The influence of the timing and methods of harvesting the seed grass of the eastern goat's rue (Galega orientales Lam.) on the yield and sowing quality of seeds

V N Zolotarev

Federal Williams Research Center of Forage Production & Agroecology, Lobnya, Moscow region, Russia, Nauchny Gorodok, str., 1.

Corresponding author’s e-mail: semvik@vniikormov.ru

Abstract. Eastern goat’s rue (Galega orientales Lam.) possesses high fodder productivity and accumulates a large amount of vegetative mass with high humidity for harvesting for seeds. This greatly complicates the harvesting of grass stand for seeds. One of the ways to solve this problem is to carry out desiccation of the grass stand. A complicating factor in choosing the optimal harvesting period is the extended flowering and ripening period of goat's rue beans, the duration of which reaches 25-35 days. The use of the drug Reglon Super based on diquat is a highly effective agrotechnical method that allows increasing the collection of seeds by 24%. The desiccation of the herbage contributes to the production of seeds with high sowing qualities. The seeds with the best sowing qualities are found in beans with yellow, brown, brown or dark brown color of the beans. In light green beans, the seeds are fully formed, but have a high moisture content. Goat's rue beans do not crack or crumble at the onset of the full ripeness phase. This allows the seed to be harvested when most of the beans are ripe. A comparative assessment of the timing and method of harvesting the seed herbage of the goat's rue showed that with a ripening of 39% and the presence of 47% of light green and yellow beans, the yield losses ranged from 26 to 56%. The highest seed yield in one confidence interval of 422-453 kg / ha and 444 kg / ha was obtained, respectively, by direct threshing with preliminary desiccation of the grass stand in the ripening phase of 74-97% of beans or by separate harvesting when mowing into swaths during ripening 74 % beans.

Keywords: eastern goat’s rue (Galega orientales Lam.), terms and methods of harvesting, productivity, seeds.

1. Introduction
The demand for crops is determined by their useful economic and biological properties that characterize the consumer qualities and the practical value of certain species in the context of their use. With regard to perennial fodder grasses, breeding efforts in breeding new varieties are primarily associated with improving the sphere of vegetative development of plants - this is an increase in foliage and the productivity of phytomass in general, an increase in the duration of the shoot formation
period, the predominance of vegetative stems in the structure of herbage, etc. or selectively induced features of plant development complicate the seed production of varieties for fodder purposes, their harvesting for seeds. At the same time, the commercial success of an agronomically superior new variety depends on the reliability of the supply of production of its quality seeds at a competitive price and in the required volumes [1].

The accumulated experimental material and experience of industrial cultivation of perennial leguminous grasses show that in the complex of agricultural technological solutions to the problem of increasing yields, the harvesting of seed herbage is one of the most critical and responsible operations. This is due to the fact that the threshing of seed herbage contains elements of the risk of the likelihood of large losses due to unfavorable weather conditions, a prolonged period of the onset of harvest ripeness, a large volume of vegetative mass and its high moisture content in most legume species during the ripening period. Due to the combination of biotic causes and weather factors, yield losses of perennial leguminous grasses during harvesting can reach 50% or more of the formed biological seed yield [2].

The efficiency of seed production is determined by the biological characteristics of crops, soil and climatic conditions. Meteorological factors are still important for good seed production, while air temperature, rainfall and sunlight intensity play the most decisive role [3, 4]. During the growing season, by the time the beans ripen, the goat's rue accumulates a large plant mass (30–35 t / ha), the leaves remain green until the seeds ripen [5]. Gale's rue has a prolonged flowering period, as a result of which, when most of the beans ripen, a certain amount of them still remained green, underdeveloped [6]. All this complicates the harvesting of the goat's rue for seeds and creates additional difficulties for the operation of combines, especially in rainy weather. In different regions of the world, both direct threshing of perennial leguminous grasses with preliminary desiccation of their crops and a separate method with swathing of grass stand, that is, two-phase harvesting, is practiced [5, 7, 8].

