**Velvet Bean (*Mucuna pruriens* L.) as an alternative to failed fallow farming: Impacts on Okra [*Abelmoschus esculentus* (L.) Moench] production in Ibadan, Nigeria**

**ABSTRACT**

Crop production continues to decline as a result of the failed fallow farming. The inclusion of nodulating leguminous low-growing plants such as *Mucuna* *pruriens* in the cropping systems can improve soil health for increased crop performance. *Mucuna* *pruriens* is underutilized in Nigeria despite its acknowledged values in agriculture. Therefore, the stand density of *M*. *pruriens* and its green manure potential on the performance of okra (*Abelmoschus esculentus*) were investigated in Ibadan, Nigeria.

The experiment was laid out in a randomized complete block design with five treatments (stand density) replicated three times. The treatments were 0 (MP0), 20,000 (MP20), 62,500 (MP62.5), 137,500 (MP137.5), and 262,500 (MP262.5) stands/ha of *M. pruriens*. At 42 days after sowing, the ground cover of *M. pruriens* was determined and the plants were incorporated into the soil, allowing three weeks for decomposition. Okra seeds were sown on each of the prepared plots at a 50 × 50 cm spacing. At seven weeks after sowing data were obtained on dry weight (g), number of flowers and fruit weight (g) of okra and dry weight (g) of weeds. Data were analyzed using ANOVA at α0.05.

With the increasing density of *M. pruriens*, its cover increased, the field cover of other weed species decreased and the fruit weight of okra increased. The cover of *M. pruriens* under only MP262.5 (4.07 hits) was significantly higher than the control (0.00 hits). The dry weight of weeds in MP20 (200.8), MP62.5 (154.1), MP137.5 (86.1), and MP262.5 (49.2) treatments were significantly lower than control (429.0). The fruit weight of okra in MP137.5 (15.50) and MP262.5 (18.8) treatments was significantly higher than control (3.99).

*Mucuna pruriens* stands at a density of 262,500 stands/ha is the appropriate density to attain optimal cover for weed management on the field. Additionally, *M*. *pruriens* can be used as green manure to increase okra fruit yield.

**Keywords:** Fallow farming, Mucuna Green Manure, okra, organic farming.

**INTRODUCTION**

The failure of fallow farming necessitated intensive agriculture with the attendant inputs such as fertilizers and pesticides to cope with reduced soil nutrients, and the outbreak of noxious weeds, other pests and diseases. The immoderate use of synthetic nitrogen fertilizers poses serious threats to the ecosystem, and the health of humans and livestock; these include water pollution, soil pollution and health disorders Chandini (2019). Plants use about 40-50% of nitrogen fertilizers applied, the remaining 50-60% pollutes surface water as a run-off and ground water as leachate (Chandini, 2019), and is given off to the atmosphere as N2O through volatilization (Egberongbe *et al*., 2017). Excessive nitrogen application damages the structure of the soil microbial community, causes a constant loss of soil nitrate nitrogen, and interferes with plants' ability to absorb nutrients (Cusack *et al*., 2016). According to Chandini (2019), the use of nitrogen fertilizers causes nitrate to build up in ground water and has been connected to health disorders such as blue baby syndrome and gastric cancer. Furthermore, the production of some of these fertilizers has been linked to global warming. Menegat *et al*. (2022) reported that greenhouse gases such as CO2, CH4 and N2O are emitted during the manufacturing process of synthetic fertilizers which requires high energy. Nodulating leguminous weeds used as green manure could serve as an alternative to the use of synthetic nitrogen fertilizers, these include *Sesbania* *pachycarpa* (Egberongbe *et al*., 2017), *Mimosa* *diplotricha* (Tanimola *et al*., 2020) and *Mucuna* *pruriens* (Adeniji *et al*., 2022)

*Mucuna* *pruriens* is a twining legume that is distributed in tropical and sub-tropical regions of the world (Nooreen *et al*., 2023), and has a rapid growth rate and readily nodulates (Adeniji *et al*., 2022). The legume plays a significant role in agriculture. The efficacy of *Mucuna* *pruriens* in the management of some noxious weeds has been documented. According to Kanatas *et al*. (2020), *M*. *pruriens*'s rapid growth rate and canopy closure are two traits that contribute to its capacity to suppress weeds, particularly in favorable environments. Also, in an allelopathic investigation, aqueous extracts of velvet bean portions significantly decreased the biomass of speargrass (Ochekwu and Udensi, 2015). Similarly, Travlos *et al*. (2018) observed that the growth and yield of stiff ryegrass were suppressed by velvet bean residues. The legume is effective in the management of some plant parasitic nematodes found in Nigerian soil (Adediran *et al*., 2005; Adeniji *et al*., 2023). The legume Additionally, the plant has nodules on its roots that aid in fixing nitrogen in the soil, which improves crop performance. According to Adeniji *et al*. (2022), the application of velvet bean as sown fallow and green manure significantly enhanced the performance *Amaranthus* *cruentus*.

