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Crop Yield Comparisons Of Conventional And Organic Farming Of Soybean In The Dry Zone Of Sri Lanka

D. M. Hunupolagama[1], P. N. Yapa[2]
[1]Department of Bio Systems Technology, Faculty of technology, Eastern University, Chenkaladi, Sri Lanka
Dulangana85@gmail.com[1]
[2]Department of Biological sciences,Faculty of Applied Science, Rajarata University, Mihinthale, Sri Lanka

Abstract: *A large number of comparison studies of soybean production in the world revealed that the organic production was equivalent to, and in many cases better than, conventional. In the drier climates organic systems had higher yields than conventional. When comparing the profitability of farming systems, it was found that organic cropping systems were always more profitable than the conventional. This was attributed to lower production costs and the environmental sustainability. Soybean obtain its nitrogen with the symbiosis of Bradyrhizobium japonicum and phosphorous by arbuscular mycorrhizal fungi. This study was focused on comparison of soybean yield in conventional and organic farming. Soil samples were collected from a soybean field of the dry zone of Sri Lanka, where conventional farming was practiced for ten years. Greenhouse pot experiment was carried out with two treatments of field soil with synthetic fertilizer and field soil with bio fertilizer. Field soil only was considered as the control. Soybean plants were harvested after 80 days of growing. When compare the mean pod dry weight of each treatment, there was no significant difference of the treatment effect. Control showed a high mean yield than other two treatments and fertilizer treatment had the lowest yield but the differences among treatments were not significant.*

Keywords —Soy Bean, Organic, Conventional, Rhizobium

1. Introduction

By 2050, global population is projected to be 50% larger than at present and global grain demand is projected to double (Alexandratos, 1999; Cassman, 1999; Cohen and Federoff, 1999; Neumann et al, 2010). Further increases in agricultural output are essential for global political and social stability and equity. But doubling the food production in ways that do not compromise environmental integrity (Vitousek et al., 1997; Carpenter et al., 1998; Tilman et al., 2001)) and public health (Smith et al., 1999; Gorback, 2001) is a greater challenge. Agricultural management practices determine the level of food production and to a great extent, the state of the global environment (Tilman et al., 2008). About half of global usable lands are already in pastoral or intensive agriculture (Tilman et al., 2001). In addition to causing the loss of natural ecosystems, agriculture management practices add globally significant and environmentally detrimental amounts of nitrogen and phosphorous to terrestrial ecosystems (Vitousek et al., 1997; Carpenter et al., 1998).

Sri Lanka annually spends more than 27 billion rupees to import chemical fertilizers and the cost for pesticides is also high. Government provide a fertilizer subsidy only for paddy and coconut but nor for other grains and pulses. So farmers have to buy fertilizers to those crops from the open market.

Use of the bio fertilizers provide better alternative to that problem. A major factor influencing plant growth and health is the microbial population living both in the rhizosphere and as endophytes within healthy plant tissues. A portion of these microorganisms possess the ability to suppress diseases and promote growth are termed as plant growth-promoting rhizo bacteria (PGPR). PGPR were first used to improve crop fertility by increasing the amount of nitrogen available to the plant (Bloemberg and Lugtenberg**,** 2001). Introduction of specific bacteria and fungi into soils has been performed in agricultural practice for decades. The main purposes of these releases are to supply nutrients to crops, to stimulate plant growth, e.g., through the production of plant hormones, to control or inhibit the activity of plant pathogens and to improve soil structure (Davison, 1988; Wilson and Lindow, 1993). A variety of bacteria have been used in soil inoculations intended to improve the supply of nutrients to crop plants. *Rhizobium* species have been successfully used worldwide to permit an effective establishment of the nitrogen-fixing symbiosis with leguminous crop plants (Bottomley, and Dughri, 1989; Bottomley and Maggard, 1990). In addition, phosphate solubilizing bacteria such as *Bacillus* and *Paenibacillus* have been applied to soils to specifically enhance the phosphorus status of plants (Cooper, 1959; Brown, 1974). The stimulation of phosphorous supply to crops has also been the main purpose of the deliberate release of many mycorrhizal fungi.

Soybean is one of the important legumes which have higher protein content that can be used to fulfill the country's protein requirement. Anuradhapura district is the main area where the highest amount of soybean was cultivated to produce the annual need of the country. According to the Department of Agriculture, farmers add fertilizers in to soybean fields before the introduction of seeds and at the flowering stage. So the cost of those fertilizers finally reduced from the profit.

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Legume plants need higher amounts of nitrogen and phosphorous for the growth. In soybean cultivation, nearly 325 kg of nitrogen and phosphorous were added per hectare. But this plant can fix atmospheric nitrogen with the help of soil bacterium named as *Bradyrhizobium japonicum* by forming root nodules and absorb phosphorous with the help of mycorrhizal fungi. By using these natural microorganisms, most harmful effects cause by chemical fertilizers can be minimized. But most of the farmers only concern about the yield and profit. Therefore this study was conducted to compare the yield given by synthetic fertilizers and natural microbes as well as to find the most economically and environmentally profitable way to cultivate soybean in Sri Lanka.

