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SILVICULTURAL EFFICIENCY OF HERBICIDES APPLICATION AS A GROWTH INHIBITOR OF HERBACEOUS PLANTS AFTER STRIP-GRADUAL FELLING

Currently in forestry weeding is widely used by way of mowing round, but as a result of it a significant portion of undergrowth is damaged. Application of herbicides in areas where weeding is planed helps to increase the safety of commercially valuable species undergrowth and reduce presence in the composition of undesirable deciduous species.

Introduction. Strip-gradual fellings are made for due removal of mature timber reserves preserving environment protection and other useful properties of forests [1].

After strip-gradual fellings and measures for promotion natural regeneration in areas, apart from natural seeding and formation of commercially valuable species undergrowth, there is an active ramping and appearance of undesirable deciduous species. After one or two years after felling, thre have been an increase in competition for soil nutrition, moisture and illumination with non-forest species in living surface cover and non-specified species. Intermediate fellings are planned for conifer stands with the age of three years, till that time mowing rounds are planned [2]. However, they provide an unstable and short-term effect and can cause mechanical damage of commercially valuable species undergrowth [3].

Soil treatment with herbicides as inhibitors of growth process and development of herbaceous plants helps reduce or remove from the living ground cover a part of herbaceous species and causes dieback of shoots and hardwoods regrowth that create competition for main species undergrowth.

Today in Belarus it is legal to use substances based on glyphosate [4], but in forestry they are not used, experiments are carried out in forest nurseries [5, 6], weeding with the use of herbicides is recommended when living ground cover comprises more than 30–40% [7].

Main part. The research object is an area after strip-gradual felling in Vaverskoe forestry GFE "Lida Forestry". Felling was carried out using conventional logging equipment. As a measure to promote natural regeneration there had been carried out soil mineralization by the plow PKL-70 in aggregate with MTZ-82 in spring of 2008 and seminal pine trees had been left.

Area treatment with herbicides was made in August 2011. As preparations inhibiting the growth and development of undesirable vegetation there have been used the substances used based on various active substances, such as tornadoes, BP (based on glyphosate, universal herbicide) and terrsan (sulfometuron-methyl acids, acts on dicotyledonous and monocotyledonous plants) [8].

The experiment was conducted in duplicate replicates using the following concentrations of drugs:

– tornado, BP : 7.5 l / ha water (option 1, EA 1 (experimental area), EA 3) and 10,0 l / ha (option 2, EA 2, EA 4);

– terrsan: 250 g / ha (option 1, EA 5and EA 7) and 350 g / ha (option 2 EA 6 and EA 8).

Results. During the experiment, the first account of undergrowth, brushwood and living ground cover was done before area treatment with herbicides, in August 2011. Characteristics of natural seeding and regrowth before treatment is given in Table 1.

Virtually all test areas have enough pine undergrowth to form a new, economically valuable crops. Pine located on the bottom of the furrow on bare soil is dominating, a significant numberis located between the furrows. According to the quality categories all plants are healthy.

According to age group three and four years undergrowth prevails (about 90%). According to height small pine undergrowth dominates (90%). Deciduous species represented by birch and aspen are located mainly between the furrows. They are much higher than pine regrowth (they are referred to medium and large undergrowth), as they are fast-growing species, and they give a significant increase in height at early growth.

Repeated record undergrowth and living ground cover preservation after treatment with herbicide was conducted in summer of 2012.

Table 2 shows the characteristics of the living ground cover before treatment with herbicides and after tornado BP with different concentrations. Table 3 shows the characteristics of the living ground cover before treatment and after treatment with different doses of herbicide application.

As part of the living ground cover after stripe-gradual felling and young grass and before herbicide treatment shrub story prevailed. Biodiversity of living ground cover reached 12 species in grass-bush cover and 4 species of moss- lichen story EA 5. There have been widespread Vaccinium myrtillus L., Vaccinium vitis-idaea L., Calluna vulgaris (L.) Hill., and t types of open habitat and felling areas (Epilobium angustifolium L., Nardus stricta L.) and sedges.

