REPUBLIC OF AZERBAIJAN

On the rights of a manuscript

ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

DEVELOPING INTEGRATED PROTECTION METHODS AGAINST WEEDS IN MAIZE FIELDS OF THE GANJA-GAZAKH REGION

Specialty: **3103.06-Plant protection**

Field of science: **Agrarian sciences**

Applicant: **Sahil Rahman Guliyev**

Ganja – 2021

The work was performed at the Azerbaijan State Agrarian University.

Scientific supervisor: doctor of agrarian sciences, correspondent member of ANAS, professor
Ibrahim Hasan Jafarov

Scientific consultant: Associate Professor of the Department of General Agriculture, Genetics and Selection of ASAU, Doctor of Philosophy in Agrarian Sciences
Fariz Shahin Alakbarov

Official opponents: - doctor of agrarian sciences, correspondent member of ANAS, professor
Alovsat Gulush Guliyev
- doctor of philosophy in agrarian sciences
Garib Gara Mammadov
- doctor of philosophy in agrarian sciences
Sevil Gulash Abbasguliyeva

Dissertation council **FD 2.18** of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at Azerbaijan State Agrarian University

Chairman of the Dissertation council: doctor of agrarian sciences, professor
_____ **Zakir Abbas Ibarahimov**

Scientific secretary of the Dissertation council: doctor of philosopy in agrarian sciences, associate professor
_____ **Mahsati Mikayil Alakbarova**

Chairman of the scientific seminar: doctor in biological sciences, correspondent member of ANAS, professor
_____ **Vagif Seyfaddin Novruzov**

GENERAL DESCRIPTION OF THE RESEARCH

Relevance and degree of completion of the topic. The main purpose of agriculture is to ensure fertile soil and the area cleaned from weeds. The main purpose of modern agriculture today is to develop environmentally friendly, soil-protective and energy-saving agricultural technologies. These technologies are used to improve soil fertility and to fight weeds.

It is known that the more fertile the soil, the more common weeds are found in that area. In the absence of a proper agro-technical control system in the field, the spread of weeds increases and the phytosanitary situation worsens. In areas where weeds spread, productivity decreases by 15-20%, product quality declines and production costs increase by about 30%. Consequently, weeds cause serious damage to sown areas and complex agrotechnical measures against them can provide clean fields.

Complex agrotechnical measures against weeds include mechanical, biological, chemical and physical methods of struggling. Contrary to the aforementioned, many farmers prefer herbicides today. Unfortunately, many farmers use chemicals against diseases and pests of crops and believe that herbicides are irreplaceable in the fight against weeds. Chemical control of weeds is the most commonly used method. Because chemical measures are highly effective, they give fast results and are economically more efficient if used properly. However, the weeds are not completely destroyed after spraying herbicides and new weeds appear before the end of the vegetation period. In this case, it becomes necessary to use herbicides against weeds throughout the season systematically. Thus, the herbicide application is not a complete method for struggling weeds, besides the use of herbicides creates agroecological problems in the environment. It means new problems arise before the existing problem is fully solved. Thus, the application of chemical methods (herbicides) is contrary to the requirements of modern agriculture.

In addition to the effectiveness of herbicides in the struggle against weeds, they have also many environmental hazards. Penetrating water basins and soil with rainfall and surface water

herbicides contaminate groundwater. Sometimes depending on soil and climatic conditions, herbicides are decomposed late, thereby creating toxic substances and worsening the activity of living organisms in the soil. Herbicides are subjected to biochemical transformations in plant tissues, penetrate to the product, degrade its quality and even after processing, herbicide residues are found in the product.

The combination with other weed control methods leads to reduced herbicide load, increased productivity and the elimination of the mentioned environmental risks. This is considered to be an integrated struggle. This plant protection system decreases the use of chemicals to a minimum, protects the environment and produces environmentally friendly products.

Maize is one of the plants particularly sensitive to the negative effects of weeds. Taking into account the urgency of the issue, we carried out this research. Combined biological, physical and chemical methods have been applied and an integrated weed control system has been developed by reducing the herbicide use.

The purpose and tasks of the research. The main purpose of the research is developing the integrated weed control system for maize fields.

According to the purpose of the research, the following tasks are proposed:

- determination of the species compositions of weeds occurring in maize fields, the study of their biomorphological properties and classification;
- Integrated application of mechanical, biological, physical and chemical methods of weed control and reducing herbicide use, based on the rotation of maize with annual grain legumes;
- improving soil fertility, environmental protection and achieving environmentally safe production within the framework of the integrated weed control measures.

