Cultivation of agricultural crops on overburden rocks

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Abstract. The success of the development of lands disturbed by open pit mining largely depends on the correct selection of the assortment of master plants, which are distinguished by good survival rate and high productivity. Overburden rocks, turned up on the day's surface, in the initial years are insignificantly overgrown with natural vegetation. They are affected by water and wind erosion under the influence of climate, environmental conditions and anthropogenic impacts. Perennial grasses have the ability to grow rapidly, accumulate a large amount of aboveground and underground mass, improve the physical properties of rocks and accumulate soil fertility in them. When selecting different types of grasses for sowing on overburden rocks, it is necessary to take into account their biological characteristics.

In grass mixtures, plants make better use of environmental conditions, because for example, leguminous grasses and their mixtures help the better growth of cereals by storing nitrogen. Cereals assimilate biological nitrogen, which is formed as a result of decomposition of the roots of leguminous plants after their withering away or the death of nodules. The sowing time has a great influence on the intensity of the development of grasses and their yield. In the climatic conditions of the Kursk region, the best time for sowing perennial grasses on overburden rocks is spring - the end of April - the first decade of May, summer sowing - the end of July - the first decade of August. One and a half seeding rate of grasses on rocks must be applied, because of the unfavorable physical properties of rocks, the lack of nutrients and the soil itself, individual plants die at the beginning of their development [1,2,3].

Agrotechnical measures for such a study should be smoothly adjusted to each type of sown plant material. The seeding depth depends on the texture of the rock. The depth of seed placement is 2–3 cm on Callovian clays, loess-like loam; on sand, and sandy soils, on average - up to 3–4 cm. Before sowing, the seeds of leguminous grasses were treated with nitrogin. The active use of fertilizers of bacterial origin caused a joint interaction with plant organisms. Bacteria extract oxygen from the environment and synthesize nitrogen for plants to absorb. It is used to feed plants from the legume family. It is based on nodule bacteria, which are synthesized in laboratory conditions. Nitrogin is a highly effective inoculant for leguminous grass seeds. Seed inoculation takes place before sowing, on the eve of the presowing disc, maximum of 24 hours before seeding. For sowing perennial grasses, the processing is minimal and consists of double disking with a disc harrow BDT-2.5. After overwintering, harrowing was carried out to remove crop residues and fertilizing with nitrogen fertilizers at the rate of N30 and N90, depending on the state of the soil cover and the conditions of the year, the type of sown vegetation. When the slopes of the dumps were tinned, the seeds of perennial grasses were sown randomly and embedded in rocks, using mineral fertilizers and high-quality coated seeds [4,5].

According to the results of the study, it is recommended to cultivate medick and blue-hybrid alfalfa, red clover, birdsfoot deer vetch, awnless bromegrass, slender wheatgrass, orchard grass, meadow fescue
on plateaus and slopes of the waste dumps, consisting of loams, without applying a humus layer; on dumps consisting of Callovian clays - white sweet clover, blue-hybrid alfalfa, red clover, meadow timothy, red fescue; on sands (Cenomanian-Alba) - sandy sainfoin, perennial lupine, red clover, blue-hybrid alfalfa, awnless bromegrass, orchard grass, slender wheatgrass; on soil mixtures - white sweet clover, medick, red clover, perennial ryegrass, awnless bromegrass [6,7]. The yield of hay of leguminous grasses for three years (2013–2015) was - on control (without fertilization) on loess-like loam 30–35 c / ha, on Callovian clay - 22–26 c / ha, on sand - 28–31 c / ha, on soil mixtures -22–32 c / ha.

The yield of hay of cereal grasses without use of fertilizers was very low and amounted to 4 c / ha on loess-like loam, 2 c / ha - on Callovian clay, 3.8 c / ha – on sand, 2.9 c / ha – on soil mixtures. The use of mineral fertilizers in the cultivation of perennial grasses on dumps is an important agricultural technique and allows increasing the yield of hay in comparison with the control by 1.5 times, legumes and cereals by 7-10 times. It is most advisable to use a legume-cereal mixture for grassing overburden rocks, since legumes form a deep root system and their meliorative effect is manifested in deep layers. The root system of cereal grasses is concentrated mainly in the 20 cm layer. For grassing the plateaus and slopes of the dumps, according to the literary sources and from the conducted research, the following set of seeding of legume-cereal grass mixtures is provided: alfalfa + awnless brome grass, sweet clover + alfalfa + bromegrass + fescue; alfalfa + clover + timothy + orchard grass. The yield of hay of grass mixtures on the control variants was 21.5 c / ha on Callovian clays, 27.2 c / ha - on loess-like loam, 23.0 29 c / ha - on soil mixtures. The use of mineral fertilizers in a dose of N60P60 K60 made it possible to obtain an additional increase in yield from 9 to 12 c / ha. During the cultivation of perennial grasses and their mixtures, the physical and chemical properties of the rocks are improved, organic matter and nutrients in them are accumulated. For three years of cultivation of legume-cereal grass mixture (sweet clover + alfalfa + brome grass + fescue), the content of organic matter in the upper layer (0–20 cm) of loess-like loam increased by 0.19%, total nitrogen - by 0.09%, phosphorus - by 3.4 mg / 100 g [8]. An increase in organic matter and mobile elements also occurs on Callovian clay and soil mixtures. The microfield study of the influence of the rocks cultivation by cultivating perennial grasses as forage lands, and natural overgrowing, has shown that the rate of soil formation during the cultivation of grasses is much higher than during natural overgrowth. Green fertilizers are an important tool for the cultivation of overburden rocks. The crops of sweet clover and alfalfa were used as green fertilizer. The increase in the yield of spring wheat for green manure crops (sweet clover, wet biomass 6.6–9.0 t / ha) amounted to 6.1-7.7 c / ha in comparison with the control, much more than from the application of a half-mineral fertilizer in dose N60P60K60 (3.5-4.2 c / ha).

