ISSN 2348-313X (Print)
International Journal of Life Sciences Research ISSN 2348-3148 (online)
Vol. 5, Issue 2, pp: (108-122), Month: April - June 2017, Available at: www.researchpublish.com

Biological and Chemical Options for Weed Control in *Vigna Unguiculata* (C.V. Ife Brown) Cultivated Under Controlled Environment

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Abstract: **This study focused on evaluating the allelophatic attributes of Siam (*Chromolaena odorata*) and Mimosa (*Mimosa pudica*) herbs as possible bio herbicides for weed control in cowpea production. It was a deliberate effort aimed at deploying local on-farm natural resources into the crop production system of resource – poor Nigerian farmers instead of relying on the rather expensive agrochemical-based pest management. It was a potted experiment under screen house condition; where soil samples were bulked, thoroughly mixed, shade-dried and sieved through a 2-mm screen after which a composite sample was taken from the bulk soil for determination of some physico-chemical characteristics. There was separate layout for each of the weed herbs evaluated along with the Force-Uron herbicide formulation and a control (no application of herbicides and the weed herbs) to obtain seven (7) treatments. Cowpea seeds (Ife Brown variety) obtained from the Institute of Agricultural Research and Training (IAR&T), Moor plantation, Ibadan were sown into pre-moistened potted soil. Data were collected on weed pressure (Number and dry weed weight and cowpea growth parameter; height cm/plant, number leaf plant, weight of fresh and dry root and shoot. For the dry matter weight determination, samples of root and shoot were oven dried at 80^{0}C till constant weights are obtained. Data were analyzed using Statistical Package for the Social Sciences (SPSS) employing the method outlined by Steel and Torrie (1980). Treatment means were separated by Duncan Multiple Range Test (DMRT) at 5% level of significance. At 2WAP the most highly recommended treatment is 30kgMm/ha because at this rate there was the lowest number of weeds. At 4WAP the most highly recommended treatment is also 30kgMm/ha because at this rate of application the weeds were most effectively controlled. At 6WAP, 40kgMm/ha is recommended because of its weed control efficacy. At 8WAP treatment 40kgMm/ha is recommended because of its weed control efficacy at this period. For mimosa leaf meal at 2WAP the most highly recommended treatment is 50kgSm/ha because at this rate there was the lowest number of weeds. At 4WAP the most highly recommended treatment is 30kgSm/ha. At 6WAP however the most highly recommended treatment is 50kgSm/ha because at this rate the lowest number of weeds was recorded. Also at 8WAP the most highly recommended treatment is 50kgSm/ha.**

Keywords: **Weed Control, Efficacy, Controlled Environment, Bio-herbicides, Properties.**

1. INTRODUCTION

In West Africa and many parts of the world cowpea (*Vigna unguiculata* L. Walp.) is an important grain legume. The total worldwide production of cowpea is estimated at 3.3 million tons of dry grain, of which, 64% is produced in Africa (FAO, 2001). According to the FAO 2001 conservative estimates suggest that 12.5 million hectares of cowpea are planted annually around the world. Of this area, about 9.8 million hectares are planted to cowpea in West Africa, making it the region with the largest production and consumption of cowpea in the world (CGIAR, 2001). The roles of cowpea as an important soil fertility improver have been documented (Haque and Jutzi, 1984). It is apparent that the use of fixed N_2 for improving soil fertility and crop yield is a cheaper substitute to the use of the expensive nitrogen fertilizer which may cause groundwater pollution and other environmental problems. However, many environmental conditions (aerial and soil) and biotic factor influence the ability of *Vigna unguiculata* and other legumes to fix N_2 optimally (Singh *et al.*, 1983). Remison (1997) observed that cultivation of cowpea is considered a rather risky investment by many growers, because of the numerous pest problems associated with it to induce low average yield. Specifically the major pests of cowpea in the humid tropics are weeds (Ayeni, 1992) and insects (Jackai and Adalla, 1997). Earlier, Okafor and Adegbite (1991) stressed that weeds constitute a major limiting factor to cowpea production in Nigeria, probably arising from the fact that weed pests are always present in farmers' plots as compared to any other pest. Tijani-Eniola (2001) reported that weeds could cause crop yield losses ranging from 50% to 80 %. Generally, the emergence of weeds on the farms usually during the first 3–4 weeks after planting suppresses other crop development at critical periods of growth like flower initiation and crop ripening stage, this leads to loss of substantial yield in both quality and quantity. Apart from serving as natural host for insect pests and inoculum (Jackai and Adalla, 1997), weed seeds and other plant vegetative parts contaminants in crop produce reduce market price (Oerke, 2006). According to FAO (2011), crop damage from weeds is larger than from any other pests. The Food and Agriculture Organisation (FAO, 2011) put crop yield losses from weeds in the United States of America in the year 2009 at $95 billion. It is therefore imperative that weed pests are to be controlled promptly by applying single or integrated control strategy.