Research methods. The research was focused on the development of an integrated weed control system. The main objects for the study were maize and soybean plants. The research was carried out based on of the efficient rotation of maize with annual

grain legumes, especially with soybean. The soybean variety “May” and maize variety “ADAU-80” were used for the study. Weeds occurring in the maize field and their spread dynamics, species composition, and biomorphological properties were studied and they were classified; an integrated plant protection system against weeds was developed; the effect of the integrated protection system on the weeding degree was studied; the impact of soil cultivation systems on soil fertility indices in various variants within the framework of the integrated measures was studied; the effect of the integrated control system on maize productivity was determined and economic efficiency was evaluated. Each mentioned in the program task was solved using the respective methods. The quantitative methods of the purity degree of the field after the weeding proposed by A.M. Shpanev, P.V. Lekomtsev, I.P.Vasilyev, A.M. Tulikov, A.G.Tomas were used; the number of weed seeds was determined using the methods by V.G. Vityazev, G.F.Lebedev, B.A.Dospekhov; the agrochemical properties of the soil were studied comparatively; soil hydrophysical properties were determined according to N.A. Kachi-niskiy and V.S. Zaytsev; the root mass of crops cultivated using crop rotation was determined and calculated based on the coefficient of conversion into biological humus (according to Popov-Zhukova); plant productivity was determined in different variants and statistical processing of results was performed according to Dospekova.

Main points presented to the defense of the dissertation:

- species composition and dynamics of the distribution of weeds occurring in the maize field,
- application of 2 effective, integrated protection systems combining mechanical, biological, physical and chemical methods against weeds of the maize field,
- the effect of the integrated protection methods on the degree of the maize field weeding,
-in the framework of the integrated protection measures, the effect of the cultivation systems on the soil fertility indices,
-the effect of the integrated protection system on the productivity of maize and economic efficiency.

Scientific novelty of the research. For the first time in the Ganja-Gazakh region, an integrated weed control system was developed for the maize field. In the maize field where crop rotation and continuous planting are applied, protection measures against weeds have been studied comparatively and new results have been obtained. Cultivation of maize by rotation with annual grain legumes, especially, maize-soybean rotation, sprinkling green manure from the mixture of barley and oat as an intermediate plant and developing an efficient soil cultivation system in rotation planting within the framework of the integrated weed control system are distinguished by the scientific novelty and are the requirement of modern agriculture.

Theoretical and practical significance of the research. An effective integrated method of soil cultivation, which incorporates physical and mechanical measures against weeds, was applied in the research, as a biological measure, grain legumes displacing weeds and forming sufficient biomass were included in crop rotation, as intermediate plants and green manure barley-oat rotation was applied and a slight amount of herbicides was used as a chemical measure against weeds. As a result, due to integrated measures in the maize field, the phytosanitary condition of the field was improved, the use of herbicides was reduced, pollution of the environment (soil, water, plants, etc.) was prevented and an effective weed control system was developed.

Approbation and application of the work. The results of the research were reported and discussed at conferences, seminars, held at the Agronomy Faculty of the Azerbaijan State Agrarian University in the annual report form for 2014-2016, as well as at local and international conferences and seminars. Thus, the dissertation was reported in the conference held at the Azerbaijan State Agrarian University on “Agrarian reforms, realities and challenges of modernity”, “Development of the agrarian field and its ecological aspects”, “National scientific and practical conference” dedicated to the 90th anniversary of national leader Heydar Aliyev and in the conference "Modern agrarian science: actual problems and development during globalization" and received high reviews.

Successful results of the research were tested in the selected farm in the Zazaly village of the Samukh district. Based on the results of the research, two effective integrated systems of weed control - herbicide-free and herbicidal technologies were used in maize farming, and the results were close to those obtained in high agrophone.

Name of the organization where the dissertation was performed: The dissertation work was performed in the educational-practical farm of the Azerbaijan State Agrarian Univesity in 2014-2016.

Total volume of the dissertation in characters with an indication of the separate volumes of the structural units.

The dissertation consists of an introduction, five chapters, results, a list of 146 references and appendices. There are 21 figures, 25 tables, and 10 appendices. The title and the contents consist of 3 pages with 4,672 characters, the first chapter - 24 pages with 47,638 characters, the second chapter – 39 pages with 71,832 characters, the third chapter-20 pages with 37,330 characters, the fourth chapter – 7 pages with 13,910 characters, the fifth chapter-6 pages with 10,928 characters, results-2 pages with 4,384 characters, recommendations for the producers-2 pages with 2,350 characters and a list of 146 references- 16 pages with 25,504 characters. The total volume of the dissertation consists of 157 pages of computer typing.

The total text of the dissertation (excluding figures, graphs, appendices, and the reference list) is 108 pages of computer typing or 20,1554 characters.

CONTENT OF THE WORK

Introduction covers the relevance of the topic and the general description of the dissertation.

The first chapter includes a summary of the literature on the topic. Issues such as the current state of integrated weed control measures, successful results of integrated weed control performed in maize fields in our country and around the world, mechanical, biological, chemical and physical methods of weed control, the

degree of the effect of the weeding methods, soil fertility, plant productivity, and agro-economic efficiency, etc. have been commented in this chapter.

