Review paper

Cultivation of cereal crops on a certified field for organic farming at the Institute of Agriculture in Karnobat, Bulgaria

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Abstract

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The research on organic growing of grain cereals at the Institute of Agriculture in Karnobat began since 1999 and a certified field for organic farming was established in 2007. During these years, scientific research has been carried out to optimize the technology for the cultivation of basic cereals – oats, barley, rye, triticale and wheat. The article presents the results of phytosanitary monitoring studies in these crops. It indicates the impact of the various predecessors, sowing times and cultivation norms on crop yield and crop phytosanitary status.

Keywords: organic farming; grain cereals; agro-technology; phytosanitary monitoring

INTRODUCTION

Organic farming comes as a sensible approach towards soil and plants, which achieves stable yield with lower expense, with no use of fertilizers, pesticides and genetically modified crops. In its essence a farm organizes as a natural ecosystem where each organism has its own destiny and lives in harmony with the others (Fukuoka, 2009).

Cereals are major field crops which provide ingredients for children's and dietary foods and there is consistent demand on both Bulgarian and foreign markets. Organic produce includes bread, breakfast cereals, biscuits, infant foods and a number of other products. Organically grown cereal crops make up 40% of the market of organic products in the world, and the greatest part of them is used in the bakery industry. Organic wheat is mainly used for flour (Bozhanova and Dechev, 2009). In Bulgaria, in recent years organically grown field crops (cereals, green feeds and technological crops) make up from 40 to 50% of the total organic plant production (Mitova, 2012).

Organic farming studies are carried out in many agricultural institutes in Bulgaria – Institute for Plant and Genetic Resources - Sadovo, Institute for Field Crops - Chirpan (Bozhanova and Dechev, 2009; Stamatov et al., 2017), Institute of Forage Crops - Pleven (Nikolova and Georgieva, 2015a, 2015b), Institute of Agriculture and Seed Production - Ruse (Ginchev, 2016) and others.

At the Institute of Agriculture in Karnobat, in 2004 began research work on developing technologies for organic cultivation of cereal crops. In 2007 the first field for production of organic produce was certified, and in 2010 the second field was certified. The total area of both fields is 9 ha. Preliminary research was conducted since 2004 on the productivity of individual crops without use of organic fertilizers and the degree of weed infestation with no application of plant protection chemicals (Atanasova and Koteva, 2005; Atanasova and Koteva, 2007; Atanasova, 2008).

The research was separated into four stages: I – from 2004 to 2006, II – from 2007 to 2010, III – from 2010 to 2014 and IV – from 2015 to 2018.

The first stage included several tasks, and one of the major ones was a selection of suitable farming area and its preparation for creating "a mini experimental field for organic farming", in compliance with the provisions of Regulation No 22/2001. In 2004, the first field localized for this purpose was with transitional period to 2005. It is located at 3 km from Karnobat, surrounded by artificially created forest shelterbelt, with an area of 3 ha. The soil is leached vertisols.

The agrochemical research showed that the soil in this section is characterized by humus A horizon of 45 cm, transitional AB horizon of 20-25 cm and B horizon of 40-50 cm; with weakly acidic to neutral reaction; medium content of total humus; insufficient supply of nitrogen and absorptive phosphorus; well supplied with mobile forms of potassium (Koteva and Atanasova, 2007). The annual monitoring of weed infestation established that at the end of the period *Cirsium arvence* (L.) Scop. was found of the perennial dicotyledonous weeds, in low density, in the central part of the field. Of the annual dicotyledonous the predominant ones were *Galium aparine* L., *Consolida orientalis* Schroding, *Anthemis arvensis* L. and *Myagrum perfoliatum* L. The poorly distributed weeds were *Papaver rhoeas* L., *Sinapis arvensis* L., etc. The predominant annual monocotyledonous weed was *Avena fatua* L. and it was mainly concentrated in the plot periphery bordering a road or a forest shelterbelt (Atanasova and Koteva, 2009).