Although, various researchers have documented the numerous importance of *Mucuna pruriens* in agriculture despite that it is still underutilized in Nigeria. Thus, this study's objectives were to ascertain the appropriate stand density of *Mucuna* *pruriens* on the field needed to attain optimal cover for weed control and to evaluate the influence of *Mucuna pruriens* green manure on the performance of okra.

**MATERIALS AND METHODS**

**Experimental site and materials**

The experiment was carried out at the Crop Garden of the Department of Crop Protection and Environmental Biology (CPEB), University of Ibadan, Ibadan, Nigeria during raining season for a period of five months (June, 2017 to November 2017). The Crop Garden lies on latitude 7o27`03.2``N and longitude 3o35`49.0``E and stands at an elevation of 218 m above sea level.

Seeds of *Mucuna pruriens* were obtained from the Teaching and Research Farm, University of Ibadan, while seeds of *Abelmoschus esculentus* were obtained from the National Horticultural Research Institute (NIHORT), Ibadan.

**Experimental design and procedure**

The experiment was laid out in a randomized complete block design at the CPEB Crop Garden. There were five treatments and three blocks (replicates). The dimension of the experimental field was 10 m × 20 m (200 m2). Each block (20m × 2m) was subdivided into 5 plots (2 m × 2 m each). The five treatments were:

1. 262,500 *M. pruriens* stands/ha (10cm × 50cm) - MP262.5
2. 137,500 *M. pruriens* stands/ha (20cm × 50cm) – MP137.5
3. 62,500 *M. pruriens* stands/ha (50cm × 50cm) - MP62.5
4. 20,000 *M. pruriens* stands/ha (100cm × 50cm) - MP20
5. 0 *M. pruriens* stands/ha (control) - MP0

The field was cleared and left for two weeks for weed seedlings to re-establish, and then *Mucuna pruriens* seeds were sown at two seeds per hole. Paraquat herbicide was then applied to kill the reestablished weeds to have a clean field. Poisoned baits were used for the control of rodents. Germination commenced four days after sowing. The *M. pruriens* plants were allowed to grow and establish for 42 days (before flowering) on the various treatment plots, after which the cover of plants was determined using the point intercept method (Floyd and Anderson, 1987). A straight metal rod was placed in five strategic locations within each plot and the number of times *M. pruriens* or other weed plants hit the rod were taken and recorded. The five strategic locations comprise four positions along the two diagonals and one in the middle of each plot.

*Mucuna pruriens* plants were cut into tiny pieces, incorporated into the soil and allowed to decompose for three weeks. Okra seeds were sown on each of the prepared plots at a 50 cm × 50 cm spacing. At seven weeks after sowing (WAS), the performance of okra was assessed using parameters dry weight (g), number of flowers and fruit weight (g) of okra. Weeds from each plot were harvested at soil level, encased in envelopes and dried in a Gallenkemp oven at 80°C to constant weight. The Mettler top-loading balance (Mettler P1210) was used to weigh the oven-dehydrated weed samples.

Before sowing and after the decomposition of incorporated plants, top soil samples were taken from each treatment plot at a depth of 0-15 cm using a soil auger. Each soil sample was mixed, air-dried to a constant weight and sieved in a 2 mm sieve for physical and chemical analyses. The analyses were carried out at Rotas Labs, Ring-Road, Ibadan, Oyo State, Nigeria.

The data obtained were analyzed using Analysis of Variance (ANOVA) at a 5% level of significance. Means were separated using Fisher’s Least Significant Difference at a 5% level of significance.