The second chapter - "Soil and climatic conditions of the experimental territory, materials, programs, and methods of the experiment". The experiment was conducted on the irrigated land in the Ganja-Gazakh region at the Research and Experimental Farm of the Azerbaijan State Agrarian University (ASAU) located near the Goygol region in 2014-2016. The soil types of the Ganja-Gazakh region are mainly gray-chestnut, chestnut (gray-brown), brown and meadow. In plains, the amount of humus in the plow layer varies within 3.0-4.5%. The amount of physical clay (0.01 mm) in the territory is 56.5-65.2%. The total amount of nitrogen in the plow layer is 0.29-0.32% and the total phosphorus is 0.14-0.17%. The total potassium content in the soil varies within 2.41-3.15%. The gray-brown (chestnut) soils spread in the area have a small, granular-dusty structure with a humus content of 2.4-3.2%. The absorption capacity of the soil is 30-32 mg equiv. in the soil solution (pH 7.8-8.2), particles smaller than 0.01 mm are 50-53%, and particles smaller than 0.001 mm are 18-23%. The climate of the Ganja-Gazakh region is characterized by mild semi-desert and dry plain climate with dry winters. In foothill territories, the active temperature is 37°C, and in plains, it is 44°C. The average July temperature ranges from 23 to 20°C from the west to the east. In the western part of the Ganja-Gazakh region, the average January temperature drops to -1.0 ° C and rises to 1.5 °C in the east.

The third chapter. "The effect of the various integrated control measures on the weeding degree of the maize field ". The research, performed in the Ganja-Gazakh region, especially in the maize field located at the Research and Experimental Farm of the Azerbaijan State Agrarian University, in the territory of the Gulustan settlement of the Ganja city, revealed the most spread early spring weeds: twining buckwheat (45.7%), desert mustard (32.8%), wild radish (12.9%); from young spring weeds galium (42.0%), green setaria (17.2%), white pigweed (16.9 %), atriplex (15.6%); from perennial weeds plantain (17.5%), field bindweed 14.3%, pink thistle

(13.6%), common dandelion 8.1%. From autumn weeds only shortpod mustard and from winter seeds chamomile were observed in our experimental field. These weeds were very few.

After establishing the degree of weed spread in the sowing fields, the results were assessed in terms of the economic threshold. The assessment of the weed spread degree in terms of the economic threshold meets the requirements of the integrated weed control measures and determines the beginning time of the weed control.

There are several norms on the economic threshold for weeds spread in the fields. According to some authors, if more than 5-15 or 10-40 monocotyledonous and dicotyledonous annual weeds (per $1m^2$ of the field) and more than 1-5 or 2-3 monocotyledonous and dicotyledonous perennial weeds (per $1m^2$ of the field) spread, it is considered to be the economic threshold for the field.

According to the integrated plant protection requirements, the measures against weeds were taken after the weed spread exceeded the economic threshold.

First, agrotechnical, physical and biological protection methods were applied and then considering the economic threshold, herbicides were sprayed against the weeds in the appropriate experimental variants.

The assessments of the weed spread in the maize field were performed before (29.04.2016) and after (30.04.2016) the fist inter-row cultivation, before (21.05.2016) and after (22.05.2016) the second inter-row cultivation and before (14.06.2016) and after(15.06.2016) the last inter-row cultivation. Before the first inter-row cultivation, the number of weeds (5-15 weeds/m^2) in a $1m^2$ field area exceeded the economic threshold, thereby making the integrated protection measures necessary. Thus, the number of weeds in the maize field in the 1st, 2nd, 3rd, 4th and 5th control variants, before the first inter-row cultivation (29.04.2016) was 56.8weeds/m^2, 73.6 weeds/m^2, 52.6weeds/m^2, 58.8weeds/m^2, and 66.9weeds/m^2, respectively, whereas after the firs inter-row cultivation (30.04.2016) the respective numbers decreased to 3.2weeds/m^2, 5.1weeds/m^2, 3.6 weeds/m^2, 3.8 weeds/m^2, and 4 weeds/m^2. As a result, in the 1st, 2nd, 3rd, 4th, and 5th control variants the number of weeds

decreased by 94.4 %, 93.1%, 93.2 %, 93.5 %, and 94.0 %, respectively. Similar results were obtained for the other periods. Thus, the number of weeds in the maize field in the 1st, 2nd, 3rd, 4th, and 5th control variants, before the second inter-row cultivation (21.05.2016) was 52.2 weeds/m^2, 66.2 weeds /m^2, 47.6 weeds /m^2, 54.1 weeds /m^2, and 61.6 weeds /m^2, respectively, whereas after the second inter-row cultivation (22.05.2016) the respective number decreased to 2.2 weeds /m^2, 3.4 weeds /m^2, 2.5 weeds /m^2, 2.8 weeds /m^2, and 2.9 weeds /m^2. Before the last inter-row cultivation (14.06.2016) the number of weeds was found to be 46.5 weeds /m^2, 58.9 weeds /m^2, 41.3 weeds /m^2, 54.2 weeds /m^2 and 60.1 weeds /m^2, whereas after the last inter-row cultivation (15.06.2016) the respective number decreased to 1.2 weeds /m^2, 2.3 weeds /m^2, 1.4 weeds /m^2, 1.7 weeds /m^2 and 1.9 weeds /m^2 (Figure).

