RETROSPECTIVE STUDY ABOUT SOYBEAN (*Glycine max*) CULTIVATION IN THE ACTUAL CLIMATE CONTEXT

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Abstract. *Considering the fact that the world's population shows an upward trajectory from one year to another, the need to ensure security at the global level by supplementing the production of agricultural crops has become a primary objective. Thus, in order to ensure the intake of proteins necessary for human consumption but also to meet the needs of the large paint-producing industries as well as livestock farms, soybean culture represents the conventional option for this demand, which is why in recent years this plant has become one of the most cultivated worldwide, due to the multiple properties it possesses, such as: symbiotic fixation of atmospheric nitrogen, it is an oleaginous plant and the protein content of the seeds is very high. Therefore, due to the desire to achieve quantitatively higher yields, the amount of chemical fertilizers applied either on the soil or incorporated at the time of sowing has increased, this causes soil pollution over time, which is why the decision was made to carry out this retrospective study in order to highlight in what proportions the distribution of chemical fertilizers influences the symbiotic fixation of atmospheric nitrogen by means of nitrogen-fixing bacteria and how it is possible that by cultivating this plant we can provide the preceding crop with the necessary amount of Nitrogen without carry out an additional application of chemical fertilizers, thus ensuring a healthier and more profitable crop but also a less polluted soil.*

Keywords*: Soybean, Nitrogen, Nitrogen-fixing bacteria.*

INTRODUCTION

Due to the fact that soybean seeds have a rich content of oils and proteins, this makes it one of the most important plants for both human and animal nutrition. Soybean plants cultivated worldwide intensively through various specialized and intensive methods are believed to originate from the domestication of wild soybeans found in East Asia 6000 – 9000 years ago. (2)

In Europe, the first attestations related to soy were more quickly related to the gastronomic field, among the first writings related to soy refer to the visit of FRANCESCO CARLETTI in June 1597 to Nagasaki, Japan (2).

The soybean was first introduced to the European continent only around 1712, thanks to a German botanist named ENGLEBERT KAEMPFER who had completed his studies in Japan. Following the first scientific study on this plant in the Western part of Europe, a study carried out by CARL VON LINNE, a botanist with Swedish origins, he names it in his writings G. max or *Glycine max* due to the ability derived from common since that time, namely the symbiotic ability to synthesize Nitrogen in the nodules formed at the level of the root system (3).

It is mainly used in human nutrition due to its protein content, being included in a wide range of Asian-specific culinary preparations, being used either in the form of grains by fermenting them with carefully selected bacterial cultures, resulting in a product called Natto and which is mainly eaten by Asians for breakfast with soy sauce added. (8).

In animal nutrition we find a wide range of uses, one of the most important being to ensure the intake of proteins and vitamins by administering it in the form of fodder in different forms: granulated fodder, flour or soybean meal. Soybean meal is recommended to feed animals because it contains a high level of oil and protein. Soybean plants can be used as green fodder as

well as hay or even silage, and the remaining pods after harvesting can be used to feed animals (8).

MATERIAL AND METHODS

The main objective of this study was to better understand what goes into making a more productive, healthier and higher quality soybean crop in terms of the nutrients found in soybean seeds.

In the conducted study, the new aspects regarding the cultivation technology of soybean plants were followed, but also possible modern methods that contribute to a better planning of the applied works.

In the following we had focused on choosing the optimal density of plants per square meter, the fertilization works carried out, the care works carried out and also the choice of the most suitable soybean variety.

RESULTS AND DISCUSSIONS

In the current inflationary context that we are facing, making soybean agricultural technology as profitable as possible is an essential aspect, which is why the most efficient and rational administration and distribution of fertilizers, seeds and also crop care works can save the farmers of an additional cost. A three-year study at the Soybean Experimental Station from Southern Brazil regarding plant density per hectare demonstrated that using a lower plant density per hectare can have a higher yield than overstocking a plots with soybean plants in terms of the formation of nodules at the level of the roots, among others, the beans obtained after harvesting showed a higher oil content in the case of using a lower density, and in terms of the amount of beans obtained per hectare, out of the three years of cultivation in only one year the soybean grown with a lower density obtained a 16% lower quantity than the soybean grown at a density of 320,000 plants per hectare, which can confirm the fact that, too high plant density does not always mean higher production (15).