It was also established that aphids were found on cereal crops grown in the conditions of organic farming – *Metapolophium dirhodum, Rhopalosiphum padi, Rhopalosiphum maidis, Schizaphis graminum* and *Sitobion avenae*, with predominant *Sitobion avenae* (Maneva et al., 2008).

An interdependency was reported between the reduction of the number of weeds and respectively the parasites on aphids. It was found that to increase the role of plurivorous predators and parasites in the cereal crops it is necessary to grow blooming nectar plants, annual and multiannual grasses as neighbors. These crops create conditions for additional nutrition and hosts where entomophages can multiply (Maneva et al., 2008; Maneva et al., 2009; Maneva et al., 2012a, 2012b, 2012c).

In collaboration with research scientists from the Institute of Field Crops in Chirpan, Dobrudzha Agricultural Institute in General Toshevo, and the Institute of Plant Genetic Resources in Sadovo, the characteristics of Bulgarian rye, oats and wheat cultivars were investigated. On the basis of their productivity, grain quality, resistance to abiotic and biotic stress and other indicators, naked and covered oats, rye, durum and common wheat, multi-row and two-row barley were selected for experiments in a system of organic production (Bozhanova et al., 2014). In 2007, the field of 3 ha has acquired the status of the organic field and received a certificate from BalkanBioCert – Plovdiv.

At the beginning of the second stage another field was selected, territorially close to the first one, with an area of 7.4 ha and also protected by a forest shelterbelt created in the 1950s. After the transitional period the 2-crop rotation, the mixture of "cereal crops-peas-sunflower" was formed. To optimize the nutrition regime of the crops, organic liquid fertilizers were tested and the application effect on productivity was established for durum and common wheat, rye, two-row and multi-row barley and oats (Koteva et al., 2013).

Studies were carried out on the effect of various sowing rates on weed infestation in the crops. For wheat, rye, triticale and barley four sowing rates were tested (optimal for each crop and increased with 25.50 and 75%. The increase of sowing rates furthers the reduction of weed infestation. For winter barley, the optimal rate can be increased with 25%, for wheat – with 50%. Thus weed infestation was almost twice reduced. For rye and triticale, weed infestation was low and was not significantly changed with an increase of the sowing rates. For naked oats the reduction of the degree of weed infestation begins with the increase of sowing rates with 50 and 75% (Atanasova et al., 2011).

Studies were also carried out on the effect of sowing rate of cereal crops on pest infestation. For barley, the highest number and greatest species diversity of aphids was observed at sowing rate of 100 + 75%, and for wheat – at optimal sowing rate (of 100%) (Maneva et al., 2012a, 2012b, 2012f, 2013).

Monitoring surveys of barley reported individual plants infected with powdery mildew *(Erysiphe graminis f. sp. hordei)*, leaf rust (*Puccinia hordei*), leaf blotch of cereals (*Rhynchosporium graminicola*), loose smut (*Ustilago nuda*) and barley leaf stripe (*Dreschlera graminea*) (Maneva et al., 2012f, 2013).

To trace the effect on biological diversity field boundaries and forest shelterbelts were monitored, accompanying the organic fields. Monitoring surveys of the field boundaries found that the species composition of the weeds differed in the years. The species *Agrostemma githago* L., *Myosotis stricta* L., *Tragopogon pratensis* L., *Vicia striata* M.B., *Myosotis stricta* L., *Apera spica-venti* L., *Eragrostis minor* L., *Hordeum murinum* L. and *Lolium temulentum* L. were reported in the three years. In spring, in the boundaries, four types of aphids were reported – *Sitobion avenae* (Fabricius, 1775)*, Schizaphis graminum* (Rondani, 1847)*, Rhopalosiphum maidis* (Fitch, 1856) and *Rhopalosiphum padi* (Linnaeus, 1758). The aphid species were found to show preference to certain weed species: *Schizaphis graminum* migrates to *Alopecurus myosuroides* L., *Bromus arvensis* L. and *Lolium temulentum* L. in June. *Sitobion avenae* was found on *Hordeum murinum* L., in June. *Rhopalosiphum maidis* was found in June on *Arrhenatherum avenaceum* P. B., whereas *Rhopalosiphum padi* was observed on *Alopecurus myosuroides* L. in May and June. The most widely distributed species in the boundaries was *Schizaphis graminum*. There were found: loose smut *Ustilago nuda* on wild barley *Hordeum murinum*, and crown rust *Puccinia coronate* on wild oat *Avena* spp. (Atanasova et al., 2012).