Based on the methodology, the weeding degree in the maize field was estimated on a 5-point scale for each of the variants. Thus, before the last cultivation the 1st and 3rd variants were rated 3 points (moderate), and the 2nd, 4th and 5th variants - 4 (strong) points. After the last cultivation, the number of weeds ranged from 1 to 5 per 1m2 field area, therefore, the weeding degree was rated 1 point (very poor). The data obtained show that in all experimental variants, the number of weeds per 1m^2 field area was below the economic threshold (5-15 weeds / m^2). According to the figure, maize-soybean rotation, application of soil cultivation methods, physico-biological protection measures, partial use of herbicides led to the decreased weed spread.

After the harvesting maize production on September 15, 2016, the number of weed seeds at the 0-10 cm depth of the 1m^2 field area was 16 seeds/ m^2, 30.7 seeds/ m^2, 20.4 seeds/ m^2, 27.2 seeds/ m^2, and 27.7 seeds/ m^2 for the 1st, 2nd, 3rd, 4th and 5th (control) variants, respectively. Thus, the least reserve of weed seeds was observed for the 1st (16 seeds/m^2) and 3rd (20.4 seeds/m^2) variants.

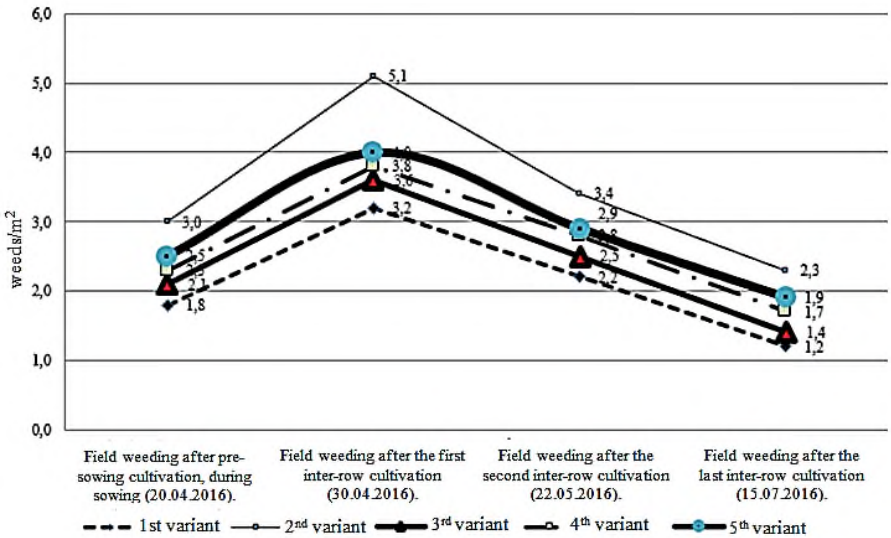

Figure. Dynamics of the weed spread in the maize field

The fourth chapter. The effect of various variants of soil cultivation, performed in the framework of the integrated protection measures against weeds in the maize field, on some soil fertility indices has been studied.

The efficiency of the integrated protection measures is assessed not only by the weeding degree but also by the improvement of soil fertility. Hydrophysical properties of soil play a major role in the formation of fertility. A strong correlation was observed between hydrophysical properties of soil and plant productivity. Therefore, we studied the effect of various variants of soil cultivation, performed in the framework of the integrated protection measures against weeds in the maize field, on the hydrophysical properties of soil. After the main soil cultivation processes, on 30 November 2015, hydrophysical properties of soil were studied for all variants and the obtained results are presented in Table 1. Bulk density, total porosity, moisture capacity at the 0-30 cm depth of soil were found to be, respectively, 1.20 g/cm^3, 55.5%, 14.5% in the 1st; 1.21 g/cm^3, 55.3%, 14.6% in the 2nd, 1.24 g/cm^3, 54.9%, 15.0% in the 3rd; 1.25

g/cm^3, 54.8%, 15.1% in the 4th and1.22 g/sm^3, 55.0%, 14.6% in the 5th (control) variants. Further determinations were carried out before sowing. In the 1st, 2nd and 5th variants, pre-sowing cultivation was conducted. In the 3rd and 4th variants, green manure was applied at the 32cm depth and pre-sowing cultivation was performed.

