УДК 630*232.325.21

V. V. Nosnikov, PhD (Agriculture), assistant professor (BSTU);
A. P. Mayseenok, PhD (Agriculture) (Dvinsky experimental forest base)

HERBICIDES APPLICATION AT CULTIVATION OF THE PLANTING STOCK OF DECIDUOUS SPECIES IN FOREST NURSERIES

The results of herbicides preemergence application in the deciduous species sowing department of forest nurseries are given here. Only herbicide Terrsanshowed reduction of biometric indices in the application dosage of 20 gr/hectare. The negative effect was not observed when the quantity of the applied drug was reduced to a half. Good results were obtained in black alder sowings after their treatment with herbicides Grom and Zontran. Treatment of silver birch (*Betulapendula*) and black alder (*Alnusglutinosa*) sowings by herbicide Terrsanresulted in the planting stock death.

Introduction. Growing of the deciduous species planting stock and, accordingly, application of herbicides has its specific character in comparison with the cultivation technique of seedlings and saplings of pine, spruce, and larch. The main reason of this difference in the chemical techniques of application are the biological peculiarities of deciduous species which are expressed in presence of the deep rest causing application of autumn sowing; in germination peculiarities when the sprout is not protected by the seed during the initial germination stage; in texture of the lamina external coating which ensures better absorption of aqueous solutions in comparison with coniferous species and because of a considerable area of laminas on which the drug remains and, accordingly, can cause a stronger negative effect. Coniferous species appear to be more resistant to herbicides exposure owing to the wax coating, which forms during the second half of vegetation on the needles surface. Besides,deciduous species are grown in forest nurseries in much smaller quantities in comparison with coniferous species. First of all it is associated with boundedness of area allotted for creation of forest plantations of these species, and with regionality of occurrence of deciduous species forest plantations.

Thus, deciduous species plantations are more difficult objects from the point of view of herbicides application in comparison with coniferous species, and that strongly limitsthe volumes of their studying and usage.

There is application experience of herbicide Grench on silver birch (*Betula pendula*) plantations in Russia; however it is possible to apply the given herbicide only during the second half of vegetation on the plantations of the first year of cultivation and at seedlings cultivation during the second year [1]. Analogues of the given drug in Belarus are the Magnum, Akkurat, Laren pro, Meturon.

Herbicides are used at cultivation of deciduous species in foreign countries when they are non-leaf-bearing, i.e. treatment is done either prior to the vegetation beginning or after exfoliation. [2]

Herbicides usage in the sowing department of deciduous species should be based on soil herbicides which can be applied both in autumn and in spring. Thanks to the long-term action they will protect the shoots of oak, maple, birch and alder from competing influence of weeds in the most difficult period of the plants initial development. The following stage is treatment by the tank mixture of herbicides,destroying gramineous and dicotyledonous weeds, which is done as the previous soil herbicides application wears off.

Main part. For herbicides teststhey selected plots, homogeneous according to the soil conditions, leveled as much as possible on relief and with characteristic for the given zone type of infestation and equal prior activities.

The sample plots were treated by aqueous drugs solutions with the help of the hand sprayer.

As there are no application recommendations for herbicides under study in the forestry of Belarus,so the optimal doses recommended by producers were taken as average doses at determination of their application possibility in forest nurseries.

When conducting the preemergence herbicides treatment the first recording was done in a month after the treatment, the second - at the end of the vegetation period.

To do the recording they used 3 stable recording plots with the size of 0.25 $m^2$and with the ratio of length to breadth 1:1on each sample plot. The following indiceswere determined when conducting the recordings:

1) the total projective soil covering by weeds (on the scale of standards-drawings of fullness of plants projective covering according to L.G.Ramensky);

2) the plot infestation with the main kinds of weeds countingthe number of pieces of each of these kinds in terms of 1 m^2;

3) the state and development phase of the survived weeds (each kind) with indication of their damage rate or oppression signs;

4) theoverground part mass in wet and bone-dry state.

At field and registration tests the following indices [3] were determined in the sowing departments:

a)seedlings amount in terms of 1m of the sowing line. Their estimation was made on 4.5 m of a line on each variant (1.5 m in triple replication);

b) seedlings biometric indices (at the last registration). 10 samples in a variant with 10 seedlings in each samplewere selected for their determination. A sample was selected in one point of the plot, points were placed uniformly on the plot. Seedlings measurements were done (total length, length of roots, of overground part and root collar diameter), and then they were weighed in the air-dry state.

Six herbicides were chosen for tests, possessing strongly pronounced soil action and recommended by the producer for application before the shoots emergence: Kallisto, Dual Gold, Gezagard, Terrsan, Zontran, Grom [4].

To pretest the herbicides there were selected sample plots with the size of 2×1 m (2 m^2) for treatment which were placed randomly in triple replication.

