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TESTING UNCONVENTIONAL SOLUTIONS IN FIGHT AGAINST LATE BLIGHT AND ALTERNARIOSIS IN POTATO, IN TRANSYLVAINIAN PLAIN, ROMANIA

Abstract: The identification of organic, unconventional, solutions in order to fight against most encountered plant mites and pathogens is a preoccupation of our days. In this context, the aim of our research consists in testing the possibility of using *Allium sativum* L., and selenium enriched *Allium sativum* L. in fight against late blight and alternariosis in potato, in conditions of obtaining appropriate interests. A bifactorial experimental design with two graduations, according to the randomized blocks methodology, was implemented in pedo-climatic conditions of Transylvanian Plain, Romania. The data were statistically processed with STATISTICA v 7.0. Basic statistics was used for calculation of means, standard deviations, coefficients of variation, and differences between means, for fungal pathogens attack degrees and potato productions. Our research shows that the use of 1.1% aqueous solution of organic selenium enriched *Allium sativum* L. is a valuable alternative in fight against *Alternaria solani* Sorauer, and *Phytophthora infestans* Mont. De Bary, in both Redsec, and Roclas potato varieties, in studied experimental conditions.

Key words: *Allium sativum* L., attack degree, interest, production.

INTRODUCTION

The constraints of our days, when effective control of large and small culture plants and trees pathogens and pests is increasingly confronted with environmental problems but also with the emergence of the phenomenon of resistance of harmful organisms to specific chemical treatments, the identification of unconventional solutions to manage these situations become an urgent issue. A large diversity of unconventional solutions, which consist in the use of plants and insects extracts in fight against phytopathogens and mites are now available worldwide (Chowdappa et al. 2014; Cobos et al. 2015; Gordon et al. 2015; Zamora-Ballesteros et al. 2016; Shuping, Eloff 2017). An important alternative, focusing these realities, is the adoption of the integrated management option. In this paradigm, an important role lies in identifying and testing the plant-based resources with phytonocidal potential (Stenberg 2017).

Potato, one of the most important plant cultures in Romania. It is confronted with the same problems related to the sustainable management of phytosanitary protection, like cereals or forest trees. Based on these prerequisites, results that the approach concerning the identification and implementation of unconventional solutions for antifungal treatments applied to potato culture, may be a solution to solve the potato disease fight in terms of respect against environment and sustainable development (Ianoși et al. 2002).

If we take into account the availability of plants extracts with demonstrated efficient effect on fungal diseases, among large diversity of such plants we also identify *Allium sativum* L. (Bordea et al. 2014; Subhani et al. 2014; Debbarma et al. 2017; Shuping, Eloff, 2017). Because of the wellknown antibactericide and anti-fungal properties, *Allium sativum* L. – the garlic, was tested, in

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several studies, with the aim of identifying its ability as antifungal agent, in fight against late blight and alternariosis, diseases produced in plants by the attack of the mushrooms *Phytophthora infestans* Mont. de Bary and *Alternaria solani* Sorauer. Majority of these tests were performed in countries from Asia, where research in this field is more developed compared to European or American (Pandey, 2001; Subhami et al., 2014).

The antifungal mechanism of garlic action may be explained by the fact that, before administration as antifungal agent as spray on the affected plant, garlic is shredded and consequently the cells are destroyed. Simultaneously, garlic releases sulfur-rich allicin, which has an irritant effect on pests and pathogens. This process was originally described as a garlic defense mechanism against birds, insects and worms attacking the plant. Later, this is the property that was successfully exploited when garlic is used as an organic phytosanitary agent (Oroian 2012, Bordea et al. 2013).

Based on above mentioned results and taking into account the synergistic effects of the use of garlic enriched in selenium, as evidenced by scientific experiments (Bordea et al. 2013), our study aims at testing the antifungal effects of the aqueous extracts of garlic and garlic enriched in selenium on the attack of *Phytophthora infestans* Mont. by Bary and *Alternaria solani* Sorauer on potato crops, and also the consequences of using garlic as antifungal agent, upon potato production and economic efficiency under the pedo-climatic conditions of the Transylvanian Plain, Romania, compared with results obtained with conventional phytosanitary treatment, in the same experimental areal.

MATERIAL AND METHOD

The experiments were carried out in the Transylvanian Plane, Pădurenii village, Pădurenii commune, Cluj County (47° 04' 14 N, 24° 00' 0E). The biological material is potato, two Romanian genuine potato varieties, respectively, Redsec and Roclas, namely. The Redsec is a semi/late variety, created at the Station of Research for Potato Culture Târgu Secuiesc. It has the biological capacity of production of 55 t/ha (<http://fermieronline.ro/Soiuri+romanesti+de+cartofi#sthash.SYbOn6V7.dpuf>). The Roclas potato variety is produced by the Potato Institute Braşov and it is a semi-early variety. It has the production capacity of 65.9 t/ha (<http://fermieronline.ro/Soiuri+romanesti+de+cartofi#sthash.FSX1eqIA.dpuf>). The Romanian variety of garlic (*Allium sativum* L.), Sibişel, was obtained from commerce.

