Introduction of Guizotia abyssinica (L.F.) Cass. in agroecological conditions of the Central region of the Russian Federation

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Abstract. Global climate changes taking place over the past decades make the issue of biodiversity of the food supply of our country more and more urgent, which can serve to strengthen it through the introduction of ecologically plastic plants, and, most importantly, resistant to abiotic stresses of the growing season. In this regard, the Abyssinian herb is of interest, in the world it is considered not only as an oilseed, but also as a fodder crop, the green mass of which is suitable for use both fresh and for silage. In 2023, in the agroecological conditions of the Field Experimental Station of the RGAU-MSHA named after K.A. Timiryazev, we conducted a study of nougat in order to determine the possibility of cultivating this crop in the conditions of the Central region of the Russian Federation for fodder purposes. The object of research was the Lipchanin variety, sowing was carried out with a row spacing of 15 cm, without fertilizing in 4-fold repetition.

1 Introduction

Guizotia abyssinica, or Niger seed (Guizotia abyssinica (L.F.) Cass.) is an annual herbaceous plant of the Asteraceae family (Asteraceae Bercht. & J.Presl), a plastic species adapted to various agroecological conditions: cool tropical East Africa, hotter tropical and subtropical lowlands of India and temperate Europe. It can be grown from sea level to an altitude of 2500 m, where average daily temperatures range from 13°C to 23°C, and night temperatures above 2°C. The optimal annual precipitation is about 1000-1300 mm, and more than 2000 mm reduces the yield of seeds. Niger seed thrives well on a wide range of soils, from poor sandy soils to heavy chernozem cotton soils, with a pH from 5.2 to 7.3. Niger seed tolerates swampy areas with poor oxygen supply due to its aerenchyma and ability to form respiratory roots. Plants have some resistance to soil salinization [1-3].

It is believed that the Niger seed originated from Ethiopia, where it was domesticated around 2000 BC. Then it spread to India. In Africa, currently, Niger seed (Guizotia Abyssinian) is mainly grown in Ethiopia, but also to some extent in countries such as Sudan, Uganda, Tanzania, Malawi, and Zimbabwe. In Asia, it is a secondary oilseed crop, cultivated mainly in India and to some extent in Nepal, Bangladesh, and Bhutan. Other countries where

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it is grown are the West Indies in the Caribbean and the USA. They tried to cultivate Niger seed in Germany, Switzerland, France, and Czechoslovakia back in the 19th century [4, 5].

Niger seed (Guizotsia Abyssinian) is one of the main sources of edible oil in Ethiopia, mainly produced by small farmers. It accounts for about 30% of the production of oilseeds in the country, and 26% of the products are stored for home consumption. Niger seed is grown in different regions of Ethiopia, although more than 90% of its production is concentrated in the highlands of the Amhara and Oromia regions. Woollega and Shewa are the main nougat production areas in the Oromia region, while Gojjam and Gondar are the main Niger seed production areas in the Amhara region. In Ethiopia, three main varieties are cultivated: Abat - a late-ripening variety that is sown in June and harvested in December; Mesno - a variety suitable for growing on waterlogged soils from late September to January; Bunegne - an early-ripening variety suitable for growing in low-lying areas from July to October [6, 7].

Cake after oil extraction is an excellent feed for poultry and livestock, as it contains from 33 to 37% protein and is rich in inorganic components and raw fibers. Niger seed can be used as feed for sheep, but cattle eat it only as silage. Guizotsia abyssinica is a valuable cover crop and siderate. For technical purposes, Niger seed oil is used for lighting, paint production, lubrication and cleaning of equipment, as well as for pharmaceutical purposes and soap production [8, 9].

