Weeds biological control technique

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Abstract. The article discusses the results of a study on an environmentally friendly and safe technique aimed at reducing weeds on experimental agricultural lands. The technique consists in sowing a crop with high allelopathic properties: in the steam field, the winter false flax was sown in a mixture with annual clover shabdar in a ratio of 2:1, and in the phase of flowering the above-ground mass of both crops was mown and ploughed as a siderat. In another experiment, amaranth, which has high competitiveness, was sown in rows on corn sown in broad rows. A few days before sowing corn stimulated the growth of weeds with mineral fertilizers ammonium nitrate. After the appearance of weeds, a mixture of a half dose of the herbicide and Nikfan biological product was introduced. Upon reaching the developmental phase of corn of 5-6 leaves, amaranth in the aisles was ploughed as a siderat. Used in crop rotation crops, winter false flax, panicled amaranth, have a high allelopathic feature, reducing the number of weeds. As a result of the studies revealed a significant reduction in weeds. This technology of weed control significantly reduces the cost of weed control and creates favourable conditions for obtaining quality products.

1. Introduction

At all times in agriculture and seed production in agriculture is an urgent problem of weeds harmfulness in the cultivation of cultural crops. They, as well as the reserves of pests and pathogens, increase the cost of harvesting and finalizing the crop [1, 2].

Weeds cause great harm during seed production of crops, especially perennial and annual grasses. The presence of concomitant weeds in the seeds makes it necessary to carry out multiple seed purifications on seed machines, which lead to a loss of 30%. Also, it was found that if there are 100 pieces/m² of weeds in clover crops, the yield decreases by 2 times, and when 200 pieces/m² - by 3 times. In alfalfa crops, weed infestation by juvenile weeds at the level of 50 pcs/m² reduced the yield by 8-12% [3, 4].

The negative role of weeds is also reflected in the production and organizational activities of agricultural enterprises. Weed vegetation makes it difficult to carry out much agricultural work: the traction resistance of tillage implements increases to 30%, the productivity of combines decreases by...
15-30%. One of the reasons for reducing crop yields is the so-called soil fatigue, which should also be taken into account when assessing the phytosanitary condition of the soil. Weeds emit toxic substances, which leads to metabolic disorders in the soil. In clogged fields, the field germination of seeds of cultivated plants decreases, growth and development is delayed due to root weed secretions containing physiologically active substances [5].

It is known that weed cultivation of weeds greatly complicates agricultural work. Weed plants significantly reduce yield, degrade product quality and increase its cost. The costs of controlling weeds reach more than 30% of all costs for agricultural practices. Weeds are especially harmful in arid and semi-arid areas, where land areas are significant [5, 6]. Introduction to the production of new technologies, varieties, the use of high-quality and new types of fertilizers sometimes do not give the desired results due to the weediness of the fields. Many weeds consume nutrients in an amount sufficient to grow 20-30 c/ha of wheat or 200 c / ha of sugar beet [7]. Therefore, the fight against weeds and reducing weediness of fields is one of the main tasks of agriculture. To successfully solve this problem, it is not enough to use any one method. Only a comprehensive weed control using agrotechnical, biological and chemical methods will reduce their number or eliminate weediness and increase the yield of cultivated crops [8]

Many common weeds are poisonous and dangerous to humans and animals. The economic damage from poisoning animals consists not only of losses from their death or illness but also from losses on livestock products, on the reproduction of the herd.

The forms of the harmfulness of weeds are diverse. Some of them, sticking to the roots and stems of cultivated plants, draw nutritious juices and plastic substances from them, deplete and kill them. In areas affected by parasitic weeds, the productivity of perennial herbs is reduced by 20-30%, seeds - by 80-85%, vegetables - by 30-50%. In crops of fodder and fodder crops, due to weeds, the protein content in production decreases to 1% [5, 9].

Certain types of weeds (frost-blite) contain the X virus in a hidden form, which leads to massive infection of cultivated plants. Such weeds as a blind weed, charlock are the reserves of fungal diseases - clubroot of cabbage, white mould, mildew. bristle grass (Setaria), Canadian thistle (Cirsium arvense), frost-blite - carriers of root rot, a mosaic of cereal crops. Many crop pests develop and persist on weeds, and then switch to cultivated ones [6, 7].

On clogged crops, the activity of microbiological processes is weakened due to shading of the soil and a decrease in its temperature by 2-5 degrees. Naturally, under such conditions, the growth and development of crops slow down, some plants die. The practice of agricultural production and numerous studies show that the minimum values of the number of weeds can be achieved with a system of measures that include biological methods of weed control, as the safest, most effective and cost-effective [8]. Weed infestation leads to large crop losses. One of the most basic and low-cost technological methods is the control of weeds by introducing biological methods into the crop rotation, and small participation of chemical elements that do not harm the environment [10, 11].

2. Goal and objectives
The aim of this work is the use of agricultural practices to reduce the weediness of crops. To achieve this goal, the task arose of finding the most effective and safe biological method of reducing the experimental agricultural plot from weeds, increasing the effectiveness of the method of controlling weeds without the use of chemicals. The advantage of the biological method is the long-term effect of exposure at a relatively small initial cost, which can be used in the crop rotation system of biological farming.