The experimental field lays on an area of 100 m². The climate is temperate and soil is of argic chernozem type (faeozem). The soil has characteristics appropriate for potato culture. For the experimental groups, soil was fertilized with commercial NPK fertilizer, in ratio of 15 : 15 : 15.

The attack degrees of *Phytophthora infestans* Mont. by Bary and *Alternaria solani* Sorauer on potato crops were monitored and calculated according to Oroian (2008). The phytosanitary treatments were applied on potato foliar tissue, by spraying. The conventional treatments were applied with the products Infinito 687.5 SC and Alcupral 50 PU, while unconventional treatments were performed with aqueous 1.1% and 2.2% *Allium sativum* L. solutions and aqueous 1.1% and 2.2% organic selenium enriched *Allium sativum* L. (aq.). Alcupral 50 PU was administered in dosis of 3 kg/ha. The product is commercialized as a fine wettable powder, homogeneous, mobile, without agglomeration tendency, green. The active substance is metallic copper (in share of 50%), in the form of copper oxychloride. The producer is Alchimex SA Bucureşti. The Infinito 687.5 SC is produced by S.C. Bayer S.A. The active substances of the product are: 625 g/l propamocarb hydrochloride + fluopicolide 62.5 g/l. It is administered in doses of 1.4 L/ha. The solutions of *Allium sativum* L. were prepared in the Laboratory of Environmental quality Control and Plant Protection from the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca (UASVM), and organic selenium enriched *Allium sativum* L. was obtained in the greenhouses of the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca (Muscă 2014).

The experiment was organized according to a bifactorial design (fertilization and phytosanitary treatment) with two graduations (fertilized, and not fertilized; untreated and phytosanitary treated), with three repetitions, in 2017. The experimental design was implemented according to the randomized blocks methodology (Sestraş et al. 2002). The data were statistically processed with STATISTICA v 7.0. Basic statistics was used for calculation of means, standard deviations (s), coefficients of variation (CV%), and differences between means (t-test independent by variables), for fungal pathogens attack degrees and potato productions.

The calculation of the economic efficiency was performed according to Cristache, 2014. We take into account the specific economic indicators, by improving a calculation algorithm in Excel. In order to calculate the field works we used the calculation model that includes the following workmanships: plowing, ditching, planting, rehabilitation, phytosanitary treatments management and harvesting fee. For the calculation of total expenditure for each type of treatment, a more complex model has been used, which takes into account more components (Cristache 2014). In our calculation, we consider the following prices: 4.50 RON/L for diesel fuel needed for field works, 0.7 RON/kg for potato seed, and 5 RON/kg for garlic (*Allium sativum* L.). We consider the price of 35 RON/kg for selenium enriched garlic, obtained in UASVM Cluj-Napoca greenhouses. We consider the following prices for potato production: 0.7 RON for unfertilized untreated potato, 1 RON/kg for conventionally treated and fertilized potato, and 1.70 RON for fertilized unconventionally treated (with garlic and selenium enriched garlic) potato.

RESULTS AND DISCUSSIONS

Analyzing the results obtained as result of administration of the phytosanitary treatment of the Redsec potato variety under experimental conditions characterized by the pedo-climatic regime in the Pădureni area specific to the Transylvanian Plain during the experimental period with unconventional treatments consisting of aqueous solutions of *Allium sativum* L. and *Allium sativum* L. enriched in organic selenium at different concentrations, it was found that there were recorded *Phytophthora infestans* Mont. De Bary attack degrees far below the untreated control, but similar in order of magnitude to those obtained from conventional treatments with Alcupral 50 PU and Infinito 687.5 SC (Table 1).

The analysis of mean attack rates over the entire experimental period, obtained for each phytosanitary treatment variant, including the untreated control (Table 1), highlights the efficacy of the treatments performed with conventional products Infinito 687.5 SC and Alcupral 50 PU, but also with 1.1% aqueous solution of selenium enriched *Allium sativum* L. The best results are reflected by the values of the lowest mean attack degrees (AD), namely AD = 5.32% (treatment with Infinito 687.5 SC), AD = 4.62% (1.1% organic Se enriched *Allium sativum* L. aq.), and AD = 4.28% (Alcupral 50 PU). The increase of concentration of aqueous solutions of garlic with, and without selenium supplements led to inferior results, reflected by the values of the increased mean attack degrees, of AD = 7.03% (2.2% *Allium sativum* L. aq.) and AD = 7.37% (2.2% organic Se enriched *Allium sativum* L. aq.). The biggest mean attack degree, AD = 17.74% is reported in untreated, unfertilized control (Table 1).

