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Effects of inorganic and organic nutrient sources on growth and nodulation of *Glycine max*in Batticaloa, Sri Lanka

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Abstract

An experiment was carried out under a rain shelter at agro technology park of Eastern University, Sri Lanka. The time duration was five weeks. The complete randomized design (CRD) was used for arrange four treatments with ten replicates. The treatments were, T1- Application of Jeewamirtha once a week, T2- Application of Panchagaveya once a week, T3- Application of Amuthakarisal once a week and T4- Application of inorganic fertilizer based on the Department of Agriculture recommendations. The measured parameters during the research were plant height, leaf area, shoot and root biomass, nodules number, number of effective nodules, and nodules weight of the plant. The significant differences were founded among the treatments on tested parameter. The study found that the application of Jeewamirtha was showed the highest parameters of growth a well as nodulation of Soybean than the other treatments. The application Panchagavya, Amuthakaraisal and also inorganic fertilizer were given approximately same measurements for growth parameters. The Jeewamirtha could be used as a nutrient source to get maximum production of Glycine max while reducing the environmental impacts by chemical fretiliers.

Keywords: Oraganic, Panchagavya, Amuthakaraisal, Jeewamirtha, Nodulaion, Growth.

Introduction

Feeding of the growing population and saving of the limited natural resources are the main problems which facing by the agriculture sector today. By next decade the food production capacity should be doubled in the all over the world. Mostly the developing countries have an uncontrolled population growth and it is caused to accelerate the imbalance between sustainable use of land and human needs. The fundamental factor in determining the productivity factor of all farming systems is the soil and soil fertility. Most of the farmers are prefer to use huge quantities of inorganic fertilizers and pesticides to obtain more production with quick return. But the excessive usage of these synthetic fertilizers and pesticides cause sevier problems for the environment[1].

Inorganic nitrogen and phosphorus fertilizers are the main causal agents for ground waterpollution[2]. Due to heavy use of synthetic chemical such as herbicides, pesticides, as well as intensification of agricultural production during the past few decades has led to other harmful effects like nitrate in the ground water, contamination, stratospheric of food materials, eutrophication changes, and degradation of biodiversity etc[3]. High agricultural inputs are unlikely to be sustainable for very long unless the inputs are correctly judged in terms of both their quality and quantity. Some synthetic chemical used in agriculture containing heavy metals like cadmium and chromium, and a higher concentrations of radio nuclides[4]. Therefore, dangerously polluted well water, especially water resources, crop production quantity and quality of product deteriorates[5].

The new trend of the modern world is organic farming, due to these various problems which caused by conventional farming. In other hand, excessive use of toxic chemicals to overcome pest and disease problems on both crop and livestock caused to reduce the biodiversity and also human health[6].

Therefore this study was done to find a best organic nutrient source to get maximum yield of soybean with negative impact on environment.

Methodology

The pot experiment was conducted under the rain shelter in Agro Technology Park, Eastern University, Sri Lanka which located in the latitude of $7^0$43' and the longitude of 81^0 42'E. It belongs to the "low country dry zone" agro ecological region in Sri Lanka. The mean annual rainfall ranges from 1400mm to 1680mm and temperature varies from 30^0C to 32^0C. Relative humidity is 60% to 90%. Sandy regosol is the main soil type of this region. The PVC pipes with 5.3cm diameter and 30cm of length was used as the pots. A soil mixture with red soil, top soil and compost at the ratio of 1:1:1 was used for filling an each pots. The potting mixture was sieved and the weight of 926 g was uniformly distributed in each container in order to maintain the 1.5 g/cm^{3}of bulk density. The experiment was arranged in a complete randomized design (CRD) with four treatments and

ten replicates. Totally forty samples were maintained. The treatments were applied as, T1-Jeewamirtha application once in a week, T2- Panchagavya application once in a week, T3-Amuthakaraisal application once in a week, T4- Inorganic fertilizer application as per the Department of Agriculture recommendations. During the research following measurements such as, shoot and root biomass, plant height, nodules number, number of effective nodules, nodules weight and leaf area of the plant were observed.