In 1926, Niger seed (Guizotsia Abyssinian) came to Russia thanks to the expedition of N.I. Vavilov to Ethiopia, nevertheless, the culture never spread due to low yields. Niger seed research in our country resumed in 2005 at the Catherine Experimental Station of the VIR n.a. N.I. Vavilov in the Tambov region. An agreement was also reached here on the shipment of seeds to Volgograd for environmental testing. Testing of the crop in the arid conditions of the Volgograd region showed that the herb is resistant to drought and elevated temperatures, as well as responsive to additional moisture. According to the results of this environmental test, the herb was announced as an alternative crop to sunflower, both in terms of oil content and its qualitative composition. Later, some of the niger seeds were transferred for study and breeding work to the Penza Research Institute of Agriculture. Sowing and studying were carried out in the breeding department of the Institute for 4 years. Breeding work with this crop was carried out at the Institute, as a result of which a variety of niger seed of the oilseed direction Medea was created. In the Penza region, the variety testing of this crop took place in milder agro-climatic conditions. The parameters of weather conditions according to the development phases of niger seed of the Medea variety characterize it as a highly productive, plastic oilseed crop capable of withstanding arid and hot weather. The same variety became the object of further research in the Volgograd region in 2015-2018. Weather conditions in these years were acutely arid. In parallel, the new Medea variety was undergoing environmental testing in the Astrakhan region and in North Ossetia – Alania. In the Research Institute of the Crimea, niger seed of the Medea variety was first tested in 2019. Field experiments were laid at a pilot site located in the central steppe of the peninsula (Krasnogvardeysky district). The research results showed that the main component of niger seed oil is polyunsaturated linoleic acid (ω-6), the content of which reaches a high index of 70%, and due to this, the oil of this crop is very similar in its qualities to ordinary sunflower oil [1-3, 5, 7].

In the Kostroma State Agricultural Academy, in 2021, researches were conducted to study the effect of various seeding rates and fertilizers on the productivity of the green mass of niger seed. The results showed that at different seeding rates, it formed a yield of green mass of 20.1-31.8 t/ha, when grown against the background of natural fertility (without fertilizers) and 29.9-47.0 t/ha with fertilizers [4].
2 Materials and Methods

The research was carried out at the experimental base of the Field Experimental Station of the RSAU-MAA named after K.A. Timiryazev in 2023, in agroecological conditions typical for the Non-Chernozem zone of Russia. We conducted a study of niger seed to determine the possibility of cultivating this crop in the conditions of the Central region of the Russian Federation for fodder purposes. The object of research was the Lipchanin variety, sowing was carried out with a row spacing of 15 cm, without fertilizing in 4-fold repetition. The harvest was harvested at the stage of full ripeness, by hand.

3 Discussion

The conducted studies have allowed to establish that to obtain a higher yield per unit area, the optimal sowing density is the most important factor affecting the growth and yield of the Guizotsia abyssinica. In the conditions of 2023, the plants were quite stunted – 37.5 cm in the 1st accounting, 88.0 cm in the 2nd accounting, with a standard height of plants in the conditions of the Central Chernozem region up to 190 cm. The bush of the Abyssinian variety Lipchanin was sprawling, semi-closed during the flowering period, the number of leaves varied from 10 to 13 pieces per plant, erect stems, branching. The leaves of the Guizotsia abyssinica are of medium size, the proportion of leaves in the conditions of heat and moisture supply in the year of research was about 35.5%, with the proportion of stems 64.5%. The leaf area of one plant averaged from 11.07 to 21.76 cm² (table).

In the first accounting, the height of the plants was 34-41 cm. In the second accounting carried out before considering the yield of green mass, linear growth was noted at the level of 85-91 cm (table). The share of niger seed leaves was 32-39%, stems accounted for 61-68% (Table 1).

Table 1. Biometric indicators and yield of plants of the Guizotsia abyssinica in 2023 in the conditions of a Field Experimental Station of the RSAU-MAA named after K.A. Timiryazev.

| Number of plants on the accounting site, pcs./m² | 83-94 |
| Number of leaves per plant, pcs. | 10 (4-16)-13(6-29) |
| Leaf area of one plant, cm² | 11.07-21.76 |
| Height of plants in the 1st account, cm | 34-41 |
| Height of plants in the 2nd account, cm | 85-91 |
| Share of leaves, % | 32-39 |
| Share of stems, % | 61-68 |
| Yield of green mass, t/ha | 30.65-37.74 |
| Yield of dry weight, t/ha | 6.19-7.63 |

4 Conclusion

The results of the introduction of nougat in the agroecological conditions of the Central region of the Russian Federation showed that without fertilization, this crop is able to form a yield of dry weight in the amount of 6.19-7.63 t/ha (table). Undoubtedly, this crop is of some interest for the expansion and strengthening of the fodder base of our region and requires further study.
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References

2. V.I. Buyankin, N.N. Borodina, V.I. Pavlenko, Farmer. Volga Region, 3(80), 34-36 (2019) EDN FZTLOS.
4. E.M. Klementyeva, V.V. Smirnova, Agrotechnological aspects of growing Guizotia Abyssinian (Guizotia abyssinicacass.) in the conditions of the Kostroma region, Topical issues of science and technology development: Collection of articles by young scientists of the 73rd Student Scientific Conference, Karavaevo, April 07, 2022 (Karavaevo: Kostroma State Agricultural Academy, 2022) 23-28. – EDN ZHHPVN.