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THE MAIN FEATURES OF SULFONYL UREA HERBICIDES APPLICATION IN THE PROCESS OF CULTIVATION OF CONIFER PLANTING MATERIAL IN FOREST

Researches have shown that the efficiency of sulfonylurea herbicides strongly is influenced by soil acidity and the content of a humus. Use of herbicide Terrsan in sowings of the first year of a *Pinus silvestris* in the dosage of 30 g/ha is possible at pH to 5.5 pH and humus content of more than 3%. At acidity 5.5–6.0 pH and the content of a humus less than 3% the application dose should not exceed 20 g/ha. In sowings of *Picea abies* at the content of a humus more than 2% it is possible to use dosing 20 g/ha. At lower content of a humus an entering dose should not exceed 10 g/ha.

Introduction. High labor input and low efficiency of mechanical ways of weed control became the reason of looking for more effective treatment methods on all objects of forest growing such as forest nurseries, cultures and forest stands of natural origin, and chemical method appeared to be the most promising of all of them.

Herbicides have passed a development way from extremely toxic substances with consumption of tens liters per hectare to moderately hazardous, and even to low-hazardous, according to producers' positioning. In a wide range of chemical weed control products, in recent years herbicides of sulfonyl urea group, which belong to preparations of the fourth generation, have been drawing more and more attention of experts.

Sulfonyl urea have single mechanicm of action based on destruction in weeds acetolactate synthase enzyme, which controls synthesis of aliphatic amino acids with branched carbon skeleton, deficiency of which leads to an error in the protein synthesis and cell division deceleration. As a result a plant stops growing and gradually dies.

This group of herbicides is characterized by a high selectivity concerning cultural plants, long protective action and low consumption rates that are important not only for decrease of pesticide load on the environment, but also for reduction of expenses for carrying out chemical treatment. They are low-hazardous for man and animals, practically don't migrate on the soil profile and, consequently, don't pollute ground waters, and the considerable time range of their use significantly expands the possibilities of regulation of weed plants quantity on the plantations. Sulfonyl urea-based preparations are successfully applied in the forest management of Russia for plant treatment in the nurseries. These preparations include Terrsan (sulfometuron-methyl acid, 750 g/kg) and its analogue Ankor-85, Grench (metsulfuron-methyl, 600g/kg), Granstar, Tameron and Artstar (tribenuron-methyl, 750 g/kg) [1].

Main part. According to the given data [2, 3], the soil acidity strongly influences the efficiency of sulfonil urea herbicides, which include Terrsan, due to a change of speed of their decay rates. On sour soils this process flows relatively rapidly, on neutral and alkaline – slowly. Generally, decomposition goes a microbiological way. Therefore the decomposition rate of sulfonil urea increases on the soils that are rich with organics, and have high microbiological activity. Favorable weather conditions help it, too. Low temperature and lack of moisture slow down decomposition process.

Besides, features of sulfonil urea herbicides include also the following after-effect: the visible beginning of its action not necessarily come at once. It depends on concentration of herbicide in the soil solution. If the concentration is below of the threshold, plants grow and develop. Then, with coming of the drought period, the concentration of herbicide in the soil solution increases. Chlorosis appears on a leaf surface. Plants' growth slows down. If afterwards drought is followed by rains, the signs of a plants depression disappear, they recover almost to a usual state and their productivity decreases slightly. If the droughty period proceeds long enough, plants either die, or stay in depression [4].

Considering tendency to hydrolysis, pH is a defining factor of resistance of many herbicides, organic acids, carbon dioxide and ammonia evolved by microorganicms, by biasing acid base balance of the soil allow to decompose herbicides successfully even without specific fermentation. According to the existing estimates, the contribution of microorganicms to processes of destruction of herbicides with different composition varies from 10 to 70%, which allows to consider biodegradation as a possible solution of a problem of utilization of residual amounts of herbicides [5, 6].

The object of the research was studying of efficacy of herbicide Terrsan depending on the soil acidity and the humus content, and also its influence on planting material biometrics.

