Peculiarities of forming the weed component of agrophytocenosis of corn hybrids depending on the methods of basic soil treatment in the temperate moisture area

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Abstract. The article presents data on the formation of the species composition of the weed component of the agrophytocenosis of corn hybrids and the effect on it of the methods of the main soil treatment-plowing, which was carried out by the Lemken EuroDiamant aggregate on 25 ... 27 cm and DHM disking 5 × 4 on 10 ... 12 cm. It was revealed that in crops of corn hybrids, weeds from the biological group of late spring prevailed, since they are similar in biology to the biology of the development of culture, perennial weeds, which are the most harmful, occupied 34.45%, which determined the system control measures including the use of herbicides and the inter-row cultivation, contributing to the destruction of weeds to phytocenotic damage threshold and identification of their significant decrease during the plowing basic treatment. The role of the hybrid in reducing weediness has not been identified, which is reliably proved by mathematical processing. However, taking into account the yield potential, it was determined that the cultivation of foreign selection hybrids contributes to a significantly high yield - AS-201 (7.5 t/ha) and Monsanto DKS 3939 (6.96 t/ha) compared with the hybrid Mashuk 171 (4.9 t/ha) when using plowing as the main method of treatment.

1. Introduction
Considering the world experience and the experience of countries similar in soil and climatic conditions to the North Caucasus region, an increase in the production of corn grain is not in doubt and this will happen not only due to an increase in the share of corn in grain crops, but also mainly due to an increase in productivity based on modern technology [1,2,12,13].

Weeds are the strongest competitors of crops for plant life factors: light, moisture, nutrients, heat, etc. Their presence in crops leads to a shortage of 20–30% of grain yield, 38–40% of vegetable and fodder crops, a decrease in protein content in grain by 2-3%, gluten - by 7%, sugar in sugar beets - by 2.5– 3.0% [10,11].

The basis for protecting crops from weeds at the present stage of development of agriculture is a complex of technological methods, the basis of which is the system of basic soil treatment. In the total anti-weed effect, its specific gravity reaches 60%, pre-sowing - 30%, post-sowing - 10% [3,5,6].

It is believed that the use of a shallow or subsurface soil-protective soil cultivation system causes a sharp increase in weediness of fields and a change in the species composition of weeds in the direction of increasing the proportion of perennial weeds [4,7,8,9].
2. Materials and methods
Field studies were carried out in 2016–2018 on the territory of the Prikubansky district of the Karachay-Cherkess Republic. The soil of the experimental plot is ordinary carbonate heavy loam on loessian carbonate clays and loams.

The two-factor experiment scheme provided for the following options: early and mid-ripening corn hybrids (factor A) - Monsanto DKS 3939, AS-201, Mashuk 171, basic tillage techniques (factor B) - 5 × 4 PM discing by 10 ... 12 cm; plowing by Lemken EuroDiamant aggregate by 25 ... 27 cm. The experiment was repeated four times, the placement of options was systematic. The accounting area of the plots is 112 m². Sowing was carried out in the second decade of May according to the scheme of 70 × 30 cm. The predecessor was corn for grain.

Farming technique of corn cultivation consisted of the following operations: after harvesting the predecessor – DHM disk peeling 5x; 4 on 8-10 cm, in autumn, the main soil treatment was carried out: for the first version – plowing with LEMKEN aggregate for 25-27 cm, for the second – DHM discing 5x; 4 on 10-12 cm, early spring cultivation was carried out by the KRNV 5.6-04 cultivator to a depth of 8-10 cm, mineral fertilizers N90P60K60 were used fractionally during sowing and pre-sowing cultivation, presowing cultivation to a depth of 5-7 cm by KSOP-5 cultivators, sowing with a John Deere seeder. Sowing was carried out in the second decade of May according to a 70x20 cm pattern. Crop care included spraying the crops in the 5-6 leaf phase with the universal post-emergence herbicide MysTer Power to control the full spectrum of weeds in corn crops. (1.26-1.5 l / ha). Inter-row cultivation was carried out by the KRNV 5.6-04 cultivator in the phase of 7-8 leaves. Harvesting was carried out by the ACROS combine in the phase of full ripeness of grain (late September - early October).

Weediness was determined by the method of Armor B.A. Vasiliev I.P., Tulikov A.M. (1987). Statistical processing of data was carried out using the multifactor experiments processing program “Polyfactor”.

The main reserve in ensuring high and sustainable crop yields and improving their quality is effective weed control. With the intensification of agriculture, the need for additional weed control measures increases, as most highly developed countries have already exhausted the possibilities of mechanical methods of weed control.

