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# PRODUCTIVITY OF GRASS-LEGUMES MIXTURES WITH POTERIUM POLYGAMUM APPLYING GROWTH STIMULATORS

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**Abstract**

The job presents the data about photosynthetic activity of plants and productivity of mixtures with Bromus Inermis, Agropyron pectiniforme with Poterium Polygamum and Onobrychis Arenaria, Medicago Caerulea, Lotus corniculatus with application of growth stimulants "Matritsarosta" and "Gumi 20M"

The best indicator of photosynthetic activity, leaf area, photosynthetic potential, as well as the maximum productivity of grass stands, the collection of dry matter, the yield of digestible protein was shown by four-component grass-legumesmixtures with Onobrychis arenaria and Medicago Caerulea.

Keywords: Bromus Inermis, Bromus erecta, Agropyron Pectiniforme, Elytrigia, Poterium Polygamum, Onobrychis Arenaria, Medicago Caerulea, Lotus Corniculatus, digestible protein, growth stumulators, "Matritsarosta", "Gumi 20M".

JEL Codes: Q1, Q16

## Introduction

One of the most important problems of agriculture is to increase the production of feed, improve their quality and energy saturation. The livestock supply is 60-70% of the annual demand. High protein deficiency in feed rations remains, which is a limiting factor of the livestock productivity growth [2, 3, 5, 7].

The problem of providing livestock with fodder remains one of the most important. That's why, the importance of organizing adaptive fodder production based on the creation of highly productive agrocenoses through the selection of crops and the introduction of new species that make full use of the bioclimatic resources of the region [5,6,8,10].

An important element of modern crop production are plant growth regulators and complex fertilizers with microelements in chelated form. They easily fit into the technology of cultivation [9,11]. One of the most promising, little-spread fodder crops is the Poterium Polygamum.

Poterium Polygamum is a perennial plant from the family of Rosaceae. The content of the hormonal substance, increase the reproductive capacity of animals. The content of protein, carotene, carbohydrates and trace elements is superior to cereals and legumes [1,3,9,11].

The main benefits of Poterium Polygamum: productive longevity 10 years or more; highly productive, yield of green mass 30-33 t/ha; dry matter 6.8-7.5 t/ha; yield of fodder units per hectare - 4.0-4.5 t/ha; digested protein 0.52-0.55 t / ha; exchange energy - 0.84-0.88 GJ / ha, digestible protein - 128 g in 1 feed unit [1, 5, 11].

The seed production of Poterium Polygamum is stable and less dependent on the weather conditions, this is due to the increased ability of pollination by honey bees, low availability of lodging, high drought resistance, the yield of seeds is 10-13 quintals per hectare [1, 2, 7, 9].

A medium-sized leveled crop can be used to harvest by serial machines; early maturity, the period from growing to maturing of seeds is 80 to 85 days, it is distinguished by morphological alignment of plants, uniform developmental phases; has a high plasticity, gives stable yields in different years in meteorological conditions, in different soil - climatic conditions [1, 9, 11].

Highly cold-resistant, heat-resistant and drought-resistant, complex resistance to diseases and pests; early regrowth quickly forms the weft mass, mostly used in the early spring green conveyor system; nutritiousness, eating and digestibility of all types of feed is good, excellent early honey, willingly visited by bees; - an excellent component for grass mixtures with medicago, galega, onobrychis, Bromus Inermis. In hay and pasture grass mixtures include up to 20-40%.Excellent pasture plant, withstands up to 3 bleedings; - the bramble contains hormonal substances that increase the reproductive capacity of animals; improves the structure and improves the fertility of the soil [1, 2, 5, 6, 7].

## Conditions and methods

The experiment was performed in the fodder crop rotation of the research laboratory "Korma" of the department of plant breeding and agriculture of the Samara State Agricultural Academy.

The total number of variants in experiments with a Bromus Inermis is 15, the same as for a Agropyron Pectiniforme. The repetition of the experiment is fourfold. The plot area is 125 $m^2$. Plots 60 for each experiment.

The scheme of each experiment included: 5 variants of mixtures (Factor A), control and use of growth stimulants (Factor B).