The weed control ability of bioherbicides has been attributed to their ability to release biotic stresses against other weeds species in the form of allelopathic interferences (Gawronska and Golisz, 2006).Chemical weed control includes the use of herbicides to suppress morphological growth and physiological functions and/ or kill the weeds out rightly. This study therefore represents a near-organic farming effort focused on evaluating the allelophatic attributes of Siam (*Chromolenaodorata*) and Mimosa (*Mimosa pudica*) herbs as possible bio herbicides for weed control in cowpea production. The project therefore was a deliberate attempt to deploy local on-farm natural resources into the crop production system of resource – poor Nigerian farmers instead of relying on the rather expensive agrochemical-based pest management.

2. MATERIALS AND METHOD

This work was a potted experiment under screen house condition. The facility is located in Babcock University Ilishan-Remo Ogun state Nigeria with an annual rainfall of 1,500mm, a mean annual sunshine of about 2,100-2,300 hours and a mean annual temperature of about 27°C. Several core soil samples (15cm deep) were collected from the open field. The soil samples were bulked, thoroughly mixed, shade-dried and sieved through a 2-mm screen after which a composite sample was taken from the bulk soil for determination of some physico-chemical characteristics namely: available phosphorus according to the method of Bray and Kurtz (1945); total N by the Kjeldahl method described by Bremmer and Malvancy (1982); soil pH (1:1 soil: water) by the pH meter, the %C will by Walkely and Black (1934) method. The mechanical analysis was also done by the hydrometer method of Bouyocous (1962). Basal fertilization of 40kgP/ha as Single Super Phosphate (20% P_2O_5), 30kgK/ha as Muriate of Potash (60%K_2O), 0.28 kg Mo/ha as Sodium Molybdate (39%Mo)and 20kgN/ha starter N dose as Urea (45%N), were evaluated by mixing the fertilizers thoroughly into the sieved bulk soil by quartering. Thereafter, 10kg of sieved soil was filled into 84, 10-liter size basally-perforated plastic buckets (to facilitate drainage).

The above soil vegetative portions of Siam and Mimosa weed herbs to be evaluated for possible bio herbicidal properties (being sources of allelochemicals) were harvested from a bush near Babcock University, Ilishan-Remo, Ogun state. The harvested vegetative portions of each weed herb were pounded in a mortal to obtain pulps; hereafter referred to as Siam and Mimosa meals respectively. A sample each of the Siam and Mimosa meal was analyzed for phytochemical properties. Pre-emergence applications of a solution of the commercial herbicide (Force –Uron 50% SC) and slurries of the Siam and Mimosa meals respectively were made onto the surface of the potted soil and mixed into it about 5cm deep, following the treatment notations on the pots. There was separate layout for each of the weed herbs to be evaluated each as possible bioherbicides along with the Force-Uron herbicide formulation and a control (no application of herbicides and the weed herbs) to obtain seven (7) treatments.

Cowpea seeds (Ife Brown variety) obtained from the Institute of Agricultural Research and Training (IAR&T), Moor plantation, Ibadan were sown into pre-moistened potted soil, 5 seeds per pot. Data were collected on weed pressure (Number and dry weed weight and cowpea growth parameter; height cm/plant, number leaf plant, weight of fresh and dry root and shoot. For the dry matter weight determination, samples of root and shoot were oven dried at 80^0c till constant weights were obtained. Variables assessment started at 2 weeks after planting (WAP) of the test crop and thereafter at fortnight intervals up to 8WAP.

Data Analysis:

Data were analyzed using Statistical Package for the Social Sciences (SPSS); employing the method outlined by Steel and Torrie (1980). Significant treatment means from the analysis of variance (ANOVA) were separated by Duncan's Multiple Range Test (DMRT) at 5% level of significance.