Table 1

Characteristics of natural seeding and undergrowth before treatment with herbicides, thousand pieces. / ha

No.	Species															Total ly
	pine (undergrowth)			pine (natural seed-ing)			birch			elder			Total amount			
	On the layer	On bottom of furrow	Between furrows	On the layer	On bottom of furrow	Between furrows	On the layer	On bottom of furrow	Between furrows	On the layer	On bottom of furrow	Between furrows	On the layer	On bottom of furrow	Between furrows	
1 (tornado, BP, B. 1)	1.7	6.7	2.1	–	–	–	–	–	–	–	–	–	1.7	6.7	2.1	10.5
2 (tornado, BP, B. 2)	0.9	14.6	2.1	–	2.1	–	–	–	–	–	–	–	0.9	16.7	2.1	19.7
3 (tornado, BP, B. 1)	2.5	4.2	1.3	–	–	–	–	–	1.3	–	–	3.3	2.5	4.2	5.9	12.6
4 (tornado, BP, B. 2)	–	0.4	0.4	–	–	–	–	–	–	–	–	1.3	–	0.4	1.7	2.1
5 (terrsan, B. 1)	4.2	7.1	0.8	1.3	–	0.4	–	–	–	0.8	–	2.1	6.3	7.1	3.3	16.7
6 (tornado, B. 2)	1.7	3.8	1.7	–	–	–	–	–	0.4	–	–	–	1.7	3.8	2.1	7.6
7 (tornado, B 1)	0.4	5.8	–	–	–	–	–	–	1.7	–	–	–	0.4	5.8	1.7	7.9
8 (tornado, B. 2)	3.8	2.9	4.6	–	–	–	–	–	1.3	–	–	8.3	3.8	2.9	14.2	20.9
Control	5.0	7.9	3.3	1.0	1.7	–	–	–	0.8	–	–	–	6.0	9.6	4.1	19.7

Table 2

Species diversity of the living ground cover before and after the tornado, BP

Species	EA 1 (tornado, BP, variant 1)				EA 2 (tornado, BP, variant 2)			
	before treatment		after treatment		before treatment		after treatment	
	occurrence of species, %	projective cover, %	occurrence of species, %	projective cover, %	occurrence of species, %	projective cover, %	occurrence of species, %	projective cover, %
Grass-shrub story								
Calluna vulgaris (L.) Hill.	4	0	–	–	4	0	–	–
Carex digitata L.	–	–	8	0	–	–	4	0
Carex leporina L.	8	0	8	0	8	0	4	0
Epilobium angustifolium L.	4	0	–	–	4	0	–	–
Hieracium murorum L.	–	–	4	0	–	–	–	–
Luzula pilosa (L.) Willd	24	2	–	–	24	2	–	–
Nardus stricta L.	72	6	44	4	72	6	32	2
Polygonatum officinale All.	52	3	–	–	52	3	–	–
Pteridium aquilinum (L.)	8	0	–	–	8	0	–	–
Rumex acetosella L.	8	0	–	–	8	0	–	–
Stellaria holostea L.	4	0	–	–	4	0	–	–
Trientalis europaea L.	–	–	8	0	–	–	–	–
Vaccinium myrtillus L.	76	14	68	9	76	14	56	5
Vaccinium vitis-idaea L.	100	22	88	17	100	22	76	12
Moss-lichen story								
Dicranum polysetum Sw.	40	5	28	3	36	5	20	2
Pleurozium schreberi	100	25	56	12	100	15	36	7
Polytrichum juniperinum H.	–	–	68	9	–	–	56	5

Table 3

Species diversity of the living ground cover before and after treatment and control terrsan