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Variants of the experience on the basis of Bromus Inermis:

1. Bromus Inermis+ Poterium Polygamum
2. Bromus Inermis+ Bromus Erecta+ Poterium Polygamum
3. Bromus Inermis+ Bromus Erecta+ Onobrychis Arenaria + Poterium Polygamum
4. Bromus Inermis+ Bromus Erecta+ Medicago Caerulea+ Poterium Polygamum
5. Bromus Inermis+ Bromus Erecta+ Lotus Corniculatus+ Poterium Polygamum

Variants of the experience on the basis of Agropyron Pectiniforme:

1. Agropyron Pectiniforme + Poterium Polygamum
2. Agropyron Pectiniforme + Elytrigia + Poterium Polygamum
3. Agropyron Pectiniforme+ Elytrigia +Onobrychis Arenaria+ Poterium Polygamum
4. Agropyron Pectiniforme+ Elytrigia +Medicago Caerulea+ Poterium Polygamum
5. Agropyron Pectiniforme+ Elytrigia + Lotus Corniculatus+ Poterium Polygamum

The studies were conducted according to a common accepted methodology. Experimental work was done taking into account the methods of field experiments of B.A. Dospekhov (1985), methodological instructions for conducting field experiments with fodder crops, developed by the All-Russian Research Institute. V.V. Williams (1987, 1997).The soil of the experimental field contains organic matter 6.9% of GOST 26213-91, mobile phosphorus - 62.2 mg/kg GOST 26204-91, mobile potassium - 230.0 mg/kg GOST 26204-91, easily hydrolyzable nitrogen - 64.0 mg/kg.

The following stimulators were used in the experiments:

- stimulant “Matritsa rosta” - plant growth regulator, bio-organic, biologically active polymeric compound with pronounced bactericidal and fungoprotective properties. It was suitable for cultivation of ecologically clean agricultural products, safe for humans, animals and environment. Applicable for cultivation of cereals, legumes, soybeans, as well as corn, potatoes, sugar beet and perennial grasses of agricultural crops.

- “GUMI 20M” growth stimulant with antistress, immunostimulating properties (potassium salts of humic acids of brown coal, contains more than 80 macro-, microelements, minerals of natural origin, enriched with additional elements). All anti-stress and immunostimulating preparations of the “GUMI” series increase the fertilizer and soil nutrient utilization coefficients by 20-30%.

**Results of the research**

The experiment to study the haymaking and pasture grass started on May 3, 2015, when the average decadal temperature was 14,6 °C, and the soil temperature was 9,2 °C, optimal for sowing perennial grasses. In the third decade of May, during the emergence of the plants, the average air temperature was 16,5 °C, which contributed to the emergence of sprouting on the 22-23 day after sowing. Completeness of shoots reached up to 86.13%.

The process of intensive accumulation of biological mass of perennial crops takes place in May-June, at which time they are most susceptible to stress factors. When the average temperatures of the spring and summer months in 2016 were above normal, and the amount of precipitation in the spring months exceeded the norm, which led to the accumulation of soil moisture and its use in the summer, the grass was formed fully. Weather conditions in 2017 can be described as favorable, precipitation fell over the spring period 2 times more than normal, in June the precipitation was 3 times higher than normal, which led to the rapid development of plants and the accumulation of green grass mass.

Thus, an assessment of the weather conditions in the region allows us to conclude that, in general, favorable conditions for the zone in 2015-2017, meet the requirements of crops.

The use of growth regulators contributed to an increase in the height of the grass and the accumulation of green mass. The highest values were obtained in the variants with treatment with “Gumi 20M”.

Our studies show that the area of the leaf surface gradually increases as the phenological phases pass. Studied stimulators had a positive effect on the formation of the leaf area. The greatest impact on the formation of the assimilation apparatus was provided by the “Gumi 20M” preparation (Figure 1).

