The use of herbicides in the cultivation of corn

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Abstract. The article discusses the results of studying the effectiveness of the use of new generation herbicides, both soil, applied before the emergence of maize seedlings – Merlin (150 g/ha); Cassius (50 g/ha), and for seedlings – Elumis (1.0-2.0 l/ha), on crops of three maize hybrids. The studies were carried out in the conditions of the foothill zone of the Republic of North Ossetia-Alania, on leached chernozems. The objects of research were different corn hybrids in terms of precocity (the originator of the KBNIISKH).) – Kabardinskaya 3812 (late-repinning), Camilla SV (mid-late), a variety of white-grain food corn Bella 451, which is cultivated not only to obtain varietal seeds, forage, but also to meet the food needs of the indigenous population. The national cuisines of most of the peoples of the North Caucasus use flour and cereals made from white-grain corn. In this regard, it is very important to introduce into production, along with yellow-grain forms used for fodder, highly productive varieties and hybrids of white-grain corn for food purposes. Middle-late variety, food grade. As a result of the conducted studies, it was found that the treatment of the soil with the herbicide Elumis was more effective than the check. We had the following grain yield: Kabardinskaya 3812 hybrid – 8.7 t/ha, on the nonfertilized ground, 12 t/ha – on the fertilized ground, Camilla SV hybrid – 8.5 t/ha – on the nonfertilized ground, 11.7 t/ha – on the fertilized ground, and Bell 451 hybrid – the yield on the nonfertilized was 7.0 t/ha, on the fertilized ground – 9.9 t/ha. The response in yield of Kabardinskaya 3812 hybrid to the application of herbicides was more effective than other hybrids studied.

1. Introduction

In North Ossetia, maize is one of the most important food, fodder and industrial crops. The area of crops of this culture exceeds 70 % of the farm fields. Corn is cultivated for grain, seeds, silage, and green feed. The main task of agricultural production is to find and to develop alternative methods of cultivation of crops that could increase the yield and quality of products. The use of pesticides is practically a mandatory element of corn cultivation technology [1,2,3,4]. The mechanism of action of herbicides is based on their multifaceted effect on the growth and development of the whole plant, its individual organs, tissues and cells [5,6,7].

Chemical weeding should be considered as a mandatory link in the suppression of weeds in the system of general agriculture, crop rotations. And here it is necessary to know the peculiarities of the
biology of the development of weeds, their harmfulness, the properties of herbicides, the effect on weeds, biosafety in relation to the environment [8,9,10].

Therefore, techniques that ensure the destruction of weeds and additional nutrition of plants are an urgent task of science and production.

2. Methods and materials
The research was carried out at the experimental field of the SKNIIGPSKH VNTS RAN, in the forest-steppe zone of the Republic of North Ossetia-Alania, Mikhailovskoye village. The soils of the experimental site are represented by leached chernozems: the enrichment horizon pH is 5.8-6.0, the humus content is 5.8 %, easily hydrolyzed nitrogen – 80 mg/kg, available phosphorus – 118 mg/kg, exchangeable potassium – 120 mg/kg, molybdenum – 0.25 mg/kg, boron – 0.5 mg / kg of soil. The average annual temperature is 9.3 °C, the average long-term sum of positive temperatures for the year is 3240 (3637) °C. The number of days with a temperature above 0 is 279. The average daily air temperature of more than 15 °C is the most favorable for the cultivation of agricultural crops. The objects of research were different corn hybrids in terms of precocity (the originator of the KBNIISKH) – Kabardinskaya 3812 (late-repining), Camilla SV (mid-late), a variety of white-grain food corn Bella 451, which is cultivated not only to obtain varietal seeds, forage, but also to meet the food needs of the indigenous population. The national cuisines of most of the peoples of the North Caucasus use flour and cereals made from white-grain corn. In this regard, it is very important to introduce into production, along with yellow-grain forms used for fodder, highly productive varieties and hybrids of white-grain corn for food purposes. Middle-late variety, food grade.

Soil herbicides were applied 2-3 days after sowing corn, Merlin in the norm – 150 g/ha, Cassius (soluble powder) – 50 g/ha. In V5-V7 stage the crops were treated with the post-emergence herbicide Elumis – 1.0-2.0 l/ha, the advantage of this herbicide is that it can be used in the stage up to V8. The experiment was laid in three replications on plots with a total area of 28 m², and 18 m² of record plot. Statistical processing of the studies was carried out by the method of variance analysis according to B. A. Dospekhov (1985) [11].

Experimental design.
Factor A.
1. Examining (without herbicides);
2. Merlin – 150 g/ha;
3. Cassius (soluble powder) – 50 g/ha;
4. Elumis – 1.5 l/ha.