Table 1. Species composition of weeds in the phase of 3-5 corn leaves (before treatment with herbicides).

| Name of weed                               | Botanical family            | Type of root system | pcs / m² | g / m² | % |
|-------------------------------------------|-----------------------------|---------------------|----------|--------|---|
| Sarepta mustard (Brássica júncea L.)      | Cruciferous (Brassicaceae)  | rod-shaped          | 4        | 6.2    | 6.55 |
| Common oatmeal (Avena fatua L.)           | Cereal (Poaceae)            | fibrous             | 4        | 4.5    | 6.55 |
| Lambsquarter goosefoot (Chenopódium álbum L.) | Amaranth (Amaranthaceae)    | rod-shaped          | 4.7      | 7.8    | 8.2  |
| Ragweed (Ambrosia artemisifolia L.)       | Aster (Asteraceae)          | rod-shaped          | 4.7      | 9.8    | 11.5 |
| Pigweed (Amaranthus retroflexus L.)       | Amaranth (Amaranthaceae)    | rod-shaped          | 7        | 10.0   | 11.5 |
| China jute (Abutílon theophrásti Medic)   | Malvaceae (Malvaceae)       | rod-shaped          | 9        | 12.7   | 14.8 |

Wintering

| Bagged sailor(Centaurea cyanus L.)         | Aster (Asteraceae)          | rod-shaped          | 4        | 6.3    | 6.55 |

Perennial

Root shoots
Perennial sow thistle (Cirsium arvense L.)  
Corn bindweed (Convolvulus arvensis L.)  
Mountain bluet (Rhaponticum repens L.)  
Rod root  
Rock cress (Barbarea vulgaris R.BR.)  
Common wormwood (Artemisia vulgaris L.)  
Couch grass (Elytrigia repens L.)  
Horsetail (Equisétum arvénse L.)  
Ashweed (Aegopódium podagrária L.)  

| Species                                      | Life form          | Root Type | Mass 1 | Mass 2 |
|----------------------------------------------|--------------------|-----------|--------|--------|
| Perennial sow thistle (Cirsium arvense L.)  | Aster (Asteraceae) | root shoots | 2     | 4.1    |
| Corn bindweed (Convolvulus arvensis L.)     | Aster (Asteraceae) | root shoots | 2     | 3.5    |
| Mountain bluet (Rhaponticum repens L.)      | Aster (Asteraceae) | root root  | 2     | 3.8    |
| Rock cress (Barbarea vulgaris R.BR.)         | Cruciferous (Brassicaceae). | rod-shaped | 3     | 4.2    |
| Common wormwood (Artemisia vulgaris L.)      | Aster(Asteraceae)  | rod-shaped | 3     | 5.8    |
| Couch grass (Elytrigia repens L.)            | Cereal(Poaceae)    | fibrous    | 3     | 2.8    |
| Horsetail (Equisétum arvénse L.)            | Horsetail (Equisetaceae). | rhizogenous | 2     | 3.8    |
| Ashweed (Aegopódium podagrária L.)           | Umbrella (Apiaceae) | rhizogenous | 4     | 5.2    |
| **Total**                                    |                    |            | 61    | 95.3   |

The species composition of weeds was presented by representatives of almost all biological groups (table 1). The subtype of juveniles included weeds from the early spring group - Sarepta mustard (Brássica júncea L.), 4 specimens per square meter with a mass of 6.2 grams, common oatmeal (Avena fatua L.) (4 pcs / m2 with a mass of 8, 5 g / m2), Lambquarters root foot, pigweed (Amaranthus retroflexus L.) 7 and 10.0, respectively, and China jute (Abutílon theophrásti Medic) 9 pcs / m2 and 12.7 g / m2. This group occupied 24.9% of the weed component of agrophytocenosis.

The weed component was also represented by late spring weeds, which occupied the largest part in the agrophytocenosis — 37.8%, since the development biology of weeds from this group is close in developmental biology to corn for grain. The infestation of ragweed (Ambrosia artemisifolia L.) was 7 specimens with a weight of 9.8 grams, pigweed (Amaranthus retroflexus L.) 7 and 10.0, respectively, and China jute (Abutílon theophrásti Medic) 9 pcs / m2 and 12.7 g / m2. All weeds have a deeply penetrating root system, with the help of which they remove moisture and nutrients from the soil.