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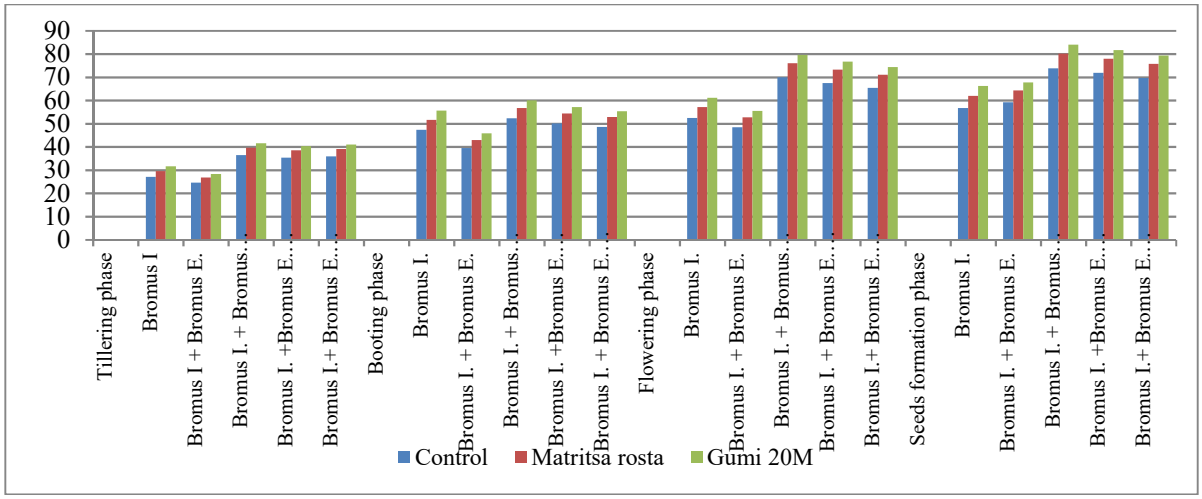


**Figure 1. Leaf area of haymaking and pasture grass on the basis of Bromus Inermis with Poteriym Polyganum with the use of growth stimulators, 2016-2017, thousand $m^2$/ha**

The growth intensity of the leaf apparatus in grass mixtures increases from the phase of tillering (branching) to seeds formation. In joint crops with the participation of grasses belonging to different biological groups, the stress (competition) of components for ecological factors of existence decreases. Due to the uniform distribution of the leaf mass over the longlines in the mixture, compared to pure grass crops, the total assimilation surface of the leaves increases, as well as increases the intensity of photosynthesis and, consequently, and yield. The maximum leaf area is observed in the herbage Bromus Inermis + Bromus Erecta. + Onobrychis Arenaria. Good indicators were noted in the same way, in the grass mixture with Medicago Caerulea and Lotus Corniculatus.

