The problems of breeding new varieties of forage and other plants for improving the soil in organic farming in Russia

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Abstract. In the agriculture of Russia, organic farming is still relatively uncommon, aimed at obtaining ecologically pure food products of the highest quality category. Such agriculture is characterized by minimal use (up to complete rejection of the use) of various pesticides and other agrochemicals. Tillage under such a farming system is also minimized. At the same time, the use of green manure plants is of great importance. The most famous of these is the seradella. But this culture is most common in the southern regions. In Western Europe, it has been used for this purpose for hundreds of years. On the territory of our country, other crops are used and mainly these are fodder plants: yellow lupine, narrow-leaved lupine, white lupine, hedgehog, perennial ryegrass, white mustard, gray mustard, spring rape, winter rape, spring vetch, winter furry vetch, meadow clover and many others. To create specialized varieties, the main thing is to select plants that, to the maximum extent, will be able to suppress the development of weeds, increase soil fertility, and make poorly soluble nutrients available. In our country, there is a huge number of soil differences and climate features (temperatures, rainfall and their distribution by seasons, etc.), therefore, the creation of one variety of each crop for the entire country is extremely difficult. The requirements for green manure and normal use of plants of the same crop differ sharply. For example, the presence in fodder plants of hydrocyanic acid, glucosinolates and other substances toxic to animals is unacceptable, and their presence in green manure crops, as a rule, is not harmful, and often useful. There are also differences in the requirements for the rate of development and longevity of varieties. Therefore, the standards for breeding varieties intended for green manure fallows or cover crops differ significantly from the requirements for a variety for other purposes - such varieties should be distinguished by rapid seed germination, rapid growth of green mass, such varieties may not differ in longevity, since they are used for one season, often they winter hardiness is not needed. Work in this direction has begun, there are specialized first varieties, but for many cultures this work is just beginning.

Keywords: green manure, selection, forage grasses, environmental factors, increasing soil fertility, adaptation, seeds, organic farming.

1. Introduction

Obtaining the most environmentally friendly agricultural products is becoming an urgent task for many manufacturers in the most developed countries of the world, and Russian agrarians have begun to solve such problems in recent years. One of the most effective solutions is the widespread use of occupied fallows with sowing green manure crops and sowing green manures after the main crop, the plant mass
of which is most often embedded in the soil, improving its agrochemical indicators - the content of
nitrogen, humus, microelements, improving its structure. This use of plants has the following effects:
- simultaneously with the germination of the sown crop, weed seeds also germinate, which are
destroyed along with the green manure and subsequently cannot harm the main crop;
- sowing green manure crops immediately after harvesting one of the main crops closes the soil from
drying out and protects the soil from erosion;
- many green manure crops provoke the activation of insect pests and pathogens, which die when the
green manures are embedded in the soil, while the soil is healed;
- when sowing cereals and cereal grasses, the top layer of the soil is loosened and its structure
improves, the water-holding capacity of the soil increases;
- when sowing legumes, deeper soil layers are loosened and, most importantly, nitrogen is bound
and stored for the next year;
- the use of cruciferous crops leads to the suppression of the seedlings of many weeds, and the roots
also perfectly loosen the soil;
- Phacelia - the main advantage of this culture is the absence of common diseases and pests with all
cultivated plants, while it also enriches the soil, suppresses weeds;
- buckwheat, this culture belongs to the buckwheat family, this culture, like phacelia, has no related
agricultural plants, therefore its cultivation will not lead to the accumulation of infections and pests.

When breeding most crops, the focus is on:
- the productivity of the new variety, its resistance to major diseases and pests;
- its resistance to abiotic factors (lack of moisture, low or high temperatures, soil acidity, etc.)
- to the content of certain useful substances (protein, fats, certain amino acids);
- to the absence of harmful substances (hydrocyanic acid, glucosinolates, alkaloids, etc.);
- a certain morphological type (plant height, branching pattern, lodging resistance).

The use of green manure is, as a rule, a rather limited time period - from several weeks to several
months. On the one hand, this imposes somewhat simplified requirements for specialized varieties - one
should not pay attention to the above indicators, but at the same time such varieties should have their
own specific properties, many of which are common to all crops used as green manure:
- fast and friendly germination of seeds (the faster the vegetation cover appears, the faster the soil
surface will be closed and the unproductive evaporation of moisture will decrease, the probability of
germination and strengthening of weeds will decrease);
- rapid growth of the aboveground and underground parts of plants (including due to larger seeds of
specialized varieties, i.e. polyploid varieties will have an advantage here)
- complete disregard for the presence of toxic substances in such plants (on the contrary, such
substances, as a rule, protect these plants from various pathogenic organisms, and therefore remove the
issues of their protection);
- specialized varieties of crops for green manure purposes should not have hard-stone seeds, since
the germination of such seeds for 2 and subsequent years will have extremely undesirable consequences
for crops grown in organic farming, since in this case it is extremely difficult and generally undesirable
to use pesticides (this is especially important for leguminous grasses, the seeds of which can be in the
soil for up to 10-15 years without germinating, for example, this phenomenon is observed in clovers, in
sweet clovers);
- for varieties of green manure, the rapid formation of the root system in the surface layer of the soil
is more important than the penetration of individual roots to a greater depth.