In the spring of 2012 in Smorgonsky forestry station and Volkovyssky forestry station pre-emergence treatment of Scots pine seed bed of 2012 year of planting was carried out in a dose of 20, 30 and 40 g/hectare, seed bed of Norway spruce was treated in a dose of 20 and 30 g/hectare. Also a seed bed of Scots pine of the second year of growing was treated in a dose of 40 g/hectare. At the time of processing Scots pine, the plants had begun to grow. Herbicide was applied on the subjects of experiments, fluid consumption was 300l per hectare using spraying device GS Egedal. Soil acidity was measured by the device Alyamovsky. The biometrics of planting materials was measured according to the “Procedures of testing herbicides and arboricides in forestry” [7].

In 30 days after treatment, the test areas were characterized by high weed infestation. The number of weed plants in yields of Scots pine made 228.8 pcs/m2, and in Yields of Norway spruce it made 283.2 pcs/m2. Preemergence treatment of Yields by Terrsan showed high efficiency. The mortality of weed plants averaged 95%, and preparation was effective for 90 days and even more.

Corn thistle and milk thistle showed relative resistance, they didn’t die, but their growth considerably slowed down. The very few of downy pea, couch grass and barn grass also survived. On the treated areas weed plants appeared in the quantity that required eradication only at the end of September. The objects of the investigation were situated on the areas with different humus content from 0.57 to 4.28%. It should be noted that the site with the humus content 0.57-0.71% was rather cmall and uncharacteristic for the rest of seedling section area. Our investigations show that the humus content in the treated areas affected markedly herbicide efficacy. On the soils that had high humus content, a part of active material was fixed, which led to decay of its activity.

The data concerning the Yield of standard planting material and biometrics of Scots pine seedlings can be seen in the Table. When Terrsan was used in a dose of 30 g per hectare, the Yield of standard planting material and biometrics data significantly decreased if the humus content was less than 3%, and most greatly it impacted on the length of aerial part and root system. In this case aerial part length made 60% and less, trunk width made 87% and less, root system length made 42% and less. When there was used a dose of 40 g per hectare, all the parameters on all the sites decreased significantly. The same tendency was noticed for Norway spruce seedlings. If the humus content in the soil decreased, the toxic action of herbicide intensified, and this resulted in decline of biometrics and plants output. The worst effect occurred when Terrasan dose was 30 g per hectare. If the dose was 20 g per hectare, negative effect could be noticed only if the humus content was less that 2%.

Researches showed that if Terrsan was applied in a dose of 40 g per hectare for Scots pine after plants have started to grow, it caused decay of growing processes. Plants mortality and crown bud damage weren’t observed, but side shoots adopted a role of a leading shoot, which led to multiple tops on treated seedling. Livability was commensurable with livability on the control area and made 98.7%, but root neck diameter decreased by 27%, aerial part decreased by 23%, root system length – by 20%. Obtained data are corresponding with the results of researches of N. Robertson, A. Davis [8] that point out inhibition by sulfometuron-methyl (active material of Terrsan) of growing processes of planting material if it is used in high dosage.

In Volkovyssky forestry station on the territory of 1-year old Scots pine seed bed, objects of experiments were planted; they were treated by Terrsan in a dose of 20 and 30 g per hectare.

The output of Scots pine standard planting material on the sites with different soil acidity after treatment by Terrsan in Smongorsky forestry station

Test variant	Humus level, %	Output of standart planting material, thous. pcs.	Aerial part, cm	Root collar diameter, mm	Root length, cm	$t_{0.95}$
Terrsan, 30 g/ha						
1	4.28	3938.5	5.6 ± 0.13	1.17 ± 0.07	16.4 ± 0.22	0.85
2	3.66	3508.0	5.1 ± 0.11	1.10 ± 0.04	15.1 ± 0.31	1.84
3	2.66	2591.5	3.5 ± 0.15	0.87 ± 0.04	9.3 ± 0.44	9.14
4	0.57	1700.7	3.2 ± 0.21	0.79 ± 0.05	7.3 ± 0.39	15.2
Terrsan, 40 g/ha						
1	4.15	2945.3	4.8 ± 0.17	0.94 ± 0.05	10.4 ± 0.48	1.99
2	3.60	2207.9	3.9 ± 0.14	0.87 ± 0.04	9.4 ± 0.42	8.47
3	2.72	1709.2	3.4 ± 0.18	0.84 ± 0.06	7.5 ± 0.35	13.42
4	0.61	1057.1	3.0 ± 0.18	0.74 ± 0.06	6.2 ± 0.40	17.5
Control						
1	4.01	3968.3	6.1 ± 0.21	1.13 ± 0.05	17.0 ± 0.51	–
2	3.74	3998.1	5.7 ± 0.17	1.18 ± 0.06	17.3 ± 0.42	–
3	2.50	3921.4	5.6 ± 0.18	1.04 ± 0.06	17.5 ± 0.40	–
4	0.71	4015.2	5.5 ± 0.16	1.00 ± 0.07	16.5 ± 0.35	–