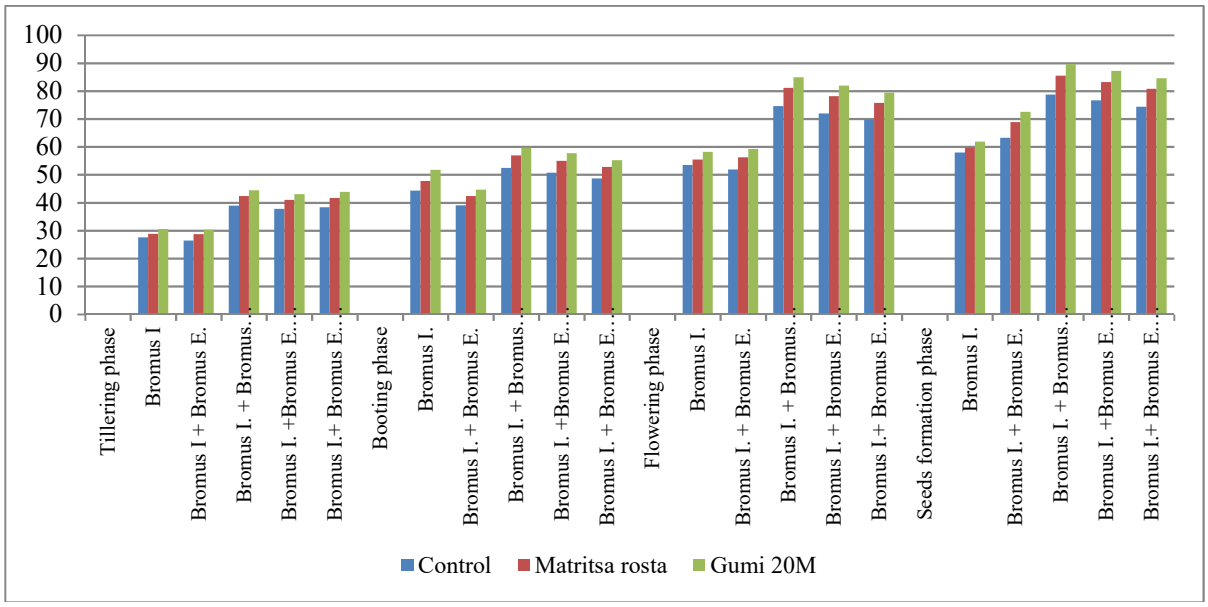


**Figure 2. The area of the leaves of haymaking and pasture grass on the basis of Agropyron Pectiniforme with Poterium Polygamum with the use of growth stimulators, 2016-2017, thousand $m^2$/ ha**

Growth intensity of the leaf apparatus in the grass mixtures with the Agropyron Pectiniforme was different. The area of the leaves in the grass stand of Agropyron Pectiniforme and its mixture with the Elytrigia Intermedia significantly increases to the booting phase, and then decreases. Conversely, with the budding phase of the grass mixture with the bean component: Onobrychis Arenaria, Medicago Caerulea, Lotus Corniculatus, grows not so significantly, but to the flowering phase it growth dramatically increase and keeps at this level until the phase of seeds formation (Fig. 2). It was revealed that the maximum leaf area observed on mixtures, consisting of a Agropyron Pectiniforme, Elytrigia Intermedia, a Onobrychis Arenariaand PoteriumPolygamum.

In the creation of a biological yield an important role is played by the photosynthetic potential of the leaf apparatus (PP), which is determined by the rate of its formation and the time of active work. The process of photosynthesis occurs in the leaves of plants, where 90-95% of the dry weight of the crop is created [2, 6, 10,12].

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Consequently, the more leaves in plants, the higher its productivity. Many researchers found that the leaf area is very important in yield formation. [2,6,13]. The application of our crops with the studied stimulants promoted to increase the photosynthetic potential.

Thus, in the mixes of Bromus inermis on control variant (without cultivation of crops), the photosynthetic potential in mixes with Poterium Polygamum was 760.8 ... 1611.7 thousand $m^2$/ha days. Whereas with the treatment of the "Matritsa rosta" it was 821.6 ... 1742.0 thousand $m^2$/ha day, and 845.5 ... 1788.7 thousand $m^2$/ha days after applying "Gumi 20M". When treated with "Matritsa Rosta" and "Gumi 20M", the maximum photosynthetic potential observed in a mixture with Onobrychis Arenaria.

In the mixtures with Agropyron Pectiniforme in control (without treatment), the photosynthetic potential in mixtures with Poterium Polygamum was 1400.48 ... 1932.85 thousand $m^2$/ha days. Whereas when treated with the stimulants, "Matritsa rosta" was 1490.2 ... 2033.37 thousand $m^2$/ha day, with "Gumi 20M" - 1722.90 ... 2200.67 thousand $m^2$/ha days. Moreover, when applying the "Matritsarosta", the maximum photosynthetic potential forms with Medicago Caerulea, while applying Gumi20M – Onobrychis Arenaria.

The increase in yield level is not only due to the photosynthetic activity of agrophytocenosis, but also in its working elements, the unit area of the leaf and the chloroplast, which is expressed in terms of the net productivity of photosynthesis (NPP). With the growth of photosynthesis productivity, it increases to a certain value, and then begins to decrease. This is due to the decrease in the use of solar radiation with high density, when it is difficult for light to reach the middle and lower levels [2, 3, 6, 13]. So the net productivity of photosynthesis in the mixtures with Bromus Inermis was in the range of 2.48-8.11 g/$m^2$ Bromus Erecta - 6.07 g/$m^2$ day, Bromus Erecta + Onobrychis Arenaria – 10.96 g/$m^2$ Bromus Inermis + Bromus Erecta + Medicago Caerulea - 9.64 g/$m^2$ day, Bromus Inermis + Bromus Erecta 6.24 g/$m^2$ per day. In the mixtures with Agropyron Pectiniforme was within 5-8.33 g/$m^2$ day, Agropyron Pectiniforme + Elytrigia Intermedia 4.78 g/$m^2$ day, Agropyron Pectiniforme + Elytrigia Intermedia + Medicago Caerulea - 3-4.92 g/$m^2$ day, Agropyron Pectiniforme + Elytrigia Intermedia + Lotus Corniculatus – 4.00-4.14 g/$m^2$ day.

