SUMMARY

of the Ph.D. thesis:

Research regarding the use of sustainable agriculture practices for the soybean crop *(Glycine max.* L. Merril*)* grown in the conditions of Moara Domenească, Ilfov

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Soybean (*Glycine max.* (L) Merril) is without doubt one of the species of high economic value and agronomic performance, first of all due to its nutritional value, soybean being an important source of protein (40%), oils (20%), carbohydrates (28%) and minerals (5%), secondly do to its properties to fix molecular nitrogen through its symbiosis with *Bradyrhizobium japonicum* bacteria, with direct implications in the Nitrogen Cycle, thus being an important source of renewable energy.

The purpose of the paper „*Research regarding the use of sustainable agriculture practices for the soybean crop (Glycine max.* L. Merril*) grown in the conditions of Moara Domensca, Ilfov*" was to analyze the behavior and suitability of soybean varieties in the specific climatic conditions of south-eastern Romania in order to evaluate the effects of the minimum and conventional soil tillage systems and fertilization on soybean crop. The purpose of the thesis was to establish superior agricultural practices in growing soybean, to ensure sustainable yields in economic terms with a minimum consumption of resources.

The paper is structured in **9 chapters**. **Chapter I** presents the origins, status of cultivated areas and soybean yields at global and national levels. **Chapter II** presents the current state of knowledge regarding soybean cropping systems, detailing its botanical framing, biological characteristics, relation to vegetation factors, areas of favorability and cropping technology. Technology elements studied for the soybean crop in this chapter concerned aspects related to the influence of the soil tillage system (conventional system (SC) and minimum tillage (SM)), as well as the influence of mineral fertilization and seeds inoculation with nitrogen fixating bacteria *Bradyrhizobium japonicum* on soybean culture.

A very valuable plant from an economic, nutritional and agronomic point of view, soybean (*Glycine Max L.* (Merrill)) has multiple applications in human nutrition, as animal feed and in industry (Roman et al., 2011; Chetan et al., 2014) mainly due to its high protein and oil content (Subramanian and Smith, 2013), as "*one third of the world's edible oils and two-thirds of the*

protein mass are derived from soybean seeds" (Bellaloiu et al., 2011, p.2). In addition to its many uses due mainly to the nutritive value of the crop (Popescu and Roman, 2008), soybean is considered an ameliorative species (Cheţan et al., 2014), which has the ability to fix atmospheric nitrogen (Popescu and Roman, 2008) through active nodules generated by the symbiosis with *Bradyrhizobium japonicum*. The fixing and assimilation of molecular nitrogen by leguminous plants (Popescu and Roman, 2008) represents a safe source of renewable energy (Rotaru, 2009), has the capacity to successfully replace chemical nitrogen fertilizers (Kovačević et al., 2011) and improves soil fertility over time (Bohlool et al., 1992; Cass et al., 1994; Tago et al., 2011; Matsumiya et al., 2013; Ferguson, 2013).

Chapter III presents the research's objectives, methods and biological material. The main objective of the research was to identify technological measures applied in order to increase the efficiency and the yield potential of soybean crops grown in climatic and pedologic conditions specific to the South – Eastern Romania (Moara Domnesca, Ilfov).

In order to achieve these objectives, two polyfactorial experiences were set up in the Experimental Field of the Faculty of Agriculture within Moara Domnească Didactic Farm, organized in three replications: **Research 1** focused on the "*Influence of soil tillage on a assortment of soybean varieties grown in the field conditions of Moara Domnească - Ilfov* "and **Research 2** focused on the "*Influence of fertilization on a assortment of soybean varieties grown in the field conditions of Moara Domnească - Ilfov* ".

In the **first field research** the following factors where analyzed: Factor A, soil tillage system: a_1 – plowing at 20 cm (A_{20}, Control), a_2 – chisel at 20 cm (C_{20}); a_3 - chisel 40 cm (C_{40}); a_4 – disking at 10 cm (D); a_5 - disking/plowing at 20 cm (D/A_{20}); a_6 - disking/chisel at 40 cm (D/C_{40}); *Factor B*, soybean variety: b_1 - Carla, 000; b_2 - PR92B63, 0; *Factor C*, seeds inoculation: c_1 – seeds inoculated with *Bradyrhizobium japonicum*; c_2 – seeds uninoculated *Bradyrhizobium japonicum*. In the **second field research** the following factors where tested: *Factor A*, soybean varieties: a_1 - Carla; a_2 - PR92B63; *Factor B*, fertilization rates: b_1 - $N_0P_{60}K_0$ (Martor); b_2 - $N_0P_{60}K_0$+foliar fertilization (F); b_3 - $N_{45}P_{60}K_0$; b_4 -$N_{45}P_{60}K_0$+ foliar fertilization (F); b_5 - $N_{45}P_{60}K_{45}$; b_6 - $N_{90}P_{60}K_{45}$; *Factor C*, seeds inoculation: c_1 – seeds inoculated with *Bradyrhizobium japonicum*; c_2 – seeds uninoculated *Bradyrhizobium japonicum*.

