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## THE INFLUENCE OF BIOORGANIC PREPARATIONS ON THE PRODUCTIVITY OF CONVENTIONALLY GROWN WINTER RAPE ACTIVATING AND SAVING THE USE OF SYNTHETIC CHEMICALS

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The aim was to determine the impact of Raskila bio-organic preparation on the productivity of winter rape 'Sunday' grown under conventional system, in order to activate and save the use of treatment Rovral aqua flo and to improve the wintering of plants.

The scientific article presents the data of the conventional winter rape 'Sunday' growth intensity, plant formation, accumulation of dry matter, seed quality parameters, fertility data and the influence of the use of bioorganic fertilizers e. winter rape 'Sunday' seeds were coated with bioorganic preparations and synthetic treatments, and additionally sprayed with a bioorganic fertilizer solution. Agrotechnics was carried out according to the technology of winter rape growing at Aleksandras Stulginskis University Experimental station. Additional treatment of winter rape seeds and additional spraying with bioorganic fertilizers had a positive influence on the processes of growth and development of winter rape. By combining seed treatments and treatment with bio-organic Raskila fertilizers (3 l for 100 kg) and spray in autumn (3 l ha<sup>-1</sup>), the best results are achieved: the maximum rape seed yield was 3.87 t ha<sup>-1</sup> and the best quality production. Bioorganic fertilizers and treatment Rovral aqua flo has significantly increased the following indicators of winter rape 'Sunday': the length of the plant (118.16-127.64 cm), the number of branches (6-10), seeds in the silique (28.27), the seed yield (3.16-3.87 t ha<sup>-1</sup>). The highest seed yield (3.87 t ha<sup>-1</sup>) was achieved, applying Nagro preparations in the autumn and the Rovral aqua flo treatment and spraying Raskila plants when the rape reaches a height of 5-7 cm (BBCH 10-19). Premium yield was 86.6 % compared to control. Raskila fertilizers and treatment Rovral aqua flo significantly increased the following parameters of winter rape seeds: content of fat (41.52-43.05 %), proteins (20.39-20.91%), glucosinolates decreased from 18.68 to 18.31 mg g<sup>-1</sup>. This has improved seed quality. Treatment with Raskila and treatment Rovral aqua flo decreased seeds and seedlings infestation and morbidity due to *Fusarium*, *Drechlera*, *Alternaria*, *Penicillium*. Rates of treatment can be reduced if combined with bioorganic fertilizers. Application of bioorganic fertilizers and treatment in combination increases the effectiveness of treatment. Bio-organic fertilizer reduces plant stress caused by synthetic treatment.

*Keywords: winter rape, bio-organic fertilizers, synthetic treatment, biometric parameters, seed yield, efficiency.*

### INTRODUCTION

Recently, much attention has been paid to the problems of climate change, global warming, greenhouse gas pollution, environmental pollution, soil quality, biodiversity and ecological farming perspectives. These are priorities for implementing the Lithuanian Rural Development Program 2014-2020 (Spruogis et al., 2013; Mokslinio..., 2013).

One of the possible solutions is the development of new generation bioorganic fertilizers and bioenergetics. The specific molecular structure of the nano bioorganic fertilizer significantly improves the absorption of plant cells, thus increasing the biometric characteristics of the crops - by fertilizing through the leaves the seed material and stimulating plant germination, growth and development. Due to the influence of humic substances, natural soil fertility increases (soil quality improves, humus content is increased). These fertilizers act as biofungicide, bioinsecticide - anti pheromone - toribone (Malecka et al., 2005). Liquid bioorganic fertilizers Raskila - the first fertilizers in agriculture, their production technologies are based on processes of fermentation – pasteurization of large molecular structures of nutrients and

biologically active substances. It is based on physical effects instead of chemical one (Svirskis, Vilkonis, 2008; Spruogis et al., 2013, Jakienė et al. 2015).

