2023 International Research Conference of Sri Lanka Technology Campus
Colombo, Sri Lanka. 14th-15th December 2023

Developing a Fertilizer Recommendation for Gurmar (Gymnema sylvestre) in the Wet Zone of Sri Lanka

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***Abstract*—Gurmar *(Gymnema sylvestre)* is a rare medicinal plant native to Asia, Africa, and Australia with valuable properties in Ayurveda medicine. This vine helps treat diabetes in patients. As this plant is rare and valuable, it requires development as plantations to increase production and meet the demand. However, there is no proper fertilizer recommendation for this plant. As such, this study aimed to identify optimal fertilizers for high Gurmar plant yield. For this, Urea, TSP (Triple Super Phosphate), and MOP (Muriate Of Potash) were used as a mixture and tested from different rates (Control, +50% controls' weight, -50% controls' weight) with a basal dressing and two top dressings, mainly aiming the vegetative growth of the plants. The number of leaves and plant height were evaluated for 13 Weeks After Planting (WAP). Results showed a significantly higher number of leaves and plant heights in all basal and top dressings with +50% controls' weight. This finding can be used in further research and effectively utilized in the maintenance of large-scale *G. sylvestre* plantations in the wet zone of Sri Lanka.**

Keywords—Gymnema sylvestre, vegetative growth, basal dressing, top dressing, chemical fertilizers

I. INTRODUCTION

The Gurmar plant (*Gymnema sylvestre*) is an Ayurvedic medicinal plant with valuable medicinal properties. It can also be classified as a perennial woody vine. This Gurmar plant belongs to the "Asclepiadacea" family [1]. Not only the leaves but other parts of this plant such as bark, roots, and flowers have medicinal properties. Native to Asia, Africa, and Australia, this vine has been recognized for its potential to treat diabetes in humans. That is, this plant has a strong ability to suppress the taste sensation of sweet substances for several hours. Other than that, *G. sylvestre* has antimicrobial, hypolipidemic, and anti-arthritic activities. This plant is also known as 'Gudmar' because of its rare ability to destroy the sweet taste. The main reason for the plants' anti-diabetic properties can be attributed to the fact that the leaves contain a mixture of tri-terpenes and saponins (Gymnemic acids, Gymmagenin, and Gurmarin) [2]. Recent studies have confirmed that Gymnemic acid is useful for treating diabetes and controlling blood sugar. It also contains cholesterol-lowering, blood-sugar-lowering, anti-cancer and antioxidant properties. Currently, there is an ongoing demand for this plant species due to its medicinal properties. So, to meet the increasing demand and to start the cultivation of the *G. sylvestre* plant on a large scale, it is essential to increase the

growth rate of the *G. sylvestre* plant and to obtain a quantitative and qualitative plant yield. A study conducted in India showed that applying 4000 kg FYM (Farm Yard Manure)/ha is promising for the growth and yield of this plant on a large scale [3]. Therefore, this experiment aimed at developing a proper fertilizer recommendation to improve the growth rate of this plant which can be effectively used in the wet zone of Sri Lanka.

II. METHODOLOGY

This experiment was conducted as open field cultivation from February 2023 to May 2023 at SLTC Research University (6.8557° N, 80.0926° E, 27 m above mean sea level, located in the Low Country Wet zone (WL1a)) Ingiriya Road, Padukka, Sri Lanka. This area has red-yellow podzolic soil. The three-week-old plants were purchased from a certified, local nursery. The plants were established in the field with a spacing of 1 m × 0.75 m. The depth of a planting hole was 0.3 m. Before the application of chemical fertilizers, each hole was filled with 100 g of compost. Also, chemical fertilizers that provide three main nutrients to the plants, (N (Nitrogen), P (Phosphorous), and Potassium (K)) were used which are Urea (46% N), TSP (44% P_2O_5) and MOP (60% K_2O). In this experiment, three treatments were used depending on the application rates (Table I). Treatment 1 (T1) was considered as the control rate and treatment 2 (T2) and 3 (T3) were decided as +50% and -50% from the weight of fertilizers applied in the control rate respectively. The basal dressing was applied to planting holes before planting the plants. After 4 and 8 WAP (Weeks After Planting), top dressings one and two were applied respectively. The first readings of *G. sylvestre* plants were taken 3 WAP and continued up to 13 weeks. The parameters obtained were number of leaves and plant height (cm). The experiment was laid out in Randomized Complete Block Design (RCBD) with ten replications per treatment. Data were analyzed using the ANOVA test and the mean separation was done using Tukey's test. Minitab 19 was used as the statistical software.

