Formation of polyvid agrophytocenosis for perennial grasses under growth stimulants

V G Vasin, A V Vasin, A A Vasina, I V Karlova and A A Kazhaeva

1Samara State Agrarian University, Kinel, 446442, Russia
E-mail: vasin_vg@ssaa.ru

Abstract: The aim of the research is the formation of polyvid hay-pasture grass stand based on Bromus inermis under growth stimulants. The paper presents the study results for 2015-2018 with the assessment of seed quality indicators, seedling completeness, plant height and aerial mass gain. Our studies have shown that when studying grass stands based on Bromus inermis, the parameters for grass stands with leguminous components have good indicators. The best option is Bromus inermis + Bromopsis riparia + Sainfoins. It is also good when there is Bromus inermis + Bromopsis riparia + Medicago. The study observations showed that the stems growth in height occurs at the beginning of the growing season gradually from the tillering phase in cereals and branching in legumes, to the phase of fruit formation. Our studies also proved that the more components in the mixture, the higher its productivity. The use of growth stimulants (GUMI 20M and Growth Matrix) leads to changes in the parameters of grass stands and the accumulation of aboveground mass. The highest indices are in the phase of fruit formation with maximum values in grass mixtures with legumes.

1. Introduction
The most important condition for the growth of livestock production is a sustainable feed base. One of the most significant problems is to improve feed quality, since today agro-industrial complexes have to increase the productivity of farm animals. To optimize the feeding rations of farm animals, it is necessary to ensure production growth of high-energy forage crops [1, 2, 3].

Perennial grasses are an important source of vegetable feed protein for the forest-steppe zone of Middle Volga. They provide the cheapest, earliest, environmentally friendly and varied feeds. By selecting the types of grasses, you can create a complete protein and energy-rich green and a raw materials conveyor [4].

This problem should be solved by cultivating perennial grass mixtures that provide high and stable yields of high-quality green mass over the years. The research object is perennial grasses sowing, both in pure form, or mixed with legumes.

Currently, the production of crop products is impossible without the plant growth and development stimulants. The use of stimulating substances in crop production along with innovative technologies to
cultivate field and fodder crops today is one of the most relevant and promising methods to increase yield and quality of crop production [5, 6].

The use of various plant growth stimulants to increase crop productivity and quality has attracted the attention of many researchers. There are sometimes opposing opinions regarding the possibility of identifying the stimulation effect and the widespread use of various natural and synthetic drugs in crop production.

Undoubtedly, the understanding of interconnectedness of those phenomena that can be characterized as the response of plants to the effects of growth stimulants is of no small importance for the final problem solution, and some studies have been carried out in this connection.

2. Materials and methods

2.1. Research objects

We used the following grasses in our research: Bromus inermis: Bezenchukskij 9, Bromopsiriparia: Dol, Sainfoins: Peschanij 22, Medicago: Vega 88, Lotus corniculatus: Solnyshko. The experiment was carried out with growth stimulants: Growth Matrix, GUMI 20M.

Growth Matrix is a bioorganic, biologically active polymer compound with pronounced bactericidal and fungicidal properties. It is applicable for cultivation of most agricultural crops. The effectiveness of Growth Matrix is determined by providing protection against phytopathogens, and it gives a yield increase of 20-35%. Thus, it significantly improves crop quality. Growth Matrix has high economic efficiency as it increases the profitability of cultivating crops and improves product quality.

GUMI 20M Potassium NPK 1: 1: 2 is a natural growth stimulator with anti-stress, immunostimulating properties (potassium salts of brown coal humic acids, contains more than 80 macro-, microelements, minerals of natural origin, enriched with additional elements). Its formulation: liquid; composition: potassium salts of humic acids; macronutrients: NPK = 1: 1: 2 [7].

The purpose of the research is the formation of polyvid hay-pasture grass stand with Bromus inermis under growth stimulants.

The research objective is to evaluate the parameters for grass mixtures of perennial grasses based on Bromus inermis.