Drugs were applied in the following doses recommended by producers: Kallisto– 0.25 l/hectare; Dual Gold – 1.3 l/hectare; tank mixture of herbicide Kallisto (0.25 l/hectare) and Dual Gold (1.3 l/hectare); Zontran - 1 l/hectare; Gezagard - 2 and 4 l/hectare; Terrsan- 10 and 20 gr/hectare; Grom - 1 l/hectare.

At the moment of application there were shoots of gramineous and dicotyledonous plants from 90 to 150 and from 130 to 280 pieces/m^2 accordingly.

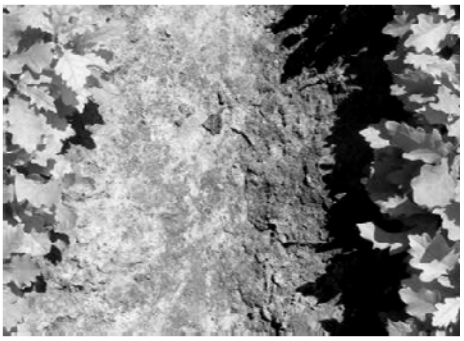
Herbicides influence results on the English oak seedlings are given in table 1.

Table 1

Quantity and height of one-year-old oak seedlings as of May 29, 2013

Drug name	Quantity, pieces/r.m.	Little trunk height $M \pm m$, cm
Kallisto	25.3	5.6 ± 0.12
Dual Gold + Kallisto	24.7	5.1 ± 0.19
Dual Gold	22.4	5.7 ± 0.13
Zontran	24.0	5.2 ± 0.18
Terrsan 10 gr/hectare	21.8	5.9 ± 0.22
Terrsan20 gr/hectare	24.9	4.3 ± 0.34
Gezagard 2 l/hectare	26.1	5.6 ± 0.14
Gezagard4l/hectare	23.5	5.3 ± 0.11
Grom	24.2	5.7 ± 0.15
Control	23.9	5.4 ± 0.14

There were no visual differences in the English oak sowings treated by herbicides as of May 10 and 29 in Smolevichsky forestry enterprise. The result of the preemergence treatment by herbicide Terrsan is given in the picture.



а

б

Influence of the preemergence treatment by herbicide Terrsan 10 gr/hectare on weeds development: *a* – treated; *b* – non-treated

All seedlings had approximately equal height and characteristic leaves coloring. The exception was the plot treated by herbicide Terrsan with the dose of 20 gr/hectare where there wasan appreciable growth delay of the planting stock. There was no decrease of seedlings quantity on any plot.

In the nursery of"Dvinsky experimental forest base of the Forest Institute of Belarus NAS"the preemergence treatment by herbicide Terrsan (10 gr/hectare) was done. Oak sowing was done on May, 13, chemical treatment (preemergence spraying) was done on May, 20. The results are given in table 2.

Table 2

Biometric indices of English oak seedlings

Experiment variant	Seedlings number, pieces/m^2	Height, cm	$t_{0,95}$	Diameter, mm	$t_{0,95}$
Control	52	9.6 ± 0.35	–	4.2 ± 0.13	–
Terrsan	52	5.6 ± 0.28	10.5	3.1 ± 0.10	6.9

There is considerable decrease in seedlings sizes, however the soil examination showed that the soil acidity on the plot is 6,7pH that once again confirms inadmissibility of this herbicide application on subacid and neutral soils.

Amount of weeds on 1 m^2 after treatment by Terrsan 10 gr/hectare - 12 pieces/m^2, on the control variant (without treatment) was 418 pieces/m^2. The weeds height after treatment was 3-5 cm in control.

The following results are received at the preemergence treatment of common maple seedlings.

At the moment of examination (5/10/2013) on the plots where herbicide Kallisto and tank mixture of Dual Gold and Kallisto were applied there was mass chlorosis of common maple shoots. The seedlings damage level was from 96.2 to 99.5 %. Only young emerged leaves were exposed to discoloration. The plot treated only by herbicide Dual Gold, was characterized by a good growth and development of shoots. There were no herbicide damage signs. Thus, herbicide Dual Gold has no phytotoxic effect on common maple seedlings even at treatment after emergence of shoots.

On the plots treated by Kallisto, on May, 29 the plants perishedalmost completely.

Common maple plants on the plot treated by Zontran had an essential growth delay; however there were no signs of leaves discoloration. There were no perished plants either. Preservation was 3.1 % as of May, 29.

On the plot treated by Terrsan in the dose of 10 and 20 gr/hectare, there were no changes in the seedlings state. Preservation was 100 %. But on May, 29 there was notable seedlings growth delay in comparison with the control on the plot with the dosage of 10 gr/hectare. There were no plants losses either. On the plot with the application dosage of 20 gr/hectare there was loss of only those plants which were beginning to rise from soil. Plants which at the moment of treatment had unclosed cotyledons were completely preserved.