In all studied cases, the variability is lower than the threshold of 30% (Merce and Merce, 2009), and this confirm the homogeneity of the data and representativeness of the attack degrees means. The biggest value of the variability (CV=22.90%) is reported in experimental variant where the lowest late blight attack degree is recorded, when phytosanitary treatment was performed with Infinito 687.5 SC, while the lowest (CV=6.01%), where phytosanitary treatment was performed with 1.1% *Allium sativum* L. aq. In control and other experimental variants, variability frames within the interval 7.71% - 13.42% (Table 1). Concerning the values of maximum and minimum, we emphasize the minimum late blight attack degree in Redsec potato variety (3.51%) when treatment is performed with conventional product Infinito 687.5 SC, and maximum, as expected, in

untreated control, 21.42%, respectively (Table 1). These results are not consistent with those obtained by Bordea (2014), in the same areal. The explanation may be put on the climatic conditions, which are also a characteristic of the year, not only of the reference areal, but also on the garlic variety used for preparation of the phytosanitary treatments.

Table 1. The basic statistics of *Phytophthora infestans* Mont. de Bary attack degree (AD%) in Redsec potato variety function of administered treatments, 2017

| Experimental variant | n | Mean | S | Min. | Max. | CV (%) |
|--|----|---------------------|------|-------|-------|--------|
| Control | 28 | 17.74 ^d | 2.38 | 15.03 | 21.42 | 13.42 |
| Treatment with 1.1% <i>Allium sativum</i> L. aq. | 28 | 6.66 ^{dab} | 0.59 | 4.22 | 6.76 | 6.01 |
| Treatment with 2.2% <i>Allium sativum</i> L. aq. | 28 | 7.03 ^{dab} | 0.41 | 5.12 | 7.12 | 11.52 |
| Treatment with Alcupral 50 PU | 28 | 5.32 ^{da} | 0.81 | 4.16 | 8.12 | 7.71 |
| Treatment with Infinito 687.5 SC | 28 | 4.28 ^{dba} | 0.40 | 3.51 | 5.15 | 22.90 |
| Treatment with 1.1% organic Se enriched <i>Allium sativum</i> L. aq. | 28 | 4.62 ^{dba} | 0.39 | 3.88 | 5.15 | 8.44 |
| Treatment with 2.2% organic Se enriched <i>Allium sativum</i> L. aq. | 28 | 7.37 ^{dab} | 0.98 | 4.02 | 7.41 | 8.01 |

Note: a – statistically no significant at $p > 0.05$; b – statistically significant at $p < 0.05$; d – statistically significant at $p < 0.001$.

Similar evolutions as those obtained in Redsec potato variety (Table 1), were obtained when Roclas potato variety was analyzed in the same areal and experimental conditions (Table 2), but the mean values of the late blight attack degrees are lower, in majority of groups. Thus, results the efficacy of the treatments performed with Infinito 687.5 SC, and 1.1% aqueous solution of selenium enriched *Allium sativum* L. with close means, followed by the value of the mean attack degree obtained in group where Alcupral 50 PU, was administered. The lowest mean attack degrees (AD), namely AD = 2.37% (treatment with Infinito 687.5 SC), AD = 2.51% (1.1% organic Se enriched *Allium sativum* L. aq.), and AD = 4.72% (Alcupral 50 PU). In Roclas potato variety, also the increase of concentration of aqueous solutions of garlic with, and without selenium supplements led to inferior results, reflected by the values of the increased mean attack degrees, of AD = 5.76% (2.2% *Allium sativum* L. aq.) and AD = 7.69% (2.2% organic Se enriched *Allium sativum* L. aq.). The biggest mean attack degree, AD = 17.75% is reported in untreated, unfertilized control (Table 2).