Bioorganic preparats help to save synthetic mineral fertilizers by repelling pests and preventing the spread of diseases (Davies, 2004). Mineral fertilizers protect plants from stress and strengthen their immune system. Increasing the potential of soil by using bioorganic fertilizers will balance the quality of the soil, improve the financial performance and reduce the effects of climate change. The Raskila fertilizer contains all the nutrients necessary for the plants. Their quantities are well balanced. It is very important that the active substance in the fertilizer contains organic matter. Humic and fulvic acids with carbon are highly active compounds that greatly enhance the absorption of nutrients from the environment. This can be compared with the rapid absorption of carbohydrates in living organisms (Liakas et al. 2006; Минеев, 2008; Gavenauskas et al, 2013; Mokslinio..., 2013; Jakienė, Spruogis, 2015).

The aim was to determine the impact of Raskila bio-organic fertilisers on the productivity of winter rape 'Sunday' grown under conventional system, in order to activate and save the use of treatment Rovral aqua flo and to improve the wintering of plants. Research objectives: 1. to investigate how and as much it is possible increase the productivity of winter rape production and improve the quality of production using treatment Rovral aqua flo. 2. to analyze the parameters of yield quality, to carry out biometric measurements and chemical analyses.

## RESEARCH METHODS

The research was carried out in 2014 - 2016 at Experimental Station of Aleksandras Stulginskis University. The soil was calcareous shallow luvisol (Calc(ar)i .Epihypogleyic Luvisols) IDg8 k (LVg-p-w-cc). The agrochemical properties of the soil were determined before experiment. The analysis was performed using PSCO/ISI Infrared Spectrometer IBM-PC 4250 according to data bank calibrations. Soil was neutral or slightly alkaline – pH 7.2, amount of mobile phosphorus ( $P_2O_5$ ) – 238 – 250 mg kg<sup>-1</sup>, of mobile potassium ( $K_2O$ ) – 154–172 mg kg<sup>-1</sup>, humus – 1.70–2.45 %.

Seeds treatment experiment scheme: 1. Control; 2. Raskila (3 l 100 kg); 3. Rovlor aqua flo (0.5 l 100 kg); 4. Raskila (3 l 100 kg) + Rovral aqua flo (0.5 l 100 kg); 5. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg); 6. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg) + sprayed with bio-organic fertilizers Raskila (3 l ha), when rape reaches a height of 5-7 cm (BBCH 10-19).

Experiment fields arranged sequentially in four replications. The total size of the plot was 30 m<sup>2</sup> (3 × 10), accounting –17.6 m<sup>2</sup> (2.2 × 8). Mineral fertilizers were applied NPK 8-20-30, 300 kg ha<sup>-1</sup>. Winter rape was sown in I decade of August. The average seed rate was ~ 4 kg ha<sup>-1</sup>, the sowing depth – 2–3 cm. Harvested at the end of July.

The wintering was evaluated in points and recalculated in %, four samples per 100 seeds were taken from each variant for estimation of seed germination energy and germination. The rape was germinated in darkness, on moist filter paper in Petri dishes for 3 to 4 days at 8 to 12 °C and after – at 20 °C. The germination energy was estimated in the laboratory after 3 days and seeds germination – after 7 days. Seed were weighted from each trial field after harvesting. The grain was dried up to 14 %, cleaned and the grain yield (t ha<sup>-1</sup>) was calculated. The chemical composition of grains was analysed in Chemical Research Laboratory and Agrochemical Research Laboratory of the Lithuanian Research Centre for Agriculture and Forestry.

Raskila bio-organic fertilizers were developed and produced in Lithuania (UAB Raskilė). Fertilizers are produced from 100% biohumus and suitable for all plants. Fertilizers contain the whole complex of macro-and trace elements, humic substances, fulvic acids, nitrogen, potassium, phosphorus, phytochemicals and useful soil micro-organisms (Mokslinio..., 2013).