Species	EA 5 (terrsan, variant 1)				EA 6 (terrsan,variant 2)				Control			
	before treatment		after treatment		before treatment		after treatment		before treatment		after treatment	
	occurrence of species, %	projective cover, %	occurrence of species, %	projective cover, %	occurrence of species, %	projective cover, %	occurrence of species, %	projective cover, %	occurrence of species, %	projective cover, %	occurrence of species, %	projective cover, %
Calluna vulgaris (L.) Hill.	8	0	–	–	8	0	–	–	8	3	8	5
Carex leporina L.	56	4	–	–	56	4	–	–	–	–	–	–
Carex pilosa Scop.	4	0	–	–	–	–	–	–	–	–	–	–
Carex sylvatica Huds.	16	1	–	–	–	–	–	–	–	–	–	–
Chamaenerion angustifolium (L.) Scop.	4	0	8	0	4	0	–	–	–	–	–	–
Hieracium murorum L.	–	–	–	–	–	–	–	–	12	2	4	1
Hieracium pilosella L.	4	0	–	–	–	–	–	–	–	–	–	–
Luzula pilosa (L.) Willd	48	3	32	2	48	3	–	–	4	1	4	1
Nardus stricta L.	56	8	24	3	56	8	16	2	16	8	12	5
Pyrola rotundifolia L.	20	1	–	–	–	–	–	–	–	–	–	–
Rumex acetosella L.	4	0	–	–	–	–	–	–	–	–	–	–
Trientalis europaea L.	–	–	16	1	–	–	–	–	–	–	–	–
Vaccinium myrtillus L.	100	25	96	20	100	25	84	15	64	18	64	18
Vaccinium vitis-idaea L.	20	2	12	1	20	2	16	1	40	6	64	18
Moss-lichen story												
Dicranum polysetum Sw.	28	3	–	–	–	–	–	–	36	1	36	1
Hylocomium splendens	80	9	56	7	56	7	36	5	–	–	–	–
Pleurozium schreberi	88	9	92	13	92	13	72	7	100	16	100	20
Polytrichum juniperinum H.	55	4	56	4	–	–	–	–	–	–	24	3

Moss-lichen story is underdeveloped (projective cover about 30%), but after cutting and herbicide treatment (August 2011) it had already begun to recover.

After treatment of all the layers biodiversity of living ground cover vegetation decreased significantly. Number of species on EA 2, EA 5and EA 6 has decreased.

Most resistant to herbicides were Vaccinium myrtillus L., Vaccinium vitisidaea L., Nardus stricta L., due to the biological features of their structure.

After treatment in the composition of moss-lichen story Polytrichum juniperinum H appeared, Pleurozium schreberi, Dicranum polysetum Sw., Hylocomium splendens reduced, but the grass- shrub story in relation to biodiversity and projective cover declined more significantly than moss and lichen.

Shrub Rubus idaeus covered a significant portion of projective cover before treatment (about 20%), after treatment its species were mostly dried out or severely damaged what means significant susceptibility to herbicides.

Table 4 provides information about the degree of preservation of undergrowth, which was formed after the first stripe-gradual felling and subsequent treatment of area wit herbicides.

Table 4

Preservation of natural seeding and pine undergrowth after herbicide treatment, %

Species	tornado, BP (variant 1)		tornado, BP (variant 2)		terrsan (variant 1)		terrsan (variant 2)	
	EA 1	EA 3	EA 2	EA 4	EA 5	EA 7	EA 6	EA 8
pine	83.0	89.5	76.0	73.0	96.7	93.2	88.2	84.0
birch	–	0	–	–	–	0	0	0
elder	–	0	–	0	0	–	–	0

With regard to the safety of undergrowth it may be noted that all softwood species undergrowth on strips treated with herbicides turned to be dead.

After treatment with tornado BP the degree of preservation of undergrowth in all cases is lower than that one with terrsan. Maximum positive effect was observed when using terrsan concentration of 250 g / ha. Preservation of pine undergrowth is significant, while softwood subjected to harmful herbicide. Grass and brush story was damaged. Biological diversity of species have declined, and the remaining species significantly depressed.

Raspberry turned to be susceptible to the effects of terrsan and it dried out.

One of the least successful case was the use of conducted tornado BP concentration of 100 ml per 3 liters of water. Here the considerable damage of pine undergrowth occurred.

Conclusion. There is a significant reduction in proportion of softwood species and projective cover for grass, lichen and moss stories on all study areas. Grass-shrub story is more susceptible to herbicides in comparison with moss-lichen one. However, some of its species was more resistant to the negative effects of inhibitors (Vaccinium myrtillus L., Vaccinium vitis-idaea L.).

The considerable damage and drying out of Rubus idaeus shrub takes place. It had a negative effect on pine undergrowth, as well as damaged individual species of pine. The most successful variant of the experiment is with terrsan concentration of 250 g / ha (5 EA and EA 7) – the protection of commercially valuable species of undergrowth is 96.7 and 93.2 % respectively.

Application of herbicides as inhibitors of growth and development of undesirable undergrowth growth is promising , but further studies are needed to clarify their permissible concentrations.

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