved also simultaneous impact of berries varieties and location on a plant on the bonding forces. The lowest values were determined for Botaniczeskaja variety in the bottom location, at the average 1.85 N.Whereas values of bonding forces of berries of this variety from the central part were similar to the values determined for Augustinka variety in both investigated zones, thus these values were in the common homogenous group (fig. 4).

In 2012 interaction of the bonding force of berries in particular zones with the years of research were also determined. In 2012, lower values of bonding forces were reported for berries from the bottom as well as from the central part. Inter alia, no statistical differences were determined; the obtained results were in the common homogenous group. While in 2013, such differences occurred and berries from the bottom part of the bush had slightly weaker bonding with a plant. The presented mean results of the bonding force are within 1.75 N in 2012 to 2.27 N in 2013 (fig. 5). Such increase in the bonding force values may cause deterioration of the efficiency of combine harvesting, similarly to variability of the bonding forces values of raspberries, presented in the Rabcewicz's and Danek's research (2010), resulted in deterioration of the combine harvesting of these berries.



A, B – uniform groups acc. to Duncan test

Figure 4. Mean values of the bonding force of berries of the investigated varieties of common seabuckthorn in particular years



A, B, C – uniform groups acc. to Duncan test

Figure 5. Mean values of bonding forces of common seabuckthorn berries in relation to location and years

It seems that the differences obtained in the bonding forces values of seabuckthorn berries between particular years of harvesting and bushes zones may be related to slightly different course of climatic conditions in those years. When comparing meteorological data

from 2012 and 2013 from the region of research, differences in the amount of precipitation are particularly visible. Observed during the August harvest in 2013 higher values of berries bonding forces in comparison to the last year, were preceded by humid May and June as well as dry July and August. The research carried out by Guo et al (2007) indicates changes in the seabuckthorn architecture under the influence of the water stress, although its tolerance to drought is well known. It should be assumed that the changes in architecture are followed by modifications in its anatomical structure, which may result in changes of the bonding forces of berries.

However, the relations, observed in the presented results, require to be confirmed in the following years of research and constitute an introduction for the deeper analysis of this subject.

Conclusions

1. Variability of the bonding force values of the investigated common seabuckthorn berries in relation to the year of research was reported. Difference between 2012 and 2013 for Botaniczeskaja variety was at the average 0.58 N, and for Augistinka variety it was 0.24 N. Higher values of bonding force were obtained in 2013.
2. Values of the bonding forces of berries with a plant were variable in relation to the applied variety and location of berries on a bush. Discrepancies in the bonding force values of berries of the investigated varieties from particular zones of bushes were reported. Botaniczeskaja variety had particularly low bonding forces at the average 1.85 N in the bottom zone whereas such relation was not observed in Augustinka variety.
3. Relation of the bonding force values of common seabuckthorn berries to location of berries on a bush and the year of research. In 2012 lower bonding force values of fruit, not related to their location were determined. On the other hand, in 2013 berries located in the lower part had slightly weaker bonding.

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WARTOŚCI SIŁ WIĄZANIA OWOCÓW ROKITNIKA ZWYCZAJNEGO Z ROŚLINĄ

Streszczenie. Rokitnik zwyczajny to krzewiasty gatunek rośliny z rodziny oliwkowatych o owocach zasobnych w składniki aktywne biologicznie. Jest wciąż mało rozpowszechniony w Polsce, co związane jest w dużym stopniu z trudnościami zbioru niewielkich i gęsto osadzonych owoców na ciernistych gałęziach. Celem pracy było wyznaczenie i porównanie wartości sił wiązania owoców z pędem dla dwóch odmian rokitnika zwyczajnego, Botaniczeskaja i Augustinka. Materiał badań pochodził z własnej plantacji doświadczalnej. Badania prowadzono na maszynie wytrzymałościowej MTS zrywając owoce z dwóch stref krzewów, środkowej i dolnej. Stwierdzono zależność statystyczną wartości sił wiązania owoców poszczególnych odmian od lat badań, a także umiejscowienia owoców na krzewie. Najsłabiej związane były owoce odmiany Botaniczeskaja zbierane w 2012 roku, charakteryzujące się średnią wartością siły wiązania wynoszącą 1,65 N. Mniejsze wartości sił wiązania dla tej odmiany obserwowano w przypadku owoców znajdujących się w dolnej części krzewu.

Słowa kluczowe: owoce rokitnika, zbiór mechaniczny, siła wiązania