2.2. Research methods

Field experience to improve methods for cultivating and using hay and pasture grass stand in the forest-steppe zone of Middle Volga region started in May 2015 in the feed crop rotation of “Forage” research laboratory of the Department of Plant Growing and Agriculture of Samara State Agrarian University.

The soil of the experimental plot is ordinary chernozem, residual carbonate, medium humus, medium heavy, heavy loamy with an organic matter content of 6.9% 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 studies were carried out according to a single generally accepted technique in the experiments. The experimental work was carried out based on the methodology of the field experiment by B.A. Dospekhov (1985), methodological guidelines to conduct field experiments with fodder crops developed by the All-Russian Research Institute named after V.V. Williams (1987, 1997), methods of field and vegetation experiments with fertilizers (1967).

Two-factor experience in studying the effect of growth stimulants on the vegetation of perennial grass crops included:
No treatment and treatment with stimulants (factor A); Growth Matrix is 0.3 l/ha, GUMI 20M - 0.4 l/ha in the phase of the third leaf of the legume components.

Herb Mix Options (B)

1. Bromus inermis
2. Bromus inermis + Bromopsis riparia
3. Bromus inermis + Bromopsis riparia + Sainfoins
4. Bromus inermis + Bromopsis riparia + Medicago
5. Bromus inermis + Bromopsis riparia + Lotus cornicalatus

Table 1. Seeding rates of grass mixtures without Poterium polygamum

| №  | Crops                                      | Seeding rate |
|----|--------------------------------------------|--------------|
|    |                                            | kg/ha        | million germinating seeds per ha |
| 1  | Bromus inermis                             | 32.8         | 5.5          |
| 2  | Bromus inermis +                           | 16.7         | 2.8          |
|    | Bromopsis riparia                          | 17.6         | 3.5          |
|    | Bromus inermis +                           | 12           | 2.0          |
| 3  | Bromopsis riparia + Sainfoins              | 17.6         | 3.5          |
|    | Bromus inermis +                           | 77.2         | 3.0          |
|    | Sainfoins                                  | 12.0         | 2.0          |
| 4  | Bromopsis riparia + Medicago               | 17.6         | 3.5          |
|    | Bromus inermis +                           | 16.2         | 5.0          |
|    | Medicago                                   | 12.0         | 2.0          |
| 5  | Bromopsis riparia + Lotus cornicalatus     | 17.6         | 3.5          |
|    | Lotus cornicalatus                         | 7.79         | 5.0          |

3. Research results

The study experience in hayfields and pasture grasslands started in May 2015, when the average ten-day air temperature was 14.6 °C, and the soil temperature was - 9.2 °C, which was optimal for planting perennial grasses. In the third decade of May, during seedlings, the average air temperature was 16.5 °C, which led to the emergence of seedlings on 22-23 days after sowing.

Table 2. Sowing seed qualities of sown crops in 2015

| №  | Crops           | % Purity | Germination | Mass 1000 seeds, g |
|----|-----------------|----------|-------------|-------------------|
| 1  | Bromus inermis  | 98       | 70          | 4.1               |
| 2  | Bromopsis riparia | 96     | 78          | 3.7               |
| 3  | Sainfoins       | 96       | 72          | 18.6              |
| 4  | Medicago        | 97       | 76          | 2.0               |
| 5  | Lotus cornicalatus | 96 | 80          | 1.2               |

Sowing seed qualities of sown crops were good. The seed purity was at the level of 96-99%. Germination was from 68-94%. Experiments included the use of perennial grass crops for green fodder and hay. To calculate the seeding rate before sowing, sowing seed qualities, their purity and germination, and the weight of 1000 seeds were determined (Table 2).
**Table 3.** Completeness of seedlings hay-pasture grass stand based on Bromus inermis in 2015