A characteristic feature of the weed component of agroecosystem is a wide variety of perennial weeds, which were represented by four biological groups: root shoots - Perennial sow thistle (Cirsium arvense L.), corn bindweed (Convolvulus arvensis L.), mountain bluet (Rhaponticum repens L.), 9.9% of weeds, the same amount was occupied by representatives of the biological group of rod root - rock cress Barbarea vulgaris R.BR. and common wormwood, (Artemisia vulgaris L.), slightly less occupied by rhizogenous weeds - 8.2% : couch grass (Elytrigia repens L.) and horsetail (Equisétum arvénse L.).The creeping biological group was represented by one weed plant - ashweed (Aegopódium podagrária L.), which occupied 6.55% of the weed component. All species of perennial weeds occupied 34.45%, that is, almost a third, given that perennial weeds are quite harmful, consuming moisture and nutrients from the soil in larger quantities than annuals, adhering to agricultural elements is an important task of corn cultivation technology.

Using the classification of life forms by K. Raunkier (1905), it can be stated that this weed community is represented by 13.9% of hemicyrptophytes, 70.7% of therophytes and % 15.4 of geophytes, that is, the third part of the weed component of agroecosystem is occupied by perennial weeds, which are powerful competitors to annual species and are more harmful.

Based on the foregoing, it can be concluded that in the research area the root-shoots-rhizogenous-juvenile type of infestation prevails.
Weeds are powerful cultural competitors in the struggle for life factors. Reduction of weediness due to various elements of agricultural technology is the key to obtaining high and stable yields. In our work, we analyzed the change in the weediness of corn hybrids depending on the methods of the main soil treatment (table 2).

Table 2. The number of weeds in crops of corn hybrids, pcs / m².

| Hybrid            | Soil treatment | Before herbicide treatment | After herbicide treatment | After inter-row cultivation | Before harvesting |
|-------------------|----------------|---------------------------|---------------------------|-----------------------------|------------------|
| Monsanto DKS 3939 | Plowing        | 52.1                      | 30.4                      | 20.5                        | 4.1              |
|                   | Disking        | 62.1                      | 36.4                      | 28.1                        | 7.4              |
| AS-201            | Plowing        | 50.9                      | 27.8                      | 19.7                        | 4.4              |
|                   | Disking        | 60.7                      | 34.5                      | 26.0                        | 8.1              |
| Mashuk 171        | Plowing        | 53.8                      | 32.7                      | 22.5                        | 4.8              |
|                   | Disking        | 63.3                      | 37.5                      | 29.4                        | 7.5              |
| HCP0.5 A          | 2.92           | 3.89                      | 3.11                      | 1.22                        |
| HCP0.5 B          | 5.55           | 4.28                      | 4.10                      | 3.99                        |
| Sx, %             | 2.75           | 3.17                      | 2.85                      | 2.56                        |

In the experiments, the infestation of crops of maize hybrids depended both on the methods of the main tillage and on the performance of agricultural operations. Before treatment with herbicides in a phase of 3-5 leaves, the weediness of the crops of the Monsanto DKS 3939 hybrid in the variant with plowing was 52.1 pcs / m², after treatment with the herbicide 30.4, after cultivation 20.5, and for harvesting their number was 4.1 pcs / m². In the case of disking, these indicators were 62.1, 36.4, 28.1 and 7.4 pcs / m², respectively. A similar situation in the direction of decrease is observed in crops of the AS-201 hybrid and in the direction of increase in Mashuk 171.

Mathematical data processing showed that differences in weediness on all dates of the survey were insignificant (F1 0.51<Ft 0.56 3.47 , before treatment with herbicides, F1 0.42<Ft 0.56 3.77 , after treatment with herbicides, F1 2.76<Ft 0.56 3.60 , after inter-row cultivation, F1 1.45<Ft 0.56 3.67 , before harvesting).

At the same time, the weediness of crops of corn hybrids was significantly influenced by the method of soil treatment. The use of plowing as the main treatment significantly reduces the weediness of crops.

So, in the crops of the AS-201 hybrid before treatment with herbicides, the weediness on the variant with plowing was 50.9, and on disking - 60.7 pcs / m², after treatment with herbicides the weediness was 27.8 and 34.5, respectively, after interrow cultivation - 19.7 and 26.0, and before harvesting - 4.4 and 8.1 pcs / m². A similar situation is observed in the crops of Mashuk 171 and Monsanto DKS 3939 hybrids. The mathematical analysis proved a significant reduction in weediness when plowing was carried out as the main plowing treatment.

