



Improving the Field Production Environment for Soybeans

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ABSTRACT

During the past 10 years, soybeans have reached a prominent position among crops in the world. A substantial contribution to world production has been achieved by tropical countries, due to favorable conditions for high yields. Two limitations keep commercial yields below those obtained in experimental results (above 3,000 kg/ha): one is the lack of local adapted varieties and the other is an adequate field production environment. Solutions must be obtained by local research data. Seedbed preparation is one of the most important production steps, since the other production practices are dependent on it. Conventional methods and minimum tillage, when soybeans follow another crop, are being used, with the problem of soil compaction and losses by erosion. Looking for superior strains of *Rhizobium* is crucial because nitrogen can be supplied by a proper symbiosis. The addition of limestone to the soil is a common practice used to raise the pH to proper levels. The use of fertilizers should be guided by local research findings. Chemical control of weeds, pests and diseases is needed to prevent yield losses, but possible effects on the environment should be considered.

INTRODUCTION

At the symposium of Nutritional Improvement of Food Legumes by Breeding, in 1972, Earl Leng from the International Soybean Program (INTSOY) pointed out the potential of tropical countries to become soybean producers (1). Yields over 3,000 kg/ha could be obtained in these countries, but 2 main limiting factors existed: the need for adapted varieties and the use of adequate production practices.

The problem of adapted varieties is almost solved in some countries, and production potentiality has been already evidenced through experimental and commercial yields, but the problem of production practices still remains to be solved (2). The determination and implementation of production practices to improve the field production environment are direct results of local research.

SEEDBED PREPARATION

The objective of seedbed preparation is to provide an optimum environment for plant development. All other practices depend on seedbed preparation, which must be done without modification of soil structure and must leave the soil free of erosion. This latter is an important factor, since soybeans are a highly mechanized crop, and sometimes there is an excess use of machinery.

As a general rule, the conventional method of soil preparation consists in one plowing and 2 leveling harrowings. This process reduces soil losses by 23% in comparison to one plowing and 4 leveling harrowings (3).

In some places, soybeans follow a cereal crop, as a crop binomial, soybean + wheat, in which minimum tillage is

used, disturbing the soil only at the planting band. This process reduces soil losses by 70% (4), and, in comparison to the check above, it accounts for only 5% of soil losses (3).

PLANTING

Planting is directly related to photoperiodic conditions and to rainfall. Care has to be taken with planting depth, since the soybean seeds are epigeal in germination, and very poor stands are obtained when they are planted at depths greater than 5.0 cm (5). Planting depth is determined by soil texture; in fine-textured soils, soil seeds should be planted at 3 cm and in coarse textured soils at 4 cm. This increase in depth assures greater soil contact with the seed and also a better moisture supply at germination time.

Seed that is going to be planted should be of the highest quality; to obtain this, special care must be taken during harvest and storage. When germination is below 85%, seed is treated with fungicides, but chemical products must be unharmed to the nitrogen fixing bacteria (6). As a general rule, a good seed treatment on a bad seed never transforms the bad seed to a good one.

DATE OF PLANTING

Setting the date of planting is one of the first practices that has to be determined locally, since it sets the best photoperiodic responses for the cultivars used. The planting date has a tremendous influence on the vegetative and reproductive plant cycles, and consequently on plant architecture and yield components. Research done in Jaboticabal, São Paulo (21°15'18" South), showed that for the locally adapted varieties (with plant cycles of around 130 days) 'Santa Rosa' and 'Vicoja,' (former F-61-2890), the best planting dates were from October 30 to November 10. Yields were 3,000-3,500 kg/ha (2,7).

PLANTING RATES

A good yield is the result of a good plant population, and this is a consequence of the space between rows and the number of plants per meter. Plant type of growth in association with a set of environmental conditions are the factors that determine the best planting rates.

The width between the rows and number of plants per meter have a direct influence on plant architecture, and have effects on plant height, first pod insertion, stem diameter, number of pods per plant and also yield per plant. For cultivars 'Santa Rosa' and 'Vicoja' plant densities of 40 plants per meter and row widths of 0.50 m give yields of 3,500 kg/ha, but 'Santa Rosa' has a high

degree of lodging, and this characteristic has to be taken into consideration (8; also Lam-Sánchez and Oliveira, 1976, unpublished data).