In the third period a stationary experiment was formed with three-crop rotation with predecessors peas-sunflower mixture, maize for silage and set-aside. Then winter wheat, winter barley, triticale, rye and oat were sown. After a three-year rotation of the crops, it was established that set-asides are a good predecessor for common wheat and spring oats as the yield is significantly higher, and weed infestation is lower in comparison with a predecessor of silage maize. Peas-sunflower mixture as predecessor is more suitable for winter barley, triticale and rye. The yield and productivity indicators were higher and the level of weed infestation was comparatively lower than after silage maize (Atanasova et al., 2013; Atanasova et al., 2014a, 2014b; Atanasova et al., 2015a).

In a three-crop rotation, barley was the crop most weakly attacked by aphids in spring. Aphids predominantly attacked oats out of the three predecessors. Rye, triticale, wheat and oats were mostly attacked after a predecessor of peas-sunflower mixture (Maneva and Atanasova, 2014).

In this period the effect of sowing period on the structure of crops, yield and quality of production and phytosanitary state of the cereal crops was studied. The cultivars of winter barley were sown on six dates and the cultivars of wheat, rye, triticale and oats – on three dates. The productivity of almost all cultivars was at a similar level, when they were sown in September and October. After that date, it began to decrease (Atanasova et al., 2015b; Atanasova and Maneva, 2016).

In the fourth period, the work focused on the project consisted of 5 tasks. The first task aimed at the characteristic of soil fertility. Experiments were set on restoring soil fertility by the use of manure, fodder plants and alfalfa wedges. The next task was use of fodder crops for sideration, followed by sowing of barley cultivars Aheloy 2 and Emon and wheat cultivar Miryana, all created at the Institute of Agriculture in Karnobat.

There have been continuous studies connected with suitable crop rotations with predecessors of chick-peas, lentils, potatoes and pumpkins; natural growth stimulation, development and productivity of cereal crops through selection of cultivars, optimal rates and sowing time.

One of the most significant objectives in the investigations was to study the effect of various technological units on the phytosanitary state of agroecosystems, which is performed by means of detailed observations on the development and distribution of diseases, pests and weeds.

The plant diversity in the certified field for organic farming is significant. The winter cereal crops, which were main subject of the trials, numbered 32 species and cultivars. The other predecessor crops were eight (Atanasova et al., 2016).

Studies continue on the phytosanitary state of the crops in the trials and in the field boundaries. The phytopathological state and pest infestation on crops, development of beneficial entomofauna and species diversity of weeds were reported. A new plant was reported to enter from buffer zones to the experimental fields – *Agrimonia eupatoria* L., agrimony. Weed vegetation in cereals and free areas varies considerably. Annual broad-leaved weeds have greater species diversity in the cereals fields, and cereals weeds have greater species diversity in the field boundaries and the forest shelterbelts. The adjacent areas do not meet the perennial broadleaf weeds – C*irsium arvense* (L.) Scop. and *Convolvulus arvensis* L.

Basic seeds from cultivar Perun were sown under the task "Study on methods and schemes for maintenance of cultivars in seed production of winter barley in organic farming and keeping the phenotype and genotype purity of barley". Elite ears from the cultivar were selected. The scheme of combined individual selection with mass one led to good results for the organic production of seeds.

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