III. RESULTS

A. Basal Dressing

The effect of basal dressing was identified in weeks of 3, 4, and 5 of WAP. There, significantly the highest number of leaves were observed with the application rate of +50% controls' weight treatment (T2) during 3 (68.00 ± 5.22), 4 (86.10 ± 6.17), and 5 (106.4 ± 8.35) WAP. A similar trend could be observed with the plant heights, where the same treatment resulted in a mean height of 43.90 ± 3.25 cm, 59.60 ± 2.42 cm, and 72.00 ± 2.89 cm during 3, 4, and 5 WAP respectively (Table II).

B. Top Dressing 01

The effect of top dressing 01 was evaluated with the results of 6, 7, 8, and 9 WAP. Same as the basal dressing best results were given with application rate of +50% controls' weight treatment (T2). A continuous increment of the leaf number and plant heights were observed with that and importantly, the results were significantly different from the other two treatments. In contrast, 7 (23.00 ± 3.90) and 9 (41.00 ± 5.70) WAP the lowest number of leaves were given with the control rate (Tab. 3).

C. Top dressing 02

The top-dressing effect for the second time was studied during the 10, 11, 12, and 13 WAP of the Gurmar plants. According to the results, it can be shown that +50% controls' weight treatment (T2) could give significantly the highest number of leaves and the highest plant height even during the latter weeks of the experiment. However, importantly when it comes to the final weeks it could be observed that significantly the lowest number of leaves had been given with the control rate (Tab. 4)

TABLE 1. THE RATE OF FERTILIZER APPLICATION IN BASAL DRESSING, TOP DRESSING 1, AND TOP DRESSING 2

	Basal Dressing (g/plant)			**Top Dressing 1 (g/plant)**			**Top Dressing 2 (g/plant)**		
Fertilizer	***T_1 (Control)***	***T_2 (T_1+$T_1$50%)***	***T_3 (T_1-$T_1$50%)***	***T_1 (Control)***	***T_2 (T_1+$T_1$50%)***	***T_3 (T_1-$T_1$50%)***	***T_1 (Control)***	***T_2 (T_1+$T_1$50%)***	***T_3 (T_1-$T_1$50%)***
Urea	30	45	15	30	45	15	30	45	15
TSP	60	90	30	-	-	-	60	90	30
MOP	25	37.5	12.5	-	-	-	-	-	-

TABLE II. EFFECT OF BASAL DRESSING ON THE NUMBER OF LEAVES AND PLANT HEIGHT

	Number of Leaves			**Plant Height (cm)**		
Treatment	***3 WAP***	***4 WAP***	***5 WAP***	***3 WAP***	***4 WAP***	***5 WAP***
T1 (Control)	10.143 ± 0.857 [b]	11.71 ± 1.17 [b]	13.57 ± 1.39 [b]	12.71 ± 1.11 [c]	19.43 ± 1.99 [b]	25.29 ± 3.44 [b]
T2 (+50%)	68.00 ± 5.22 [a]	86.10 ± 6.17 [a]	106.4 ± 8.35 [a]	43.90 ± 3.25 [a]	59.60 ± 2.42 [a]	72.00 ± 2.89 [a]
T3 (-50%)	22.78 ± 2.27 [b]	27.00 ± 2.79 [b]	32.11 ± 3.64 [b]	25.33 ± 3.37 [b]	28.89 ± 3.86 [b]	32.67 ± 4.58 [b]

Values in each column represent the means of 10 replicates ± SE (Standard Error). The mean followed by the same letter within each column is not significantly different at p<0.05.

TABLE III. EFFECT OF TOP DRESSING 01 ON THE NUMBER OF LEAVES AND PLANT HEIGHT

	Number of Leaves				Plant Height (cm)			
Treatment	***6 WAP***	***7 WAP***	***8 WAP***	***9 WAP***	***6 WAP***	***7 WAP***	***8 WAP***	***9 WAP***
T1 (Control)	14.00 ± 1.62 [b]	23.00 ± 3.90 [c]	32.43 ± 4.54 [b]	41.00 ± 5.70 [c]	28.29 ± 4.30 [b]	33.57 ± 4.34 [b]	40.14 ± 4.20 [b]	52.14 ± 5.48 [b]
T2 (+50%)	121.70 ± 9.66 [a]	141.5 ± 10.10 [a]	157.30 ± 12.30 [a]	174.7 ± 13.20 [a]	81.40 ± 4.29 [a]	99.60 ± 5.50 [a]	118.50 ± 6.70 [a]	138.10 ± 7.86 [a]
T3 (-50%)	39.78 ± 5.03 [b]	51.56 ± 4.54 [b]	64.67 ± 6.06 [b]	80.22 ± 8.27 [b]	35.22 ± 5.14 [b]	47.00 ± 5.66 [b]	57.56 ± 5.66 [b]	66.89 ± 6.54 [b]

Values in each column represent the means of 10 replicates ± SE (Standard Error). The mean followed by the same letter within each column is not significantly different at p<0.05.