Compared to the application of traditional organic fertilizers, green manure requires much lower
costs - sowing 10-50 kg of seeds per hectare is much cheaper than transportation with loading and
spreading tens of tons of manure or peat.

2. The most important green manure plants and the basic requirements for their varieties.
Cruciferous crops. Plants such as oil radish (Raphanus sativus L. var. oleifera Metzg.), rape (Brassica
campestris L.), white mustard (Sinapis alba L.), spring and winter rape (Brassica napus L.) as green
manure crops began to be used relatively recently, but in recent years they have gained wide popularity among both producers and among individual producers. The main advantages of these crops are the speed of seed germination, excellent loosening of the soil, deep penetration of roots, the possibility of using both as a catch crop in stubble and post-harvest crops, and as the main sowing. Even a mowing crop leaves 5-8 tons of organic matter in the soil [1]. The resistance of these crops to low temperatures makes it possible to achieve excellent results even in the northernmost regions, but also in the south, with a lack of moisture, they show good results.

White mustard and other cruciferous crops can be successfully used in grass mixtures with spring vetch, rank, peas and other legumes, especially those that need support.

Of all these crops, rape is the least demanding on the quality of the soil, which allows it to be sown on all types of soils.

Other species of the cabbage family (camelina, gray mustard) can also be used as green manure, preserving such qualities of the family as fast germination of seeds, rapid growth of green mass, unpretentiousness, suppression of many weeds and harmful insects, deep and strong loosening of the soil.

Currently, there are no specialized varieties of these crops for green manure sowing, mainly varieties intended for green fodder and oil are used. When setting the tasks for the breeding of such varieties, it is necessary first of all to pay attention to the rate of seed germination and to the relative power of the development of the root system.

Legumes. Leguminous plants have long been used for the purpose of increasing soil fertility and subsequently increasing the productivity of cereals and other crops. The most famous is seradella sowing (Ornithopus sativus L.), this is an annual fodder and melliferous crop, which is widely used in Western Europe on light soils with sufficient moisture, it can produce several mows, does not contain harmful substances at all, and it retains all useful properties until the end of flowering. In Russia, it can also be successfully grown in many places, but there are no zoned varieties.

In many cases, legumes are included as an essential component in crop rotations. Leguminous forage grasses are used as green manure: different types of alfalfa - alfalfa sowing (Medicago sativa L. subsp. sativa), alfalfa volatile (Medicago sativa L. nothosubsp. varia (Martyn) Arcang.), alfalfa yellow (Medicago sativa L. subsp. falcata (L.) Arcang.), different types of clover (Trifolium), melilot (Melilotus MILL.), sainfoin (Onobrychis MILL.), as well as leguminous crops for various purposes - sowing peas, fodder peas or pelushka (Pisum sativum L.), fodder beans (Vicia faba L.), furry winter vetch (Vicia villosa Roth), spring vetch (Vicia sativa L.) and many others.

The main advantage of leguminous plants is their ability to accumulate significant amounts of nitrogen in symbiosis with certain microorganisms, for example, modern alfalfa varieties are capable of accumulating up to 300 kg of nitrogen per 1 hectare of sowing [2]. Moreover, the nitrogen accumulated by these crops in their underground organs is not easily washed out and is very fully used by subsequent crops.

Legumes are often used in mixtures with other crops (peas and vetch with mustard or oats, creeping clover with ryegrass, etc.)

Most legumes do not have specialized varieties for green manure crops. Existing herb varieties often have such drawbacks as slow growth at the initial stages of development (grasses), excessively large seed weight (legumes), hardness of grass seeds, which leads to their emergence a number of years after the use of green manure crops, and then they become weeds ...

Lupins also belong to legumes, this is one of the most ancient crops used as green manure, more than 2000 years ago Mark Terentius Varro mentioned the use of white lupine instead of manure on poor, sandy soils [3]. Nowadays, lupins in Russia are the most effective plants for plowing into soil for nutrient enrichment and weed control.

Three types of this crop are grown in Russia - white lupine (Lupinus albus L.), lupine angustifolia (Lupinus angustifolius L.), lupine yellow (Lupinus luteus L.). Currently, these crops are most often used in Russia as green manure, even special varieties have been bred. In narrow-leaved lupine, such varieties
as Siderat 38, Siderat 46 and Bryansk siderat were bred specifically for use as siderates [4]. Such varieties are characterized by unlimited shoot growth, less control over the content of alkaloids, they often do not have a rosette phase, and start growing immediately after germination. The main work with such a culture is carried out at the All-Russian Scientific Research Institute of Lupine, a branch of the V.I. V.R. Williams. The narrow-leaved lupine is valuable because it is a very early crop and can be cultivated up to the northernmost border of agriculture in Russia. In terms of its effectiveness, the green mass of narrow-leaved lupine is completely adequate to manure, and the deeply penetrating root system is capable of pumping nutrients from the sub-arable layer to the arable layer. This significantly increases the effectiveness of the use of this crop in organic farming.

