Macronutrient management for the cultivation of Soybean (Glycine max L.): A review

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Abstract. The review is focused on management of macronutrients for cultivating Soybean. Soybean is an important crop in the world because the only reliable plant-based source of complete protein, comparable to meat and eggs, is from soya protein. Soybean yield is crucial for meeting protein malnutrition and edible oil needs. The wide variation in Rhizobial cell counts and nodule mass in beans are likely related to variation is Physico-chemical conditions of the soil.
1. Introduction

Soybean Glycine max is a pulse crop of great global importance. It provides 43.3% protein and 19.5% oil, which makes it a "miracle bean". Soybean is indigenous to China and was introduced to India in the 1950s [1]. Soybean is a high nutritional value legume, and its beans contain up to 30% of proteins. They provide all the essential amino acids except methionine. Soybean is also used as a protein supplement for animal feed [2]. It has been estimated that the soybean plant requires up to 80 kg of assimilable nitrogen to produce a ton of pod, accounting for 240 kg/ha on average. Nitrate or ammonia becomes available in soil by organic nitrogen mineralization, chemical fertilization, and biological nitrogen fixation. The later process is essential for nitrogen incorporation into the biosphere. The conversion of atmospheric nitrogen into ammonium conducted by microorganisms bearing the enzyme nitrogenase is an intrinsic non-contaminating process that prevents soil impoverishment [3]. At the same time, high concentrations of nitrate or ammonium in soil inhibit the nitrogen biological fixation. Soybean has a significant importance due to its high protein and oil concentration in its pods. Because atmospheric N2 is abundant, no eukaryotic organism is able to assimilate it, as the bond is too strong [4]. However, in nitrogen-deficient soils, much of soybean's nitrogen requirement can be met through the symbiotic association with bacteria called rhizobia, which belong to the species Bradyrhizobium japonicum and Bradyrhizobium elkanii [5].

2. Nitrogen management in soybean

Soybean, can fix atmospheric nitrogen in symbiotic association with Bradyrhizobium japonicum. Thus, soybean has a rich nitrogen content, which is delivered to the seedling stage, while biologically fixed nitrogen looks after the crop needs under favourable conditions. Therefore, in low-nitrogen soils, nitrogen deficiency rarely occurs, but when it does, it results in BNF failure and in soil-nitrogen deficiency. To alleviate nitrogen deficiency that arises between the depletion of seed nitrogen and nodule formation, 20 kg N/ha is a recommended starter dose. It is critical in sandy loam soils where nitrogen content is low. Temperatures of 30°C in the topsoil profile of 10 cm could delay nodule development [6].

The significant nitrogen requirement of soybeans has been recognized, instructing the use of nitrogen fertilizer to increase soybean yield. Even though soybean is a legume, it has been found to readily incorporate soil inorganic nitrogen, and this leads to net nitrogen removal from soil. In a mature soybean plant, 40 to 75% of the nitrogen may be in the residual soil inorganic nitrogen and soil mineralization characteristics [7]. It appears that soybean needs this soil-derived total plant nitrogen component to achieve high yields. The renewed attention on soybean nitrogen metabolism, together with other physiological aspects of soybean nitrogen use, has maintained interest in improving nitrogen supply and use in hopes of increasing yield and grain protein. Depending on the amount of nitrogen available from the soil and the conditions for nodule development, the ratio of nitrogen supplied from these two sources can vary widely. Symbiotic fixation can range from 25% to 75% when it comes to the supply of nitrogen to plants [8]. The least expensive method of supplying adequate nitrogen to soybeans is to inoculate the seeds when planting. If soybean has not been grown on the site, inoculation is required. In such a situation, soil application of a bioinoculant may yield greater yield potential than the application of bioinoculant to seeds. For previously grown soybean fields, inoculants for either seed or soil application provide adequate nitrogen for the crop. N fixation can meet a significant part of the nitrogen demand of the crop. The article by Shibles [7] discusses soybean's two different ways of acquiring nitrogen: inorganic nitrogen through the soil and symbiotic nitrogen fixation. It is fascinating to learn how nitrate supply negatively affects Bradyrhizobium infection and symbiotic nitrogen fixation (that is, delayed infection and reduced nodulation and nitrogen fixation in response to increased soil nitrate). It's a big challenge to increase total plant nitrogen through fertilization, because of this nitrogen acquisition interrelationship.

