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The Influence of Seeding Rates on Crop Infestation and Safflower Yield

Andrey Valerevich Solonkin[1], Elena Petrovna Sukhareva[1], Anna Vasilievna Belikina[1]

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ABSTRACT

Background: Safflower is an oil seed crop that can form seeds in extreme conditions, so it can be used as an alternative to sunflower because their growing technologies are similar. Weeds cause significant damage to the safflower crop. The safflower crop does not tolerate chemicals used to control weeds, so the study was devoted to alternative methods of weed control in its crops, namely the effect of seeding rates on weed infestation and seed yield. The goal is optimal seeding rate and its effect on weed infestation of safflower crops.

Methods: The experimental site was laid out on the right bank of the Volga River, Kamyshinsky district, Volgograd region, in a dry steppe zone of chestnut soils with a hydrothermal coefficient of 0.6-0.4. Safflower seeds were sown with three seeding rates: 25, 30, 35 kg/ha in triplicate, with row spacing of 15 cm. The experimental results were presented graphically and processed by dispersion analysis.

Result: The research results showed that in the area with a sowing rate of 35 kg/ha of viable seeds there was the least weed in the safflower crops, and the seed yield was higher than in other areas with lower sowing rates. Statistical analysis determined that the seeding rate has a 51.1% effect on safflower yield.

Key words: Crops, Safflower, Seeding rate, Weeds, Yield.

INTRODUCTION

The introduction of safflower tincture into field crop rotations in the Lower Volga region is aimed at stabilizing the collection of its seeds in the driest, chestnut soil zone of the Volgograd region (Prahova *et al*., 2020; Belyakov and Nazarova, 2022; Bhadre *et al*., 2022). The main uncontrollable factor that has a negative impact on agricultural production, confirmed by scientists, is global warming of the planet (Mahadik *et al*., 2018; Tukhina, 2019; Andriyuk *et al*., 2014; Akentyeva *et al*., 2017; Kulik *et al*., 2023). Safflower is in many ways similar to sunflower, but, unlike it, it is not so demanding on the moisture regime, which is especially important in arid climates (Meshram *et al*., 2018; Kuleshov, 2020; Leus, 2020; Licata *et al*., 2023; Gatske *et al*., 2023,). At the same time, its cultivation does not require expensive insecticide treatments that have a negative impact on the ecological situation of the region, as with mustard (Mehdi *et al*., 2016; Kakabouki *et al*., 2020). However, having a number of advantages, safflower is still little known and widespread in the Volgograd region. This may be due to the low demand for its seeds and flower petals in food markets. The peak sales volume of safflower seeds was in 2016 and reached 192.63 thousand tons. The main consumers of safflower seeds in the world are China, Türkiye, USA, Belgium, the Netherlands and Poland. Russian seed supplies in 2022 amounted to more than 155.81 thousand tons. Currently, demand for safflower flower petals is emerging, contributing to the expansion of safflower planting areas (Sudhakarrao *et al*., 2015; Steberl *et al*., 2020). The further use of safflower seeds in the national economy is associated with the development of new technologies for growing and using seeds in industry for various purposes (Kott *et al*., 2003; Vasilenko *et al*., 2018, Turina, 2020; De Oliveira *et al*., 2021; Rathaur Aman *et al*., 2023).

A significant issue in the technology of growing safflower is the control of weeds in safflower crops, the culture of which does not tolerate the treatment of crops with herbicides and the plants die (Andriyuk *et al*., 2014). According to scientists, weeds are those plants in agrophytocenoses that reduce the yield of cultivated crops. However, it is impossible to remove weeds from a field sown with agricultural plants, so the question of its control in agricultural landscapes remains (Luneva, 2021). In earlier experiments on growing safflower and eliminating weeds, the application of pre-emergence soil herbicide was successfully tested (Kuleshov, 2020: Kuleshov, 2020). However, the detrimental effect of herbicides on soil is

[1]Federal State Budget Scientific Institution«Federal Scientific Centre of Agroecology, Complex Melioration and Protective Afforestation of the Russian Academy of Sciences»(FSC of Agroecology RAS) Volgograd, Russia.