The presence in the green mass of specialized varieties of a noticeable amount of alkaloids leads to the suppression of pathogens of rhizoctonia, scab and even potato nematode.

The disadvantages of narrow-leaved lupine include its hygrophilicity, it needs a sufficient amount of water and still weak resistance to pathogens of fusarium, especially to *Fusarium oxysporum ortocerus*. The solution of these problems is the main task in the selection of varieties of this crop for green manure fallows.

Currently, both yellow lupine and white lupine are used as siderates. They are used in more southern regions, as they are more drought-resistant. The requirements for them as green manure crops are similar to those for narrow-leaved lupine.

Limitations when using lupins as siderates of a general plan are, like all legumes, the undesirability of having a large number of legumes in the crop rotation, since in this case the effectiveness of lupins as siderates is greatly reduced, and the risk of spreading common diseases increases.

**Cereals.** Plants of this family are used to create a loose fertile layer, to accumulate humus (the humus of chernozems owes its appearance mainly to cereal grasses), and cereal plants are also able to quickly accumulate a large mass of organic matter, which is easily decomposed in the soil. In addition, the fibrous root system of all cereal plants is the best remedy against various types of erosion [5].

Of cereals, cereals are widely used - wheat (*Triticum*), rye (*Secale cereale L.*), oats (*Avena sativa L.*) [6], forage annual crops - Sudanese grass, Sorghum-Sudanese hybrids (*Sorghum xdrummondii* (Stead.) Mills. & Chase ) and very often perennial grasses perennial ryegrass (*Lolium perenne L.*), annual ryegrass (*Lolium multiflorum Lam. var. westerwoldicum Witm.*), cocksfoot (*Dactylis glomerata L.*) [7].

Most often, cereal plants are sown in autumn as winter crops and plowed in early spring in order to improve the structure of the soil, increase its water-holding capacity, and accumulate easily assimilated organic matter in it. Usually, winter rye or wheat is sown before winter. This practice is most commonly used in vegetable and potato crop rotations.

Crops of oats, often with spring vetch or peas, are used as green manure for intermediate crops or early spring crops.

Of the perennial grasses, species are mainly used that sprout quickly and quickly build up the aboveground mass. For this reason, red fescue and bluegrass are not used at all. Often, cereal grasses are used in joint crops with the main crops, and after harvesting, after a while, the grass that has already grown under the cover is embedded in the soil.

Since most of our fields are mainly occupied by various cereals - wheat, barley, rye, the use of plants of the cereal family as green manure is not very common, since this is hindered by the presence of common pests and diseases. There are no varieties of cereals specialized for use as green manure.

**Phacelia.** From the aquatic family, as a siderat, the phacelia tansy is mainly used (*Phacelia tanacetifolia Benth.* ). Other plants of this family are not used in agricultural production, for this reason phacelia is one of the most versatile crops for use as green manure - there are no common diseases and pests, the culture is cold-resistant, forms a significant plant mass in a short time, the effect of its use is significant [8 ]. The culture is annual, in favorable conditions it can be biennial. The seeds can overwinter in the soil. There are no specialized varieties of this culture, the few available varieties were created exclusively as honey plants.
Buckwheat (*Fagopyrum esculentum* Moench), as well as phacelia, it practically does not have other members of its family used in agriculture. For this reason, it can be used with almost no restrictions.

Most often it is sown after harvesting the main winter crops and embedded in the soil before winter. In addition, buckwheat is often included in mixtures for the same purposes. The use of buckwheat as green manure leads to an increase in available phosphorus [9]. This makes it significantly different from other cultures. Buckwheat is very versatile in relation to the climate in the growing regions; it can germinate even at relatively low temperatures. For the purposes of greening, varieties of food are used.

3. Conclusion

In the Russian Federation, as well as in the whole world, there are practically no specialized varieties of crops, which are intended for use as green manure in organic farming systems. The exceptions are several varieties of lupine bred in the branch of the Federal State Budgetary Scientific Institution "Federal Scientific Center for Forage Production and Agroecology named after V.R. Williams" - All-Russian Research Institute of Lupine [10]. At the same time, such varieties should differ significantly from the available varieties due to the specifics of their use - they should have high vigor of germination, quickly increase the vegetative mass, have a well-developed root system, and be resistant to adverse conditions. Of the specific signs that may be useful, this is the removal of restrictions on the content of harmful and, in part, toxic substances in the green mass. The presence of such substances can significantly reduce the number of insect pests and pathogens in the soil and thereby significantly improve its health.

To solve this problem, it is necessary to create a separate research program, which will provide, at the first stage, a massive study of bioresource collections, as well as the study of many wild-growing species, especially those that contain substances that are currently considered harmful, for example, the variegated artichoke or elm multicolored (*Securigera varia*).

Limitations in the selection of new plant species for green manure mudflows are the absence of rhizomes that can overwinter and become a source of contamination; seed death in winter conditions is desirable so that non-sprouted seeds do not begin to germinate during the cultivation of subsequent crops. When breeding such varieties, it is possible to use existing breeding institutions with experience in such studies; it is also necessary to conduct a wide botanical analysis of the available information in this area in order to identify the most promising forms.

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