Comparative evaluation of seed productivity rapeseed (brassica napus), camelina (camelina sativa) and white mustard (sinapis alba) in conditions forest-steppe zone of Prebaikalia

R A Sagirova, T B Vlasova and S V Shapenkova
Irkutsk State Agrarian University named after A.A. Ezhevsky, pos.
Youth, Irkutsk district, Irkutsk region, 664038, Russian Federation

E-mail: Roza.sagirova.66@mail.ru

Abstract. The aim of the research was to study the characteristics of growth and development; determination of seed productivity of camelina of the Chulymsky variety and mustard of the white Rainbow variety in comparison with the widely cultivated crop in the Prebaikalia - rapeseed of the Ratnik variety. The studies were conducted in 2017-2019 at the experimental site of the Irkutsk State Agrarian University. The earliest flowering over the years was observed in the camelina on 39-43 days after emergence of seedlings, which was ahead of the onset of this phase in rapeseed by 12-13 days, white mustard entered the full bloom phase on 44-49 days, ahead of rapeseed by 7-8 days. The earliest ripening of seeds was noted, also in saffron milk and occurred during the years of research on August 10-15, 82-87 days after seedling formation; white mustard seeds ripened after 85-92 days, which was due on August 15-20, rape later ripened both camelina and mustard on August 23-27. The highest seed yield in all years of research was obtained from camelina and amounted to 1.39-1.62 t/ha; white mustard provided yields of 1.21-1.39 t/ha. Seed productivity of rape was inferior to the above crops and ranged from 0.93 to 1.22 t/ha over the years. The simultaneous ripening of spring oilseeds of the Brassicaceae family in the sequence camelina, white mustard and rapeseed will allow conveniently organizing the harvesting and processing of seed material.

1. Introduction

Oilseed production in the world is constantly increasing, due to the growing demand for vegetable fats [1, 2]. One of the leaders in cultivated oilseed crops on sown areas is currently rape, as the authors of Goncharov S.V., Gorlova L. indicate. This is the second crop in the world, after soy. Rapeseed culture is in demand, both for agricultural producers and for livestock enterprises, when used in feed production in the form of meal and oilcake [1].

Scientists of the Krasnoyarsk State Agrarian University E. N. Oleinikova, M. A. Yanova, N. I. Pyzhikova point out that rape, as an oilseed crop, can be successfully cultivated in most regions with a temperate climate, including in Eastern Siberia. The cultivation of oilseed rape is a highly profitable production, in particular for the countries of the Asia-Pacific region [3]. The results of the research conducted by A. N. Khalipsky, N.G. Vedrov, A.A. Ryabtsev confirms that modern spring rape varieties cultivated in the Krasnoyarsk Territory form seeds with a sufficient oil content, which is suitable for the production of edible vegetable oil by fatty acid composition [4].
Undoubtedly, rapeseed, which is an export crop, is also promising for the conditions of the Prebaikalia, both oilseed and fodder crops.

At the same time, promising, high-yielding crops are spring camelina (Camelina sativa) and white mustard (Sinapis alba), which are currently not cultivated in agricultural enterprises of the Baikal region. In recent years, interest in the cultivation of these crops has revived abroad and in Russia.

Spring ginger is distinguished by a high potential seed yield (up to 2.5 t/ha) with a high content of drying oil in them from 36 to 40% and a high protein content of 25 to 30%. The camelina oil extracted from seeds has universal use for food purposes, for dietary nutrition, in the paint and varnish industry for the preparation of drying oil, for soap making, namely for the manufacture of green soap, in the perfumery industry and medicine [5, 6, 7]. As scientists A N Kshnikatkina, T Ya Prakhova point out, in studies conducted in the conditions of the Middle Volga region it was proved that the quality indicators of camelina oil, open the possibilities of its use for food and technical purposes in the production of biodiesel for aviation, due to the relatively high content long chain fatty acids — eicosenic and erucic, up to a total of 17–24%, characterized by high heat of combustion [5, 8].

Seed productivity of white mustard is from 1.2 to 1.5 t / ha, and its potential can be realized up to 4.0 t / ha. Scientists of the Belarusian State Agricultural Academy A P Panasyuga, P A Saskevich, V R Kazharsky emphasize that the ecological plasticity of this culture allows you to get seeds up to 62 ° north latitude, and as a forage crop, you can cultivate even beyond the Arctic Circle [9]. White mustard is especially significant for the national economy.