Before maize sowing, on 10 April 2016 hydrophysical properties of soil were studied for all variants and results are presented in Table 2. Bulk density, total porosity, moisture capacity at the 0-30 cm depth of soil were found to be, respectively, 1.22 g/cm^3, 54.1%, 15.8% in the 1st, 1.22 g/cm^3, 54.0%, 15.9% in the 2nd, 1.20 g/cm3, 55.0%, 15.3% in the 3rd, 1.26 g/cm^3, 53.5%, 15.0% in the 4th, and 1.23 g/cm^3, 53.8%, 15.6% in the 5th (control) variants. The last determination was performed before harvesting maize. On 4 September 2016, before harvesting maize, hydrophysical properties of soil were determined for all variants. The obtained results are presented in Table 1. Bulk density, total porosity, moisture capacity at the 0-30 cm depth of soil were found to be, respectively, 1.27 g/cm^3, 53.4%, 15.3% in the 1st, 1.27 g/cm^3, 53.3%, 15.2% in the 2nd, 1.19 g/cm^3, 56.3%, 13.5% in the 3rd, 1.29 g/cm^3, 52.7%, 16.0% in the 4th and 1.29 g/sm^3, 52.6%, 15.0% in the 5th variants (Table).

Better results for hydrophysical properties which are the index of soil fertility was obtained in the field after maize-soybean rotation compared with continuous maize cultivation. The best results for hydrophysical properties of soil were obtained in the maize field after rotation with soybean in the 3rd variant.

In this variant, such hydrophysical properties of soil lead to the development of above-ground parts of the plant and enhancement of productivity. The dry root mass of maize was determined at the end of the vegetation period (at the 0-30 cm depth). The root mass of the maize plant was found to be 52.1 cwt/ha in the 1st, 50.4 cwt /ha in the 2nd, 58.1 cwt /ha in the 3rd, 42.5 cwt /ha in the 4th, and 46.8 cwt /ha in the 5th variants. The most root mass for maize was obtained in the 3rd variant, i.e. performing barley-oat sowing as a green manure application after soybean, plowing green manure at the 32cm depth in the early spring and conducting pre-sowing cultivation.

Table. Dynamics of hydrophysical properties depending on soil cultivation performed within the framework of the integrated protection measures taken against weeds in the maize field

Variants	Description of Variants		Hydrophysical properties of the soil after harvesting the predecessor plant and major land cultivation (30 November 2015)				Hydrophysical properties of the soil before sowing maize (10 April 2016)			Hydrophysical properties of the soil before harvesting maize (4 September 2016)		
			Soil layer, cm	Bulk density of soil, gr/cm^3	Total porosity of soil, %	Moisture capacity of soil, %	Bulk density of soil, gr/cm^3	Total porosity of soil, %	Torpağın nəmlik tutumu, %	Bulk density of soil, gr/cm^3	Total porosity of soil, %	Moisture capacity of soil, %
1	Plowing soybean stubble at the 32 cm depth, cultivation of the field as black fallow till spring	Applying herbicides and sowing maize after pre-sowing cultivation and along with sowing	0-10	1.12	58.30	12.00	1.14	57.80	13.40	1.21	55.60	12.60
			10-20	1.22	54.70	14.30	1.25	53.20	15.60	1.26	53.50	15.30
			20-30	1.25	53.40	17.20	1.27	51.40	18.30	1.34	51.10	18.10
			0-30	1.20	55.5	14.5	1.22	54.1	15.8	1.27	53.4	15.3
2	Plowing soybean stubble at the 32 cm depth, cultivation of the field as black fallow till spring	Pre-sowing cultivation and maize sowing	0-10	1.13	58.20	12.10	1.13	57.70	13.50	1.21	55.50	12.50
			10-20	1.23	54.10	14.40	1.25	53.00	15.80	1.27	53.20	15.10
			20-30	1.26	53.50	17.30	1.28	51.30	18.50	1.34	51.20	18.10
			0-30	1.21	55.3	14.6	1.22	54.0	15.9	1.27	53.3	15.2
3	Covering soybean stubble with soil and crumbling green manure consisting of barley-oat mixture	Plowing green manure at the 32cm depth in the early spring, conduction pre-sowing cultivation and maize sowing	0-10	1.12	58.50	11.90	1.11	58.70	12.40	1.20	55.80	12.80
			10-20	1.25	53.90	15.10	1.23	53.90	15.30	1.24	53.80	15.40
			20-30	1.36	52.40	18.10	1.25	52.40	18.20	1.32	51.30	18.30
			0-30	1.24	54.9	15.0	1.20	55.0	15.3	1.25	53.6	15.5
4	Covering soybean stubble with soil and crumbling green manure consisting of barley-oat mixture d	Covering green manure, keeping stubble as a cover and maize sowing (applying herbicides before sowing and during sowing)	0-10	1.13	58.60	12.00	1.12	58.40	12.20	1.19	56.30	13.50
			10-20	1.25	53.80	15.20	1.28	52.10	15.10	1.28	53.10	15.70
			20-30	1.37	52.10	18.20	1.37	50.00	17.80	1.39	48.70	18.80
			0-30	1.25	54.8	15.1	1.26	53.5	15.0	1.29	52.7	16.0
5 (control)	Plowing maize stubble at the 32 cm depth, cultivation of the field as black fallow till spring	Applying herbicides and sowing maize after pre-sowing cultivation and along with sowing	0-10	1.15	58.00	12.30	1.14	57.50	13.20	1.22	55.10	12.30
			10-20	1.23	53.90	14.30	1.26	52.90	15.40	1.29	52.80	15.00
			20-30	1.28	53.10	17.20	1.28	51.10	18.30	1.35	49.80	17.80
			0-30	1.22	55.0	14.6	1.23	53.8	15.6	1.29	52.6	15.0