While passing the phenological phases, the productivity of the green mass in all mixtures increases to the phase of earing (flowering). In the phase of earing (flowering), the growth of green mass stops due to the fact that the grass crops have reached their peak of development and pass to the phase of seeds formation, and the legumes begin or continue their flowering. The foliar use of stimulants contributed to the additional portion of nutrients, microelements, which positively affected yield. From the diagram (Fig. 3) it is evident that the greatest positive effect on the formation of the green mass yield was done after "Gumi 20M" treatment.

While growing and passing the phenological phases, mixtures with Bromus Inermis, Bromus Erecta, Onobrychis Arenaria, Poterium Polygamum, the maximum increase in yield compare with control increased, and the yield reached: in the phase, tillering (branching) - 13.19 t/ha, the booting (budding) phase - 22,34 t/ha, in the phase the earing (flowering) – 28.07 t/ha, in the phase of fructification - 32,77 t/ha.

The "Matritsa rosta" has had a positive effect on the formation of the yield of mixture with Bromus Inermis, Bromus Erecta, Onobrychis Arenaria and Poterium Polygamum in the phase of seeds formation - 29.54 t/ha.

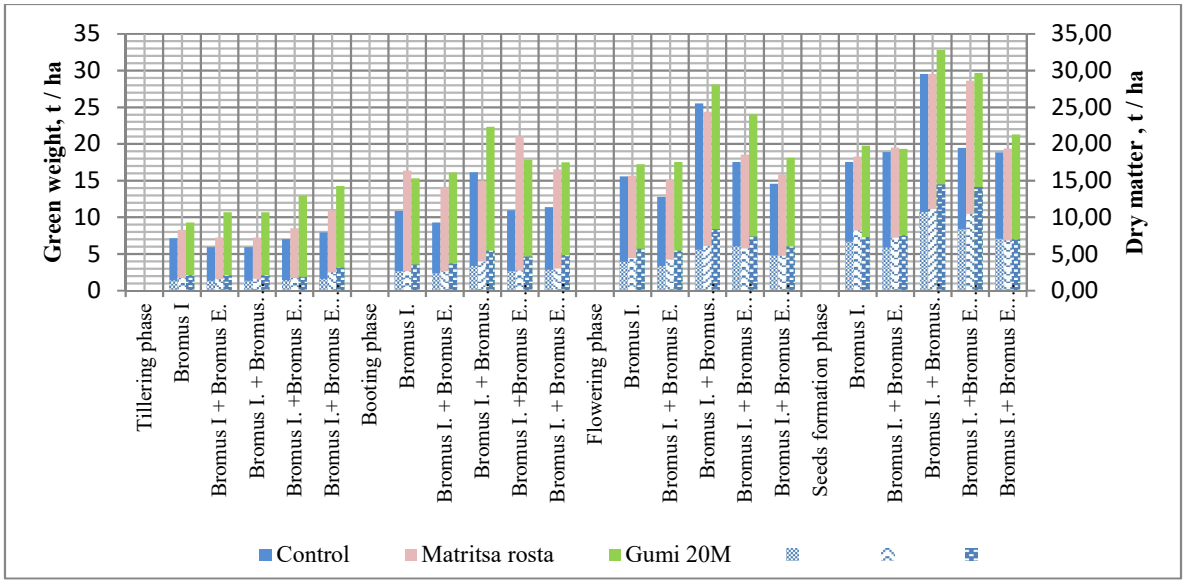


**Figure 3. Productivity of grass mixtures on the basis of Bromus Inermis with Poterium Polygamum using growth stimulators, 2016-2017, t/ha**

Mixture with Agropyron Pectiniforme, Elytrigia Intermedia, Onobrychis Arenaria, Poterium Polygamum while growing increased its additional yield compare to control variant: in the phase, tillering (branching) -

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8.14 t/ha, the booting phase (budding) - 9.25 t/ha. Addition began to decrease from the phase of earing (flowering) - 7.88 t/ha, in the phase of seeds formation – 4.01 t/ha.