**RESULTS**

**Effect of stand density on the cover of *Mucuna pruriens* and other weeds**

The effect of the stand density of *Mucuna pruriens* on the cover of *M*. *pruriens* and the cover of other weeds at 6 WAS is presented in Figure 1. The cover of *M. pruriens* under only 262,500 stands/ha was significantly higher (P≤0.05) than the control. However, the rate of cover of other weeds in all treatment plots was not significantly lower (P≤0.05) than control (Figure 1).

**Figure 1: Effect of stock of *Mucuna* *pruriens* density on the cover of *Mucuna pruriens* and other weeds at six weeks after sowing in Ibadan**

**Relationship between *Mucuna pruriens* cover and other weeds cover**

The link between the rate of *Mucuna* *pruriens* field cover and other weeds field cover is graphically illustrated in Figure 1. It was observed that as the stand density of *M. pruriens* increased, the field cover of *M. pruriens* increased while that of other weeds decreased. A high degree of association was indicated by the linear correlation value obtained (r = 0.9589) and a negative regression (R2 = 0.9188) showed that as the density of *M. pruriens* increased, the field cover of other weeds decreased (Figure 2).

**Effect of *Mucuna pruriens* green manure on the performance of okra (*Albemoschus esculentus)* and dry weight of weeds**

The highest number of flowers of okra were observed in 137,500 stands/ha treatment plots (Table 1). The 262,500 stands/ha treatment plot had the highest fruit and dry weights of okra (Table 1). The number of flowers and dry weight of okra in all treatment plots were not significantly higher (P≥.05) than control (Table 2). However, the fruit weight of okra in 137,500 stands/ha and 262,500 stands/ha treatment plots were significantly higher (P≤0.05) than control (Table 1).

The lowest and highest weed dry weight was observed in 262,500 stands/ha treatment plots and control respectively (Table 1). There was a significant reduction (P≥.05) in the dry matter of weeds in all treatment plots when compared to the control plot, and no significant difference (P≤0.05) between the dry matter of weeds in the 137,500 stands/ha and 262,500 stands/ha treatment plots (Table 1).

 (R2 = 0.9188)

**Figure 2: The relationship between the cover of *Mucuna* *pruriens* and the cover of weeds**

**Table 1: Effect of *Mucuna pruriens* green manure on the number of flowers, fruit weight, dry weight of Okra (*Albemoschus esculentus*), and dry weight of weeds at seven weeks after sowing**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **No. of Flowers of Okra**  | **Fruit weight (g) of Okra** | **Dry Weight (g) of Okra** | **Dry Weight (g) of Weeds** |
| 0 stands/ha | 1.00a±0.00 | 3.99a±0.29 | 3.02a±0.37 | 429.0a±73.65 |
| 20,000 stands/ha | 1.40a±0.53 | 9.47a±5.47 | 3.12a±1.34 | 200.8b±62.89 |
| 62,500 stands/ha | 1.33a±0.31 | 11.18ab±4.97 | 3.58a±1.65 | 154.1bc±34.32 |
| 137,500 stands/ha | 2.00a±0.40 | 15.50b±2.14 | 3.69a±1.84 | 86.1c±50.78 |
| 262,500 stands/ha | 1.73a±0.23 | 18.8b±8.73 | 5.29a±0.69 | 49.2c±34.96 |

Means (± S.E) in the same column with the same letters are not significantly different at the LSD (0.05) probability level.

**Effect of *Mucuna pruriens* green manure on macro nutrients and organic matter content in the soil**

Table 2 shows the effect of *M. pruriens* green manure on nitrogen, phosphorus, potassium, and organic matter content in the soil. It was observed that the nitrogen, phosphorus, potassium, and organic matter contents in the soil decreased as the amount of *M*. *pruriens* green manure increased.

**TABLE 2: Effect of *Mucuna pruriens* green manure on macro nutrients and organic matter in the soil**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments** | **Incorporated *M. pruriens* biomass****(kg/ha)** | **Nitrogen (%)** | **Phosphorus (ppm)** | **Potassium (Cmol-1)** | **Organic Matter (%)** |
| 0 stands/ha | - | 0.53 | 30.57 | 0.24 | 9.46 |
| 20,000 stands/ha | 0 | 0.51 | 33.65 | 0.34 | 9.40 |
| 62,500 stands/ha | 5625 | 0.47 | 25.12 | 0.15 | 8.71 |
| 137,500 stands/ha | 11,850 | 0.49 | 23.58 | 0.17 | 9.29 |
| 262,500 stands/ha | 12,125 | 0.45 | 23.58 | 0.12 | 8.00 |