Table 2. The basic statistics of *Phytophthora infestans* Mont. de Bary attack degree (AD%) in Roclas potato variety function of administered treatments, 2017

| Experimental variant | n | Mean | s | Min. | Max. | CV (%) |
|--|----|---------------------|------|-------|-------|--------|
| Control | 28 | 17.75 ^d | 1.12 | 14.07 | 19.32 | 6.31 |
| Treatment with 1.1% <i>Allium sativum</i> L. aq. | 28 | 5.76 ^{dab} | 0.44 | 5.16 | 7.82 | 7.64 |
| Treatment with 2.2% <i>Allium sativum</i> L. aq. | 28 | 6.69 ^{dab} | 0.51 | 5.55 | 7.99 | 7.62 |
| Treatment with Alcupral 50 PU | 28 | 4.72 ^{dab} | 0.34 | 3.82 | 5.08 | 7.20 |
| Treatment with Infinito 687.5 SC | 28 | 2.37 ^{dba} | 0.42 | 2.17 | 3.07 | 17.72 |
| Treatment with 1.1% organic Se enriched <i>Allium sativum</i> L. aq. | 28 | 2.51 ^{dba} | 0.31 | 1.99 | 3.61 | 12.35 |
| Treatment with 2.2% organic Se enriched <i>Allium sativum</i> L. aq. | 28 | 7.59 ^{dab} | 0.54 | 6.11 | 8.88 | 7.11 |

Note: a – statistically no significant at $p > 0.05$; b – statistically significant at $p < 0.05$; d – statistically significant at $p < 0.001$.

In Roclas potato variety, the variability is lower than the threshold of 30% (Merce and Merce, 2009), and this confirm the homogeneity of the data and representativeness of the attack degrees means. The biggest value of the variability (CV=17.72%) is reported in experimental variant where the phytosanitary treatment was performed with Infinito 687.5 SC, while the lowest (CV=6.311%), in control (Table 2). The values of maximum and minimum, of the late blight attack degree in Roclas potato variety are AD = 1.99% when treatment is performed with 1.1% selenium enriched *Allium sativum* L. (aq.), and AD = 19,32% for maximum value, respectively (Table 2).

In both studied potato varieties, Redsec, and Roclas, respectively, very significant differences ($p < 0.001$) are reported between mean late blight attack degrees reported in control, and all six experimental variants, while statistically no significant differences are emphasized between mean late blight attack degrees reported in variants treated with phytosanitary conventional products Alcupral 50 PU and Infinito 687.5 SC, and also unconventionally treated variant with 1.1% organic Se enriched *Allium sativum* L. (aq.) (Tables 1, and 2). When the fight against *Alternaria solani* Sorauer is analyzed, in the same potato varieties, Redsec, and Roclas, respectively, we record bigger attack degrees (Tables 3, and 4), compared to those reported for *Phytophthora infestans* Mont. De Bary (Tables 1 and 2).

The mean attack degrees expressed by the entire experimental period, obtained for each phytosanitary treatment variant, including the untreated control (Table 3), emphasize the efficacy of the treatments performed with conventional product Infinito 687.5 SC and unconventional aqueous solution 1.1% selenium enriched *Allium sativum* L. The lowest mean attack degree (AD), namely AD = 6.64% is reported in experimental variant where treatment was performed with conventional product Infinito 687.5 SC, followed by the value of alternariosis mean attack degree (AD = 6.99%) reported when treatment is performed with 1.1% organic Se enriched *Allium sativum* L. (aq.). The increase of concentration of aqueous solutions of garlic with, and without selenium supplements led to inferior results, reflected by the values of the increased mean attack degrees, of AD = 11.09% (2.2% *Allium sativum* L. aq.) and AD = 12.50% (2.2% organic Se enriched *Allium sativum* L. aq.). The study of *Alternaria solani* Sorauer attack, also emphasizes the biggest mean attack degree, AD = 17.86%, in untreated, unfertilized control (Table 3).

Table 3. The basic statistics of the *Alternaria solani* Sorauer attack degree (AD%) in Redsec potato variety, function of administered treatments, 2017

| Experimental variant | n | Mean | s | Min. | Max. | CV (%) |
|--|----|----------------------|------|-------|-------|--------|
| Control | 28 | 17.86 ^d | 2.04 | 14.72 | 20.55 | 11.42 |
| Treatment with 1.1% <i>Allium sativum</i> L. aq. | 28 | 10.28 ^{dab} | 0.41 | 8.65 | 11.97 | 3.99 |
| Treatment with 2.2% <i>Allium sativum</i> L. aq. | 28 | 11.09 ^{dab} | 0.47 | 10.86 | 11.92 | 4.24 |
| Treatment with Alcupral 50 PU | 28 | 9.40 ^{da} | 0.59 | 8.86 | 10.82 | 6.28 |
| Treatment with Infinito 687.5 SC | 28 | 6.64 ^{dba} | 0.46 | 5.39 | 7.88 | 6.93 |
| Treatment with 1.1% organic Se enriched <i>Allium sativum</i> L. aq. | 28 | 6.99 ^{dba} | 0.71 | 5.01 | 7.33 | 10.16 |
| Treatment with 2.2% organic Se enriched <i>Allium sativum</i> L. aq. | 28 | 12.50 ^{da} | 0.68 | 10.32 | 13.08 | 5.44 |

Note: a – statistically no significant at $p > 0.05$; b – statistically significant at $p < 0.05$; d – statistically significant at $p < 0.001$.