| Crops                                      | Seeding rate | number of plants, pcs./m² | Germination, % |
|--------------------------------------------|--------------|----------------------------|----------------|
| 1. Bromus inermis                          |              | 122                        | 22.18          |
| 2. Bromus inermis + Bromopsis riparia      |              | 119                        | 42.50          |
| 3. Bromus inermis + Bromopsis riparia + Sainfoins |          | 142                        | 40.57          |
| 4. Bromus inermis + Bromopsis riparia + Medicago |          | 120                        | 60.00          |
| 5. Bromus inermis + Bromopsis riparia + Lotus cornicalatus | 114        | 95                         | 31.67          |
|                                            |              | 157                        | 78.50          |
|                                            |              | 163                        | 46.57          |
|                                            |              | 148                        | 29.60          |
|                                            |              | 120                        | 86.13          |
|                                            |              | 85                         | 17.00          |

The maximum germination of seedlings of Bromus inermis is in the grass mixture with Bromus inermis and Lotus cornicalatus with plant density is 180 pcs./m², which is about 86.13%. Bromopsis riparia is 163 pcs./m² - 46.57% in a grass stand with Bromopsis riparia and Medicago.

The fullness of germination of Sainfoins was 31.67%, the formation of seedlings - 95 pcs./m². A low germination of seedlings was in Lotus cornicalatus - 86.13 pcs./m².

A significant factor that affects plants in the research year was weather conditions. The nature of their changes during the growing season of the studied crops was reflected in the growth and development of plants.

The component density of the grass stand is greater in multi-species communities due to the tiered distribution of the aerial and underground organs of plants, although with excessive thickening there is inhibition of species with a slow pace of development. Thanks to the rapid development of Bromus inermis and Bromopsis riparia, the plants were able to form a good root mass, thereby avoid June drought (0.5 mm instead of 39 mm). This is primarily due to the biological characteristics studied by perennial grasses. These plants belong to mesoxerophytes, for the swelling and germination of seeds they need a small amount of water, 30-35% of the weight of the seeds. The lack of precipitation, as well as high day and night temperatures lead to the death of seedlings of perennial legumes, which did not have time to form a complete root system.

Plant shoot formation in autumn 2015 was lower than in subsequent years of development. The greatest completeness of shoot formation was observed in Bromus inermis in a grass mixture with Bromopsis riparia and Lotus cornicalatus - 154 pcs./m². Good indicators were in a grass stand with Medicago - 128 pcs./m² and two types of Bromus - 133 - 135 pcs./m². In the period from June to August 2015, the air temperature was slightly higher than the average annual data by 2.7, 0.5, and 0.3°C, respectively, which negatively affected the formation of the grass stand. A small amount of precipitation during this period only aggravated the condition of perennial grasses, which led to a decrease in their shoot formation.

The shoot formation during the growing season 2016 was intensive. Overwintering of perennial crops was good, as the winter turned out to be warm. Thanks to warm April and precipitation of 68.3 mm, there was the intensive growth of perennial grasses. There were 165 Bromus inermis shoots/m².

Precipitation in July was 55.2 mm and in September in the first decade it was 42.0 mm, which led to a good growth after cutting on June 29. The maximum shoot formation was observed in Bromus inermis -
175 pcs. /m² with Lotus corniculatus, in two component crops, shoot formation was 159 pcs/m². The best indicators were Medicago 124 pcs./m², Sainfoins - 121 pcs./m² among legumes.

The average daily temperature in May 2017 was 13.8 °C, slightly lower than the average annual data of 14.0 °C. The amount of precipitation in May was 70.4 mm and the whole June it was 129.8 mm. Thus, it played a significant role in the growth of perennial grasses.