Average amounts of total nitrogen, active phosphorus, exchangeable potassium, and humus were comparatively determined

before harvesting maize (04.09.2016) at the 0-45 cm depth of soil in the optimum variant (the 3rd variant) of the integrated protection measures against weeds in rotation and monoculture variants (the 5th, control variant).

In the optimum variant (the 3rd variant) of the integrated protection measures against weeds during crop rotation, the average amounts of total nitrogen, active phosphorus, exchangeable potassium, and humus were found to be 0.09%, 16.5 mg/kg, 502 mg/kg, 2.7 % at the 0-45 cm depth of soil, respectively. However, these values were slightly lower in the 5th (control) variant, when continuous cultivation of maize was performed and traditional weed control measures were applied. Thus, the amounts of total nitrogen, active phosphorus, exchangeable potassium, and humus were, respectively, 0.05%, 7.8 mg/kg, 202.8 mg/kg and 1.2 % at the 0-45 cm depth of soil in the control variant (monoculture) before maize harvesting.

The fifth chapter. The effect of integrated weed control measures on plant productivity and economic efficiency has been studied. In the first year of the experiment, maize plants were cultivated using crop rotation as well as monoculture, in the initial (integrated measures) and control variants to create the same agricultural background and study specialized weeds spread in this field. Because in the first year of the experiment, the initial (integrated measures) and control variants of maize plants were cultivated in the same agricultural background, the comparison of economic efficiencies of these variants was performed since the 2nd year.

The highest productivity was detected in the 3rd variant. Thus, the grain yield of maize was found to be 90.1 cwt/ha in the 1st, 85.6 cwt//ha in the 2nd, 93.4 cwt/ha in the 3rd, 76.3 cwt/ha in the 4th and 74.6 cwt/ha in the 5th (control) variants, respectively (Table 2).

The results showed that the productivity index in the 3rd variant was higher compared with other variants. Thus, productivity in the 3rd variant was 93.4 cwt/ha, whereas, in the 1st, 2nd, 4th and 5th variants productivity was less by 3.3 cwt/ha, 7.8 cwt/ha, 17.1 cwt/ha and 18.8 cwt/ha, respectively. Based on the results, the 3rd

variant is considered to be most optimal. The weed number decreased significantly, soil fertility is improved and maize productivity was high. In this variant, weed control was performed without applying herbicides, the environment was protected and eco-friendly products were produced.

The 1st variant is ranked second on economic efficiency, high productivity and less application of herbicides among the studied variants due to the integrated weed control measures. Generally, the highest economic efficiency was observed in the 3rd variant.

In the 1st variant, soybean stubble was plowed at the 32 cm depth, the field was cultivated as black fallow till spring, then in the spring, pre-sowing cultivation was conducted, after the cultivation, inter-row herbicide application was performed during sowing maize and soil cultivation in the vegetation period. Net profit and profitability during a two-year rotation were 6,552.7 manats/ha and 337.9 %; In the 2nd variant, soybean stubble was plowed at the 32 cm depth, the field was cultivated as black fallow till spring, in the spring, pre-sowing cultivation was conducted, maize was sown and soil was cultivated during the vegetation period (non-herbicide technology). In this variant, net profit and profitability were, respectively, 6,426.7 manats/ha and 333.1 %; In the 3rd variant, soybean stubble was covered with soil and green manure consisting of barley-oat mixture was applied, in the early spring, green manure was plowed at the 32 cm depth, pre-sowing cultivation was conducted, maize was sown and soil was cultivated during the vegetation period (non-herbicide technology). In this variant, net profit and profitability were, respectively, 6,650.6 manats/ha and 342.9 %; In the 4th variant, soybean stubble was covered with soil and green manure consisting of barley-oat mixture was applied, green manure was covered with soil in the early spring, stubble was kept as a cover and maize was sown. Before and during maize sowing and soil cultivation in the vegetation period, inter-row spraying of herbicides was performed. In this variant, net profit and profitability were, respectively, 6,042.0 manats/ha and 297.0 %; In the 5th (control) variant, stubble of soybean cultivated in monoculture was plowed at the 32 cm depth, the field was cultivated