Treatment Rovral aqua flo is a contact carboxamide group fungicide for seed treatment and protection of plants during vegetation from fungal diseases. Dry seeds are treated just before sowing / planting (Merkys, Miliuvienė, 1993). The density of winter rape crop was determined by calculation in each field in four places of 0.25 m<sup>2</sup>. The root neck diameter is determined by measurement. The yield of rape seed is determined by weighing from each test plot. The average productivity of a plant was determined by dividing the weight of one- sheaf seeds from number of plants in the sheaf. The number of silique was determined by counting the siliques in the sheaf and by dividing the number of plants in the sheaf. The amount of seed is calculated according to the formula:  $S = P \times 1000 / m$ , where S is the amount of seed; P - plant productivity g; m - 1000 seed mass in g. The amount of seed in the silique is calculated according to the formula:  $a = S / A$ , where a is the number of seeds in silique; S – the amount of seed; A - the amount of siliques. The elements of yield and harvest structure were determined by direct measurement, calculation.

Quantitative grain contamination by micromycetes (CFU / g) was determined by dilution. There are weighed 10 g of grain, placed in a 90 ml of distilled water and stirred for 20 minutes. Then the sample is diluted to  $10^{-3}$ . After obtaining the necessary dilution, 1 ml of solution is taken and inoculated in Petri dish with Chapec agar medium with chloramphenicol and yeast extract, glucose, chloramphenicol agar (YGC Agar) - four replicates. Petri dishes are incubated at  $26 \pm 2^\circ C$  for 7-10 days. Growing micromycetes colonies are evaluated at 7, 10 development day. Then the number of viable micromycetes spores is calculated in gram of grain.

Internal contamination by micromycetes of grains determined using the direct seeding method. 200 of grains were taken from each sample and placed in a sterile room in a Petri dish on a sterile, agarized Chapec (CH) medium with chloramphenicol. At the beginning of the analysis grains are disinfected with 70° ethyl alcohol. Exposition 3 min., then washed with sterile distilled water, and placed to the Petri dishes. In each Petri dish 9 grains are placed in a circle and 1 grain in the center. Sowing takes place on 10 Petri dishes. The dishes are incubated at  $26 \pm 2^\circ C$  for 7-10 days. Growing

micromycetes colonies are scored at 7, 10 development day. The morphological features of micromycetes were investigated by a light microscope based on various descriptions (Samson, Pitt, 2000; Lugauskas, Stakeniene, 2002; Flannigan et al. 2016). Defined fungal genera growing and estimated composition expressed in percentage.

The research data were statistically evaluated by means of dispersion analysis of quantitative attributes using the computer program ANOVA (Tarakanovas, Raudonius, 2003).

## RESULTS AND DISCUSSION

The results of the research showed that in agriculture, applying fertilizers, pesticides and various preparations is very important to obtain the possible highest and the best quality yield. An important factor is the economic efficiency of fertilizer use. As we can see from Table 1, the highest income was obtained in variants 5 and 6 (428.64–489.46 € ha<sup>-1</sup>), applying bioorganic fertilizer Raskila. The highest financial efficiency was achieved combining application of fertiliser with treatment Rovral aqua flo. This combination allows saving up to 50 % of treatment.

Table 1. The effect of bioorganic fertilizer Raskila and treatment Rovral aqua flo on winter rape 'Sunday' and cost-effectiveness

| Treatment  | Grain yield<br>t ha <sup>-1</sup> | Grain yield<br>increase<br>t ha <sup>-1</sup> | Grain yield<br>increase<br>value<br>€ ha <sup>-1</sup> | Raskila and<br>Rovral<br>aqua flo<br>cost<br>€ ha <sup>-1</sup> | Income<br>€ ha <sup>-1</sup> |
|--|-----------------------------------|---|--|---|------------------------------|
| 1. Control   | 2.08                              | -   | -  | -   | -                            |
| 2. Raskila (3 l 100 kg)  | 3.45                              | 1.37  | 396.78   | 5.79  | 390.99                       |
| 3. Rovlor aqua flo (0.5 l 100 kg)  | 3.16                              | 1.08  | 312.79   | 23.17   | 289.62                       |
| 4. Raskila (3 l 100 kg) + Rovral aqua flo (0.5 l 100 kg)   | 3.56                              | 1.48  | 428.64   | 28.96   | 399.68                       |
| 5. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg)  | 3.62                              | 1.54  | 446.01   | 17.38   | 428.64                       |
| 6. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg)<br>+ sprayed with bio-organic fertilizers Raskila (3.0 l ha) | 3.87                              | 1.79  | 518.42   | 28.96   | 489.46                       |
| LSD <sub>05</sub>  | 0,52                              |   |  |   |                              |