3. Objects and methods of research
The studies were carried out on the experimental site of the experimental base of the North Caucasian Research Institute of Mountain and Piedmont Agriculture of the Vladikavkaz Scientific Center of the Russian Academy of Sciences. Our methodology consisted in the fact that in the fall, we sowed winter
false flax culture mixed with the annual clover shabdar in a ratio of 2:1, and in the budding-flowering phase, after wintering, the green mass was trimmed and planted as green manure in the soil.

Thus, in a steam field, we sowed winter false flax in the amount of 8 kg/ha (500-600 pieces of seeds per 1 m²) and 4 kg/ha of clover of an annual shabdar with a grass seeder in the 3rd decade of August or early September.

In another experiment, an amaranth culture was sown in the rows of corn. In this experiment, an area of 20 hectares stimulated the germination of weeds with an aqueous solution of ammonium nitrate 6-7 days before sowing corn. After the appearance of weeds, the plot was treated with Nikfan biological product of 0.1% water concentration in a mixture with a half dose of secateurs-turbo herbicide in an amount of 50-60 g/ha. Because the introduced herbicide is quite toxic, the added biological product Nikfan reduces the harmfulness of the chemical preparation, providing reliable protection of cultivated plants from stress factors.

The Nikfan biological product, obtained by cultivating endophytic fungi isolated from the roots of sea buckthorn plants, has a multi-sided stimulating effect when added as a top dressing of cultivated plants. Adding this drug to the initial phase of plant development at a concentration of 0.1% aqueous solution as a stimulant reduces the dose of the herbicide by half the toxic load on the microflora of the soil, contributes to an increase in the productivity of corn, its quality and a decrease in the incidence of corn.

The experimental field was cultivated by embedding an aboveground mass of weeds in the soil. Then, surface tillage was performed and corn seeds were sown broadly (60-70 cm). Amaranth was planted in the aisles with a grass seeder. Upon reaching 5-6 leaves of corn, amaranth in the aisles was sowed as green manure, destroying weeds.

4. Results and discussion
Winter false flax plants contain a significant amount of phosphoric acid (3-4% in ash), a sufficient amount of sulfur. In the initial period of development of the winter false flax plants, nitrogen fertilizers are required. As biological nitrogen, winter false flax plants are enriched due to nodule bacteria of the clover of the annual shabdar (Trifolium resupinatum L.), sown in the mixture at one time (3rd decade of August). Clover culture can accumulate biological nitrogen in the range of 120-150 kg/ha, which is quite enough for the normal development of the winter false flax culture.

The winter false flax culture itself has high allelopathic properties due to the high content of flavonoids, which are growth inhibitors for many weeds. Allelopathy - the biochemical interaction of plants, rhizospheric microorganisms and their decay products after death through complex physiologically active substances, ensures the survival of plants with high competition. Rutin, a flavonoid glycoside contained in the winter false flax, inhibits seed germination of competing for weed species in the soil. The essential oils contained in the seeds and the aerial part of the vegetative winter false flax are antimicrobial disinfectants and also have an inhibitory effect on competing plants from other families. In winter false flax seeds, phenolic compounds are found in the form of aglicons and glycosides, which inhibit the regrowth of seeds of many types of weeds.

Shabdar clover seeds also contain free flavonoids (quercetin), which are not an antagonist of winter false flax flavonoids, and, consequently, in joint crops of winter false flax and clover, the effect on weeds increases and inhibits their development. The productivity of both crops increases, due to the favourable mutual influence of the root secretions of these plant species. The rationale for the seeding rate (2:1) is explained by the advantage of winter false flax culture as more competitive.

The Nikfan biological product is quickly included in the metabolic process at the cellular level, activates biological processes, affects the formation of chlorophyll and the intake of mineral salts by inhibiting the growth of weeds. The bacteria of the drug Nikfan that entered the soil activate oxidative and photosynthetic formations, and change cell membranes. The combined application of the herbicide and bacterial fertilizer reduces the cost of cultivating corn.
From the data given in the table, it follows that sowing winter false flax in a steam field significantly reduces weed vegetation, and its mixture with the annual clover shabdar reduces the growth of several species of weeds by 100%.