The slopes of the dumps in the early years of the dump were very poorly overgrown with natural vegetation, thereby being exposed to water and wind erosion. When grassing the slopes of the dumps by legume-cereal mixtures of alfalfa + bromegrass, sweet clover + alfalfa + bromegrass + meadow fescue, alfalfa + clover + orchard grass + timothy with the use of mineral fertilizers and pelleted seeds a hay yield of 26.2–29.7 c / ha was obtained, on average for three years on the control variants; in the variants with the use of mineral fertilizers –33.1–40.1 c / ha. With the use of pelleted seeds, an increase in yield was obtained on average 10–15 c / ha. As a result, on slopes sown with perennial grasses, the soil washout decreases by 25–50 times in comparison with non-seeded areas [9, 10, 11].

For the cultivation of crops on overburden rocks without applying a humus layer, the following crop rotation is recommended with grasses, which are subsequently used, both as green manure crops in the soil, and as fodder lands for scything:

- Melilot plowed for green manure.
- Winter wheat.
- Barley with sowing of grasses.
- 1st year grasses.
- 2nd year grasses.
- Winter crops.
When studying the effectiveness of mineral fertilizers on sown hayfields, in dumps, with a large amount (more than 30%) in the herbage of leguminous components, it was possible to establish how much the use of fertilizers depends on the degree of soil cultivation [12,13,14]. On sod-podzolic soil, with an average degree of cultivation, a significant effect of mineral fertilizers on the productivity of cereal-legume herbage was noted (table 1).

Table 1. Influence of fertilizers on the yield of cereal-legume herbage of sown hayfields, kg / ha.

| Application time of herbage | Without application of fertilizers | Annually applied | Medium-term soil cultivation |
|----------------------------|-----------------------------------|-----------------|-----------------------------|
|                            | P0K60                             | P120K120        | P180K180                    | N0P0K60 | N0P120K180 | N0P120K180 | N0P120K210 |
| First                      | 68                                | 77              | 87                          | 84      | 87          | 83          | 79          | 81          |
| Second                     | 80                                | 86              | 94                          | 101     | 95          | 100         | 109         | 106         |
| Third                      | 39                                | 54              | 58                          | 58      | 75          | 79          | 80          | 79          |
| Total for 3 years          | 187                               | 217             | 239                         | 243     | 257         | 262         | 268         | 266         |

The soil of a three-year cultivation period

| Application time of herbage | Without application of fertilizers | Annually applied | Medium-term soil cultivation |
|----------------------------|-----------------------------------|-----------------|-----------------------------|
|                            | P0K60                             | P120K120        | P180K180                    | N0P0K60 | N0P120K180 | N0P120K180 | N0P120K210 |
| First                      | 98                                | 89              | 84                          | 82      | 92          | 93          | 100         | 101         |
| Second                     | 104                               | 94              | 96                          | 92      | 100         | 106         | 101         | 110         |
| Third                      | 74                                | 84              | 81                          | 88      | 92          | 91          | 85          | 83          |
| Total for 3 years          | 276                               | 267             | 261                         | 262     | 280         | 292         | 292         | 296         |

Annually, when applying phosphorus-potassium and complete mineral fertilizers, significant increases in hay yield were obtained, compared to the control. An increase in the RK norm from 60 to 120 kg / ha contributed to an increase in the yield of grasses. For 3 years, the increase was 22 c / ha. The application of 60 kg / ha of nitrogen against the background of P60K60 contributed to an increase in the yield of grasses. For 3 years, the increase was 22 c / ha. The increase in the rate of complete mineral fertilization to N0P120K180 did not give a significant effect, the yield remained at the same level, and later this rule was not used.