Data from Table 2 show that Raskila fertilizers and treatment Rovral aqua flo significantly increased the following indicators of winter rape 'Sunday': the length of the plant from 118.16 up to 127.64 cm, number of branches from 6 up to 10, number of seeds per silique from 25.95 up to 28.27, grain yield from 3.16 t ha<sup>-1</sup> to 3.87 t ha<sup>-1</sup>. The most effective result was achieved in variant 6. As can be seen from the presented data, application of Raskila increased plant and silique length, number of seed per silique and seed yield. The highest seed yield (3.87 t ha<sup>-1</sup>) was received after treatment with bioorganic fertilizer Raskila rate 3 l 100 kg as well as applying autumn single-spray with Raskila (3,0 l ha<sup>-1</sup>) when rape reached 7 cm length (BBCH 10-19). Harvest increase was 86.6 % compared to control. There was no significant difference between them. The analysis of grain quality and calculation of economic efficiency showed that the most rational is combination of Raskila and Rovral aqua flo together with spraying with Raskila.

Table 2. The influence of bio-organic fertilizers Raskila and treatment Rovral aqua flo on winter rape 'Sunday' yield and biometric characteristics

| Treatment  | Plant<br>length cm | Number<br>of<br>branches | Number of<br>seeds per<br>silique | Grain yield<br>t ha <sup>-1</sup> | Yield<br>increase<br>% |
|--|--------------------|--------------------------|-----------------------------------|-----------------------------------|------------------------|
| 1. Control   | 94.21              | 5                        | 22.40                             | 2.08                              | 100                    |
| 2. Raskila (3 l 100 kg)  | 118.16             | 6                        | 26.05                             | 3.45                              | 165.86                 |
| 3. Rovlor aqua flo (0.5 l 100 kg)  | 120.47             | 8                        | 25.95                             | 3.16                              | 151.92                 |
| 4. Raskila (3 l 100 kg) + Rovral aqua flo (0.5 l 100 kg)   | 125.78             | 9                        | 27.87                             | 3.56                              | 171.15                 |
| 5. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg)  | 120.06             | 10                       | 27.98                             | 3.62                              | 174.04                 |
| 6. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg)<br>+ sprayed with bio-organic fertilizers Raskila (3.0 l ha) | 127.64             | 10                       | 28.27                             | 3.87                              | 186.6                  |
| LSD <sub>05</sub>  | 3.95               | 2                        | 1.63                              | 0.52                              |                        |

Raskila fertilizers and treatment Rovral aqua flo significantly increased the quality of winter rape 'Sunday': changes in fats – 41.52–43.05 %, compared to the control – 40.23 %, in proteins 20.39–20.91 %, compared to the control – 19.56 %, reduced glucosinolates from 18.68 to 18.31 mmol g<sup>-1</sup>, compared to control – 19.91 mmol g<sup>-1</sup> (Table 3). Application of fertilisers Raskila improved the quality of the grain.

The results of the study showed that Raskila fertilizers and treatment Rovral aqua flo significantly increased all indicators of winter rape "Sunday": seed germination – 87.9–94.5 %, seed germination energy – 86.1–94.8 %, wintering – 62.2–67.0 % (Table 4). The most effective combination of Raskila 3 l 100 kg with Rovral aqua flo 0.25 l 100 kg and spray with Raskila fertilizers 3 l ha<sup>-1</sup> when rape reached 7 cm length (BBCH 10-19) in autumn. Seed coating has been s to be more effective comparing to spraying.