Corresponding Author: Anna Vasilievna Belikina, Federal State Budget Scientific Institution«Federal Scientific Centre of Agroecology, Complex Melioration and Protective Afforestation of the Russian Academy of Sciences»(FSC of Agroecology RAS) Volgograd, Russia. Email: belikina-a@vfanc.ru

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widely known and it is necessary to find ways to combat weeding of safflower crops. Methods and methods for controlling weeds in safflower crops will be well complemented by the choice of the optimal seeding rate, on which the productivity of the crop depends and will serve as one of the methods in the fight against weeds. Russian scientist Zhuchenko (2009) noted that the process of photosynthesis is the most vital element for a plant, thanks to which all its vital functions are ensured. Photosynthesis contributes 90-95% to the formation of plant biomass from organic substances (Koleda and Duduka, 2010). Therefore, the seeding rate is a pressing issue in the technologies of growing agricultural crops and safflower. The purpose of the presented scientific research is to determine the optimal seeding rate and its effect on the infestation of safflower crops.

MATERIALS AND METHODS

The research was carried out on an experimental site located on the right bank of the Volga River. It is a dry steppe zone of chestnut soils with a hydrothermal coefficient of 0.6-0.4. The site's climate is sharply continental. Summer air temperature reaches +45 and winter -41°C. Snow cover reaches a height of 22 cm in snowy winters and persists for up to three months.

The experimental plot's soil is light chestnut. Its mechanical composition is heavy, loamy and solonetzic, with medium and deep solonetzes of 5-10%. The relief is a slightly undulating plain. The soils of the experimental plot have a somewhat alkaline reaction of 7.6-8.0 and are low in nitrogen, medium in phosphorus and high in potassium. The humus content reaches 1.2-2.0%. The average annual precipitation is 300-350 mm.

The experiment was repeated three times and the variations were continuous. All repetitions were placed in one field. The area of the experimental plot is 180 m^2. Studies of soil weeds in safflower crops were carried out according to the experimental scheme (Fig 1).

The control mass method was used to account for weeds in the study. Safflower seeds, a super-elite category, were sown for seed purposes in the same way as their predecessor-black fallow. In the fall, primary soil tillage was carried out-disking and in the spring, spring harrowing was carried out in two tracks, followed by pre-sowing cultivation. The safflower variety Alexandrit, characterized by high yield and heat resistance, was sown (Belyaev *et al*., 2010). During the safflower growing season in the 2022 and 2023 agricultural seasons, about 107.4 and 110 mm of precipitation fell, respectively. The average monthly air temperature was 18.5 and 19.6°C. Current weather conditions in 2022-2023 contributed to sowing in the third ten days of April with an average monthly air temperature of 11.2°C (the long-term average value for this month corresponded to 8.5°C). Shootings were observed on May 5-6, *i.e.* two weeks later in 2022 and May 2 in 2023. Safflower seeds were sown at three seeding rates: 25,30,35 kg/ha in triplicate, row spacing 15 cm. Moisture reserve at a depth of 0-30 cm-86.9%, 0-50 cm-141.6%, 0-100 cm 277.7%. The growing season of safflower during the years of research was 110-114 days. The results of the experiment to establish the optimal seeding rate and determine its effect on the infestation of safflower crops were processed by the method of analysis of variance (Dospehov, 2014). The observation results are presented graphically. The purpose of the research is to identify the influence of seed sowing rates on the weed infestation and productivity of safflower tincture crops grown using the row sowing method.

RESULTS AND DISCUSSION

Crops contain weeds, which, just like cultivated plants, need food, light and moisture. The presence of weeds in crops reduces the yield and its quality, due to the rapid development of the root system, they intercept moisture from crops, consume a large number of food elements and deplete the soil, increasing large biomass, shading the crops

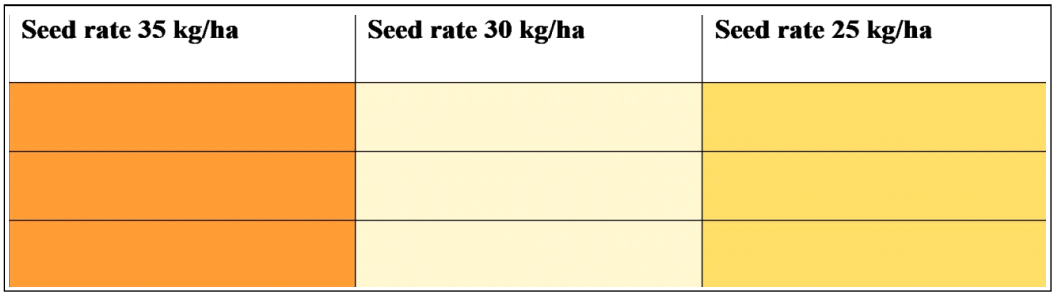

Fig 1: Scheme of experiment to determine the optimal rate for reducing weeds in safflower crops.

Table 1: Average number of safflower plants in areas with and without weeds, %.