In Redsec potato variety, the biggest value of the variability (CV=11.42%) is reported in control, while the lowest (CV=3.99%), where phytosanitary treatment was performed with 1.1% *Allium sativum* L. (aq.). In the other experimental variants, variability frames within the interval 4.24% - 10.16% (Table 3). Concerning the values of maximum and minimum, we emphasize the minimum *Alternaria solani* Sorauer attack degree in Redsec potato variety (5.01%) when treatment

is performed with 1.1% organic Se enriched *Allium sativum* L. (aq.), and maximum, as expected, in untreated control, 20.55%, respectively (Table 3).

In Roclas potato variety (Table 4), the mean values of *Alternaria solani* Sorauer attack degrees are much bigger in all experimental groups. The efficacy of the treatments performed with Infinito 687.5 SC, 1.1% aqueous solution of selenium enriched *Allium sativum* L. and Alcupral 50 PU, are the best. The lowest mean attack degrees are AD = 10.44%, corresponding to the treatment with Infinito 687.5 SC, AD = 11.02%, corresponding to the treatment with solution of 1.1% organic Se enriched *Allium sativum* L. (aq.), and AD = 11.14%, corresponding to the treatment with Alcupral 50 PU. In Roclas potato variety, also the increase of concentration of aqueous solutions of garlic with, and without selenium supplements led to inferior results, reflected by the values of the increased mean attack degrees, of AD = 16.95% (2.2% *Allium sativum* L. aq.) and AD = 17.80% (2.2% organic Se enriched *Allium sativum* L. aq.), the last one also being the biggest mean attack degree, by entire experiment, even slight bigger compared to the mean values of AD = 17.76% reported for untreated, unfertilized control (Table 4). The biggest value of the variability (CV=11.32%) is reported in control, while the lowest (CV=1.36%), where phytosanitary treatment was performed with 1.1% *Allium sativum* L. (aq.). In the other experimental variants, variability frames within the interval 2.96% - 5.57% (Table 4). Concerning the values of maximum and minimum, we emphasize the minimum *Alternaria solani* Sorauer attack degree in Redsec potato variety (9.01%) when treatment is performed with unconventionally with 1.1% organic Se enriched *Allium sativum* L. (aq.), and maximum, as expected, in untreated control, 20.42%, respectively (Table 3).

Table 4. The basic statistics of the *Alternaria solani* Sorauer attack degree (AD%) in Roclas potato variety, function of administered treatments, 2017

| Experimental variant | n | Mean | s | Min. | Max. | CV (%) |
|--|----|---------------------|------|-------|-------|--------|
| Control | 28 | 17.76 ^{ab} | 2.01 | 14.72 | 20.42 | 11.32 |
| Treatment with 1.1% <i>Allium sativum</i> L. aq. | 28 | 16.95 ^{ab} | 0.23 | 15.65 | 17.97 | 1.36 |
| Treatment with 2.2% <i>Allium sativum</i> L. aq. | 28 | 15.22 ^{ab} | 0.45 | 14.86 | 17.92 | 2.96 |
| Treatment with Alcupral 50 PU | 28 | 11.14 ^{ba} | 0.62 | 9.86 | 12.82 | 5.57 |
| Treatment with Infinito 687.5 SC | 28 | 10.44 ^{ba} | 0.33 | 9.39 | 11.88 | 3.16 |
| Treatment with 1.1% organic Se enriched <i>Allium sativum</i> L. aq. | 28 | 11.02 ^{ba} | 0.41 | 9.01 | 11.33 | 3.72 |
| Treatment with 2.2% organic Se enriched <i>Allium sativum</i> L. aq. | 28 | 17.80 ^a | 0.72 | 17.32 | 19.08 | 4.04 |

Note: a – statistically no significant at $p > 0.05$; b – statistically significant at $p < 0.05$.

In both studied potato varieties, Redsec, and Roclas, respectively, means are representative, and data are characterized by a good homogeneity. Also in both studied potato varieties, Redsec, and Roclas, no significant differences ($p > 0.05$) are reported between mean *Alternaria solani* Sorauer attack degrees reported in control, and groups unconventionally treated with solutions 1.1%, and 2.2% *Allium sativum* L. (aq.) and 2.2% selenium enriched *Allium sativum* L. (aq.), while between control and experimental variants treated with Infinito 687.5 SC, Alcupral 50 PU, and 1.1% selenium enriched *Allium sativum* L. (aq.), the differences are statistically significant ($p < 0.05$). The differences between mean *Alternaria solani* Sorauer attack degrees reported in variants treated with phytosanitary conventional products Alcupral 50 PU and Infinito 687.5 SC, and also unconventionally treated variant with 1.1% organic Se enriched *Allium sativum* L. (aq.) are statistically not significant at significance threshold of 5% (Tables 3, and 4).

