EFFECT OF DIFFERENT LEVELS OF NITROGEN FERTILIZER AND JEEWAMIRTA APPLICATION ON GROWTH AND YIELD OF *Abelmoschus esculentus L.*

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ABSTRACT

Okra is one of the important vegetable of Sri Lanka. It can be response to the both organic and inorganic fertilizers to improve the growth and yield. Jeewamirta is an organic liquid fertilizer. The study investigated the "effect of different levels of Nitrogen fertilizers and Jeewamirta application on growth and yield of Abelmoschus esculentus L. This experiment was carried out in the Crop Farm, Eastern University of Sri Lanka as a pot experiment during January to April 2019. The experiment was with six treatments and eight replicates in a Completely Randomised Design. The treatments are T1 (100% Urea), T2 (75% Urea + 25% Jeewamirta), T3 (50% Urea + 50% Jeewamirta), T4 (25% Urea + 75% Jeewamirta), T5 (100% Jeewamirta), T6 (Urea + TSP + MOP (Department of Agriculture Recommendation)) and tested their performance on the growth and yield. Growth parameters and yield parameters shown significant increase treated with 25% Urea + 75% Jeewamirta (T4) in comparison with other treatments. This might be due to the presence of macro and micronutrients as well as growth promoting substances in Jeewamirta. The treatment receiving organic liquid fertilizer resulted in highest fungal population. The 25% Urea and 75% Jeewamirta (T4) increased plant height (20.89%), chlorophyll content (13.65%), number of leaves per plant (24.96%), number of pods per plant (21.09%), fresh and dry weight of roots (154.15%,193.50%), fresh and dry weight of shoot (85.52%, 105.01%) fresh and dry weight of pods (32.53%, 134.63%), length and girth of pods (27.72%, 39.19%), leaf area (37.72%) and total yield per hectare (61.11%) in comparison to plants applied with Control (T6). Therefore, the 25% Urea and 75% Jeewamirta fertilizer could be recommended for the cultivation of Abelmoschus esculentus L. In order to enhance the growth and yield, which is environmental friendly for Sustainable Agriculture.

Keywords: Abelmoschus esculentus L., Jeewamirta, Urea

INTRODUCTION

Okra, (*Abelmoschus esculentus* L.) Is an annual vegetable crop that grown throughout the tropical and the subtropical part of the world as sole crop or intercropped (Emuh *et al*., 2006). It is an annual, herbaceous, flowering plant belonging to the Malvaceae family. Okra is valued for its edible green pods, capsule that containing many seeds and is to be economic importance because of its nutritional value that has the potential to improve the food security (FAO, 2006).

In Sri Lanka, Okra (*Abelmoschus esculentus* L.) Is one of the mostly cultivated crop grown in Wet, Intermediate, and Dry zones (Department of agriculture, Sri Lanka., 2018). For the high production of okra, the nutrients such as Nitrogen (N), Potassium (K), Phosphorous (P), Calcium (Ca), Sodium (Na), Sulphur (S) which have the specific function and must be applied in optimum quantity at correct time. Okra responds well to the dressing of organic and

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inorganic fertilizers. Palm *et al.,* (1997) reported that the importance of organic and inorganic fertilizers as essential tools in okra production. Okra can be given the combination of both organic and inorganic fertilizers to improve the fruit yield and supply balance nutrient to the crop (Mario *et al.,* 1989).

Okra (*Abelmoschus esculentus* L.) Is good sources of Amino acid, Vitamins, Minerals, and Calories found in seeds (Brady and Welly, 1999). Despite the high nutritive value of okra, quality and optimum yield have not been attained because of continues decrease of soil fertility and low usage of organic fertilizers (Akanbi *et al.,* 2010).

Jeewamirta is an organic fertilizer, which has been used by the Indian farmers. Jeewamirta immense biological activities in the soil and makes the nutrient available to the crop (Palekar, 2006). Jeewamirta as an organic fertilizer has been poorly investigated. When animal manure efficiently and effectively used, ensures sustainable crop productivity by immobilizing nutrients that are susceptible to leaching. Nutrient which containing organic manure are released more slowly and are stored for a longer time in the soil thus ensuring longer residual effects; higher crop yield and improved root development (Sharma and Mittra, 1991).