Preparation of Jeewamirtha (for one acre): Fifty liters of water added to the barrel. Then 2.5Kg of cow dung and 2.5 liters of cow urine were added to the water containing barrel. After that, 0.5Kg of Jaggery, 0.5 Kg pulse powder and a hand full of living soil were added to the same barrel. Then whole ingredients were stirred well and container closed by cotton cloth. The barrel was kept in shade and stirred in clock wise twice a day in order to accelerate the activities of microbes. Two days after fermentation, Jeewamirtha was used and this could be used for up to twenty days. Jeewamirtha was diluted 10 times with water before application.

Preparation of Amuthakaraisal (for one acre): Twenty liters of water, two liters of cow urine and 2Kg of fresh cow dung from indigenous cow were added in to plastic container. Then 2Kg of jaggery was added and stirred well. After that container was closed by cotton cloth. The barrel was kept in shade and stirred clock wise twice a day in order to accelerate the activities of microbes. The prepared Amuthakaraisal was applied two days after fermentation. This organic mixture was used maximum up to twenty days. Amuthakaraisal was diluted 10 times with water before the application.

Preparation of Panchagavya (for one acre): 5Kg of fresh cow dung, 3liters of cow urine, 2 liters of fresh milk were taken from indigenous cow were added in to plastic container. Then 2 liters of ghee, 2 liters of curd, 2 liters of tender coconut water, 2 liters of toddy, 2Kg of jaggery and 12 ripened banana were added to that plastic container. After that whole ingredients were mixed well and container was covered by cotton cloth for fifteen days. For fermentation, it was stirred twice as every morning and evening to activate microbes. 15 days after preparation, it could be applied up to 45 days. Before application the organic mixture was diluted 100 times with water for dilution.

The Analysis of variance (ANOVA) was done by using SAS and Duncan Multiple Range Test (DMRT) test at 5% significant was performed within the treatments to find the mean comparison.

Results and discussion

Plant height: A significant differences ($p<0.05$) was found among the treatments on average plant height. Data regarding average plant height at 3rd, 4th and 5th weeks are given in below Table-1. There was no significant different ($p<0.05$) among the treatments at 3rd weeks after planting and according to the finding significant different was observed among the treatments at 4th and 5th week after planting. Therefore, all this organic and inorganic fertilizers affect similarly on plant height up to 3rd weeks after planting (WAP).

A significant differences ($p<0.05$) was observed from 4th WAP. Among them T1, the plants which were applied Jeewamirtha showed significant difference on plant height while T2, T3 and T4 treatments were not showed a significant affect ($p<0.05$) on the plant height of soybean at 4th and 5th WAP.

Table-1: Effect of different nutrient sources on plant height *of Glycine max.*

Treatment	Plant height at 3rd week (cm)	Plant height at 4th week (cm)	Plant height at 5th week (cm)
Jeewamirtha (T1)	19.340± 0.504a	28.720± 0.544a	39.210± 0.416a
Panchagavya (T2)	18.710± 0.360a	26.440± 0.440b	34.820± 0.480b
Amuthakaraisal (T3)	19.180± 0.528a	24.940± 0.940b	34.100± 0.498b
Inorganic (T4)	18.290± 0.311a	25.730± 0.386b	35.370± 0.379b
F test	ns	*	*

*is significant at 5% level while ns is not significant in probability. Mean values which are having the dissimilar letter indicate the significant differences at 5% level of significant according to the DMRT.

The treatment effects were observed from the 4th WAP. Jeewamirtha started to give better result compare to other treatments. Jeewamirtha is one of the bio enhancer which consists of huge amount of beneficial effective microbes to enhance the availability of nutrients towards rhizozosphere. The application of Jeewamirtha has the capacity to increase height of the plant than chemical fertilizer application. Theingredients used for preparation of Jeewamirtha such as, cow urine, cow dung, jaggery and legume flour which containing both macro and essential micro nutrients, many vitamins, essential amino acids, growth promoting substances like Indole Acetic Acid (IAA) and Gibberlic Acid (GA) should be the reason for presence of many beneficial microorganism in the liquid nutrient solution[7,8]. That may be the possible reason for higher plant growth in soybean under application of Jeewamirtha. Because of adding of jaggery and pulse powder, Jeewamirtha may help in proliferation of N fixing bacteria (*Rhizobium japonicum*) at faster rate compare to other organic nutrient sources[9].