2. METHADOLOGY

Soil was collected from a soy bean field situated at Galenbindunuwewa in Anuradhapura district which has been used to cultivation more than 10 years. Research was conducted as a greenhouse pot experiment. Average temperature of both sites is about 290C-350C and average rain fall is about 1000-1500 mm/year.

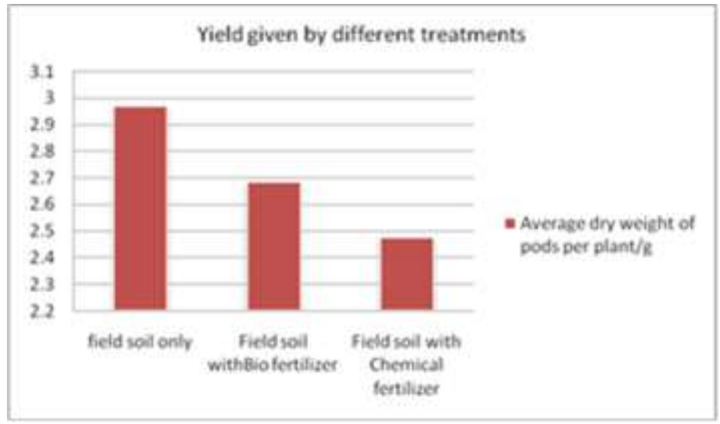
2.1 Inoculum preparation

Bradyrhizobium japonicum was isolated from soybean root nodules using crushed method (Barton, 1984). Then pure cultures were made and stored in refrigerator. From pure cultures, broth culture was prepared to use as seed inoculum. Soybean plants were grown in pots with field soil for trap culture. At the maturity level, plants were uprooted and roots were taken as inoculum of mycorrhizae.

2.2 Greenhouse pot experiment

100 kilograms of soil was randomly collected from the soybean field, placed in cleaned gunny bags, transported to the laboratory and then filled in to pots. Greenhouse pot experiment was carried out with two treatments of field soil with synthetic fertilizer (N,P,K) and field soil with biofertilizer. Biofertilizer was consisting of five milliliters of Bradyrhizobium broth culture with 30g of mycorrhizal root trap culture per 3kg of field soil. Field soil only was considered as the control. Soybean plants were harvested after 80 days of growing and dry weight of pods was measured. By using complete randomized block design all the data were analyzed statistically and interpreted by using ANOVA.

3. RESULTS AND DISCUSSION



Graph 01: Yield given by different treatments measured as the average dry weight of pods per plant in grams.

When compare the mean pod weight of each treatment, there was no significant difference of the treatment effect (P=0.5618). Control showed a high mean yield than other two treatments and fertilizer treatment had the lowest yield but the difference between that and bio fertilizer treatment was not significant.

There can be many reasons for the highest yield given by control. Soil samples were collected from the field, after two months of the harvesting. Previous plants may already absorbed high amounts of applied chemical fertilizers. Part of the remaining chemicals may leach out from the field with the rain water. So the remaining amount of fertilizers may act as an initial nutrition supply for the indigenous soil microbes.

During the non-cultivating period, weeds have been occupied the field. They also can absorb some amount of fertilizers and by releasing the root exudates they can support the growth of native microflora which is now free from inhibition of excess fertilizers. Therefore the highest yield may occurs due to the combine effect of all above factors. Difference of the bio fertilizer yield and others may due to the fact that microbes need some time to establish on the new environment.

Besides the intrinsic physiological characteristics of the organisms, abiotic and biotic soil factors play an important role for survival in field soil. Abiotic soil factors such as textural type, pH, temperature, and moisture exert their direct effect on inoculum population dynamics by imposing stress of various natures on the cells ((Elsas et al., 1991; Evans et al., 1993). They can also act indirectly by affecting the activity of the indigenous soil microflora (Paul and Clark, 1988; Berry and Hagedorn, 1991).

However comparing with chemical fertilizers, bio fertilizer can give higher soybean yield for very low cost and need no or few secondary application. Therefore natural microbial inoculums can save the extra cost of chemical fertilizers that farmers spend for twice per every year. Then eventually it can increase the profit of soybean farmers and protect the environment and indigenous soil microflora.

4. Conclusion

There is no statistically significant difference between the yields of two treatments and the control. Therefore we can recommend to do some field trials without chemical fertilizers, and if the same results obtained we can cut the use of chemical fertilizers and use bio fertilizers to increase the soybean yields in Sri Lanka. To increase the profit while protecting the environment, bio fertilizers can be recommended as the best alternative.

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