as black fallow till the spring, pre-sowing cultivation was conducted in the spring and soybean was sown, after cultivation, during soybean sowing and soil cultivation in the vegetation period, inter-row spraying of herbicides was performed. In the control variant, net profit and profitability were, respectively, 2,528.7 manats/ha and 129.7 %.

According to the results, in the 3rd variant (non-herbicide technology), after covering soybean stubble with soil and applying green manure consisting of barley-oat mixture (weed control measures), plowing green manure at the 32 cm depth in the early spring, pre-sowing soil cultivation, sowing maize and at the expense of appropriate soil cultivation in the vegetation period, non-herbicide measures for weed control were successful, environment was protected, eco-friendly product was produced.

In terms of economic efficiency and high productivity, the 1st variant was ranked second. Fewer herbicides were used in this variant due to integrated protection. In this variant, after plowing soybean stubble at the 32 cm depth, cultivation of the field till the spring as black fallow, pre-sowing cultivation in the spring, and cultivation during soybean sowing and in the vegetation period, inter-row herbicide spraying, the number of weeds declined significantly, herbicide use decreased to a minimum and higher productivity was observed compared with other variants (2nd, 4th and 5th).

Results

1. Weeds occurring in the maize field, their species composition were determined, biomorphological properties were studied and they were classified in groups. The research, performed in the Ganja-Gazakh region, revealed the most spread early spring weeds: twining buckwheat (45.7%), desert mustard (32.8%), wild radish (12.9%); from young spring weeds galium (42.0%), green setaria (17.2%), white pigweed (16.9 %), atriplex (15.6%); from perennial weeds plantain (17.5%), field bindweed 14.3%, pink thistle (13.6%), common dandelion 8.1%. From autumn weeds only

shortpod mustard and from winter seeds chamomile were observed in our experimental field. These weeds were very few.

2. Combined mechanical, biological, physical and chemical methods against weeds were applied, integrated protection system, decreasing herbicide use, was developed and phytosanitary condition of the field was improved.

3. Maize-soybean rotation, application of the soil cultivation method, taking physicochemical measures, and partial using herbicides, resulted in a decreasing tendency in weed spread degree. Compared with the field where monoculture cultivation was done and traditional measures against weeds were taken, in the field where crop rotation was applied after the last inter-row cultivation (15.07.2016), the number of weeds decreased almost in all variants (except the 2nd). Thus, when applying crop rotation, after the last inter-row cultivation (15.07.2016) the least number of weeds was found in the first variant-1.2 weeds/m^2, followed by the 3rd variant (non-herbicide technology)-1.4 weeds/m^2. Thus, a little difference can be seen between these variants.

4. The taken integrated protection measures decreased weed spread along with increasing soil fertility. The best fertility of the soil was observed in the 3rd variant where soybean-maize rotation was applied. Compared with other variants, hydrophysical and agrochemical properties of the soil improved, roots and above-ground parts of maize were developed strongly and productivity increased.

5. The highest productivity was detected in the 3rd variant. Thus, productivity in the 3rd variant was 93.4 cwt/ha, whereas, in the 1st, 2nd, 4th and 5th variants productivity was less by 3.3 cwt/ha, 7.8 cwt/ha, 17.1 cwt/ha and 18.8 cwt/ha, respectively.

6. Based on the results, the 3rd variant is considered to be most optimal. The weed number decreased significantly, soil fertility improved and maize productivity was high. In the 3rd variant (non-herbicide technology), after covering soybean stubble with soil and applying green manure consisting of barley-oat mixture, plowing green manure at the 32 cm depth in the early spring, pre-sowing cultivation, sowing maize and at the expense of appropriate

cultivation in the vegetation period, non-herbicide measures for weed control were successful, environment was protected, eco-friendly products were produced.

7. In terms of economic efficiency and high productivity, the 1st variant was ranked second. Fewer herbicides were used in this variant due to integrated protection. In this variant after plowing soybean stubble at the 32 cm depth, cultivation of the field till the spring as black fallow, pre-sowing soil cultivation in the spring, cultivation during soybean sowing and in the vegetation period, inter-row herbicide spraying, the number of weeds decreased significantly, the use of herbicides was minimized to a 0.75 l / ha dose or 1 spray and higher productivity was observed compared with other variants (2nd, 4th and 5th).