A similar study was also carried out at Fundulea Research Station on 13 soybean varieties with different maturity groups sown at different distances and densities. Following the study, it was concluded that the distance of 25 cm is the most optimal for the cultivation of soybeans, this distance being ideal for carrying out all the care and fertilization works necessary to maintain a clean crop of weeds, diseases and pests. The maximum number of germinating grains per square meter being 60 seeds, at a density higher than this the productivity of the crop started to decrease, an aspect that every farmer wants to avoid (13).

The biggest influence on production was the area where soybeans were grown, productivity being influenced by 55.95% (13).

Research carried out in Glesindorf, Austria during 2016 and 2017 demonstrated that the soybean plant is very adaptable from an agronomic point of view, it can be successfully cultivated in difficult development conditions, even sown at a lower density of seeds, with a distance between rows between 13 and 38 centimeters, without the need for additional application of nitrogen fertilizers. Although the experiment was divided into different rows, seed density, different level of fertilization and different cultivars, there were no major differences between them in terms of the appearance of the first pod, which was located at a height of 11.6 centimeters from ground level (1).

Soil pollution with chemical substances is a well-known phenomenon among farmers nowadays, which is why the organic farming model has started to become a frequent practice among farmers, who are looking for alternatives to supplement the soil's nutrient content, one of them being the application of organic fertilizers of animal origin, so one of the solutions can be the administration of manure from pig farms, this solution becoming an object of research for a

group of researchers from the Institute of Education, Sciences and Technologies from Rio, who analyzed the effects of administration of fertilizers made from pig urine. This experiment was carried out by applying an organic fertilizer consisting of pig urine and water to a plot with a clay soil. They noted that the application of this fertilizer can result in an increase in the content of Zinc and Copper in the soil, which in too high quantities can cause the phytotoxicity of soybean plants, the dose recommended by them being 200 Kg N/ha in the form of a mixture of pig urine and urea (4).

The application of chemical fertilizers in foliar form with the aim of obtaining a richer yield is a common practice among farmers, fact that has conducted to numerous studies been carried out on this topic. A study that sheds some light on this practice was carried out in the USA during 2019-2020 divided into 49 experimental fields spread across 6 states, and exposed to six types of foliar fertilizers. After completing the experimental period, the study was completed and the conclusion was that, the application of foliar fertilizers with NPK content did not bring a real benefit to soybean plants, the method of prophylactically administering this type of fertilizers does not present a real yield only in the case in which soybean plants show distinct signs of nutrient deficiency (16).

Considering the fact that soybean is present in the human diet processed in various food products, the oil resulting from pressing the seeds of this plant is a rich source of natural fats, fats that are found in a lower or higher content in the beans. Soybean whose content is influenced by the culture technology applied. In view of the veracity of these things, a research was carried out in Poland during 2016-2017 which proved the hypothesis that the content of fatty acids in soybeans can be influenced by the genetics of the selected varieties but also by the application of chemical fertilizers with nitrogen content, thus, they demonstrated that the application of an amount of 30 kg N/ha can represent a "starter" and the application of an amount of up to 60 kg N/ha did not have a remarkable influence regarding the increase of the oil content (6).

The study carried out by IOANNA KAKABOUKI in Greece demonstrated that the application of a dose of nitrogen fertilizers that is too high can decrease the efficiency of soybean plants, this fact being in direct agreement with the soil works that were carried out. In the no-tillage system, soil porosity was much better compared to conventional tillage systems, which leads us to the idea that soybean plants may react differently, depending on the tillage (7).

In the case of a soil with higher absorption properties and water retention, such as Gleysol, which is a wetter soil, BOJANA BROZOVIC recommends performing a conventional soil work consisting of plowing at 30 cm in autumn, at the expense of minimum-tillage or no-tillage works. This obtaining a production of 2590 kg / ha (12).