If we analyze the potato production, in both studied varieties, function of phytosanitary treatments, we obtained different results, function of both administered treatments, and variety. In

Resec potato variety (Table 5), the biggest mean of production is reported in experimental variant treated with Infinito 687.5 SC, 7.11 t/ha, respectively, followed by the mean production reported in experimental variants treated with 1.1% aqueous solution of selenium enriched *Allium sativum* L. and Alcupral 50 PU, of 6.86 t/ha, and 6.76 t/ha, respectively. The lowest mean production of 4.58 t/ha is reported in experimental variant treated with 2.2% aqueous solution of selenium enriched *Allium sativum* L. value close to the means reported in experimental variants treated with 2.2% aqueous solution of *Allium sativum* L., and in unfertilized, phytosanitary untreated, control, of 4.79 t/ha, and 4.89 t/ha (Table 5).

Table 5. The basic statistics of the production reported in Redsec potato variety (t/ha), function of phytosanitary treatments, 2017

| Experimental variant | n | Mean | s | Min. | Max. | CV (%) |
|--|----|-------------------|------|------|------|--------|
| Control | 50 | 4.89 ^a | 0.85 | 3.97 | 6.44 | 17.38 |
| Treatment with 1.1% <i>Allium sativum</i> L. aq. | 50 | 5.68 ^a | 0.28 | 2.85 | 8.42 | 4.93 |
| Treatment with 2.2% <i>Allium sativum</i> L. aq. | 50 | 4.97 ^a | 0.47 | 3.34 | 7.61 | 9.46 |
| Treatment with Alcupral 50 PU | 50 | 6.76 ^a | 0.66 | 5.73 | 9.14 | 9.76 |
| Treatment with Infinito 687.5 SC | 50 | 7.11 ^a | 0.38 | 6.25 | 9.87 | 5.34 |
| Treatment with 1.1% organic Se enriched <i>Allium sativum</i> L. aq. | 50 | 6.85 ^a | 0.43 | 6.82 | 9.58 | 6.28 |
| Treatment with 2.2% organic Se enriched <i>Allium sativum</i> L. aq. | 50 | 4.58 ^a | 0.79 | 3.94 | 8.31 | 17.25 |

Note: a – no significant at $p > 0.05\%$.

The biggest values of the production variability are reported in control (CV=17.38%), and in experimental variant where treatment was performed with 2.2% aqueous solution of selenium enriched *Allium sativum* L. (CV=17.25%). The lowest production variability (CV=4.93%) is emphasized in experimental variant where phytosanitary treatment was performed with 1.1% aqueous solution of *Allium sativum* L. In the other experimental variants, variability frames within the interval 5.34% - 9.76% (Table 5).

In Roclas potato variety, bigger mean productions were obtained (Table 6), compared to those reported in Redsec variety (Table 5). The biggest mean of production is reported in experimental variant treated with Infinito 687.5 SC, 7.47 t/ha, respectively, followed by the mean production reported in experimental variants treated with 1.1% aqueous solution of selenium enriched *Allium sativum* L. equal to 7.33 t/ha, and Alcupral 50 PU, of 6.99 t/ha, respectively. The lowest mean production of 5.89 t/ha is reported in unfertilized, phytosanitary untreated control (Table 6). Similarly with data emphasized in Redsec variety, the biggest production variabilities are reported in control (CV=22.58%), and in experimental variant where treatment was performed with 2.2% aqueous solution of selenium enriched *Allium sativum* L. (CV=22.61%). The lowest production variability (CV=13.92%) is emphasized in experimental variant where phytosanitary treatment was performed with 1.1% aqueous solution of organic selenium *Allium sativum* L, while in the other experimental variants, variability frames within the interval 16.17% - 19.46% (Table 4).

The variability lower than 30% (Merce and Merce, 2009), demonstrates the homogeneity of data, and also shows that means are representative, for the productions of both studied potato varieties, Redsec, and Roclas, respectively. Also, in both studied potato varieties, no significant differences, at significance threshold of 5%, were identified between the means of productions, function of phytosanitary treatments.