TABLE IV. EFFECT OF TOP DRESSING 02 ON THE NUMBER OF LEAVES AND PLANT HEIGHT

	Number of Leaves				Plant Height (cm)			
Treatment	***10 WAP***	***11 WAP***	***12 WAP***	***13 WAP***	***10 WAP***	***11 WAP***	***12 WAP***	***13 WAP***
T1 (Control)	50.00 ± 8.36 [c]	60.43 ± 9.29 [c]	70.70 ± 11.80 [c]	83.70 ± 13.10 [c]	59.86 ± 6.42 [b]	73.00 ± 9.64 [b]	82.10 ± 12.40 [b]	90.10 ± 15.00 [b]
T2 (+50%)	185.10 ± 13.10 [a]	196.50 ± 13.30 [a]	212.50 ± 14.90 [a]	226.50 ± 15.90 [a]	155.70 ± 10.20 [a]	171.90 ± 10.70 [a]	190.40 ± 12.50 [a]	210.20 ± 13.40 [a]
T3 (-50%)	99.30 ± 11.00 [b]	114.90 ± 12.40 [b]	130.70 ± 15.80 [b]	145.00 ± 18.20 [b]	75.67 ± 6.98 [b]	87.78 ± 8.79 [b]	102.33 ± 9.53 [b]	111.89 ± 9.56 [b]

Values in each column represent the means of 10 replicates ± SE (Standard Error). The mean followed by the same letter within each column is not significantly different at p<0.05.

IV. DISCUSSION

Increased fertilizer use can result in modest but important and rapid gains in yields. In other words, to get a sustained yield, 'necessary' and 'sufficient' nutrients should be available to the plants. On the other hand, most soils require the application of both organic and inorganic fertilizers to reach adequate nutrition levels [4] and the quality of plants may suffer if chemical fertilizers or organic manure are used alone as amendments. Moreover, regardless of the agroecological zones, applying organic manure to all crop groups has been advised to increase crop yield in Sri Lanka [5]. Therefore, in this experiment, all the fertilizer application rates tested were priory provided with compost to ensure the sustainability of the cultivation. Depending on the goal of increasing productivity, different nutrients are required for different levels of crop growth [4]. As the primary aim of cultivating *Gymnema* plants was to harvest their leaves, this study aimed to improve the vegetative part of the crop. Because of that when preparing this recommendation, priority was given to improve the leaf production and height of the plants. This recommendation was created by combining and modifying several crop fertilizer recommendations; such as *Vitis vinifera* (grapes), *Passiflora edulis* (passion fruits), *Trichosanthes cucumerina* (snake gourds), and *Alternanthera sessilis* (Mukunuwenna) available specifically for the wet zone region. Sri Lanka currently advises applying N, P, and K primarily to all crops out of the 17 essential nutrients needed for plant growth [5].

N is a crucial building block of organic molecules, and a lack of it can delay phenological development, reduce crop growth, and lower yield. P is essential for root system development, and water-soluble P fertilizers like TSP can provide rapid availability of nutrients. K is the most prevalent inorganic cation, essential for healthy plant growth and activating enzymes involved in protein synthesis, sugar transport, N and Carbon (C) metabolism, and photosynthesis. K also contributes to yield and quality improvement.

It is advisable to apply N fertilizers multiple times during growth to improve efficiency, which is known as the split application of fertilizers [6]. When N is applied in two split doses than in a full basal application yield can be improved. Therefore, in this experiment, urea was applied as two more top dressings other than the basal dressing (Table I). When looking into the results since all three treatments have given continuous increments of the plants' vegetative growth it can be shown that the split application of urea has a positive impact on the growth of Gurmar plants (Table II).