In conditions of water stress, the application of chemical fertilizers with nitrogen content can have both positive and negative effects, as demonstrated by BASAL who conducted an experiment in two soybean fields in Hungary. He carried out a bifactorial experiment in which he demonstrated the effects of progressive Nitrogen administration, in the case of a soybean crop exposed to a controlled water stress and one in an irrigated system. The results obtained demonstrated that, in the case of plants under the effect of drought, the application of Nitrogen was not as successful in terms of protein assimilation in the grains, on the other hand, in the case of the soybean crop under the irrigated system, the protein content of the grain was increased progressively as Nitrogen fertilizers were applied (9; 10).

The drought we face from year to year increasingly affects the process of symbiotic nitrogen fixation by soybean plants. A study carried out in South Africa within the department of Plant and Soil Sciences comes with a solution in the case of solving this situation through an experience on the nodules formed at the level of the roots exposed to a controlled water stress according to the type of symbiotic bacteria used. They noted the following aspect, the use of

Sinorhizobium fredi bacteria showed the best resistance, specifically, the nodules formed by the plants whose seeds were inoculated with this type of bacteria, showed the best characteristics in terms of hydric-stress resistance. Although the nodules showed a very good development, the biomass of the plants was less developed compared to the plants whose seeds were inoculated with bacteria of the genus *Bradyrhizobium*, which leads us to the idea that the increase in the number of nodules is not directly correlated with the development of the vegetative mass of the plant and the inoculation of the seeds with bacteria of the genus *Bradyrhizobium* is more appropriate even if fewer nodules were formed, they compensated instead by developing the green mass much better(14).

Regarding the inoculation of soybean seeds with *Bradyrhizobium* bacteria and nitrogen fertilization, MAGDALENA BOROWSKA came up with a study that demonstrated to what extent soil moisture and precipitation can affect the yield of the soybean crop grown within the University of Sciences and Technologies in Mochelek, Poland. She carried out an experience over the course of two years in which she used two varieties of soybeans, after carrying out the experience she concluded that the lack of precipitation faced by the plants during the vegetation period can have a major impact on the development of the plant and implicitly of the pods, which is why soil moisture plays a very important role in nitrogen assimilation and nodulation formation. This also discovered the fact that soybean plants grown in a lower density show a better development of grains and pods (5).

Given the fact that the application of treatments to combat diseases and pests by chemical methods has become a common practice in most agricultural farms, the side effects they can have on the environment are not always taken into account, which is why they end up being used excessively and harmfully. Studies undertaken in Dakota University Research Farms regarding the application of foliar fertilizers, the application of insecticides and fungicides on soybean plants at different stages of development with the aim of deducing their effect on the protein content of soybeans demonstrating that, the application of phyto treatments -sanitary had no influence on plant development, except in one year out of the four during which the experiment was carried out. The application of foliar fertilizers at the threshold of flowering did not affect the accumulation of proteins in the grains, which is why the destination of the treatments carried out within a crop must be chosen very carefully for both financial and ecological reasons. They emphasizing the hypothesis that the application of treatments and foliar fertilizers without a yield of production can only bring a decrease in the profit of the production achieved and the choice of the variety with the most suitable maturity group for the cultivation area is much more important than the selection of the applied treatments (11).

CONCLUSIONS

Concluding the analyzes carried out on the research that has been done, we can note a series of aspects that can help us in adapting the soybean cultivation technology depending on the area where the culture is located, the type of soil, the method of administration of fertilizers and the type of seed chosen.

In order to achieve the most productive soybean technology, the type of variety and its maturity group must be carefully chosen according to the climate of the area where soybeans will be cultivated, it is also recommended to carry out an agrochemical mapping of the plot where the culture will be located in order to be able to accurately create the fertilization scheme that lends itself to the selected area.

The application of nitrogen fertilizers can affect nodulation and symbiotic fixation of atmospheric nitrogen depending on soil moisture and the type of bacteria used to inoculate the seeds.

Seed selection should be done from a reliable supplier who can provide seeds and a quality certificate, and seed treatment with nitrogen-fixing bacteria is essential for nodulation.

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