2. Material and methods
The research was carried out on the FWRC FPA experimental field in 2015-2018 on the eastern goat’s rue seed grass of the West variety 3-6 years of use. The dynamics of maturation and the value of the biological yield of seeds were determined by selecting sheaves on plots of 0.25 m² in 4 replicates on a typical grass stand. To determine the timing of harvesting ripeness, four fractions of beans were isolated:
- "green beans" - fully formed fruits of green color with dark green seeds, which have a liquid content, when dry become shriveled and have low sowing qualities (germination does not exceed 50-55%);
- "light beans" - characterized by a change in color to light green with high moisture content with fully formed seeds, having a milky-waxy consistency, light yellow color and high sowing qualities;
- "yellow beans" (from light yellow to yellow-brownish color) - seeds with a firm consistency, yellow in color with high sowing qualities;
- "ripe beans" - have hard, leathery pods with a brown, brown or dark brown color, seeds with a hard consistency of yellow or yellow-brownish color with high sowing qualities.

Desiccant efficiency Reglon Super, V.R. (150 g / l diquat) was studied at doses of 2-5 l / ha. Consumption of working solution 300 l / ha. The seed yield was counted from the entire accounting area of the plot (20 m² in 4-fold replication with a randomized placement) using a Sampo 130 combine. The statistical processing of the experimental data was carried out by the method of analysis of variance based on the method of B.A. Dospekhova (1985) on a PC using the Microsoft Office Word 2007 application package using Excel 2000.
3. Results and discussion
The biological feature of the eastern goat's rue is the preservation of leaf phytomass in an active
growing state until the seeds ripen. In addition, starting from the first year of seed use, in the herbage
of the eastern goat's rue, along with generative shoots, vegetative shoots with a higher leafiness and
moisture content develop, which also complicates direct harvesting for seeds. A comparative
assessment of the effectiveness of Reglon Super application showed that with an increase in the dose
of its application from 2 to 4 l / ha, after 4 days there was a consistent decrease in the moisture content
of the grass stand from 72.8 to 41.7%, and after 8 days - already up to 30, 4-29.0% even against the
background of precipitation in the period after spraying in the years of research (Table 1). In dry warm
weather, the moisture content of the stand after desiccation decreased more pronounced, to 23%.
When threshing dry grass stand, almost complete destruction of leaves was observed. As a result, the
use of Reglon Super in doses from 2 to 5 l / ha contributed to a consistent increase in the yield of
goat's rue seeds by 12-24%. However, at the highest dose of 5 l / ha, there was a decrease in seed
collection by 6-7% compared to the optimal rates of 3-4 l / ha, which is due to the dropping of a part
of the beans with faster drying of the plants.

The analysis of the sowing qualities of the seeds revealed that the desiccation of the herbage
promoted the production of viable seeds with high sowing qualities with a tendency to increase the
seed hardness of the obtained seed material with an increase in the dose of the preparation (Table 1).

Table 1. Influence of desiccation on the yield and sowing qualities of seeds of eastern goat’s rue
variety West (on average for 2016-2018)

| Application dose of Reglon Super, l / ha | Vegetative mass moisture, % | The yield of seeds, kg / ha | Moisture of the pile of seeds after harvesting, % | Seed germination energy, % | Germination total incl. hard (viable seeds), % |
|-----------------------------------------|-----------------------------|-----------------------------|-----------------------------------------------|---------------------------|---------------------------------------------|
| Control (water)                         | 72,8                        | 72,9                        | 314                                           | 30,6                      | 32                                          | 92                                          | 49                                          |
| 2 l / ha                                | 60,6                        | 44,1                        | 350                                           | 26,5                      | 34                                          | 93                                          | 50                                          |
| 3 l / ha                                | 53,6                        | 34,4                        | 388                                           | 23,9                      | 31                                          | 95                                          | 51                                          |
| 4 l / ha                                | 47,1                        | 30,4                        | 391                                           | 22,5                      | 31                                          | 95                                          | 53                                          |
| 5 l / ha                                | 41,7                        | 29,0                        | 364                                           | 21,1                      | 29                                          | 94                                          | 52                                          |
| least significant difference            | -                           | -                           | 32,4                                          | -                         | 3,7                                         | 2,5                                         | 4,0                                         |

* - moisture content of the stand before desiccation 72,3%.