From the date of transplanting up to the top dressing 1 the required N, P, and K nutrients come mainly from the basal dressing and the rapidly decomposable soil organic fraction. When a lot of base fertilizer is applied, both the N from the base fertilizer and the N from the soil are more readily absorbed, which speeds up plant growth [7]. The same scenario may have occurred with P and K where the +50% fertilizer application rate (T2) resulted in the highest yield within the respective period (Tab. 2).

According to reference [8] on potato plants, it was revealed that while the increase in P and K fertilizers had no significant effect on plant height, the addition of N fertilizers did have an impact. They have further concluded that this is due to the plant experiencing robust growth as a result of a fairly large N application dose. Current results of higher plant height and number of leaves may have been created with the applied urea. By increasing the N content up to 45 g/plant (T2) while providing the highest amount of P and K fertilizers in three application times, it is possible to achieve relatively higher growth without any signs of nutrient toxicity in plants. It has been proven that applying an excessive amount of chemical fertilizers will not increase crop output [5]. This means the +50% application rate of fertilizer for Gurmar plants cultivated in the wet zone of Sri Lanka does not create any toxic conditions for the plants. However, further investigation is necessary to determine if the current proposed application rate can be increased without causing toxic effects on plants while remaining economically viable and chemical composition. Meantime looking for more organic amendments to substitute the nutrient requirement that can be provided solely by chemical fertilizers is highly recommended to maintain *Gymnema* plantations sustainably. It is recommended to explore future research directions by conducting field trials in representative sites in the Wet Zone of Sri Lanka where *G. sylvestre* is commonly cultivated. In this regard, it is important to consider variations in soil types, climate, and other environmental factors.

Also, it is crucial to conduct a thorough soil analysis to determine the nutrient levels, pH, and other properties of the soil in the cultivation area. It is highly recommended to perform additional trials to validate the developed fertilizer recommendations to ensure that they can be used in different seasons and locations within the Wet Zone.

V. CONCLUSION

As *Gymnema sylvestre* gains popularity for its ability to treat diabetes in humans, the demand for its vegetative parts is also increasing. To meet the demand through qualitatively and quantitively improved yield, maintaining *Gymnema* plants in large-scale plantations is mandatory. For that plants should be provided with a balanced N, P, and K fertilizer mixture, and the current experiment was conducted with that aim. Results showed that when *Gymnema* plants were cultivated in the wet zone of Sri Lanka, providing one plant with 45, 90, 37.5 g N, P, K respectively as a basal dressing, 45 g/ plant N in top dressing 1 and 45, 90 g/ plant N and P respectively as top dressing 2 gave the highest yield when applied with compost 100 g/plant. Further investigation is needed to determine if increasing the proposed application rate would be safe for plants and economically feasible. Meantime experiments should be conducted to study the relationship between increment of fertilizer dose with the chemical constituents of the plants.

REFERENCES

[1]. P. Kanetkar, R. Singhal, and M. Kamat, "*Gymnema sylvestre*: A memoir," J. Clin. Biochem. Nutr., vol. 41, pp. 77-81, 2007.

[2]. S. Laha, and S. Paul, "*Gymnema sylvestre* (Gurmar): A potent herb with anti-diabetic and antioxidant potential", Pharmocogn. J., vol. 11, pp. 201–206, 2019.

[3]. A. K. Pandey, "Cultivation technique of an important medicinal plant *Gymnema sylvestre* R Br (Gurmar)," Acad. J. Plant Sci., vol. 5, pp. 84-89, 2012

[4]. B.A. Larson, and G.B. Frisvold, "Fertilizers to support agricultural development in sub-Saharan Africa: What is needed and why", Food Policy, vol. 21, pp. 509-525, 1996.

[5]. P. Weerasinghe, "Best practices of integrated plant nutrition system in Sri Lanka," in Best Practices of Integrated Plant Nutrition System in SAARC Countries, F. N. Jahan and T. R. Gurung, Eds. Dhaka: SAARC Agriculture Centre, 2017, pp. 135-160.

[6]. A.A. Salardini, L.A. Sparrow, and R.J. Holloway, "Sweet corn responses to basal and top-dressed rates and sources of nitrogenous fertilizers," Aust. J. Agric. Res., vol. 43, pp. 171-180, 1992.

[7]. G. Wada, S. Shoji, and T. Mae, "Relationship between nitrogen absorption and growth and yield of rice plants," J.A.R.Q., vol. 20, pp. 135-145,1986.

[8]. R.C. Adhikari, "Effect of NPK on vegetative growth and yield of Desiree and Kufri Sindhuri potato," J. Nep. Agric. Res., vol. 9, pp. 67-75, 2009.