**Table 4.** Plant shoot formation in grass mixtures based on Bromus inermis in 2015-2018

| №   | Crops                  | 2015               | 2016               | 2017               | 2018               |
|-----|------------------------|--------------------|--------------------|--------------------|--------------------|
|     |                        | autumn | spring | autumn | spring | autumn | spring | autumn |
| 1.  | Bromus inermis         | 100    | 165    | 160    | 176    | 172    | 156    | 141    |
| 2.  | Bromus inermis, Bromopsis riparia | 121    | 149    | 131    | 159    | 151    | 138    | 123    |
| 3.  | Bromus inermis, Sainfoins | 94    | 138    | 134    | 147    | 144    | 133    | 127    |
| 4.  | Bromopsis riparia, Medicago | 133    | 173    | 167    | 189    | 183    | 162    | 154    |
| 5.  | Bromus inermis, Lotus corniculatus | 128    | 159    | 142    | 168    | 164    | 130    | 125    |
|     |                        | 154    | 185    | 175    | 196    | 191    | 162    | 158    |
|     |                        | 99     | 141    | 133    | 152    | 149    | 136    | 121    |
|     |                        | 78     | 97     | 88     | 119    | 112    | 56     | 49     |

The number of Bromus inermis in grass stands varies from 176 to 196 pcs. / m², Bromopsis riparia - from 149 pcs./m² - to 189 pcs./m², Sainfoins - 139 pcs./m², Medicago - 168 pcs./m², Lotus corniculatus - 119 pcs./m².

July 2017 was characterized by insufficient moisture (the amount of precipitation was 2 times less than normal) against a background of average temperatures. In August, about 1.3 mm of precipitation fell for the entire month, compared with 44 mm in the long-term average. It led to a decrease in plant safety by autumn 2017.

Despite the adverse weather conditions in 2018, perennial grasses showed not bad results, but due to the return of cold weather in April and cool June, the number of shoots decreased.

Almost half the number of Lotus corniculatus shoots decreased in the hay-pasture grass to 56 pcs./m² in spring, and there were 49 pcs./m² after the cut. The number of Sainfoins shoots decreased from 117 pcs./m² in spring to 95 pcs./m² in autumn. The number of Medicago shoots was 130 - 125 pcs./m². The shoot formation of Bromus inermis was lower than in the first year of formation - 162 pcs./m² up to 133 pcs./m², Bromopsis riparia was 162 - 121 pcs./m².

The linear growth dynamics is an indicator, which characterizes the growth intensity of stem length depending on weather conditions, mineral nutrition, as well as the type of plants, methods of sowing, and seeding rates. The prevailing weather conditions for three years of research contributed to the favorable process of growth of perennial grasses.

In the studied cultures, certain patterns of change in linear dimensions were noted. The observations showed that the stem growth in height occurs at the beginning of the growing season gradually from the tillering/branching phase to the fruiting phase.
When examining plants to height, the maximum values were obtained in the phase of fruit formation of the crops, when treated with growth stimulants GUMI 20M and Growth Matrix.