Common maple shoots treated by the herbicide Gezagard in the dosage of 2 l/hectare, as of May, 10 hadthe chlorotic discoloration of cotyledonsof 62.4 % of plants. The formed real leaves were also damaged - had an edge of dry darkbrown tissue. Treatment also caused the plants stunt.

The majority of plants perishedas of May, 29. Preservation on the plots did not exceed 6.5 %.

The last plot was treated by the herbicide Grom. 100 % of plants had chlorotic real leaves which had already started to dry upas of May, 10. The treated plants had a stunt and were noticeably behind the non-treated.Preservation was 14.5 % as of May 29. The remained plants had small sizes and deformed leaves.

In Smorgonsky experimental forestry enterprise there was conducted the preemergence treatment of autumn sowings of silver birch which was done practically right after sowing. Application of soil herbicides in silver birch and black alder sowings can be difficult, as seeds of the given species are seeded either with shallow covering or without covering with subsequent mulching. That is there may be a direct contact of the surface treated by herbicide and the seeds, and that can lead to reinforcement of the drug phytotoxicityon the given species.

As of June, 4 on the plot the first hand weeding has already been done and weeds started to appear: meadow grass - 82 pieces/m^2, barnyard grass - 46 pieces/m^2, horseweed - 31 pieces/m^2, wild radish - 2 pieces/m^2, dandelion - 1 piece/m^2, field pansy -7 piece/m^2. On the plot treated by Terrsan in the dose of 10 gr/hectare, there were practically no herbaceous plants. There was only a single occurrence of barnyard grass 1-4 pieces/m^2.

However on the treated plots the silver birch had a stunt at the stage of cotyledons and acquired a reddish shade. At the same time on the non-treated plots the shoots entered the phase of the first leaf. It testifies to impossibility of autumn application of Terrsan for treatment of silver birch sowings.

In spring of the same year in the same forestry there was initiated an experiment on preemergence treatment of spring sowings of silver birch and black alder.

There were absolutely no shoots of silver birch on the plots treated by Terrsanas of June, 4. It means that the given herbicide oppresses the seeds germination process of silver birch, and that leads to their loss.

On the plots treated by the herbicide Grom in the dose of 0.5 and 1.0 l/hectare, there were no birch seedlings as well.

Treatment by the herbicide Gezagard in the dose of 2.0 l/hectare had less effect. On the plot there were silver birch shoots in the quantity of 84 pieces/m^2. However, it is much less, than on the non-treated plots. On the plot with the application dosage of 4.0 l/hectare the amount of plants was 31 piece/m^2, that testifies to a stronger herbicide influence on the silver birch shoots.

Dual Gold herbicide had the least effect on birch shoots. There were 147 piece/m^2 on the plot, and that approximately corresponded to the plants amount on control (164 piece/m^2). However, the given herbicide showed a good effect in relation to monocotyledonous which are practically absent on the plot. On dicotyledons its effect was average.

On the plots treated by the herbicide Kallistoand by tank mixture of herbicides Kallisto and Dual Gold the shoots were single, and that testifies to the unfavorable effect of the herbicide Kallistoon birch shoots.

Herbicide Zontranis slightly worse than Gezagard. On the plot treated by the given drug, there were 63 piece/m^2 birch shoots.

Thus, Dual Gold turned out to be the best among the tested herbicides; however this drug possesses a restricted action spectrum and, accordingly, cannot be applied by itself. The drug recommended by the producer in addition to it, appeared to be toxic for birch shoots.

At the moment of treatment there were no black alder shoots. Herbicides treatment was carried out on mulch - sawdust.

On the plots treated by herbicide Zontran, visually the amount of shoots was at the control level. The given herbicide also has ahigh herbicidal activity. There was a sporadic occurrence of common chickweed, of annual meadow grass, of myagrum perforated on the plot.

On the plot treated by Kallisto, shoots were in a smaller amount in comparison with the control. There was a sporadic occurrence of myagrum perforated, but it had little influence on annual meadow grass (83 piece/m^2).

On the plot treated by herbicide Dual Gold there were numerous shoots of black alder black. Practically there were no gramineous plants on the plot (7 piece/m^2). However, herbicidal action on dicotyledons was weak. There was myagrum perforated (63 piece/m^2), common chickweed (5 piece/m^2).

On the plot where the tank mixture of herbicides Dual Gold and Kallisto was applied, there was smaller amount of shoots. Sowings were almost clean (annual meadow grass 3-6 piece/m^2).

Treatment by herbicide Grom in the dose of 0.5 l/hectare had not negative effect on the black alder shoots. However, the dosage of the given drug appeared to be insufficient for successful weed control (myagrum perforated- 48 piece/m^2, common chickweed- 35 piece/m^2, annual meadow grass- 33 piece/m^2).