Table 6. The averages and parameters of dispersion of the total production tubercles of tubercles (t/ha) of the experimental plots of potatoes, Roclas variety, in experimental year 2013

| Experimental variant | n | Mean | s | Min. | Max. | CV (%) |
|--|----|-------------------|------|------|------|--------|
| Control | 50 | 5.89 ^a | 1.33 | 3.97 | 6.44 | 22.58 |
| Treatment with 1.1% <i>Allium sativum</i> L. aq. | 50 | 6.22 ^a | 1.11 | 2.85 | 8.42 | 17.85 |
| Treatment with 2.2% <i>Allium sativum</i> L. aq. | 50 | 6.27 ^a | 1.22 | 3.34 | 7.61 | 19.46 |
| Treatment with Alcupral 50 PU | 50 | 6.99 ^a | 1.13 | 5.73 | 9.14 | 16.86 |
| Treatment with Infinito 687.5 SC | 50 | 7.47 ^a | 0.89 | 6.25 | 9.87 | 16.17 |
| Treatment with 1.1% organic Se enriched <i>Allium sativum</i> L. aq. | 50 | 7.33 ^a | 1.02 | 6.82 | 9.58 | 13.92 |
| Treatment with 2.2% organic Se enriched <i>Allium sativum</i> L. aq. | 50 | 6.06 ^a | 1.37 | 3.94 | 8.31 | 22.61 |

Note: a – no significant at $p > 0.05\%$.

As regards the economic efficiency of the experimental treatments administered in potato studied varieties, there are reported very large differences (Fig. 1, and Fig. 2). Thus, in Redsec potato variety, interest was obtained for five experimental variants, while in control and experimental variant where unconventional treatment with 2.2% aqueous solution of organic selenium *Allium sativum* L, important loss (-40%, and -50%, respectively), is reported. The biggest interest resulted in experimental variant treated with Infinito 687.5 SC (+46%), while for experimental variants treated with 1.1% organic selenium enriched *Allium sativum* L. (aq.), and Alcupral 50 PU, also consistent interest is reported, in share of 29%, and 27%, respectively (Fig. 1).

If we discuss the results concerning the interest obtained for the other studied potato variety, Roclas, respectively (Fig. 1), we also find positive interest in only five experimental variants of the total of 9, but the shares are lower compared to those reported in Redsec variant (Fig. 2).

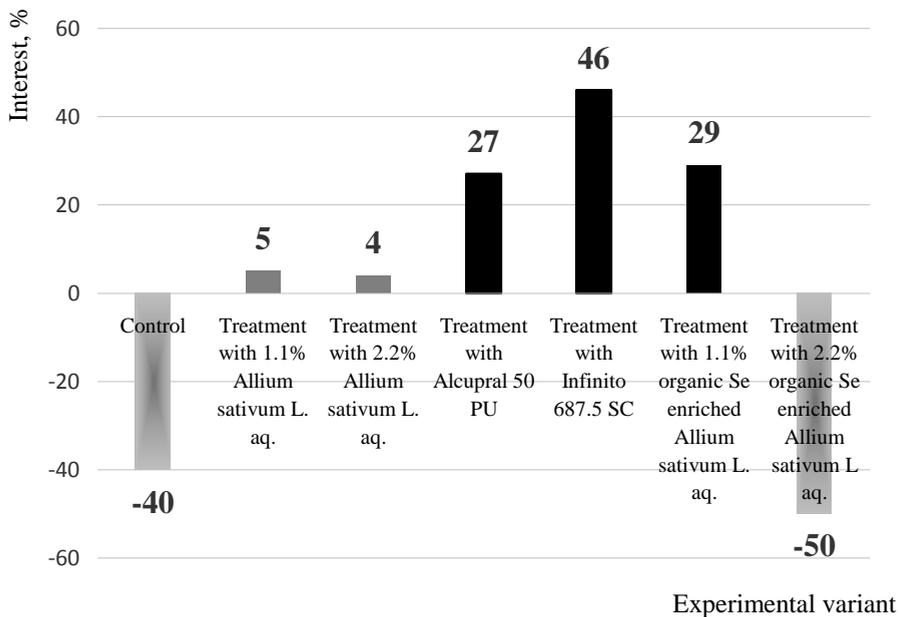


Fig. 1. The economic efficiency of experimental treatments in Redsec potato variety, 2017