Integrated of organic and inorganic fertilizers are accepted in many countries under the soil management strategy. Apart from enhancing the crop yield the practice has a beneficial residual effect that can be derived from the use of either inorganic or organic fertilizers applied alone. Combination of organic nitrogen have increasingly received recognition as integral and indispensable components of sustainable soil fertility management and significant advances also have been made on their influence on the soil chemical and physical properties (Palm and Rowland, 1997).

Application of the Nitrogen not only increases the growth and fruit yield but also improves soil characters by affecting soil fauna and flora. The deficiency of soil Nitrogen in soil allow the poor plant growth due to decline in soil fertility status. Therefore, the Nitrogen is an important element in plant nutrition; plants take it in significant levels. Sufficient Nitrogen improves the cell division, foliage production, and photosynthetic activity of plant, thus producing higher number of flowers and fruits (Sharma and Yadav, 1996). Knowledge about the integrated use of inorganic and organic fertilizers could enable the development of new agricultural approaches for improving Nitrogen management and contribute to developing models of sustainable agriculture (Saez *et al.,* 2012).

Ever increasing cost of energy would be an important constraint for increased use of chemical fertilizers in crop production, use of organic fertilizers to meet

requirement of crop would be an inevitable practice in years to come for sustainable agriculture.

Therefore, this study was carried out with the following Objective; to find out the effect of different levels of Jeewamirta and Nitrogen fertilizer on the growth and yield of *Abelmoschus esculentus* L.

METHODOLOGY

A pot experiment was conducted in the Crop Farm of Eastern University, Sri Lanka from January to April 2019, it is located in the latitude of 7° 43' N and the longitude of 81° 42' E. Which comes under the Agro Ecological Zone of Low Country Dry Zone (DL_2). The mean annual rainfall of this area ranges from 1400mm to 1680 mm, annual mean temperature varies from 30° to 36°C and major soil type of the experimental area is classified as sandy loam. This experiment was conducted using polythene bags. A number of three holes were made at the bottom of each pot to facilitate the drainage of water. The pots were filled with top soil: Compost: red soil in the ratio of 1:1:1 and a distance of 5 cm was left unfilled from the top of the soil to facilitate irrigation.

Okra variety "P 11" was used for this study and a quantity of 100g of seeds were collected from the Crop Farm in Faculty of Agriculture, Eastern University, Sri Lanka. Fertilizers were applied according to the treatment structure. Department of Agriculture, Sri Lanka recommended inorganic fertilizers were used in this experiment and Top dressing was carried out at 4th week after seeding.

The experiment consisted six treatments and eight replications. The experiment comprised with following treatments: T1 (100% Urea), T2 (75% Urea + 25% Jeewamirta), T3 (50% Urea + 50% Jeewamirta), T4 (25% Urea + 75% Jeewamirta), T5 (100% Jeewamirta), T6 (Urea + TSP + MOP (control)). Jeewamirta was applied with one-week interval from the 1st week after planting.

The pot experiment was laid out in Completely Randomized Design (CRD) with six treatments and eight replications. A number of 48 pots were used in this experiment and each pot contained one plant. All the agronomic practices were carried out in accordance with recommendation made by the Department of Agriculture, Sri Lanka. The parameters viz. Plant height, number of leaves per plant, chlorophyll content of leaves, total biomass, number of flowers per plant, tap root length, number of pods per plant and fresh weight of pods at harvest were measured. Data measured were statistically analyzed using SAS 9.1 and the mean comparison within treatments was performed by Duncan Multiple Range Test at 5 % significant level.