3. Phosphorous management in soybean

Soybean is an accomplished crop even under low levels of soil phosphorus. Phosphorus is critical for soybean crop growth and is almost absent from most soybean cropland. Most legume fertilization methods rely on phosphorus for intensive nitrogen fixation. Therefore, phosphorus has an essential role in energy transformation and root growth, as well as nitrogen fixation. Because of moisture stress,
phosphorus fertilization may reduce the phosphorus available for uptake, causing poor biomass production and reduced phosphorus uptake. Phosphorus fertilization is usually more needed in acidic soils due to higher phosphorus fixation. Other phosphorus sources (rock phosphate excluded) are equally effective in soybeans. Rock phosphate is a bad source of phosphorus in neutral to alkaline soils, but a good source in acidic soils [9]. Usually, it is not an issue to fertilize the soil with phosphorus at subsoil levels. Nandini [10] has found that sources and evaluated levels of phosphorus affect the productivity of soybean. These treatments used four phosphorus sources (single superphosphate, diammonium phosphate, single super phosphate + phosphate solubilizing bacteria, diammonium phosphate + phosphate solubilizing bacteria), with one absolute control. Total phosphorus uptake was maximized with the treatment of SSP + PSB. The SSP+PSB treatment greatly benefits the agronomic efficiency, physiological efficiency, and P use efficiency. However, phosphorous recovery was greater in the DAP+PSB system due to a higher stover yield and higher phosphorus uptake. Consequently, the efficiency fractions rise until 60 kg P$_2$O$_5$ ha$^{-1}$ and decline at 80 kg P$_2$O$_5$ ha$^{-1}$[11].

4. Potassium management in Soybean

Potassium is a limited requirement for soybean and ranged from 14.3 to 57.7 kg /t of grain. Potassium is seldom needed in clay soil for soybean production. Potassium application before planting is the most efficient method [12]. Determine fertilization requirements such as potassium and phosphorus for soybeans based on soil test values. Therefore the rate of application of low-nutrient soils is 50-70 kg P2O5/ha and 60-100 kg K2O/ha with grain yield of 2.5-2.7 tonnes per hectare, a low-fertility soil would recommend 40-60 kg of P$_2$O$_5$/ha and a moderate-fertility soil would recommend 100-150 kg of K2O/ha. In soil with high clay content, application rates will be higher. P2O5/ha and K2O/ha were recommended for each additional tonne of grain yield. for clay soils, an extra 10-15 kg P$_2$O$_5$/ha and 20-30 kg K$_2$O/ha were recommended with each additional tonne of grain yield [13]. Because the completion of the High Dam in Aswan stopped the deposition of Nile silt rich in potassium bearing minerals on agricultural fields, the use of potassium fertilization in agriculture has become increasingly important [14]. In addition, Nile alluvial soils that have a high clay content and are highly potassic can have a high potassium fixing capacity. While a high Kex level might be present, there may not be enough potassium for various crops due to this [15]. In general, in plants and animals, macronutrients play an important role in different biochemical pathways; thus, they are needed to survive and grow considerably. These also stimulate the growth and yield of numerous crops [16-22]. They also play an significant role in the growth of crop. Based on their roles, macronutrients like N, P and K were graded as primary macronutrients. Plants and their productivity in many parts of the world are restricted by environmental factors like salinity and drought, mineral deficiency [23-30]. Many of these studies concluded that low productivity is primarily related to management practices in dryland agriculture [31-55]. Research has shown important ties between humidity, fertilizer applications, plant populations and planting dates [56-71]. Numerous studies indicate that the availability of nutrients is important for plant growth, especially in the case of weeds that influence and inhibit the growth of crops that compete with the crop for the nutrients in the soil [72-92]. On the other hand, soil organic matter is essential to crop production and sustainable soil fertility [92-107].

5. Conclusions

Soybean is a high nutritional value legume; its beans contain up to 30 % of proteins. They provide all the essential amino acids except methionine. This deficiency can be compensated by diet combinations with cereals as recommended in classical dietary procedures. Soybean is also used as a protein supplement for animal feed. In the last years, the world soybean production surpassed 250 million tons, led by US, Brazil, Argentina, China, India, Paraguay and Canada. In Cuba, soybean production recently arose as an economic policy priority, in order to substitute pod import, with a remarkable rise in the number of areas destined to soybean crops and the introduction of mechanized sowing. It has been estimated that the soybean plant requires up to 80 kg of assimilable nitrogen to produce a ton of pod, accounting for 240 kg/ha on average.
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