Chapter IV presents the administrative framework and climatic and pedologic conditions specific to the area where the research was conducted. The experiments were placed on chromic luvisol, with a clay loam texture (40% clay content), a moderate acidity (pH 5.2 - 5.4) and a low humus content 2.1% - 2.2% (Mihalache, 2010). The research was carried out at Moara

Domnească Didactic Farm, which is part of the Belciugatele Didactic Center and belongs to USAMV Bucharest, located in Ilfov County, at approx. 17 km from Bucharest.

Climatic conditions of the area have significantly influenced the vegetative development of soybean plants, so during the two years of the research (2015-2016) the climatic conditions showed deviations from the normal values during the periods when the plants had maximum requirements for water: on emergence, blooming and in the phase of reproductive organs formation.

Chapter V presents the results of the research under the influence of soil tillage (**Research 1**) for the two agricultural years 2014/2015 - 2015/2016 when the research was carried out. In this context, in order to grow, soybean plants needed 4-5 days in addition to the **minimum tillage system** (MS) recording an average density of 295.000 pl/ha in 2015 and a density of 310.000 pl / ha in 2016.

Under the field conditions of the agricultural year 2014/2015, Carla matured 144 days after sowing, and PR92B63 variety was harvested 186 days after sowing. In 2015 for the variants inoculated with nitrogen fixing bacteria the lowest grain yield of 1961.4 kg/ha was recorded by Carla when disking was applied, and the highest yield of 2566.1 kg/ha was recorded by PR92B63 in the disking / chisel at 40 cm soil tillage. For the uninoculated variants, the lowest grain yield of 1879.6 kg/ha was recorded by Carla in the disking variant, and the highest grain yield of 2408.4 kg/ha was recorded by PR92B63 at the variant disking/plowing at 20 cm. The average grain yield increase generated by bacteria inoculation in the agricultural 2014/2015 was 116.5 kg/ha, the average yield of the inoculated varieties recorded an increase of 5.2% compared to the uninoculated ones.

In the agricultural year 2015/2016, Carla variety matured 154 days after sowing, and PR92B63 variety was harvested 195 days after sowing. On the basis of the recorded results, in the agricultural year 2015/2016, in the bacteria inoculated variants the lowest grain yield of 2205 kg/ha was recorded by Carla in the disking variant and the highest yield of 2711,9 kg/ha was recorded by PR92B63 for the disking/chisel at 40 cm variant. In the uninoculated variant, the lowest grain yield of 2082.7 kg/ha was recorded by Carla in the disking variant and the highest yield of 2577.5 kg/ha was recorded by PR92B63 for disking/plowing at 20 cm. The average growth rate generated by bacteria inoculation in the agricultural year 2015/2016 was 132.5 kg/ha, the average yield of the varieties in bacteria inoculated variants was 5.5% higher than the uninoculated variants.

On average, for the two years of research, for the inoculated variants the lowest grain yield was recorded by Carla (2083.2 kg/ha) for the disking soil tillage, while the highest yield of 2639.0

kh/ha was recorded by PR92B63 when disking / chisel at 40 cm was applied. For the uninoculated variants the lowest grain yield was of 1981.2 kg/ha, recorded by Carla when disking was applied, and the highest yield (2492.9 kg/ha) was recorded by PR92B63 when disking/chisel at 40 cm was applied. The average growth rate generated by nitrogen fixing bacteria inoculation of soybean seeds for the two years of research was 124.5 kg/ha, the average yield of the varieties in the inoculated variants was 5.4% higher than the one recorded for the uninoculated variants.

In **Chapter VI** research results of two agricultural years, 2014/2015 - 2015/2016, are presented as they were obtained under the influence of fertilization (**Research 2**). In 2014/2015 agricultural years, soybean seeds germinated and grow sprung 24 days after sowing, recording an average density of 265,000 pl/ha. According to the results recorded in 2014/2015 agricultural year for the bacteria inoculated variants, the lowest grain yield was 1455.7 kg/ha, recorded by Carla fertilized $N_0P_{60}K_0$, and the highest yield of 2466.4 kg/ha was recorded by PR92B63 fertilized $N_{90}P_{60}K_{45}$. For the uninoculated variants the lowest grain yield of 1364.4 kg/ha was recorded by Carla at $N_0P_{60}K_0$ fertilization level and the highest yield of 2388.4 kg/ha was recorded by PR92B63 when $N_{90}P_{60}K_{45}$ fertilization was applied. The average yield growth rate generated by nitrogen fixing bacteria inoculation in the agricultural year 2014/2015 was 85 kg/ha, the average yield of varieties for the inoculated variants increased by 4.6% compared to the uninoculated variants.