At the dose increase to 1 l/hectare there is some decrease of shoots amount with simultaneous decrease of weeds (myagrum perforated - 5 piece/m^2, common chickweed - 16 piece/m^2, annual meadow grass - 3 piece/m^2).

Influence of herbicide Gezagard in the dose of 2 l/hectare is similar to Grom influence in the dose of 0,5 l/hectare. With the absence of visual effect on alder shoots the given drug appeared to be insufficiently effective for weed control. At the dose increase up to 4 l/hectare the herbicidal effect becomes stronger and there is no effect on black alder shoots.

On the plots treated by Terrsan in the dose of 10 and 20 gr/hectare, black alder shoots are sporadic. There is no grass either.

Thus, herbicides Terrsan and Kallisto had uniquely negative effect on black alder shoots.

In Krupsky forestry enterprise there was done spring preemergence treatment of autumn sowings of English oak by herbicide Terrsan in the dosage of 10 gr/hectare. The results are given in table 3.

Table 3

Quantity and height of one-year-old oak seedlings

Object	Seedlings number, piece / r. m.	Seedlings height, cm	Weeds number, piece/m^2	Green weight of weeds, gr
Control	37.8	7.2 ± 0.15	175	285.7
Plot No. 1	35.5	6.9 ± 0.17	4	2.7
Plot No. 2	36.4	7.5 ± 0.18	2	2.3
Plot No. 3	38.2	7.3 ± 0.18	3	1.9

The herbicide treatment effects registration was done on June 13, 2013, it showed a high efficiency of the given weed control treatment. At the moment of registration there was practically no weeds on the treated plot. There was sporadic occurrence of muchweed, caseweed, barnyard grass. And these plants were not healthy and had small sizes. The projective cover was almost equal to zero. At the same time on the non-treated plot there was abundance of muchweed, caseweed, wild marigold, purple sandwort, knot grass, common plantain, corn speedwell, marsh cudweed, common chickweed, Tal cress, barnyard grass, annual meadow grass, toad grass. The projective cover was from 35 to 75%.

In “Minsk forestry enterprise”the experiment was carried out for 2 years to studythe influence of the limiting dose (50 gr/hectare)of herbicide Terrsanon sowings oftillet and European ash. The preemergence treatment of the current yearsowings was done in spring of 2012.

According to the results of two-year observations such high rate of the drug application had no appreciable influence on growth and development of European ash and tillet seedlings, however allowed during the past vegetation season not to weed. As of the beginning of June there were only sporadic plants of Canadian thistle and wild marigold. There were no other kinds of weeds on the plot.

Conclusion. Herbicides application technique in the sowing department of deciduous species should be based on soil herbicides which can be introduced both in autumn and in spring. Thanks to the long-term action they will protect the shoots of oak, maple, birch and alder from the competing influence of weeds during the most difficult period of plants initial development.

In the sowing department an English oak the preemergence treatment can be done by the herbicide Terrsanwith the application dose of 10 gr/hectare provided that the soil acidity will be not lower than 5.5 pH or by herbicides containing glyphosate. It is an effective remedy against the first wave of weeds. It is also possible to use the soil herbicides Grom, Gezagard, Dual Gold, Kallisto and Zontran for preemergence applications.

Tillet and European ash sowings are resistant even to the application of herbicide Terrsan in the dose of 50 gr/hectare, and that makes possible the one-time treatment by the drug with protective action extending on the whole vegetation period and partially on the following one. However, the given herbicide is absolutely unsuitable for usage on silver birch and black alder sowings as it causes the complete loss of plants both at autumn and spring treatment.

To grow the seedlings of black alder it is possible to use thefollowing drugs for the preemergence treatment: Zontranin the dosage of 1 l/hectare, Grom– 0.5 l/hectare.

References

1. Егоров А. Б., Жигунов А. В. Лесовосстановление с применением химического метода: учеб. пособие. С.-Пб.: СПбГЛТА, 2009. 67 с.

2. Мартынов А. Н., Беляева Н. В., Григорьева О. И. Современные проблемы лесовыращивания. Химический и комплексный уход за лесом: учеб. пособие для студентов, обучающихся по направлению 250200 «Лесное хозяйство и ландшафтное строительство». С.-Пб: СПбГЛТА, 2008. 80 с.

3. Сорока С. В., Лапковская Т. Н. Методические указания по проведению регистрационных испытаний гербицидов в посевах сельскохозяйственных культур в Республике Беларусь // «Институт защиты растений». 2007. 58 с.

4. Миренков Ю. А., Саскевич П. А., Сорока С. В. Химические средства защиты растений: справочник. Несвиж: Несвиж. укрупненная тип. им. С. Будного. 2011. 394 с.

Received 20.01.2014