**Table 1. Reduction in the number of weeds. The most common weed plants of winter false flax and clover (pcs. per 1 m²).**

| Weed name                     | The number of weeds in the steam field without winter false flax (control) | The number of weeds after planting winter false flax | The number of weeds after a mixture of winter false flax and shabdar | % of reduction in weeds compared to control |
|-------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------|---------------------------------------------------------------------|--------------------------------------------|
| **One-year early**            |                                                                          |                                                     |                                                                     |                                            |
| Sinapis arvensis              | 23                                                                       | 6                                                   | 2                                                                  | 86.9%                                     |
| Chenopodium album L.          | 8                                                                        | 3                                                   | 0                                                                  | 100%                                      |
| Chenopodium urbicum L.        | 12                                                                       | 6                                                   | 0                                                                  | 100%                                      |
| Sonchus oleraceus L.          | 28                                                                       | 12                                                  | 2                                                                  | 93.9%                                     |
| **One-year late**             |                                                                          |                                                     |                                                                     |                                            |
| Setaria viridis L.            | 36                                                                       | 18                                                  | 3                                                                  | 92.7%                                     |
| Setaria verticillata L.       | 42                                                                       | 19                                                  | 2                                                                  | 85.3%                                     |
| Setaria glauca L.             | 32                                                                       | 12                                                  | 8                                                                  | 25.0%                                     |
| Xanthium Spinosum L.          | 36                                                                       | 14                                                  | 5                                                                  | 87.3%                                     |
| Portulaca oleracea            | 46                                                                       | 15                                                  | 5                                                                  | 89.2%                                     |
| Canabis ruderalis L.          | 38                                                                       | 17                                                  | 12                                                                 | 68.8%                                     |
| **One-year winter**           |                                                                          |                                                     |                                                                     |                                            |
| Bromus secalinus L.           | 21                                                                       | 14                                                  | 7                                                                  | 66.7%                                     |
| **One-year wintering**        |                                                                          |                                                     |                                                                     |                                            |
| Sisymbrium Lotselii L.        | 16                                                                       | 8                                                   | 3                                                                  | 81.3%                                     |
| Capsella bursa pastoris       | 18                                                                       | 12                                                  | 4                                                                  | 77.8%                                     |
| Thlaspi arvense L.            | 24                                                                       | 9                                                   | 2                                                                  | 83.3%                                     |
| **Root-sprouting**            |                                                                          |                                                     |                                                                     |                                            |
| Acroptilon repens             | 12                                                                       | 5                                                   | 2                                                                  | 83.4%                                     |
| Root-rods                     |                                                                          |                                                     |                                                                     |                                            |
| Artemisia vulgaris            | 10                                                                       | 4                                                   | 4                                                                  | 40.0%                                     |
| Circhorium inthybus L.        | 6                                                                        | 2                                                   | 0                                                                  | 100%                                      |
| Cirsium arvense               | 22                                                                       | 14                                                  | 6                                                                  | 72.8%                                     |

Analyzing the data given in the table, it follows that the binary sowing of winter false flax and clover shabdar suppresses weed vegetation. Favourable conditions are created for the subsequent crops in the crop rotation - corn, winter cereals.

In the experiment with corn and amaranth sown between rows, weeds were reduced, explaining this fact by the high allelopathic ability of the planted grass culture (table 2).

The data in the table show that in the optimal variant of experience, where before sowing corn stimulation of weed germination by applying ammonium nitrate and after their appearance, the site is treated with an aqueous solution of bio preparation Nikfan in a mixture of half a dose of herbicide and a subsequent ploughing into the soil, which provides a reduction in weed vegetation, from 14 in the control version to 5 pcs. per 1 m². Translated with www.DeepL.com/Translator (free version). At the same time, the yield increased from 4.6 to 6.4 t/ha, and the protein content increased from 9.6 to 11%. Thus, preliminary stimulation of weed growth with ammonium nitrate, treatment with a half dose of the secateurs herbicide Secateurs - turbo mixed with the Nikfan biological product, ploughing growing amaranth in the rows of maize can reduce the weediness of crops by 2-3 times.
Table 2. The impact of agricultural practices on reducing weeds.

| Test variants                                                                 | Harvest grain corn, t/ha | The protein content in the grain, % | The number of weeds, pcs/1m² |
|-------------------------------------------------------------------------------|--------------------------|------------------------------------|------------------------------|
| Stimulation of weed growth before sowing corn with ammonium nitrate            | 4.6                      | 9.6                                | 14                           |
| Seeding of amaranth between rows                                              | 4.2                      | 9.2                                | 12                           |
| Herbicide secateurs - turbo + Nikfan biological product + sowing amaranth in corn aisles | 5.6                      | 10.2                               | 10                           |
| Biological product Nikfan                                                        | 4.8                      | 11.0                               | 19                           |
| Half-dose turbo secateurs herbicide + Nikfan biological product               | 5.2                      | 10.8                               | 8                            |
| The introduction of the biological product Nikfan 0.1% aqueous solution + secateurs-turbo herbicide in the half dose and amaranth ploughing in the aisles as siderate with preliminary stimulation of weed vegetation before sowing corn | 6.4                      | 11.0                               | 5                            |

5. Conclusion

Thus, the methodology for reducing weediness of crops in biological farming, including the sowing of crops with high allelopathic properties, has shown the greatest efficiency and safety and can be applied on experimental agricultural lands. One of the important agricultural practices is the preliminary stimulation of the growth of weeds, followed by treatment of the plot for sowing row crops in the crop rotation link. By regulating crops in a crop rotation with high allelopathic properties, it is possible to significantly reduce the number of weeds with a simultaneous improvement in the quality indicators of cultivated crops and reduce costs.

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