DISCUSSION AND RESULTS

01. Leaf area (cm^2)

Leaf area was significantly different at different stages of growth (Table 1.0). The maximum leaf area was recorded in T4 followed by T5, T1, T2, T6 and the minimum leaf area was recorded in T3 at 7 WAP. This significant increase of leaf area due to the application of 75% of Jeewamirta liquid fertilizers to the T4. It may be due to growth hormones in the plants were induced by soil application of liquid organic formulations which have more beneficial microbes and leads to the activation of cell division and cell elongation in the auxiliary buds which had a promoting effect in increased number of leaves and leaf area and application of Jeewamirta might be induce the solubilization of nutrients in soil and absorption of nutrients and moisture in the same line as reported by Yogananda *et al*. (2015); and Siddappa *et al*. (2016).

Yogananda *et al.,* 2015 reported that application of Jeewamirta at 1000 l/ha has recorded higher leaf area (1039.56 cm^2) compared to without application of Jeewamirta (588.62 cm^2). Increase in growth attributes might be attributed to solubilisation of nutrients in soil and absorption of nutrients and moisture due to soil application of Jeewamirta. These findings are in line with those reported by Boraiah, (2013).

Table 1.0 Different levels of Nitrogen fertilizers and Jeewamirta application on Leaf area of Abelmoschus esculentus L.

Treatment	Leaf area (cm^2)
T1	**757.59±0.99^{c}**
T2	**764.78±1.19^{c}**
T3	**932.24±1.17^{b}**
T4	**1177.85±0.93^{a}**
T5	**889.19±0.79^{bc}**
T6	**855.19±0.83^{bc}**
F-test	*

Value represents mean ± standard error of 8 replicates. *= Significant at 5% level of probability. Mean values in a column having the dissimilar letter/letters indicates significant difference at 5% level of significance (DMRT).

02. Number of flowers per plant

The Table 2.0 showed the Number of flowers per plant of *Abelmoschus esculentus* at 4 and 5 weeks after planting. The data showed that application of 75% Jeewamirta liquid fertilizer and 25% of urea had significant increase in number of flowers per plant when compared to control plants. At 4 WAP there was a significant differences ($p < 0.05$) between Treatments compared with control. Similar trend was observed 5 WAP.

The maximum Number of flowers per plant was recorded in T4 followed by T5, T3, T2, T6 and the minimum number of flowers plant was recorded in T1 at 5 WAP. This

significant increase of number of flowers due to the application of 75% Jeewamirta liquid fertilizer and 25% of urea to T4.

This may due to the presence of hormonal substances in the Jeewamirta, especially Cytokinins. In reproductive stage higher levels of Cytokinins are associated with nutrient mobilization (Khan *et al.,* 2009). Crop yield is associated with number of flowers at maturity. The number of plants produced are associated with the development stages of plant.

When considering the treatment applied with Jeewamirta 75% and 100% there were no significant differences ($p<0.05$) observed. Growth regulators probably stimulate flower initiation and hence enhance the number of flowers per plant. The treatment receiving Jeewamirta starting flowering earlier than without Jeewamirta application. Same trend was observed by Palekar (2006) in okra.

Table 2.0 Different levels of Nitrogen fertilizers and Jeewamirta application on Mean number of flowers per plant of Abelmoschus esculentus L.

Treatment	4WAP	5WAP
T1	1.87±0.72^{b}	2.37±0.70^{b}
T2	1.62±1.06^{b}	2.87±0.48^{b}
T3	2.12±0.72^{b}	3.00±1.46^{b}
T4	2.75±0.94^{a}	3.87±1.14^{a}
T5	2.00±1.09^{b}	3.12±0.87^{b}
T6	2.12±1.31^{b}	2.37±1.02^{b}
F-test	*	*

Value represents mean ± standard error of 8 replicates. *= Significant at 5% level of probability. Mean values in a column having the dissimilar letter/letters indicates significant difference at 5% level of significance (DMRT).

03. Biomass of shoot and root (g)

Fresh weight of shoot and root were significantly affected by the 75% of Jeewamirta application. As shown in Table 3.0, the maximum fresh weight of shoot was recorded in T4 followed by T1, T3, T6, T5 and the minimum in T2.this was due to the increased shoot height due to application of Jeewamirta which have macro and micro nutrients as well as growth regulators as cytokine and Gibbrellic acid which help in producing higher biomass and better recovery of N and P in plant. Similar finding has been reported by Beaulah (2001).