Studies have shown that eastern goat's rue West cultivar blooms for 25-35 days. Due to the
extended flowering period, the ripening of the beans is also uneven and stretched. It was found that
seeds in green beans are characterized by low sowing qualities (Table 2). In light green beans, the
seeds are fully formed, but have increased moisture. The accumulation of plastic substances in them is
over. In yellow beans, the seeds are fully formed as well.
Table 2. Maturation dynamics eastern goat’s rue (on average for 2015-2017)

| Number of beans, total, pcs / m² | Distribution of beans by fractions, % | * Weight of 1000 seeds from beans of different ripeness, g |
|---------------------------------|--------------------------------------|-------------------------------------------------------------|
|                                 | green  | bright | yellow | ripe | of green | Of bright | Of yellow | Of ripe |
| 1893                            | 14     | 22     | 25     | 39   | 3,72     | 6,38      | 6,50      | 6,69    |
| 1913                            | 4,5    | 12     | 25     | 58   | 4,19     | 6,39      | 6,72      | 6,52    |
| 1976                            | 2,5    | 7      | 17     | 74   | 4,07     | 6,59      | 6,62      | 6,65    |
| 1935                            | 1      | 2      | 9      | 88   | 3,63     | 6,48      | 6,67      | 6,60    |
| 1898                            | 0,2    | 0,5    | 2      | 97,3 | 3,60     | 6,20      | 6,31      | 6,65    |
| LSD05                           | -      | -      | -      | -    | 0,39     | 0,43      | 0,41      | 0,33    |

*p at standard seed moisture

Table 3. Comparative assessment of methods of harvesting seed grass stand of eastern goat’s rue (on average for 2015-2017)

| harvesting method | Number of ripe beans, % | Herbage moisture, % | Seed yield, kg / ha |
|-------------------|-------------------------|---------------------|---------------------|
|                   | before processing, mowing | before threshing | biological | actual |
| Straight          | 39                      | 73,6                | 72,4 | 470 | 278 | 163 |
| straight with desiccation | 58                  | 72,6                | 28,0 | 520 | 364 | 236 |
| separated         | 25,0                    | 25,0                | 26,8 | 398 |
| Straight          | 74                      | 71,2                | 27,8 | 564 | 422 | 293 |
| straight with desiccation | 88                  | 72,0                | 25,3 | 567 | 453 | 444 |
| separated         | 21,7                    | 21,7                | 21,7 | 424 |
| Straight          | 68,8                    | 68,8                | 68,8 | 324 |
| straight with desiccation | 97                  | 68,9                | 22,9 | 577 | 422 | 381 |
| separated         | 17,7                    | 17,7                | 17,7 | 381 |
| LSD05             | -                       | -                   | -     | 44,6 | 33,7 |

The eastern goat’s rue beans do not crack or crumble at the onset of the full ripeness phase. This allows the seed to be harvested when most of the beans are ripe. A comparative assessment of the timing and method of harvesting the eastern goat’s rue seed herbage showed that with the ripening of 39% of the beans and the presence of 47% of light green and yellow beans, the yield losses ranged...
from 26 to 56% (Table 3). The highest seed yield in one confidence interval of 422-453 kg / ha and 444 kg / ha was obtained, respectively, during direct threshing with preliminary desiccation of grass stand in the ripening phase of 74-97% of beans or during separate harvesting when cutting eastern goat’s rue into swaths when ripe, 74% of the beans (Table 3). At the same time, the completeness of harvesting the formed crop was, respectively, 73-80% and 78%. In growing seasons with stable dry weather, the moisture content of the pile of seeds with chaff after threshing at the optimum time ranged from 18.3 to 22.2%.

Thus, pre-harvest desiccation of eastern goat’s rue seed herbage with the use of one of the diquat-based preparations is a highly effective agricultural technique, especially in unstable rainy weather, which makes it possible to increase seed yields by 24%. The best way to harvest eastern goat’s rue is by direct threshing of the seed grass with pre-desiccation, collecting up to 80% of the biological yield. In dry weather conditions, a separate harvesting method is also effective, which allows to collect 78% of the formed seed yield when mowing the grass stand in windrows in the ripening phase of 74% and the presence of 17% of yellow beans with fully formed seeds. The method of cleaning should be determined based on weather conditions and applied technologies, availability and capacity of drying plants.

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