**DISCUSSION**

The results obtained from the study showed that 262,500 stands/ha of *Mucuna* *pruriens* at a spacing of (10 cm × 50 cm) will significantly reduce the plant cover of other weeds. This supports the finding by Baligar and Fageria (2007) that *M*. *pruriens* can cover the ground in two to three months, creating a dense mat and preventing weed growth. The rapid growth rate of *M. pruriens* (Adeniji and Awodoyin, 2022) and its canopy closure are important attributes used to inhibit the growth of other weeds (Ekeleme *et al*., 2003; Lawson *et al.,* 2006; Kanatas *et al.,* 2020).

Application of *M. pruriens* as green manure, especially at 262,500 and 137,500 *M. pruriens* stands/ha increased the fruit weight of okra from the study. A similar observation was reported by Ferreira *et al*. (2013) that the yield of *Phaseolus vulgaris* was enhanced by the incorporation of *M. pruriens* before flowering. The study's findings further support Odhiambo's (2011) assertion that applying green manure made from velvet bean, lab-lab, and sun hem significantly increased maize yield. The adoption of the legume as green manure improved the yield of *Amaranthus* *cruentus* (Adeniji *et al*., 2022). significantly as green manure will improve the performance of subsequent crops (Adeniji *et al*., 2022). Additionally, it was established by Egberongbe *et al*. (2017) and Tanimola *et al*. (2020) that green manure from *Sesbania* *pachycarp*a and *Mimosa* *diplotricha*, respectively, increased the yield of crops significantly.

From the study, the dry weight of weeds was significantly reduced by *M. pruriens* green manure. This corroborates the observation of Ochekwu and Udensi (2015), that there was a significant reduction in the yield of spear grass by aqueous extract of *M. pruriens*. In the same way, the residues of *M*. *pruriens* suppressed the biomass of rigid ryegrass (Travlos *et al*., 2018). It is possible that the decrease in the dry weight of weeds in the study was due to the release of allelochemicals during the decomposition process of incorporated plants, which can either positively or negatively affect the survival of other plants (Cheng and Cheng 2015). *Mucuna* *pruriens* is regarded as one of the strongest allelopathic plants (Ortiz-Ceballos *et al*., 2012), and it contains the amino acid levodopa, also known as L-DOPA (L-3,4-dihydroxyphenylalanine), which has been linked to its allelopathic effect (Adler and Chase, 2007).

The decrease in the macro nutrients and organic matter content observed in the soil may be attributed to the uptake of and retainment of inorganic before converting them to organic forms. Additionally, the the slow and gradual mineralization of nutrients from the decomposing plants may be responsible for the low macro nutrients level. Zhou *et al*. (2022) reported that the availability of nutrients such as nitrogen is longer in green manure when compared to chemical fertilizers.

**CONCLUSION AND RECOMMENDATIONS**

This study demonstrated that the use of *M. pruriens* as an alternative to failed fallow farming can significantly impact okra (*Abelmoschus esculentus* (L.) Moench) production and weed management in Ibadan, Nigeria. *M. pruriens*, at optimal stand densities, not only contributed to a reduction in weed cover but also had a positive influence on the fruit weight of okra, particularly at 262,500 stands/ha. The study also found that increasing the stand density of *M. pruriens* reduced the cover of other weeds, with a strong negative correlation (r = -0.9589) between the density of *M. pruriens* and the cover of other weeds. Despite the benefits of weed control, it was observed that the increase in *M. pruriens* green manure led to a decrease in the nitrogen, phosphorus, potassium, and organic matter contents in the soil, which suggests that the management of soil fertility must be carefully considered when using *M. pruriens* as green manure. In order to make up for the noted decline in soil macronutrients and organic matter content, farmers that use *M*. *pruriens* as green manure should think about including additional fertilisation techniques for crop production.

Based on the findings, a stand density of 137,500 to 262,500 stands/ha of *M. pruriens* is recommended for weed management and enhancing okra fruit yield. It is recommended that further studies be conducted to evaluate the long-term effects of *M. pruriens* green manure on soil nutrient dynamics and crop yields. Additionally, research into the synergistic effects of *M. pruriens* with other crop management practices, such as mulching or composting, could offer insights into optimizing productivity and soil health.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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