8. Compared with the field where monoculture cultivation was conducted and traditional measures against weeds were taken, in the field where crop rotation was applied and integrated protection measures against weeds were taken, net profit and rentability level were higher in all variants. Thus, net profit and profitability were higher, respectively, by 4,024.0 AZN/ha and 208.3 % in the 1st, 3,898.1 AZN/ha and 203.4 % in the 2nd, 4,122.0 AZN/ha and 213.2 % in the 3rd, and 3,513.4 AZN/ha and 167.4 % in the 4th variants.

Recommendations for producers

Based on the results of the research, the following integrated protection measures were recommended to the farmers cultivating maize.

1. Using grain legumes forming quite big biomass, especially soybean, in crop rotation within the framework of the integrated protection measures against weeds, covering soybean stubble with soil and applying green manure consisting of barley-oat mixture (biological protection measure), plowing green manure at the 32 cm depth in the early spring, pre-sowing soil cultivation, sowing maize and at the expense of appropriate cultivation in the vegetation period, non-herbicide measures for weed control, which were successful

leading to protected environment, producing eco-friendly products are recommended.

2. Planting grain legumes, especially soybean in rotation, plowing soybean stubble at the 32 cm depth, cultivation of the field till spring as black fallow, pre-sowing soil cultivation in spring, herbicide application after the cultivation, during maize sowing - 1.6 l of / ha of Dual Gold (960 g / l of metolachlor) 0.8 l / ha in every spray-is recommended against annual monocotyledonous and dicotyledonous weeds. During cultivation in the vegetation period, in the 3-8-leaf phase of maize, inter-row herbicide spraying against annual and perennial monocotyledonous and dicotyledonous weeds is recommended - 0.75 l/ha of Milagro Extra (containing 60 g/l nicosulfuron) in every spray.

The main points of the dissertation are presented in the following articles:

1. Guliyev S.R. The integrated system of corn production // Azerbaijan State Agrarian University “Modern agricultural science: current problems and prospects of the century in conditions of globalization”, - Ganja: ASAU, -2014, Vol I, -pp.140-141.

2. Guliyev S.R., Alakbarov F.Sh. The role of integrated protection measures in decreasing the herbicide application // Azerbaijan Agrarian Science, - 2017. No4, - pp.84-85 (in Azerbaijani).

3. Guliyev S.R. The effect of main soil cultivation in the maize field on hydrophysical properties of the soil // Azerbaijan Agrarian Science, - 2018. No3, pp.179-181 (in Azerbaijani).

4. Alekperov F.Sh., Guliyev S.R. The dynamics of the distribution of weeds in maize fields grown in crop rotation and monoculture// Economic and social analysis journal of Southern Caucasus, - 2018. No5, - pp.10-12 (in Russian).

5. Guliyev S.R. The most common weeds in maize cultivated fields of the Ganja-Gazakh region // - Ganja: Azerbaijan National Academy of Sciences ”Proceedings”, - 2018, No 2 (72), pp.24-27 (in Azerbaijani).

6. Jafarov I.H., Alakbarov F.Sh., Guliyev S.R. The effect of the integrated protection measures against weeds on maize productivity

// ASAU-nun Scientific works, Ganja:- 2019, No2, pp.4-7 (in Azerbaijani).

7. Guliyev S.R. Agro-economic efficiency of the integrated protection measures taken against weeds in maize fields // Materials of the scientific conference of the Ganja State University on "Current problems of the modern nature and economic sciences" - Ganja: GSU, - 2019. V 2, - pp. 171-174 (in Azerbaijani).

8. Guliyev S.R. Weeding degree of the maize field and resource of weed seeds in the soil depending on the integrated protection measures //- Ganja: Azerbaijan National Academy of Sciences "Proceedings", 2019. No (76), - pp.144-149 (in Azerbaijani).

9. Guliyev S.R. Agroecological advantages of non-herbicide (biological) weed control measures in maize sowings // 8th International conference Science and society – Methods and problems of practical application, Vancouver, Canada, 15th August, - 2019, - pp.92-98.

10. Guliyev S.R. The influence of integrated control measures on the dynamics of weed distribution in maize sowings // Agrarian science, Belgorod, -2019, No7-8, -pp.50-53 (in Russian).

The defense of the dissertation will be held on ***17 marth*** 2021 at ***11^{00}*** at the meeting of the Dissertation council FD.2.18 of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at Azerbaijan State Agrarian University.

Addres: Az2000, Azerbaijan Republic, Ganja city, 450, Ataturk avenue.

Dissertation is accessible at the Azerbaijan State Agrarian University library

Electronic versions of the dissertation and its abstract are available on the official website of the Azerbaijan State Agrarian University

Abstract was sent to the required addresses on ***16 february*** 2021.

Signed for print: 12.02.2021
Paper format: (210x297) 1\4
Volume: 39474
Number of hard copies 30