Factor B.
1. Examining (without mineral fertilizers);
2. N60 P60 K60;
3. N90 P90 K90.

As a result of studies during the growing season of maize there were selected soil and plant samples. Records, observations and analyses were carried out according to generally accepted methods (Adinyaev E. D., Abaev A. A., Adaev N. L.,2012) [12].

3. Results and discussion
The maize crops were dominated by annual weeds (both cereals and dicotyledons) and perennial species: ragweed (Ambrosia artemisiifolia L), corn bindweed (Convolvulus arvensis L), lambquarter goosefoot (Chenopodium album L), wheatgrass (Elytigia repes), Cuba grass (Sorgum halepense).

In Table 1 it is shown the content of impurities of maize crops by periods of growth and development, depending on the level of mineral nutrition and herbicides.
Table 1. The content of impurities of corn crops depending on herbicides and the level of mineral nutrition (avg for 2018-2020)

| Variants | Seedlings | V8-V9 stage | Before winning | Average for the growing season |
|----------|-----------|-------------|----------------|--------------------------------|
|          | Number of weeds, pcs/m² | Dying, % | Number of weeds, pcs/m² | Dying, % | Number of weeds, pcs/m² | Dying, % |
| Ground - without herbicides | | | | | |
| 1. Examining (without herbicides) | 36.0 | - | 53.0 | - | 97.0 | - |
| 2. Merlin – 150 g/ha | 11.0 | 69.4 | 9.0 | 83.0 | 7.0 | 92.7 | 90 |
| 3. Cassius, SP – 50 g/ha | 35.0 | - | 19.0 | 64.1 | 17.0 | 82.4 | 24.0 | 61.2 |
| 4. Elumis – 1.5 l/ha | 9.0 | 75.0 | 5.0 | 90.5 | 5.0 | 94.8 | 6.0 | 90.3 |
| Ground - N₉₀ P₉₀ K₉₀ | | | | | |
| 1. Examining (without herbicides) | 34.0 | - | 49.0 | - | 81.0 | - |
| 2. Merlin – 150 g/ha | 10.0 | 70.5 | 7.0 | 85.7 | 5.0 | 93.8 | 7.3 | 86.6 |
| 3. Cassius, SP – 50 g/ha | 34.0 | - | 14.0 | 71.4 | 9.0 | 88.8 | 19.0 | 65.2 |
| 4. Elumis – 1.5 l/ha | 8.0 | 76.4 | 4.0 | 91.8 | 2.3 | 95.3 | 4.7 | 91.4 |
| Ground - N₉₀ P₉₀ K₉₀ | | | | | |
| 1. Examining (without herbicides) | 35.0 | - | 47.0 | - | 79.0 | - |
| 2. Merlin – 150 g/ha | 10.0 | 71.4 | 6.0 | 87.2 | 4.0 | 94.9 | 6.6 | 87.6 |
| 3. Cassius, SP – 50 g/ha | 34.0 | - | 13.0 | 72.3 | 7.0 | 91.1 | 18.0 | 66.4 |
| 4. Elumis – 1.5 l/ha | 7.0 | 80.0 | 2.0 | 93.6 | 2.0 | 96.2 | 3.6 | 93.2 |

It was found that the number of weeds in the examining, where no herbicides were introduced, reached different years by the end of the growing season from 34-97 pcs/m2. Here, the percentage of weeds such as ragweed, corn bindweed, and wheatgrass increased. Weeds die using the herbicide Merlin in an average of 64.6 to 87.6% over three years. When cultivating the Cassius, SP the table data show that on the nonfertilized and fertilized in different doses ground, it ensured the dying of weeds by 61.2 – 91.1% during the growing season, destroying the seedlings of weeds.

Elumis herbicide, applied to seedlings in the V5-V7 stage, provided a higher weed dying – 75-96.2%. The best option was the use of Elumis, where the weed dying was 90.3-93.2%. Corn crops on this variant remained clean even by the harvest period.
The data obtained on the effect of herbicides on the yield of corn grains of various maturity groups are shown in Table 2.