The humus content in the soil varied from 1.87 to 1.96%, soil active acidity varied from 5.02 to 6.64 pH.

Terrsan efficacy appeared to be very high: on the treated areas it suppressed weeds entirely, with field pansy in single quantities as an exception.

On the control area weed grew rather intensively (projective cover made 63–78%), which caused necessity of first weed eradication.

According to the report dated 29.05.2012, soil treatment using herbicide hadn't influenced significantly on the germinating ability of Scots pine seed. For example, quantity of seedlings on the sites treated by Terrsan in doses 20 and 30 g per hectare averaged respectively 380.4 and 369.7 pcs./m^2. On the control site quantity of seedlings averaged 377.8 pcs./m^2 and projective coverage by weed – 68.4%.

Further observation showed that in the middle of July Scots pine seedlings were visibly suppressed on the sites that were treated by the preparation in a dose of 30 g per hectare. Growth processes and needle decoloration were observed in blocks that were randomly located on the site. On the site with a treatment dose of 20 g per hectare the adverse effect was constrained and had local features. Agrochemical analysis revealed significant difference in soil acidity on the sites with different degree of suppression. In Figure 1 there is a relation between soil acidity and output of Scots pine standard planting material, which is quite fully characterized by linear dependency.

If pH is higher than 5.7, there is a output of standard material, and if acidity is close to neutral, there is almost total Yield failure. Besides a decrease of output of standard planting material, there is a considerable differentiation according to biometrics of Scots pine seedlings. If pH is higher than 6, seedlings height reduces by almost 4 times. If pH is from 5.5 to 6.0, seedlings height makes about 70% from the maximal one (Fig. 2).

The difference of root neck diameter isn't so noticeable. Diameters of root neck significantly differ if pH is 5.0–5.25. If pH is more neutral, plants' diameter decreases by 42–53% (Fig. 3).

The suppressing effect of herbicide can be noticed while analyzing length of root system of Scots pine seedlings. This index changes 6-fold if compare maximal and minimal length of root system on a site (Fig. 4). Minimal length is specific to pH less than 6.5.

Besides a significant decrease in the size of seedlings that have grown in such conditions, their root systems are also immature. Tertiary roots are fully absent, secondary roots are shortened, their length rarely reach 1 cm.

Such immature root system decreases resistance of seedlings to negative environmental conditions. For example, even short-time drought may cause plants mortality.

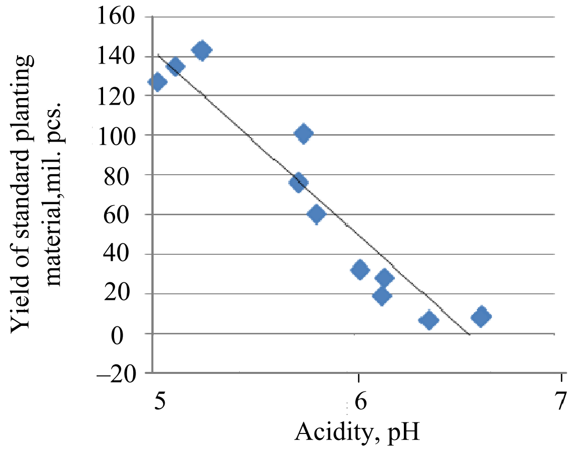

Fig. 1. The output of Scots pine standard planting material on the sites with different soil acidity after treatment by Terrsan in Volkovyssky forestry station