For conditions in São Paulo, row widths of 0.50 and 0.60 m and 30 to 40 plants per meter are recommended.

LIMING

The use of agricultural lime in soybean production is a common practice which, besides raising soil pH to proper levels for an adequate symbiosis (pH 5.8-7.0), furnishes the ions Ca^{2+} and Mg^{2+} and transforms Al^{3+} and Mn^{2+} to less toxic forms.

The application of limestone to the soil has to be done 3 to 6 months before planting soybeans, preferably with the previous crop, since the action of lime is very slow, and particle size and soil moisture influence it.

In Brazilian soils, when pH is lower than 5.0, aluminum is the most prevalent cation, and when the saturation level is around 10%, the soybean plant experiences reduced growth (9). The presence of aluminum is not only restricted to the upper layers of the soil, but its presence can be confirmed to a depth of 15 cm, as can be seen in soils of the Cerrado area. This implies a need for deeper application of lime (10).

Another example of plant toxicity is that presented by manganese. According to Gupta et al. (11), soybean plant had higher concentration of manganese when its pH was 4.4-5.0, and lower concentrations when its pH was 6.2-6.4. In the soils of Rio Grande do Sul, when the levels of manganese are around 20-25 ppm, it shows toxicity to the plant.

The quantity of limestone that needs to be applied depends directly on soil pH level, the type of lime rock, the level of exchangeable aluminum, the levels of calcium and magnesium, the organic matter content and the soil texture. There is still a need for local research on this topic, which would consider the climatic factors and the soybean variety that is going to be planted.

FERTILIZATION

I am going to consider only nitrogen fertilization and the implications that *Rhizobium* symbiosis has on it. In relation to the other macro-nutrients, secondary nutrients and micro-nutrients, a large quantity of research is present in the literature, which shows their essentiality and the quantities that have to be furnished to the soybean plant for proper yields. There is a need, however, for local research data, to establish recommendations when factors such as edaphic and climatic conditions must be considered. Attention must be given to local sources of elements such as phosphorus.

To achieve the most efficient yields from these recommendations, good calibration studies are needed, along with a look at the possible interactions between the nutrients.

Nitrogen, an essential element, can be supplied by a proper symbiosis with the nitrogen fixing bacteria *Rhizobium japonicum*. This can be seen by the results obtained in Mississippi, where atmospheric nitrogen was fixed by the bacteria to levels of 180 kg/ha (5). Another way of supplying nitrogen to the plant is through the mineralization of organic matter.

Chemical nitrogen is expensive and requires a large quantity of nonrenewable energy. Its detrimental effects on nodulation are well known—reduction in the number, weight and efficiency of the nodules. When chemical nitrogen is in direct contact with the soybean seed, it brings out some prejudicial effects to the root system of the plantule.

In spite of this, the application of nitrogen to soil is being recommended, as in Rio Grande do Sul, where the rate of 10 kg of N/ha is used for maintenance fertilizations (9). Perhaps the reason for this recommendation is the response to nitrogen that was obtained in several studies (2,12). This response might have been due to the fact that there was not a good symbiosis or because the effect of *Rhizobium* was not as was expected. Many factors could have contributed to this, such as soil with a high C/N relation, varieties with low potential for nodulation, or, even worse, the use of inefficient bacterial strains.

The last factor is most feasible, since it was already proved that the natural *Rhizobium* flora is more efficient than that used in commercial inoculants (13). Also, experiments have shown that treatment favored nodulation, as in the application of molybdenum (2), or reduced it, as in some seed treatment experiments (6). There is a need for research on *Rhizobium* breeding for tropical soils.

WEED CONTROL

To obtain a good yield there must be efficient and economical weed control, since weeds are highly competitive for water, nutrients and sunlight. The high cost of labor and the introduction of good selective herbicides into the market are favoring an increase in chemical control of weeds. Herbicides are not limited to controlling only those weeds between the rows, but also those weeds inside the row, thus keeping the crop free of weeds until harvest.