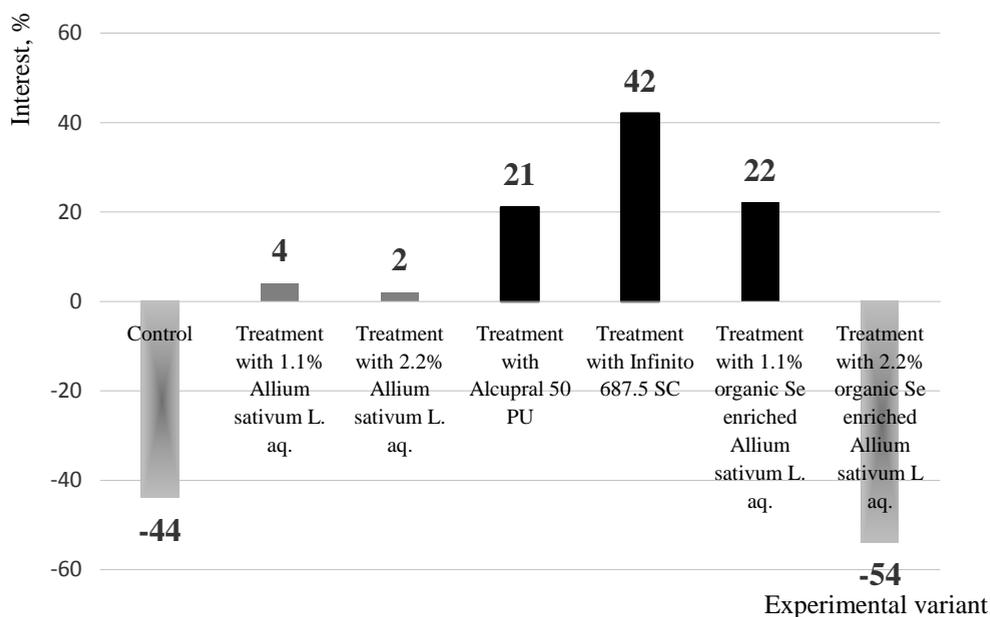


Fig. 2. The economic efficiency of experimental treatments in Roclas potato variety, 2017

Thus, in Roclas potato variety, in control a loss of 44% is reported, and in experimental variant where unconventional treatment with 2.2% aqueous solution of organic selenium *Allium sativum* L., bigger loss, in amount of 54%, is reported. The biggest interest resulted in experimental variant treated with Infinito 687.5 SC (+42%), and for experimental variants treated with 1.1% organic selenium enriched *Allium sativum* L. (aq.), and Alcupral 50 PU, almost the same interest is reported, in share of 22%, and 21%, respectively (Fig. 2).

CONCLUSIONS

The hierarchy of the efficacy of the conventional, and unconventional phytosanitary products administered as treatments against *Phytophthora infestans* Mont. De Bary, and *Alternaria solani* Sorauer attacks in both potato varieties studied in experimental areal located in Transilvanian Plane, Redsec, and Roclas, respectively, in descendent order, is the following: Infinito 687.5 SC, 1.1% organic Se enriched *Allium sativum* L. (aq.), Alcupral 50 PU, 1.1% *Allium sativum* L. (aq.), 2.2% *Allium sativum* L. (aq.), 2.2% organic Se enriched *Allium sativum* L. (aq.). The late blight occurrence is less intense compared to alternariosis, in both potato varieties, Redsec, and Roclas, respectively. The smallest mean attack degrees of *Phytophthora infestans* Mont. De Bary, are reported in Roclas variety, in variants treated with Infinito 687.5 SC, AD% = 2.37%, and with 1.1% organic Se enriched *Allium sativum* L. (aq.), AD% = 2.51%, while *Alternaria solani* Sorauer smallest mean attack degrees are reported in Redsec potato variety, also in variants treated with Infinito 687.5 SC., AD% = 6.64%, and with 1.1% organic Se enriched *Allium sativum* L. (aq.), AD% = 6.99%.

In pedo-climatic conditions of Transilvanian Plane, Romania, Redsec potato variety is more resistant against alternariosis, while Roclas potato variety, against late blight, while the biggest productions are obtained in Roclas variety, with the biggest mean productions reported in

experimental variants when phytosanitary treatments are performed with Infinito 687.5 SC. (7.47 t/ha), and with 1.1% organic Se enriched *Allium sativum* L. (aq.), where a mean production of 7.33 t/ha is recorded. No interest is reported in both studied potato varieties, when phytosanitary treatment with 2.2% organic Se enriched *Allium sativum* L. (aq.) was administered (with loss of 50% in Redsec and 54% in Roclas), and when no fertilization and no phytosanitary treatments were administered (loss of 40% in Redsec, and 46% in Roclas). Biggest interest are reported for phytosanitary treatments performed with Infinito 687.5 SC. (interest of 46% in Redsec, and interest of 42% in Roclas), and with 1.1% aqueous solution of organic Se enriched *Allium sativum* L. (interest of 29% in Redsec, and interest of 22% in Roclas).

Based on low late blight, and alternariosis attack degrees, productions and interests values, our research shows that the use of 1.1% organic Se enriched *Allium sativum* L. (aq.) is a valuable solution in fight against *Alternaria solani* Sorauer, and *Phytophthora infestans* Mont. De Bary, in both Redsec, and Roclas potato varieties, not only for organic, but also in conventional potato culture.

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