Table 3. The influence of bioorganic fertilizers Raskila and treatment Rovral aqua flo on the chemical composition of winter rape 'Sunday' seeds

| Treatment   | Fats % | Proteins % | Glucozinolates mmol g <sup>-1</sup> |
|---|--------|------------|-------------------------------------|
| 1. Control  | 40.23  | 19.56      | 19.91                               |
| 2. Raskila (3 l 100 kg)   | 41.52  | 20.39      | 18.68                               |
| 3. Rovlor aqua flo (0.5 l 100 kg)   | 41.69  | 20.59      | 18.40                               |
| 4. Raskila (3 l 100 kg) + Rovral aqua flo (0.5 l 100 kg)  | 42.98  | 20.91      | 18.55                               |
| 5. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg)   | 42.99  | 20.51      | 18.59                               |
| 6. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg) + sprayed with bio-organic fertilizers Raskila (3.0 l ha) | 43.05  | 20.78      | 18.31                               |
| LSD <sub>05</sub>   | 1.21   | 0.82       | 0.98                                |

Table 4. The influence of bio-organic fertilizers Raskila and treatment Rovral aqua flo on winter rape 'Sunday' seed germination, germination energy and wintering

| Treatment   | Seed germination % | Germination energy % | Wintering % |
|---|--------------------|----------------------|-------------|
| 1. Control  | 80.6               | 79.7                 | 61.0        |
| 2. Raskila (3 l 100 kg)   | 91.8               | 90.6                 | 65.6        |
| 3. Rovlor aqua flo (0.5 l 100 kg)   | 87.9               | 86.1                 | 62.2        |
| 4. Raskila (3 l 100 kg) + Rovral aqua flo (0.5 l 100 kg)  | 92.8               | 91.6                 | 65.3        |
| 5. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg)   | 94.1               | 93.8                 | 66.3        |
| 6. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg) + sprayed with bio-organic fertilizers Raskila (3.0 l ha) | 94.5               | 94.8                 | 67.0        |
| LSD <sub>05</sub>   | 4.5                | 6.2                  | 3.1         |

It was important to determine the effect of application of bioorganic fertilizers on the severity of seeds and seedlings combining seed treatment with the reduction of synthetic chemicals. The data presented in Tables 5-6 allows to state the bioorganic preparations used in this experiment had positive effect. Application of Raskila and Rovral aqua flo (as compared to control) decreased the infection of seeds and seedlings by micromycetes: *Fusarium*, *Drechlera*, *Alternaria*, *Penicillium* and others (Table 5). Application combination of Raskila 3 l 100 kg with Rovral aqua flo 0.25 l 100 kg and spray with Raskila fertilizers 3 l ha<sup>-1</sup> when rape reached 7 cm length (BBCH 10-19) in autumn decreased morbidity of winter rape 'Sunday' seedlings, roots and seeds.

Table 5. The influence of bio-organic fertilizers Raskila and treatment Rovral aqua flo on winter rape 'Sunday' seed and seedlings infestation by micromycetes

| Treatment   | Healthy seeds % | <i>Fusarium</i> spp. | <i>Drechlera</i> spp. | <i>Alternaria</i> spp. | <i>Penicillium</i> spp. | Other |
|---|-----------------|----------------------|-----------------------|------------------------|-------------------------|-------|
| 1. Control  | 0               | 6.2                  | 4.8                   | 46.1                   | 19.0                    | 48.9  |
| 2. Raskila (3 l 100 kg)   | 0               | 2.9                  | 3.0                   | 19.2                   | 12.8                    | 25.3  |
| 3. Rovlor aqua flo (0.5 l 100 kg)   | 0               | 0.5                  | 0.4                   | 7.9                    | 2.5                     | 1.2   |
| 4. Raskila (3 l 100 kg) + Rovral aqua flo (0.5 l 100 kg)  | 0               | 0.5                  | 0.4                   | 7.7                    | 2.3                     | 1.2   |
| 5. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg)   | 0               | 0.5                  | 0.3                   | 7.5                    | 2.3                     | 1.0   |
| 6. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg) + sprayed with bio-organic fertilizers Raskila (3.0 l ha) | 0               | 0.5                  | 0                     | 7.8                    | 2.0                     | 1.0   |
| LSD <sub>05</sub>   |                 | 2.7                  | 2.0                   | 7.1                    | 4.9                     | 10.4  |