Seed rate 35 kg/ha		Seed rate 30 kg/ha		Seed rate 25 kg/ha	
Clean area, %	Clogged area %	Clean area, %	Clogged area %	Clean area, %	Clogged area %
36	64	70	30	40	60

of crops (Khadtare *et al*., 2017). The vital activity of weeds reduces the efficiency of the development of microorganisms and the speed of processes that provide crops with food, contributing to the growth of the number of pests and the development of diseases.

Safflower crops are susceptible to clogging with unnecessary vegetation. The fight's difficulty lies in the fact that safflower plants do not tolerate the treatment of crops with herbicides and die. During the years of research, weed vegetation was represented by annual shepherd's purse [*Capsella bursa-pastoris* (L.) Medik] and perennial weeds, which dominated in numbers: field bindweed (*Convolvulus arvensis*), some representatives of the family *Euphorbia* L. and numerous spurges Waldstein Euphorbia waldsteinii, thistle [*Cirsium arvense* (L.) Scop.], wheatgrass (*Elytrígia*), *etc*.).

Table 1 provides information on the weediness of areas with safflower crops sown at different rates. The cleanest crops were in the area, with a sowing rate of 30 kg/ha of viable seeds, 70% (Fig 2).

During the research period, during the development phase of safflower seedlings with a rosette of three true

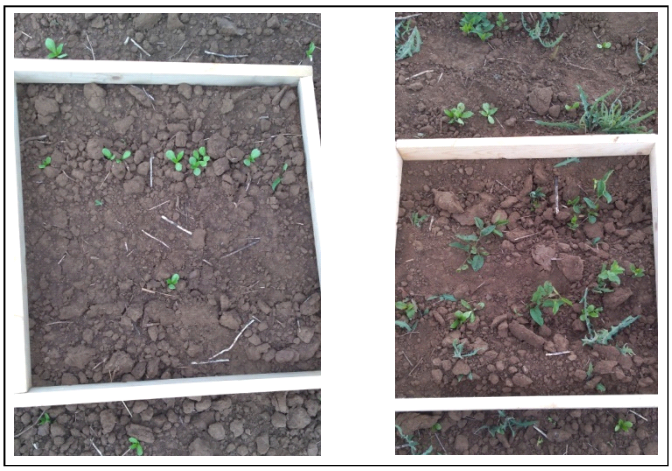

Fig 2: Clean and clogged safflower seedlings. 17.05.2022.



Fig 3: Safflower plants, "sprouting" phase.



Fig 4: Safflower plants, "3 true leaves" phase.

leaves, the seeding rate did not affect the number of weeds.

During this phase, safflower plants intensively develop the root system, which is currently 3.5-5.5 cm compared to the rosette's 2-2.5 cm size (Fig 3).

In Fig 4, it can be observed that weeds have not yet harmed safflower plants.

Fig 5 provides information on weed infestation of safflower crops in 2020-2023. in the phase of three true leaves.

In Fig 4, the lowest average weed infestation was in crops with a seeding rate of 30 million units/ha and the highest was in 25 million units/ha.

Mass shoots of weeds appeared at the end of the "three true leaves" phase, around середина мая and the

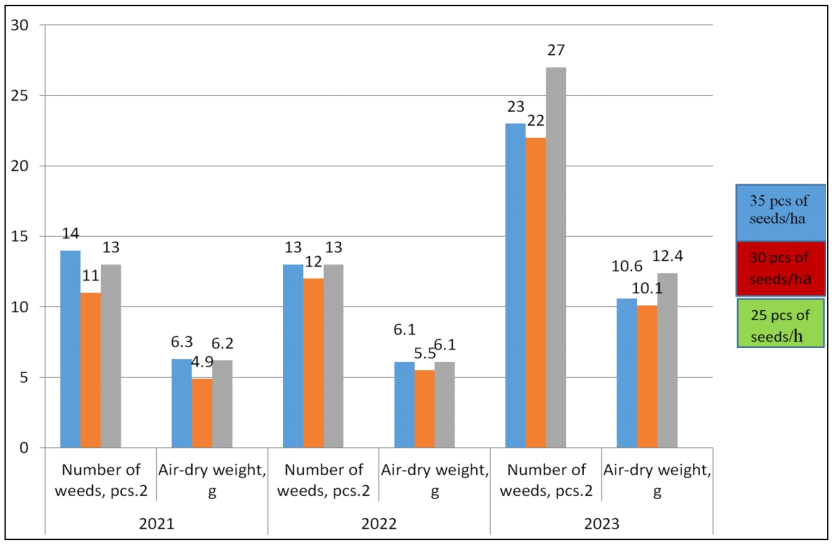

Fig 5: Effect of seeding rate on weed infestation of safflower crops in 2021-2023, phase of the third true leaves.