The seeds contain 25–39% of oil, which is successfully consumed in the canning, bakery and confectionery, pharmaceutical, textile, and other industries. Mustard oil contains essential oils that are used in the chemical industry, metallurgy, perfume industry. Mustard seeds are used in the form of spices [9, 10].

In connection with the foregoing, for the first time, studies, according to a comparative assessment, of spring crops of the Brassicaceae family are relevant, which will expand the range of cultivated field crops and is one of the reserves for obtaining various types of high-quality oil, characterized by various uses, and will also increase economic efficiency of agricultural enterprises in Prebaikalia.

2. Conditions, materials and methods.
The purpose of research: a comparative evaluation of the productivity of camelina and mustard white in comparison with the widely cultivated crops in the Baikal Region - rape. The objectives of the research was to study the characteristics of growth and development; determination of seed productivity.

The climate of the forest-steppe zone of Prebaikalia is sharply continental, characterized by short summers and weak humidification, so according to the long-term average annual data, precipitation falls in the summer period from 220 to 260 mm, and from 320 to 340 mm during the year, the sum of positive temperatures is from 1500 to 17000 С, frost-free the period is fixed at 94 days [11, 12]. The studies were conducted in 2017, 2018 and 2019.

It should be noted that the air temperature during the years of research throughout the summer was higher in comparison with long-term average data. So, 2017 was marked as the hottest and driest year, the sum of active air temperatures above 100 °C was 2099 °C, and the amount of precipitation for the growing season was within - 277, 1 mm. In 2017 and 2018, the indicators of moisture availability were noted insufficient. Monthly rainfall was uneven. In particular, June, July, August and September were arid. The amount of precipitation for the period May – September was 277.1 mm and 322.2 mm, respectively. In 2019, May was cold and arid. June and July were mostly arid except for the third decade of June and July, which turned out to be plentiful in precipitation; August and September were also hot, the sum of active temperatures during the growing season was 2048 °C, the amount of precipitation for the period May – September was 294.3 mm. In general, the conditions of moisture and heat supply over the years of research contributed to the growth and development of the studied crops and ensured seed reproduction.
Studies were conducted at the experimental site of the Irkutsk State Agrarian University (figure 1, figure 2).

The soil is gray forest, slightly acidic, heavily loamy, with a humus content of 3-4%, and is characterized by a high content of metabolic calcium and magnesium. The studies used zoned varieties of spring crops in the Irkutsk region: rapeseed Ratnik, camelina Chulymsky, and white mustard Rainbow, which is approved for use in the regions of the Russian Federation [13]. The experiment was laid in 4-fold repetition, the accounting area - 25 m2. Sowing crops was carried out in the second decade of May, by the ordinary method of sowing with a row spacing of 15 cm, sowing rate: rapeseed - 3.0 million germinating seeds per 1 ha; camelina - 6.5 million germinating seeds per 1 ha, white mustard - 2.7 million germinating seeds per 1 ha. The precursor is potatoes. The main treatment in the form of chaffinch plowing was carried out in the first ten days of September. Pre-sowing treatment consisted of the following technological operations: in the third decade of April, harrowing was carried out, in the first decade of May, cultivation was carried out to a depth of 2-3 cm, rolling before and after sowing.

When developing the research program, we were guided by: “The methodology for conducting field agrotechnical experiments with oilseeds” [14] and “The state variety testing method for agricultural crops: Issue 3. Oilseeds, essential oils, medicinal and industrial crops, mulberries, and silkworms” [15].

3. Research results and discussion
The study of the features of the growth and development of observations showed that when sowing rapeseed, camelina and white mustard at the beginning of the second decade of May, on average over
the years of research, the sowing-seedling period averaged 6-8 days. In the first three weeks, the growth and development of the aerial parts of plants of the studied cultures occurs slowly, since in this period the root system develops first. 5-7 days after seedlings, the plants formed the first true leaf, stalking was observed after 12-15 days. The earliest flowering over the years was observed in the camelina on 39-43 days after emergence of seedlings, which was ahead of the onset of this phase in rapeseed by 12-13 days, white mustard entered the full bloom phase on 44-49 days, ahead of rapeseed by 7-8 days.

It should be noted that the earliest ripening of seeds was noted, also in camelina and occurred during the years of research on August 10-15, 82-87 days after seedling formation; white mustard seeds ripened in 85-92 days, which was due on August 15–20, rape later ripened both camelina and white mustard on August 23–27 (table 1).