Leaf area of plant: Dissimilar latter/letters in the top of the bar indicate significant differences at 5% level of significant (DMRT).

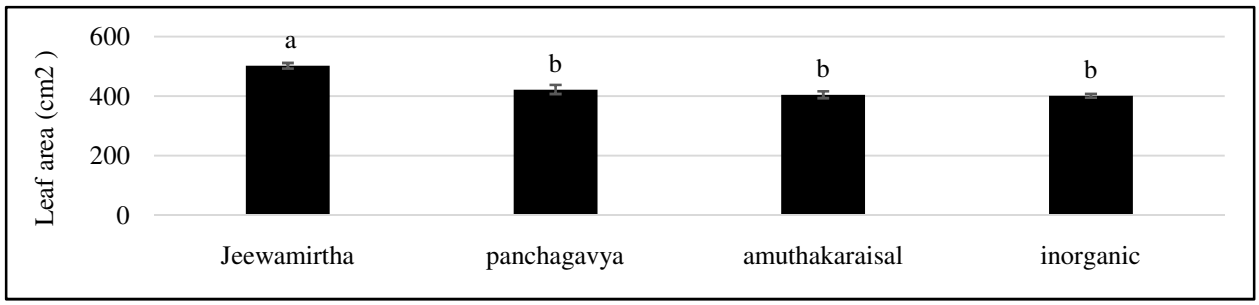

Figure-1: Effect of different fertilizer on plant leaf area at 5th WAP in *Glycine max.*

The results obtained from leaf area were showed a significant differences ($p<0.05$) at 5th WAP as shown in the Figure-1. The highest leaf area of soybean (501.74cm^2) was shown by application of Jeewamirtha while the lowest (400.64cm^2) was shown by inorganic fertilizer under different nutrient sources at 5th WAP. But T2, T3, T4 were not significantly differed according to DMRT. Application of Amuthakaraisal, Panchagavya and inorganic fertilizers were given approximately same results. This can be due to high nutrient supply by Jeewamirtha compare to other nutrient sources. The leaves are the main sites for photosynthesis which produce biomass, partioning for various parts of the plant and also store excess food and thus they can be used as a index for measure plant growth as well as yield[10]. The inoculation of two soybean cultivars with Bradyrhizobium japonicum bacteria significantly increased the leaf area index in soybean[11].

Total number of nodules, nodules weight and effective nodules of plant: Significant differences were observed ($p<0.05$) among the treatments on number and weight of nodules as well as numbers of effective nodules at five weeks after planting.

Table-2: Effect of different nutrient sources on total number of nodules, nodules weight and effective nodules of Glycine max at 5th WAP.

Treatments	Total numbers of nodules	Fresh Nodules weight(g)/ plant	Effective nodules/ plant
Jeewamirtha (T1)	42.60± 1.34a	0.6466± 0.0458a	18.20± 0.892a
Panchagavya (T2)	22.00± 1.51c	0.2988± 0.0165c	11.30± 1.050b
Amuthakaraisal (T3)	30.20± 0.91b	0.4970± 0.0234b	10.70± 0.667b
Inorganic (T4)	15.60± 1.21d	0.2119± 0.0146d	7.10± 0.605c
F test	*	*	*

* is significant at 5% level while ns is not significant in probability. Mean values which are having the dissimilar letter indicate the significant differences at 5% level of significant according to the DMRT.

The results showed that the highest number of nodules and effective nodules as well as the weight of nodules were given by the plants with application of Jeewarmirtha while the lowest were given by inorganic fertilizer application. Application of Panchagavya and Amuthakaraisal also given higher number of each result compared to inorganic fertilizer. Therefore, compared to inorganic, organic treatments were highly influenced on nodulation of soybean at 5th WAP. The study revealed that, every parameters related to nodulation was higher nearly three times in application of Jeewamirtha than inorganic fertilizer. It was doubled in number of total nodules and also in number of effective nodules for application of Amuthakaraisal than the inorganic fertilizer application. Numbers of effective nodules per plant showed 156.33% of increment for application of Jeewamirtha while it was 59.1% for Panchagavya application and 50.7% for Amuthakaraisal application.