Compared with the cultivated soddy-podzolic soil, no positive effect of phosphorus-potassium fertilizers on the yield of cereal-legume herbage was established [16,17,18]. Some effect from the use of complete mineral fertilizers was noted. With the annual application of N90P120K180 to the top dressing of grasses over three years, the increase in hay yield was 16 kg / ha at 15% moisture. On well-cultivated soils, a high yield of the cereal legume mixture can be obtained without the use of mineral fertilizers. The botanical composition of herbage on cultivated forage lands largely depends on the type and norms of fertilizers used. As it is known the legumes accumulate more phosphorus in the green mass than cereals. The sown plant from the very first days of growth should be provided with fertilizers, namely phosphorus. Otherwise, weak spikelets are created in cereals, since their rudiments are formed soon after sprouting. Lack of phosphorus in a plant negatively affects the formation of reproductive organs, disrupts the normal passage of phases of plant development. It participates in the formation of chlorophyll, in the construction of phosphorus-containing enzymes, accelerates the maturation of plants, and stimulates the vital activity of beneficial microorganisms. The energy of a living cell is associated with chemical reactions of phosphates. Different types of grassland grasses react differently to increasing doses of phosphate fertilizers. Red canary grass (splendid), meadow fescue and meadow grass respond positively to an increase in the phosphorus dose; in common timothy and meadow foxtail, this reaction is less pronounced.

At the time, the research was carried out on the productive longevity of meadow clover in the composition of cereal-legume herbal mixtures on a cultivated pasture and hayfields under conditions of various mineral nutrition [19, 20]. When creating a cereal-legume herbage on a cultivated pasture, meadow clover was included in a multicomponent herbal mixture consisting of orchard grass, timothy grass, meadow fescue, and perennial ryegrass. Annually, they added P90K60 and nitrogen 22.5 kg / ha to the spring feeding. As a result of the work carried out, after the first, second and third grazing, only
nitrogen (22.5 kg / ha) was applied. $N_{90}P_{120}K_{120}$ were brought in during the season. Such norms of mineral fertilizers and fractional application positively influenced the growth and development of meadow clover. Despite the intensive grazing of the grass stand, the plants were well preserved, and a good harvest was obtained (table 2).

**Table 2.** Botanical composition of cereal-legume herbage by years of vegetation use, %.

| Grass group          | Years of vegetation use, % | Fertilizer, norm |
|----------------------|-----------------------------|------------------|
|                      | first year                  | second year      | third year     |
| Cereals, total       | 66.7                        | 62.8             | 78.4           |
| Legumes, total       | 27.4                        | 34.9             | 18.0           |
| Including meadow clover | 27.4                    | 31.5             | 15.9           |
| Herbs                | 5.9                         | 2.3              | 3.6            |

The use of ammonium nitrate in top dressing against the background of phosphorus-potassium fertilizers at rate $N_{60}$ and $N_{90}$ in the first year of using grasses, had a negative effect on the development of meadow clover and positive effect on the content of meadow clover in the herbage (table 3).

**Table 3.** The content of meadow clover in the composition of cereal-legume herbage depending on the dose of fertilizer, % (first mowing).

| Year of herbage use | control | $P_{60}K_{60}$ | $P_{90}K_{90}$ | $P_{120}K_{120}$ | $N_{60}P_{60}K_{60}$ | $N_{60}P_{90}K_{120}$ | $N_{90}P_{120}K_{180}$ |
|---------------------|---------|---------------|---------------|-----------------|----------------------|----------------------|-------------------------|
| First               | 27.4    | 35.4          | 29.2          | 22.5            | 5.9                  | 11.5                 | 3.5                     |
| Second              | 44.0    | 45.4          | 24.4          | 10.2            | 4.9                  | 4.7                  | 1.9                     |
| Third               | 45.2    | 43.3          | 26.7          | 22.1            | 7.5                  | 7.5                  | 4.6                     |

In subsequent years of vegetation use of the herbage, the development of cereals under the influence of nitrogen increased and reached 90% or more, the content of meadow clover was 1.9-6.9%.

As a result of the study, it was found that on soils well supplied with nutrients, or on soils already used for sowing annual and perennial grasses, it is possible to cultivate cereal-legume herbal mixtures with a high content of leguminous components without additional costs for fertilization. An increase in the rate of phosphorus-potassium fertilizers up to $P_{120}K_{180}$ did not contribute to the productive longevity of meadow clover. This is confirmed by the conducted experiment and data from other scientific studies.

An increase in the rate of phosphorus-potassium fertilizers from $P_{60}K_{60}$ to $P_{180}K_{180}$ did not have a significant positive effect on the content of meadow clover in the herbage. The addition of 60 kg / ha of nitrogen to the top dressing of grasses in spring against the background of $P_{120}K_{120}$ was the reason for the loss of meadow clover from the herbage. The difference in the content of clover depending on the fertilizer was noted in the first and subsequent years of using the herbage. Under the influence of nitrogen, the content of meadow clover in the herbage decreased by 3 times on average. Thus, the rational use of mineral nitrogen introduced into the top dressing is the most important factor in the preservation of meadow clover in leguminous herbage. It is recommended to preserve the productivity of meadow clover on forage lands for 4–5 years, using no more than 30 kg / ha of nitrogen in one step. A dose of phosphorus and potassium of no more than 90 kg / ha. is used on soddy-podzolic soils of an average degree of cultivation, in spring top-dressing of legume-cereal herbage. The postponement of the period of top-dressing of grasses with phosphorus-potassium fertilizers from spring to summer does not increase the productive longevity of legumes in herbage.

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