The maximum fresh weight of root were recorded in T4 followed by T3, T1, T6, T5 and the minimum in T2. The reasons of increase root length are may be due to enhancement of the physical, chemical and biological conditions of the soil which facilitated the better growth and development of the roots. Soil micro flora and fauna which has consequently increased the enzymatic activity and helped in mineralization, solubilization of native and applied nutrients and making them available in soil for plant uptake.

Vasanthakumar (2006) and Devakumar *et al.,* (2008) reported the beneficial effect of Jeewamirta which was attributed to huge quantity of microbial load and growth hormones which in turn might have enhanced the soil biomass, thereby sustaining the availability uptake of applied as well as native soil nutrients which ultimately have resulted in better growth and yield of crops. These finding are conformity with the results of Sharma and Thomas (2010).

Table 3.0 Different levels of Nitrogen fertilizers and Jeewamirta application on biomass of shoot and root of Abelmoschus esculentus L.

Treatments	Biomass of shoot (g)	Biomass of root (g)
T1	4.00±0.90^{b}	1.01±0.73^{b}
T2	3.40±0.99^{b}	0.73±0.43^{b}
T3	3.33±0.67^{b}	0.97±0.43^{b}
T4	8.18±1.25^{a}	2.26±1.97^{a}
T5	3.19±1.12^{b}	0.62±0.66^{b}
T6	3.99±0.94^{b}	0.77±0.85^{b}
F-test	*	*

Value represents mean ± standard error of 8 replicates. *= Significant at 5% level of probability. Mean values in a column having the dissimilar letter/letters indicates significant difference at 5% level of significance (DMRT).

04. Chlorophyll content of leaves

The Table 5.0 showed the chlorophyll content of the leaves of *Abelmoschus esculentus* from 4 weeks after planting up to 7 weeks after planting. The maximum Chlorophyll content was recorded in T4 followed by T5, T6, T2, T3 and the minimum plant height was recorded in T1 at 7 WAP. This application of 75% of Jeewamirta liquid fertilizers to the T4 significantly increase the chlorophyll content of leaves.

Chlorophyll content was also more in plants receiving liquid organic fertilizers. Chlorophyll content increased gradually in all the treatments because of more enzyme activity and production of growth promoters (Krishnan, 2014). The results agree with the finding of Gathala *et al.,* (2007), where the application of organic inputs especially foliar spray of liquid organic fertilizers showed accumulation of nutrients in leaf tissues, which in turn ensured better photosynthetic efficiency causing greater synthesis, translocation and accumulation of carbohydrate and chlorophyll. It was previously reported by Vadiraj *et al.* (1998) that the nitrogen being the major constituent of chlorophyll therefore increases in nitrogen availability leads to increase in chlorophyll content. Significant increase in chlorophyll content was recorded due to increased absorption of nutrients, which resulted in increased synthesis of carbohydrates and increased activity of hormones produced by *Azospirillum* and phosphate solubilizing bacteria.

Table 5.0 Different levels of Nitrogen fertilizers and Jeewamirta application on chlorophyll content of Abelmoschus esculentus L.

Treatment	Chlorophyll content
T1	46.23±1.10^{d}
T2	48.56±1.19^{cd}
T3	47.55±1.30^{cd}
T4	56.77±0.95^{a}
T5	52.72±0.63^{b}
T6	49.95±0.56^{c}
F-test	*

Value represents mean ± standard error of 8 replicates. *= Significant at 5% level of probability. Mean values in a column having the dissimilar letter/letters indicates significant difference at 5% level of significance (DMRT).

05. Fresh and dry weight of pods (g)

As shown in Table 6.0, the maximum fresh weight of pods was recorded in T4 followed by T3, T2, T6, T1 and the minimum in T5, maximum dry weight of pods were recorded in T4 followed by T3, T1, T2, T5. Application of 75% Jeewamirta significantly ($P<0.05$) increased the fresh and dry weight of pods over control plants. Which may due to the cytokine present in Jeewamirta liquid fertilizer (Ravikumar *et al.,* 2011) where reported that application of Jeewamirta enhanced the yield.