The maximum value of the yield increase in relation to the control was in themixture of Agropyron Pectiniforme, Elytrigia Intermedia, Medicago Caerulea and Poterium Polygamum in the phase of seeds formation - 10.4 t/ha (Fig. 4).

"Matritsarosta" stimulator has had a positive effect on the mixture of Agropyron Pectiniforme, Elytrigia Intermedia, Medicago Caerulea and Poterium Polygamum in the phase of seeds formation -9.9 t/ha.

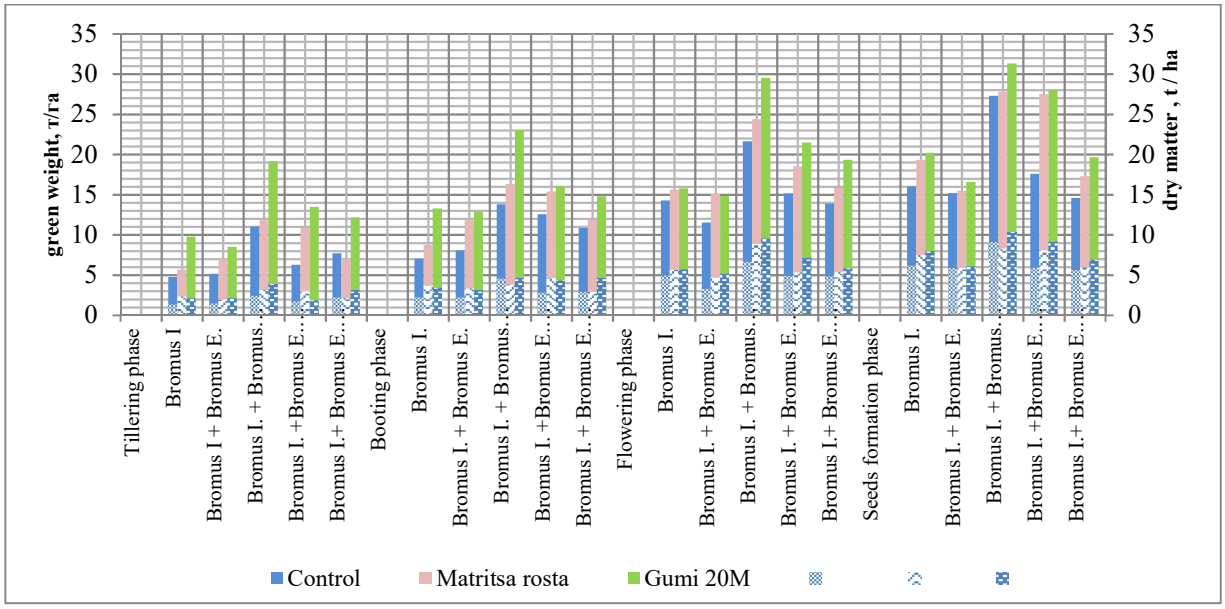


**Figure 4. Productivity of grass mixtures on the basis of Agropyron Pectiniforme with a Poterium Polygamum with the use of growth stimulators, 2016-2017, t/ha**

A comparative evaluation of the mixtures according the productivity showed that for the collection of dry matter, the mixture of Bromus Inermis+ Bromus Erecta+ Onobrychis Arenaria outperformed other variants. The higher numbers were in the variant with foliar application of "Gumi 20M" in seeds formation phase – 14.45 t/ha. It should also be noted that mixture with Bromus Inermis + Bromus Erecta + Medicago Caerulea, which also has high rates of dry matter collection (Fig. 3). Agropyron Pectiniforme. + Elytrigia Intermedia+ Onobrychis Arenariawas the best among other variants. The highest yield was in the variant with "Gumi 20M" foliar treatment in seeds formation - 10.26 t/ha. It should also be noted herb mix Agropyron Pectiniforme+ Elytrigia Intermedia+ Onobrychis Arenaria, has high rates of collecting dry matter (Fig. 4).