Table 6. The influence of bio-organic fertilizers Raskila and treatment Rovral aqua flo on morbidity of winter rape 'Sunday' seedlings, roots and seeds

| Treatment   | Seedlings % | Roots % | Seeds % |
|---|-------------|---------|---------|
| 1. Control  | 34.2        | 36.3    | 39.1    |
| 2. Raskila (3 l 100 kg)   | 21.8        | 21.4    | 19.2    |
| 3. Rovlor aqua flo (0.5 l 100 kg)   | 0.7         | 0.2     | 0.1     |
| 4. Raskila (3 l 100 kg) + Rovral aqua flo (0.5 l 100 kg)  | 0.7         | 0.6     | 0.3     |
| 5. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg)   | 0.5         | 0.3     | 0.5     |
| 6. Raskila (3 l 100 kg) + Rovral aqua flo (0.25 l 100 kg) + sprayed with bio-organic fertilizers Raskila (3.0 l ha) | 0.5         | 0.3     | 0.5     |
| LSD <sub>05</sub>   | 9.6         | 9.8     | 9.7     |

Summarizing the results of the research, it can be stated, that the application of bioorganic fertilizers in the intensive farming winter rape 'Sunday' crop was denser, luscious, the plants were higher, the root system was more

developed. The obtained data suggest that in the intensive farming the most effective variant where winter rape 'Sunday' seeds were treated with bioorganic fertilisers Raskila 3 l 100 kg, treatment Rovral aqua flo 0.25 l 100 kg and sprayed with Raskila fertilizers 3 l ha<sup>-1</sup> when rape reached 7 cm length (BBCH 10-19) in autumn. Obviously, the application of bioorganic fertilizer Raskila together with treatment Rovral aqua flo increased efficiency of the treatment, as well as had a positive effect on yield, yield quality, biometric indicators and wintering.

## CONCLUSIONS

1. Bioorganic fertilizers Raskila and treatment Rovral aqua flo significantly increased the yield of winter rape 'Sunday' seeds 3.16–3.87 t ha<sup>-1</sup> in 2014 – 2016 and the highest income was received respectively 428.64–489.46 € ha<sup>-1</sup>. The best results are obtained when bioorganic fertilizer Raskila is applied together with treatment Rovral aqua flo during seeds coating. Then it is enough to use half the rate, thus saving 50 % of the Rovral aqua flo.
2. The following biometric indicators of winter rape 'Sunday' significantly increased due to application of bioorganic fertilisers Raskila and treatment Rovral aqua flo: the plant length by 118.16–127.64 cm, the number of branches in 6–10, the amount of seeds per silique in 25.95–28.27, grain yield in 3.16–3.87 t ha<sup>-1</sup>. The most effective combination of bioorganic fertilisers Raskila 3 l 100 kg, treatment Rovral aqua flo 0.25 l 100 kg and sprayed with Raskila fertilizers 3 l ha<sup>-1</sup> when rape reached 7 cm length (BBCH 10-19) in autumn.
3. The following grain quality indicators of winter rape 'Sunday' significantly increased due to application of bioorganic fertilisers Raskila and treatment Rovral aqua flo: fats in 41.52–43.05 %, proteins in 20.39–20.91 %, glucosinolates decreased from 18.68 to 18.31. mmol g<sup>-1</sup>.
4. Biofertilisers Raskila and treatment Rovral aqua flo significantly increased winter rape 'Sunday' seeds germination in 87.9–94.5%, germination energy was 86.1–94.8 %, wintering in 62.2–67.0 %. The most effective combination of bioorganic fertilisers Raskila 3 l 100 kg, treatment Rovral aqua flo 0.25 l 100 kg and sprayed with Raskila fertilizers 3 l ha<sup>-1</sup> when rape reached 7 cm length (BBCH 10-19) in autumn.
5. Application of Raskila and Rovral aqua flo decreased seeds and seedlings infestation by micromycetes: *Fusarium*, *Drechlera*, *Alternaria*, *Penicillium* and others. Application Raskila with Rovral aqua flo decreased morbidity of winter rape 'Sunday' seedlings, roots and seeds.

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