**Table 5.** The height of hay-pasture grass stand based on Bromus inermis in 2016-2018, cm

| Vegetation processing | Options      | Tillering (branching) | Stem formation (budding) | Earing (flowering) | Fruiting |
|-----------------------|--------------|------------------------|--------------------------|--------------------|----------|
| Control               | Bromus inermis | 48                     | 56                       | 64                 | 68       |
|                       | Bromus inermis | 39                     | 57                       | 63                 | 70       |
|                       | Bromopsis riparia | 37                    | 46                       | 49                 | 54       |
|                       | Bromus inermis | 42                     | 59                       | 63                 | 69       |
|                       | Bromopsis riparia | 36                    | 58                       | 59                 | 64       |
|                       | Sainfoins     | 36                     | 51                       | 78                 | 86       |
|                       | Bromus inermis | 46                     | 50                       | 61                 | 59       |
|                       | Bromopsis riparia | 41                  | 46                       | 55                 | 49       |
|                       | Medicago      | 25                     | 36                       | 47                 | 53       |
|                       | Bromus inermis | 39                     | 44                       | 51                 | 83       |
|                       | Bromopsis riparia | 35                 | 41                       | 46                 | 76       |
|                       | Lotus corniculatus | 16                 | 22                       | 28                 | 30       |
|                       | Bromus inermis | 49                     | 49                       | 58                 | 70       |
|                       | Bromus inermis | 40                     | 50                       | 66                 | 84       |
|                       | Bromopsis riparia | 34                 | 45                       | 53                 | 71       |
|                       | Bromus inermis | 37                     | 59                       | 64                 | 73       |
|                       | Bromopsis riparia | 31                 | 55                       | 60                 | 70       |
|                       | Sainfoins     | 33                     | 48                       | 68                 | 63       |
|                       | Bromus inermis | 46                     | 50                       | 60                 | 81       |
|                       | Bromopsis riparia | 41                 | 46                       | 52                 | 63       |
|                       | Medicago      | 28                     | 34                       | 39                 | 48       |
|                       | Bromus inermis | 41                     | 46                       | 56                 | 66       |
|                       | Bromopsis riparia | 37                 | 42                       | 51                 | 65       |
|                       | Lotus corniculatus | 17                 | 19                       | 23                 | 25       |
|                       | Bromus inermis | 51                     | 65                       | 69                 | 75       |
|                       | Bromus inermis | 46                     | 66                       | 75                 | 87       |
|                       | Bromopsis riparia | 42                 | 58                       | 55                 | 78       |
|                       | Bromus inermis | 42                     | 62                       | 67                 | 87       |
|                       | Bromopsis riparia | 36                 | 60                       | 63                 | 82       |
|                       | Sainfoins     | 37                     | 56                       | 71                 | 96       |
|                       | Bromus inermis | 48                     | 61                       | 69                 | 84       |
|                       | Bromopsis riparia | 43                 | 57                       | 70                 | 77       |
|                       | Medicago      | 29                     | 51                       | 56                 | 63       |
|                       | Bromus inermis | 47                     | 51                       | 71                 | 87       |
|                       | Bromopsis riparia | 44                 | 49                       | 67                 | 86       |
|                       | Lotus corniculatus | 28                 | 31                       | 34                 | 40       |
When processing with Matrix of Growth in the fruiting phase, the stem length of Bromus inermis is 49 cm - 84 cm. The height of Bromopsis riparia is from 41 cm to 70 cm, Sainfoins height is 33 cm - 63 cm, Medicago is 28 cm - 48 cm, Lotus corniculatus is 17-25 cm. The best length indicators of the plant stem are at the phase of plant fruiting, when treated with GUMI 20 M. The height of Bromus inermis is from 51 cm to 87 cm, Bromopsis riparia is from 44 cm to 86 cm, Sainfoins is 37 cm - 96 cm, Medicago is 29 cm - 63 cm, Lotus corniculatus is 28 cm - 40 cm.

The observations on above-ground mass showed that in all cases the intensity of this process largely depends on weather conditions, as well as the effects of drugs used in the treatment of plants with growth stimulants.

In the initial period of the growth, the accumulation of aboveground mass is slow, and then it gradually increases. In different applications of growth stimulants, grass mixtures respond differently. The growth of green mass increases from the second phase of plant development (stem formation, budding), this is due to favorable weather conditions.

**Figure 1.** The growth dynamics of green mass of hayfields and pasture grasses based on Bromus inermis in 2016-2018

There was the best increase in green mass in the hay-pasture grass stand for three years when we used growth stimulants. When we used GUMI 20M, the best results were with Bromus inermis + Bromopsis riparia + Sainfoins with the maximum weight gain in earing (flowering) phase and fruit formation. Grass mixture Bromus inermis + Bromopsis riparia + Medicago, as well as grass mixture with Lotus corniculatus were also good, despite the fact that the number of shoots in the third year decreased and the weather conditions were not favorable enough.
4. Conclusions
The assessment of weather conditions in the region proved that weather conditions in 2015-2018 met the requirements for perennial crops.

Due to favorable conditions during the development period of 2015-2018, the number of shoots for the period increased 1.5-2 times regarding 2015. In 2018, due to cold weather, the colds returned in the initial period of crop development - the number of shoot formation decreased.

The study observations showed that the stems growth in height increases significantly from the tillering/branching phase to the fruiting phase.

The maximum accumulation of above-ground mass is in the fruit formation phase during GUMI 20M processing in the option Bromus inermis + Bromopsis riparia + Sainfoins.

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