This results were in agreement with Vemaraju (2014) where reported that the treatment receiving Jeewamirta was found to be superior in terms of number of fruits per plant, weight of fruits per plant, yield per hectare and dry matter production in organic oriental pickling melon.

Table 6.0 Different levels of Nitrogen fertilizers and Jeewamirta application on Fresh and Dry weight of pods in Abelmoschus esculentus L.

Treatment	Fresh weight (g)	Dry weight (g)
T1	12.33±0.98^{b}	2.67±0.88^{c}
T2	12.77±1.12^{b}	2.58±0.61^{c}
T3	13.36±1.19^{b}	3.72±1.53^{b}
T4	16.66±0.69^{a}	5.42±0.86^{a}
T5	11.92±1.07^{b}	2.37±0.92^{c}
T6	12.57±0.82^{b}	2.31±0.93^{c}
F-test	*	*

Value represents mean ± standard error of 8 replicates. *= Significant at 5% level of probability. Mean values in a column having the dissimilar letter/letters indicates significant difference at 5% level of significance (DMRT).

06. Total yield per hectare (t/ha)

The Table 7.0 Showed the total yield per hectare of *Abelmoschus esculentus* at 7 weeks after planting. The data showed that application of 75% Jeewamirta liquid fertilizer had highest total yield when compared to other treatments. The maximum yield was recorded in T4 followed by T3, T6, T1, T5 and the minimum yield was recorded in T2 at 7 WAP. This significant increase of total yield due to the application of 75% of Jeewamirta liquid fertilizers and 25% of Nitrogen fertilizer as basal to the T4.

In the present investigation, application of Jeewamirta at 1000 l/ha recorded significantly higher grain yield (1412 kg/ha) with an increase of 50.28% compared to without Jeewamirta application (702 kg/ha). Similarly, significantly higher haulm yield was also recorded with Jeewamirta at 1000 l/ha (4957 kg/ha) with an increase of 37.10% compared to without Jeewamirta application (3118 kg/ha) the increase in yield and haulm yield due to application of Jeewamirta 1000 l/ha could be due to better availability of nutrient throughout the crop growth which was ensured further by improved microbial activity in the soil (Kasbe *et al.,* 2009) wherein it is reported that higher nutrient status of Jeewamirta formulation (2500 l/ha) resulted in professed growth in the form of higher dry matter accumulation and yield parameter.

Table 7.0 Different levels of Nitrogen fertilizers and Jeewamirta application on the Total yield of Abelmoschus esculentus L.

Treatment	Total yield (t/ha)
T1	**0.51±0.85^{b}**
T2	**0.49±0.56^{b}**
T3	**0.56±1.12^{b}**
T4	**0.87±1.38^{a}**
T5	**0.50±1.13^{b}**
T6	**0.54±0.70^{b}**
F-test	*

Value represents mean ± standard error of 8 replicates. *= Significant at 5% level of probability. Mean values in a column having the dissimilar letter/letters indicates significant difference at 5% level of significance (DMRT).

CONCLUSIONS

This study showed that 75% of Jeewamirta and 25% urea significantly increased the growth and yield of *Abelmoschus esculentus* L. When compared to control plants. In this investigation, the statistical analysis of data proved that 75% Jeewamirta liquid fertilizer and 25% Urea gave the best performance when compared to control.

The 25% Urea and 75% Jeewamirta (T4) increased plant height (20.89%), chlorophyll content (13.65%), number of leaves per plant (24.96%), number of pods per plant (21.09%), fresh and dry weight of roots (154.15%, 193.50%), fresh and dry weight of

shoot (85.52%, 105.01%) fresh and dry weight of pods (32.53%, 134.63%), length and girth of pods (27.72%, 39.19%), leaf area (37.72%) and total yield per hectare (61.11%) in comparison to plants applied with Control (T6).

Therefore, the 75% Jeewamirta and 25% urea fertilizer could be recommended for the cultivation of *Abelmoschus esculentus* L. In order to enhance the growth and yield which is environmental friendly for Sustainable Agriculture.

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