Carrying out such agrotechnological methods such as inter-row cultivation and the use of herbicides does not reduce the share of the influence of the main soil treatment factor.

Table 3. Yield of corn hybrids depending on the methods of soil treatment, t / ha.

| Hybrid (factor A) | Year | 2016 | 2017 | 2018 |
|-------------------|------|------|------|------|
|                   |      |      |      |      |
| Plowing (factor B)|      |      |      |      |
| Monsanto DKS 3939 | 7.0  | 6.5  | 7.4  |
| AS-201            | 7.5  | 7.0  | 8.0  |
| Mashuk 171        | 5.0  | 4.2  | 5.3  |
| Disk peeling (factor B)| | | | |
| Monsanto DKS 3939 | 6.2  | 5.2  | 5.5  |
| AS-201            | 6.0  | 6.0  | 6.3  |
| Mashuk 171        | 4.0  | 3.0  | 3.3  |
Considering the yield by year, (table 3), we can state the fact of a significant increase in the yield of Monsanto DKS 3939 and AS-201 hybrids compared to the Mashuk 171 hybrid, in 2016 the yield of hybrids was 7.0, 7.5 and 5.0 t / ha when plowing; 6.2, 6.5 and 4.0 t / ha during disking (HCP05, A 1.9, HCP05, B 0.8), in 2017, the yield of maize hybrids was 6.5, 7.0 and 4.5 t / ha during plowing; 5.2, 6.0 and 3.0 t / ha during disking (HCP05, A 2.1, HCP05, B 0.9), in 2018, the yield of hybrids was 7.4, 8.0 and 5.3 t / ha during plowing; 5.5, 6.3 and 3.3 t / ha during disking (HCP05, A 3.2, HCP05, B 1.6),

Mathematical data processing shows that the productivity of the Monsanto DKS 3939 and AS-201 hybrids is significantly higher than the productivity of the Mashuk 171 hybrid when using plowing as the basic treatment method.

Consequently, the use of disking as the basic method of soil treatment leads to the formation of a larger number of weeds than during plowing, that’s going to affect the corn yield.

References

[1] Sotchenko V S et al. 2015 Prospects for the production of grain and seeds of corn in the North Caucasus Federal District Corn and sorghum 2 3-6
[2] Sotchenko V S et al 2015 Corn cultivation technology Bulletin of the agro-industrial complex of Stavropol 52 79-84
[3] Tsikov V S et al 2006 Weeds: harmfulness and protection system (Dnepropetrovsk: ENEM)
[4] Gostev O Net al 2016 Comparative evaluation of corn hybrids of different ripeness groups when growing for grain, and their impact on weediness of crops Collection of scientific papers dedicated to the 85th anniversary of Michurinsky State Agrarian University: Collection of scientific papers ed V A Grandm (Michurinsk) pp 13-7
[5] Kurdyukova O N 2016 The system of primary soil treatment and weediness of crops in crop rotation Izvestia TSHA 2 76-80
[6] Miller S S et al 2018 The influence of the main soil treatment methods on the weediness of corn crops in the northern forest-steppe of the Tyumen region Science alley 8(24) 210-3
[7] Filin V I et al 2014 Sowing density and soil cultivation method as factors for increasing corn grain productivity in the southern chernozems of the Volgograd Region Bulletin of the Lower Volga Agricultural University: Science and higher professional education 1(33) 112-7
[8] Tolorai T R et al 2018 The influence of presowing soil treatment systems on the yield of corn with different methods of the main processing and application of herbicides Agriculture 1 23-6
[9] Kravchenko R V et al 2011 Efficiency of the shallow primary soil treatment for corn under conditions of unstable humidification Transactions of Kuban State Agrarian University 5(32) 103-6
[10] Perederieva V et al 2019 Influence of pre-crops on weedy component of agrophytocenosis in cultivation of winter wheat under no-tillage technology Engineering for Rural Development 2019 426-9
[11] Vlasova O I et al 2018 Previous crop - as an element of organic farming in the cultivation of winter wheat in the Central pre Caucasus Research Journal of Pharmaceutical, Biological and Chemical Sciences 9(6) 1272-6
[12] Tormena C A, Karlen D L, Logsdon S and Cherubin M R 2017 Corn stover harvest and tillage impacts on near-surface soil physical quality Soil and Tillage Research 166 122-30
[13] Zhai L, Xu P, Zhang Z et al 2017 Effects of deep vertical rotary tillage on dry matter accumulation and grain yield of summer maize in the Huang-Huai-Hai Plain of China Soil and Tillage Research 170 167-74