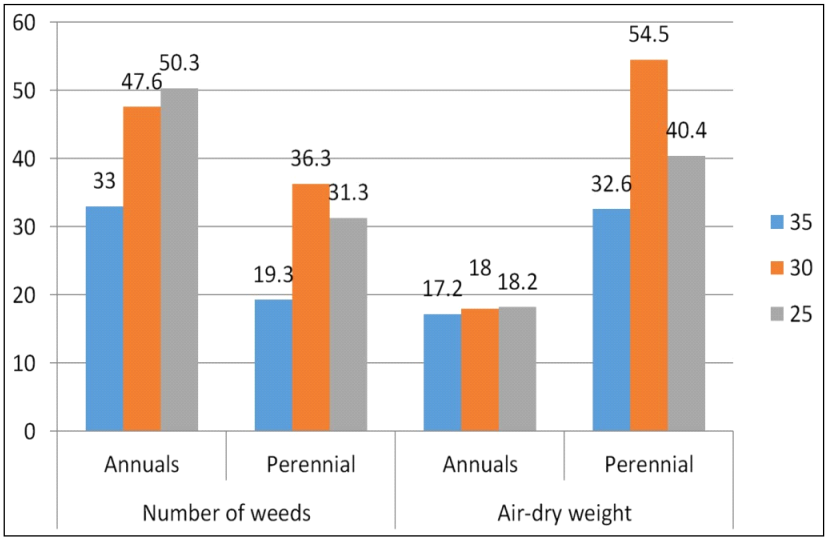

Fig 6: Infestation of safflower crops in the "budding" phase in 2021-2023.

Table 2: Yield of safflower seeds in areas with different seeding rates and degrees of weediness, t.

Seeding rates	2021 y.	2022 y.	2023 y.	Average in 3 years
35	1.1	1.07	1.06	1.07
30	1.1	1.08	1.07	1.08
25	0.93	0.88	0.73	0.84
Average in a year	1.04	1.01	0.95	1.01

active development of weeds occurred in the middle of the "stemming" phase, the beginning of the "budding" phase. During this period, weed growth largely depended on the density of safflower plants (Fig 6).

Observations of weeds in safflower crops in the Lower Volga region show that the numbers of crops during the budding phase of safflower were lower at a seeding rate of 35 kg/ha than in other options. Annual weeds increased by more than 1.5 times at 25 kg/ha and 1.4 times in crops with a 35 kg/ha seeding rate. There were 1.6 times more perennial weeds in crops with a seeding rate than in crops with a seeding rate of 30 kg/ha and 1.2 times less than in thinned crops with a seeding rate of 25 kg/ha. Competition between safflower and weeds intensifies during the "budding" phase because the increase in favorable environmental temperatures contributed to developing cultivated and weed plants. During the years of research in the budding phase, safflower reached a height of 45 cm and a root length of 11 cm. Therefore, its plants in denser crops did not allow weeds to develop as they did in thinned ones. The results characterizing the yield of safflower seeds sown with different rates are presented in Table 2.

According to this data in the Table 2 you can see that the biggest yield was under the normal base of sowing in the amount of 35 kg/ha-1.09 t/ha. From the picture 6 you can see the in the phase of budding of weeds of the less than the variant of norm of sowing in 35 kg/ha of growing seeds.

Having processed the results of the experiment with analysis of variance, where it was initially assumed that the seeding rate does not have any effect on the weediness of safflower crops, it was found that with a probability of 95%, the experiment results were significant. The results of the experiment to determine the value of weediness of crops on the safflower yield were influenced by the seeding rate of 50.1% and 23.9% were influenced by other factors that directly affect the weediness of safflower crops (meteorological conditions, variety, primary tillage, *etc.*).

CONCLUSION

In a study on weed control in safflower crops, it was found that the optimal sowing rate was 35 kg/ha of viable seeds and the highest yield was obtained in the experiment. During the experiment, it was found that the seeding rate affects the yield of safflower in crops and the number of weeds by 50.1%. Fewer weeds develop in denser crops. Therefore, to control them in crops, it can be recommended to increase the seeding rate to 35 kg/ha of viable seeds.

It has been established that the seeding rate affects the weed infestation of safflower crops, suppressing it and increasing the seed yield.

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Conflict of interest

All authors declared that there is no conflict of interest.

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