The reason for these results should be the nitrogen fixing bacteria (*Rhizobium japonicum*) who always presented in organic nutrient sources. This bacteria encourages the nodule formation for increase the atmospheric nitrogen fixation. They produced low numbers of nodules when the soil contained enough amount of inorganic nitrogen. That may be the reason for the plants under the application of organic nutrient sources produced the high number of nodules compare to inorganic treatment (T4). Incensement of rhizobial population due to effective microbial culture application can be coursed to increase the number of nodules[12]. High nodulation in green gram by inoculated with Rhizobium was observed[13].

In this experiment, urea, triple supper phosphate ware applied to T4 as a basal application that was only N and P sources for T4. But in other treatments there were different ways to supply those nutrients to the plant. The presence of sufficient amount of N and P in the soil caused to inhibit the nodulation[14,15]. It was proof in this research also which application on inorganic fertilizer significantly reduced the nodule number, fresh weight of nodules in soybean compare to organic nutrient sources.

Dry matter content (g) of shoot and root at 5th WAP: A significantly difference was observed in dry matter content of soybean at 5thWAP. The highest result was given by the application of Jeewamirtha. It was showed 20.68% increment for dry matter content of shoot in jeewarmirtha application

compared to the control. This should be due to high nitrogen fixing capability of microorganisms which are presented in the nutrient source of Jeewamirtha and thus the increment of the nutrient availability in the soil. Application of Jeewamirtha was caused to increase the leaf area of the plant. The photosynthesis rate could be increased due to higher leaf area and thus, the dry matter content of the plant can be increased. A microbial population in which has a combination of mycorrhiza and protozoa can be coursed to maximize the shoot height, stem, shoot biomass[16].

Table-3: Effects of different nutrients sources on shoot and root dry matter content (g/plant) of Glycince max at 5th WAP.

Treatments	Dry shoot weight(g)/plant	Dry root weight(g)/plant
Jeewamirtha (T1)	2.842± 0.147a	1.313±0.085a
Panchagavya (T2)	2.226± 0.068b	1.194±0.051ab
Amuthakaraisal (T3)	2.205± 0.070b	1.163± 0.032ab
Inorganic (T4)	2.355± 0.124b	1.021± 0.057b
F test	*	*

*is significant at 5% level while ns is not significant in probability. Mean values which are having the dissimilar letter indicate the significant differences at 5% level of significant according to the DMRT.

According to the dry matter content of root, the highest value was obtained from application of Jeewamirtha (1.313g). It was significantly differed from application of inorganic fertilizer. There was no significant difference observed among the organic nutrient sources (T2 and T3). Both fresh and dry weight caused to increase the growth performance of the plant. A vigorously grow plant can be a result of the more dry and fresh weight[17]. This may be due to better utilization of nutrients in the soil as well as in the atmosphere through inoculation of efficient microorganisms. The protozoan grazing altered microbial diversity and also strongly affects root architecture and increased the root length, length of fine roots and number of root tips[18] and also observed that increase in root biomass with the presence of amoeba in rice[19].

Conclusion

Tested parameters such as plant height, leaf area, nodules number, effective nodules, nodule weight, fresh and dry matter content of soybean were showed significant effects due to different types of nutrient sources. The study revealed that the highest result were given by the organic nutrient sources compare to the inorganic fertilizer. That should be due to the presence of beneficial microorganisms, containing both macro and essential micro nutrients, many vitamins, essential amino acids, growth promoting substances in the organic nutrient sources compare to control. The highest results were given by the application of Jeewamirtha compare to all other nutrient sources for all tested parameters. The application of organic fertilizer were given higher parameters for nodulation than the inorganic fertilizer application. It was156.33% of increment for application of Jeewamirtha compare to the application of inorganic fertilizer. Application of Panchagavya and Amuthakaraisal too showed 59.1% and 50.7% increment compared to inorganic fertilizer treatment, respectively. According to above results it could be concluded that application of Jeewamirtha on soybean as a nutrient source produced the greatest result on growth parameters and nodulation compared to inorganic fertilizer as well as other organic nutrient sources such as Panchagavya and Amuthakaraisal. Therefore, using Jeewamirtha can be used for cultivation of soybean as an alternative organic source of nutrient to obtain optimum growth in sustainable and environmental friendly manner.

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