**Table 2.** The impact of the timing of herbicide application on the corn grain yield (avg for 2018-2020)

| Hybrid          | Ground          | Variants        | Output yield, t/ha | Increment |          | Herbicides | Fertilizers |
|-----------------|-----------------|-----------------|--------------------|-----------|----------|------------|-------------|
|                 |                 |                  |                    | Herbicides| Fertilizers| t/ha      | t/ha | %   | t/ha | %   |
| Kabardinskaya 3812 | Not fertilized | Examining (without herbicides) | 5.0 | - | - | - | - | - | - |
|                 |                 | Merlin – 150 g/ha | 5.8 | 0.8 | 15.1 | - | - | - | - |
|                 |                 | Cassius, SP – 50 g/ha | 7.4 | 2.4 | 47.0 | - | - | - | - |
|                 |                 | Elumis – 1.5 l/ha | 8.7 | 3.7 | 71.1 | - | - | - | - |
|                 | Fertilized      | Examining (without herbicides) | 6.1 | - | - | 1.1 | 17.4 | - | - |
|                 |                 | Merlin – 150 g/ha | 7.8 | 1.7 | 27.9 | 2.0 | 25.6 | - | - |
|                 |                 | Cassius, SP – 50 g/ha | 10.2 | 4.1 | 67.7 | 2.8 | 27.6 | - | - |
|                 |                 | Elumis – 1.5 l/ha | 12.0 | 5.9 | 96.4 | 3.3 | 37.8 | - | - |
| Camilla SV      | Not fertilized  | Examining (without herbicides) | 5.0 | - | - | - | - | - | - |
|                 |                 | Merlin – 150 g/ha | 5.7 | 0.7 | 12.1 | - | - | - | - |
|                 |                 | Cassius, SP – 50 g/ha | 7.4 | 2.4 | 46.8 | - | - | - | - |
|                 |                 | Elumis – 1.5 l/ha | 8.5 | 3.5 | 67.9 | - | - | - | - |
|                 | Fertilized      | Examining (without herbicides) | 6.3 | - | - | 1.3 | 20.0 | - | - |
|                 |                 | Merlin – 150 g/ha | 7.6 | 1.3 | 19.8 | 1.9 | 25.2 | - | - |
|                 |                 | Cassius, SP – 50 g/ha | 9.4 | 3.1 | 49.7 | 2.0 | 21.5 | - | - |
|                 |                 | Elumis – 1.5 l/ha | 11.7 | 5.4 | 85.4 | 3.2 | 27.6 | - | - |
| Bella 451       | Not fertilized  | Examining (without herbicides) | 4.6 | - | - | - | - | - | - |
|                 |                 | Merlin – 150 g/ha | 5.2 | 0.6 | 13.0 | - | - | - | - |
|                 |                 | Cassius, SP – 50 g/ha | 6.1 | 1.5 | 32.8 | - | - | - | - |
|                 |                 | Elumis – 1.5 l/ha | 7.0 | 2.4 | 51.2 | - | - | - | - |
|                 | Fertilized      | Examining (without herbicides) | 5.4 | - | - | 0.8 | 14.5 | - | - |
|                 |                 | Merlin – 150 g/ha | 7.1 | 1.7 | 30.6 | 1.8 | 26.1 | - | - |
|                 |                 | Cassius, SP – 50 g/ha | 8.5 | 3.1 | 58.2 | 2.4 | 28.3 | - | - |
|                 |                 | Elumis – 1.5 l/ha | 9.9 | 4.5 | 83.0 | 2.9 | 29.5 | - | - |

Fertilizers provided an increase in yield in the control variant for Kabardinskaya 3812 hybrid – 1.1 t/ha, for Camilla SV hybrid – 1.3 t/ha and Bella 451 – 0.8 t/ha.

Merlin destroys weed vegetation by 79-84.9 %, contributes to the strengthening of growth processes in maize hybrids, which affected the productivity of plants.

Relatively high purity of crops from weeds was achieved when applying the Elumis herbicide, applied on maize seedlings, while the weeds dying ranged from 84.5 to 90.6 %, which provided an increase in the yield of hybrids Kabardinskaya 3812 by 3.7 t/ha (71.1 %), Camilla SV – 3.5 t/ha (67.9%) and Bella 451 – 2.4 t/ha (51.2%), without fertilizers.
On a fertilized ground, the increase in hybrids was – Kabardinskaya 3812 – 5.9 t/ha (96.4 %), Camilla SV – 5.4 t/ha (85.4%), Bella 451 – 4.5 t/ha (83.0%). The corn crops remained clean until the harvest. This affected the productivity of maize hybrids, providing a yield of 3.7 to 5.9 t/ha for Kabardinskaya 3812 hybrid, 3.5 to 5.4 t/ha for Camilla SV hybrid, and 2.4 to 4.5 t/ha for Bella 451 hybrid.

4. Conclusion
 Soil treatment with the Elumis herbicide was more effective, compared to the control variant and the herbicides Merlin and Cassius. The grain yield was 8.7 t/ha in Kabardinskaya 3812 hybrid, on the nonfertilized ground, 12 t/ha – on the fertilized ground, in Camilla SV hybrid – 8.5 t/ha – on the nonfertilized ground, 11.7 t/ha – on the fertilized ground, and in Bella 451 hybrid, the yield on the nonfertilized ground was 7.0 t/ha, on the fertilized ground – 9.9 t/ha. Crop response of Kabardinskaya 3812 hybrid to the application of herbicides was more effective than that of other hybrids studied.

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