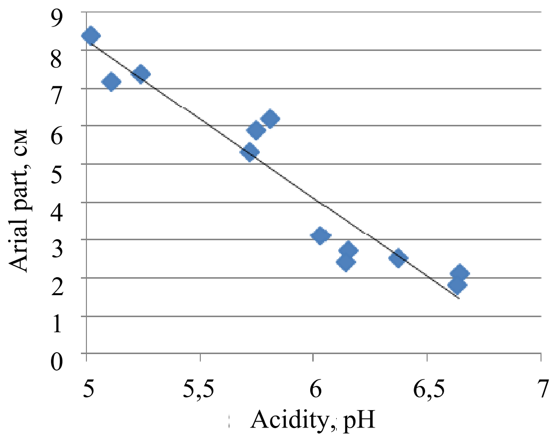

Fig. 2. Arial part on the sites with different soil acidity after treatment by Terrsan in Volkovyssky forestry

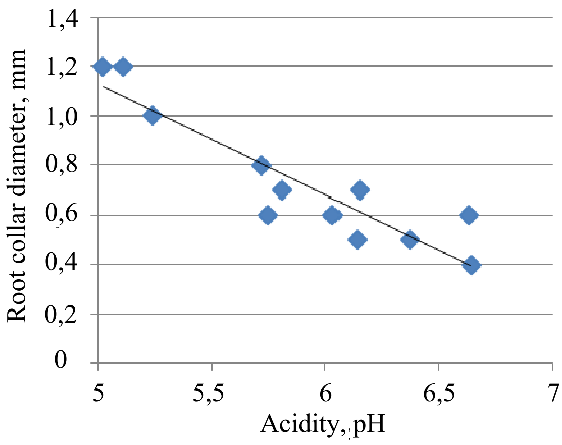

Fig 3. Root collar diameterax on the sites with different soil acidity after treatment by Terrsan in Volkovyssky forestry

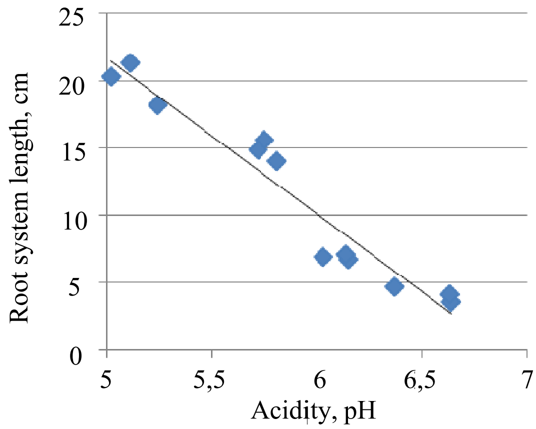

Fig. 4. Root system length on the sites with different soil acidity after treatment by Terrsan in Volkovyssky forestry

Soil acidity analyze on the sites that were treated by herbicide Terrasan in a dose of 20 g per hectare showed that suppression appeared on the areas with pH more than 6. Herbicide treatment hasn't detectably influenced the plants mortality.

Conclusion. Consequently, the application of Terrasan in a dose of 30 g per hectare in first-year Scots pine seedlings is reasonable only if the humus content is more than 3%. Soils with less content of humus should be treated with Terrsan in a dose no more than 20 g per hectare.

For first-year Norway spruce plantations it's acceptable to apply Terrsan in a dose of 20 g per hectare if the humus content is more than 2%. On the plantations with less humus content the dose shouldn't exceed 10 g per hectare. Second-year Scots pine seedlings in the first half of vegetation period shouldn't be treated by Terrsan in a dose of 40 g per hectare, because it leads to reduction of planting material's quality indicators.

Besides, the conducted researches show that soil acidity control is a necessary condition for sulfonyl urea herbicides application. For instance, the herbicide Terrsan application in a dose of 20 and 30 g per hectare is reasonable if pH is less than 5.5. If pH is 5.5-6.0, the dose shouldn't exceed 20 g per hectare.

If pH is more than 6, the herbicide can be applied only under constant monitoring. If there are suppression features that are expressed in chlorosis of current increment, colour change with red shades dominance, and necrosis of needles ends, it's necessary to conduct intensive irrigation with the depth of wetting no less than root systems spread zone and foliage treatment by growth stimulators.

Nitrogen fertilizers application is undesirable, because they are a reason of synergicm. Besides, to reduce the negative effect of sulfonyl urea herbicides it's useful to apply microbiologic preparation Sapronit (0.2 l/ha) [2] that provides activation of herbicides decay processes due to the soil microbiologic activity enforcement.

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