Table 1. Agrobiological estimation Camelina and white mustard as compared with rape in a steppe Prebaikalia zones 2017-2019.

| Indicators                              | Crop            |
|----------------------------------------|-----------------|
|                                       | Rapeseed Warrior (Ratnik) | Ginger Chulym | Mustard White Rainbow |
| 2017                                   |                 |               |
| The number of days from seedling to    | 53              | 40             | 45               |
| flowering                              |                 |               |
| The number of days from seedling to    | 95              | 82             | 87               |
| ripeness of seeds                      |                 |               |
| Ripening date                          | 23.08           | 10.08          | 15.08            |
| Biological seed yield, t/ha            | 0.93            | 1.39           | 1.21             |
| HCP05 t/ha by biological yield of seeds| 0.07            |               |
| 2018                                   |                 |               |
| The number of days from seedling to    | 56              | 43             | 49               |
| flowering                              |                 |               |
| The number of days from seedling to    | 99              | 87             | 92               |
| ripeness of seeds                      |                 |               |
| Ripening date                          | 27.08           | 15.08          | 20.08            |
| Biological seed yield, t/ha            | 1.22            | 1.62           | 1.39             |
| HCP05 t/ha by biological yield of seeds| 0.05            |               |
| 2019                                   |                 |               |
| The number of days from seedling to    | 52              | 39             | 44               |
| flowering                              |                 |               |
| The number of days from seedling to    | 97              | 82             | 85               |
| ripeness of seeds                      |                 |               |
| Ripening date                          | 25.08           | 11.08          | 16.08            |
| Biological seed yield, t/ha            | 1.14            | 1.47           | 1.28             |
| HCP05 t/ha by biological yield of seeds| 0.10            |               |

It should be noted that the studied crops have a high ability of seed reproduction, the highest seed yield in all years of research was obtained from camelina and amounted to 1.39-1.62 t/ha; white mustard provided yields in the range 1.21-1.39 t/ha. Seed productivity of rapeseed was inferior to the above crops and ranged from 0.93 to 1.22 t/ha over the years (table 1).
4. Conclusion
Ginger and white mustard, along with rapeseed, are promising crops for cultivation in agricultural enterprises of the Prebaikalia region, which will expand the range of oilseeds capable of providing high seed productivity for cultivation on oilseeds. The yield of camelina seeds over the years of research ranged from 1.39 to 1.62 t/ha; white mustard from 1.21 to 1.39 t/ha; rapeseed from 0.93 to 1.22 t/ha.

The simultaneous ripening of spring oilseeds of the Cabbage family in the following sequence: camelina, white mustard and rapeseed will make it convenient to organizationally carry out the cleaning and processing of seed material.

References
[1] Goncharov S V and Gorlova K A 2018 Change in the assortment of rapeseed in Russia as a result of competition in the seed market Oilseeds Scientific and Technical Bulletin of the All-Russian Scientific-Research Institute of Oilseeds 1(173) 36-41
[2] Sohrabi M, Zebarjadi A and Najaphy D 2015 Isolation and sequence analysis of napin seed specific promoter from Iranian Rapeseed (Brassica napus L) Gene 563(2) 160-4
[3] Oleinikova E N, Yanova M A, Pyzhikova N I, Ryabtsev A A and Bopp V L 2019 Spring rape - a promising culture for the development of the agricultural complex of the Krasnoyarsk Territory Bulletin of the Krasnoyarsk State Agrarian University 1(142) 74-80
[4] Khalipsky A N, Vedrov N G, Khalipsky A N and Ryabtsev A A 2015 Fatty acid composition of vegetable oil of spring rape varieties in the Krasnoyarsk forest-steppe Bulletin of the Krasnoyarsk State Agrarian University 3 90-4
[5] Prahova T Ya 2013 Oil-lettuce: biology, productivity, technology Bulletin of the Altai State Agrarian University 9(107) 7-11
[6] Tulkubaeva SA 2017 Study of elements of the technology of spring rye cultivation in Northern Kazakhstan Bulletin of Altai State Agrarian University 7(153) 30-5
[7] Davis P B, Fabian D M, Peterson R K D and Maxwell B D 2011 Refinement of weed risk assessments for Biofuels using camelina sativa as a model species Journal of Applied Ecology 48 989-97
[8] Kshnikatkina A N, Prahova T Ya, Krylov A P et al. 2018 Quality assessment of oilseeds of cabbage crops in the Middle Volga region Achievements of Science and Technology AIC 32(4) 41-3
[9] Panasyuga A P, Saskevich P A and Kazharsky V R Effect of morphoregulators on the productivity of white mustard Bulletin of the Belarusian State Agricultural Academy 1 33-7