In 2015/2016 agricultural year, varieties needed 22 days to germinate and sprung, recording an average density of 270,000 plots/ha. For the bacteria inoculated variants, the lowest grain yield of 1550.8 kg/ha was recorded by PR92B63 for the variant fertilized with $N_0P_{60}K_0$, and the highest yield was recorded by Carla variety fertilized $N_{90}P_{60}K_{45}$ with a value of 2698.0 kg/ha. For uninoculated variants, the lowest grain yield of 1517.0 kg/ha was registered by PR92B63 for the fertilization level $N_0P_{60}K_0$ and the highest yield with a value of 2610.8 kg/ha was recorded by Carla when $N_{90}P_{60}K_{45}$ fertilization was applied. The average growth rate generated by bacteria inoculation in 2015/2016 agricultural year was 56.4 kg/ha, the average yield of the varieties in bacteria inoculated variants increasing by 2.8% compared to the uninoculated variants.

On average for the two years of research, in bacteria inoculated variants, the lowest grain yield was 1533.0 kg/ha, recorded by Carla fertilized $N_0P_{60}K_0$ and the highest yield recorded was 2551.7 kg/ha obtained by PR92B63 for the fertilized variants $N_{90}P_{60}K_{45}$. For the uninoculated variants, the lowest grain yield had a value of 1464.6 kg/ha and was recorded by Carla fertilized $N_0P_{60}K_0$ and the highest yield of 2483.4 kg/ha was recorded by PR92B63 fertilized $N_{90}P_{60}K_{45}$. The average growth generated by bacteria inoculation of soybean seeds in the two years of research was 70.7 kg/ha, and the average yield of the varieties in bacteria inoculated variants was 3.7%

higher than the yield recorded for uninoculated variants.

Chapter VII presents the results regarding the economic efficiency of soybean cultivation in the specific climatic conditions of the South-Eastern Romania. According to data recorded in **Research 1** for the bacteria inoculated variants, the average net profit registered the lowest value of 1186.0 lei for the disking variant and the highest value was 1655.7 lei for the disking / chisel at 40 cm. For the uninoculated variants the lowest value of the net profit was of 1009.8 lei recorded in the variant where disk was used for soil tillage and the highest net profit was of 1455.9 lei for the disc / chisel variant at 40 cm, bacteria inoculation generated an average net profit increase of 164.5 lei, 13.3% higher compared to the uninoculated variant. The best economic return was registered by the variety PR92B63 when disk / chisel at 40 cm was applied with a net profit of 1730.9 lei and a return of 0.5 lei profit for 1.6 lei investment.

Influenced by variety, fertilization and bacteria inoculation the lowest net profit recorded for **Research 2**, for bacteria inoculated variants, had a value of 281.4 lei for $N_0P_{60}K_0$+F fertilization and the highest net profit had a value of 1232.5 lei for $N_{90}P_{60}K_{45}$ fertilization level. For uninoculated variants, the lowest average net profit was 194.2 lei (variant $N_0P_{60}K_0$ + F) and the highest net profit had a value of 1147.0 lei (variant $N_{90}P_{60}K_{45}$). Seeds inoculation with nitrogen fixing bacteria generated an average increase of the net profit of 84.8 lei, 14.3% higher compared to the uninoculated variants. The best economic return was recorded by PR92B63 variety (fertilized $N_{90}P_{60}K_{45}$ and inoculated with nitrogen fixing bacteria) with a value of 0.3 lei profit at 1.4 lei investment, and a net profit of 1248.7 lei.

Chapter VIII presents the conclusions and recommendations based on the results recorded in the two years of research. According to the data recorded in **Research 1**, the minimum soil tillage disk/chisel at 40 cm (D / C40) is an efficient practice for the conditions of the research area. Also, irrespective of the bacteria inoculation, results revealed that growing PR92B63 variety is recommended under the influence of the tillage system, to capitalize grain yield and its qualitative parameters. Concerning **Research 2**, the mid-early variety PR92B63 was superior to the early variety Carla, both in bacteria inoculated and uninoculated variants. Thus, in the conditions of Moara Domnească it is recommended to cultivate the PR92B63 variety, applying seeds inoculation with nitrogen fixing bacteria and the use of NPK complex fertilizers.