One of the most used of herbicides in soybeans is Trifluralin, which is applied by incorporation to the soil before planting. Trifluralin has very good control for annual grasses such as: *Eleusine indica*, *Cenchrus echinatus* and *Brachiaria plantaginea*. The recommended rate is 1.2 to 2.4 l/ha of the commercial product, depending on the soil texture (14).

For controlling grasses and some dicotyledonous plants, Alachlor has proven to be efficient when applied in pre-emergence at rates of 3.0 to 6.0 l/ha of the commercial product. This product requires good soil moisture, and is favored by rains since it has to be carried to a proper depth without being too much adsorbed and without suffering decomposition by sunlight.

A good control of dicotyledonous plants is provided by Metribuzin, which is applied alone in pre-emergence or in mixtures with the 2 herbicides previously mentioned. The use of mixtures increases the expectrum of control and decreases the rates to be used, and consequently the danger of plant toxicity. Rates for Trifluralin are 1.0 to 2.0 l/ha, and for Alachlor, 2.5 to 4.5 l/ha of the commercial products.

Other products with good possibilities are Pendimethalin and Dimitramine, and some post-emergence herbicides such as Bentazon and Acifluorfen.

Several problems with chemical weed control inhibit a more adequate and greater use of herbicides: the low level of knowledge farmers have about physical and chemical properties of the products, and about the type of weeds for control.

The continuous use of one herbicide can result in selection and an increase in aggressiveness of certain weeds. A rotation program can avoid this. Continuous use can also induce effects on some physiological characteristics of the plant and certain interactions could take place with *Rhizobium* that would have a harmful effect on it. This information contains some contradiction and needs some discussion, and more evidence is needed.

Technical errors can lead to the failure of some herbicides, mainly the residual types. Because the rates applied

are not compatible with soil texture, an improper depth of incorporation can bring a higher concentration in the upper layers of the soil or a high dilution of the product, which results in a loss of effectiveness. Another factor that can contribute to this is a poor soil preparation.

Basic studies are needed on the interaction between herbicides and soil in tropical conditions, and on the residual effects on soils, plants, animal and atmosphere.

PEST CONTROL

Soybeans in tropical conditions have serious entomological problems. There are about 28 native species of insects that attack soybeans. Leaf-feeding insects such as *Anticarsia gemmatalis* and *Plusia oo*, and pod-feeding insects such as *Nezara viridula*, *Piezodorus guildini* and *Euchistos beros* have a great economic importance in Brazil due to the damage that they induce.

Chemical pest control has been used, sometimes in excess. There is no worry about environment pollution and its consequences. An urgent need exists to decrease chemical control of pests in soybeans, and to fulfill this need, studies on breeding for pest resistance, insect population fluctuations, and residual effects are necessary.

OTHER PRACTICES

Proper harvest machinery and conditions have to be established to prevent harvest losses and mechanical seed injury. The application of Paraquat as a defoliant has produced some good results, in spite of the high amount of residues in the seeds (15).

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Soybean Pest Management

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ABSTRACT

The rapidly growing world population and rising cost of fossil fuel has caused the increase in importance of soybeans as a source of high protein food and quality vegetable oil. The area planted with soybeans is not likely to increase greatly because of geographic adaptation and environmental limitations. Any large increase in the quantity of soybeans, therefore, must come from increases in yield per unit area, that is, increased production efficiency. Part of this can be accomplished by improved pest management systems that use cultural, mechanical, biological, ecological, and chemical methods to reduce the 30% loss caused by insects, weeds, and diseases. Pest control strategies are discussed.

INTRODUCTION

A few introductory remarks should make it evident that soybean pest management is an essential part of soybean

production. It took the people of the world from the beginning of time until 1830 to reach a population of one billion. In the last 150 years the population has doubled twice and it is expected to double again, from 4 to 8 billion, in the next 40-50 years. The amount of food produced in the world will have to double during this same period just to keep up with the world population. We barely produce enough food and fiber to feed and clothe the people of the world now. Poor distribution and economic inequalities have resulted in two-thirds of the people not having enough food, particularly food with adequate protein. As the world population rapidly increases, there is no way to feed the people without making all nations as self sufficient as possible. People who feel that it will be easy to feed our children and grandchildren do not understand the magnitude of the problem. One of the primary