When analyzing the quality of fodder yield, it was revealed that with the age of the grass stand the yield of fodder units increases and reaches a maximum in the phase of seeds formation.

The highest yield of fodder units was shown on the four-component mixtures with Bromus Inermis, Bromus Erecta, Poterium Polygamum, Onobrychis Arenaria and Medicago Caerulea. The maximum productivity of these herbs is achieved with the use of growth stimulants. So, when using the "Matritsa rosta" in flowering phase the mixtures with Onobrychis Arenaria showed the yield of feed units of 7.84 thousand/ha, in the phase of seeds formation 8.81 thousand/ha, mixtures with Medicago Caerulea 4.34 thousand/ha and 5.73 thousand/ha, respectively. However, the best yield of fodder units was evaluated on a variant when applying "Gumi 20M". It is revealed that the mixtures with Onobrychis Arenaria preserves 8.39 thousand hectares / ha in the flowering phase and 8.31 thousand/ha in the phase of seeds formation, mixtures with Medicago Caerulea – 4.83 thousand/ha and 6.92 thousand/ha respectively.

Mixtures of Agropyron Pectiniforme with Elytrigia Intermedia and Poterium Polygamum had the lowest values of energy collection and fodder units on the booting phase on all variants with growth stimulators. Accumulation intensity of this indicator in different phases was the lowest.

The best yield of fodder units were evaluated on the four compound mixture with Agropyron Pectiniforme, Elytrigia Intermedia, Poterium Polygamum with Onobrychis Arenaria and Medicago Caerulea. Moreover, the maximum productivity value of these mixtures was achieved with the use of growth stimulants. So, with the use of "Matritsa rosta" in flowering phase, mixture with Onobrychis Arenaria provides the yield of fodder units at 6.05 thousand/ha, in the phase of seeds formation 5,88 thousand / ha, mixture with Medicago Caerulea 4,10 thousand/ha and 5.95 thousand/ha, respectively. However, the best yield of fodder units was shown on the variants with "Gumi 20M".Grass mixture with Onobrychis Arenaria accumulates 7.59 thousand hectares/ha in the

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flowering phase and 6.95 thousand/ha in the phase of seeds formation, mixtures with Medicago Caerulea 5.13 thousand/ha and 6.56 thousand/ha respectively.

Digestible protein yield was higher on the mixtures containing legumes components. The best variant was a mixture with Poterium Polygamum and Bromus Inermis, Bromus Erecta, Onobrychis Arenaria and Medicago Caerulea - the yield of the digestible protein is up to 1.01 ... 1.14 t/ha, as well as PoteriumPolygamum with Agropyron Pectiniforme, Elytrigia Intermedia and Onobrychis Arenaria - the yield of the digested protein is up to 1.22 ... 1.25 t/ha.

## Conclusion

Agrophytocenosis formation of perennial herbals: Poterium Polygamum, Bromus Inermis and Erecta, Onobrychis Arenaria or Medicago Caerulea or Lotus Corniculatus as well as mixtures with Poterium Polygamum with Agropyron Pectiniforme, Elytrigia Intermedia, Onobrychis Arenaria and Lotus Corniculatus depends on the photosynthetic activity of the crops. Growth stimulants application of “Matritsa osta” and “Gumi 20M” increases the intensity of leaf formation, as a consequence, the formation of a photosynthetic potential, which finally increasing the yield. The maximum productivity, highest dry matter collection, the biggest number of fodder units and the digestible protein were evaluated on the mixtures with traditional leguminous crops of the region: Onobrychis Arenaria and Medicago Caerulea, provides a green mass yield of up to 32.77 t/ha, dry matter 14.45 t/ha, fodder units up to 8.31 thousand/ha and 1.14 t/ha digestible protein. Mixtures on the basis of Agropyron Pectiniforme provide a yield of green mass up to 30.29 t/ha, dry matter 10.29 t/ha, fodder units up to 7.59 thousand/ha and 1.25 t/ha digested protein.

All variants reaches the highest productivity when applying “Gumi 20M”.

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