3. RESULTS AND DISCUSSION

The Pre-cropping Soil Physico-chemical Properties:

The Soil physico - chemical characteristics, (physical and chemical properties) are presented in Table 1. The table shows that the soil used for the screen-house experiment has a low % C (0.85) and hence a correspondingly low organic matter (1.47%). This can be partly explained by the sandy nature of the soil because sandy soils are known to be low in organic matter, (Havlin *et al.*, 2005). Organic matter has been identified as the largest reservoir of sulphur in a soil (Norton *et al.*, 2013). It is apparent therefore that the soil would contain low concentration of sulphur. The Cation Exchange Capacity (CEC) of the soil used was low, possibly due to its low organic matter. Havlin *et al*. (2005) noted that the CEC of a soil is mainly determined by its organic matter content. The author also noted that the productivity of a soil decreased by 40% due to low or decreased organic matter status when subjected to intensive tillage, a cultural practice capable of enhancing organic matter decomposition. Earlier authors, Isirimah *et al.* (2003), indicated that the proportion of clay in a soil texture has influence on CEC of a soil. Therefore, the low CEC of the soil used (Table 1) can be attributed to both its low organic matter and its low proportion of clay. Also, in tropical soil the characteristic high temperature is known to speed up organic matter decomposition rate resulting in a low status of organic colloid and a concomitantly low exchange bases (Ca^{2+}, K^+, Mg^{2+} and Na^+) retention expressing as the low base status in the soil used for this trial in addition to apparent leaching losses of the bases in the sandy soil (Table 1).Onweremedu *et al*. (2003) stressed the importance of soil colloids in basic nutrient retention in Ultisols (low nutrient status soil).

Soil organic matter has been identified as an important soil quality/fertility indicator by Oluwatosin, *et al*. (2008) arising from its attributes as a store-house for both macro and micro nutrient and a crucial factor in soil structure stability. The soil used for the study was slightly acid and this may account for the low total soil N of 0.09% and the low available P of 36.73 mg/kg^{-1} (Singh, 2002). The slightly low pH can be explained by the low exchange acidity H^+ recorded in the soil (Table 1.).

Generally the exchange bases in the soil used were low (Table 1). However by comparison, exchangeable sodium (Na^+) and potassium (K^+) concentrations were lower compared separately to the Calcium (Ca^{2+}) and Magnesium (Mg^{2+}). This is most probably because each of the latter bases has smaller ionic size and bear higher valence than the former bases. Ionic size and magnitude of valence are factors that are generally known to influence the strength of adsorption of exchange cations onto soil colloids. The low total N in the soil (0.09%) can be attributed to its low organic matter status, its slightly acidic status (with the correspondingly low P status) and the sandy nature of the soil which may have prompted $N0_3$-N leaching. The soil used for this study can thus be classed as low in nutrients and therefore belongs most likely to a soil order Ultisols (Brady and Weil, 1999).

The Phytochemical Properties of Siam and Mimosa Herbs:

The phytochemical and nutrient properties that were obtained from laboratory analysis of Siam (*Chromolaena odorata*) and Mimosa (*Mimosa pudica*) meals are presented in Table 2. Alkaloids, Tannis, phlobatannin, Saponin, phenols are suspected as possible sources of the phytotoxic properties of Siam and Mimosa herbs being evaluated as possible bioherbicides in this study. Wink (1993) has named alakaloids, saponins and Tannins as phytochemicals with some properties in plant products. Plants compete with other plants for light, water and nutrients and so plants have evolved complex strategies to cope with this competition problem by production allelopatic substances. The production of secondary compounds that inhibit the germination or development of competing plants is one way to enhance the fitness of the plant producing the allelopathic substances. Allelopathic substances have been reported by Rizvi and Rizvi (1991). The authors have identified plants and plant products with allelopathic properties.

Both herbs investigated as possible bioherbicides contain Alkaloids. However the concentration of Alkaliods was slightly higher in Siam (0.45%) than in Mimosa (0.32%) (Table 2). The toxicity of the alkaloids in the herbs may explain their allelopathic activities on other weed plants. Haslam (1989) defined Tannins as plant polyphenols capable of effecting cell and tissue constriction. Another scientist, Hascom (1989) described tannins as having ability to bind pigments and metallic ions to produce the phytotoxic effect on the plant thus killing cells. It is most probable that the Tannis found on Siam (0.004%) and Mimosa (0.0022%)(Table 2) would exert toxic effect on weed. According to Jaliliet *et al.* (2007) the relative concentrations of allelochemicals define the inhibiting effect on a target. Saponin is also found in higher concentration in Siam (0.38%) compared to Mimosa (0.23%). The allelopathic effect of Saponin is probably on the description of the function of biomembrane (Bottger and Melzig, 2013). Phenolic compounds are a constituent of allelochemicals consisting of a hydroxyl group (-OH) bonded directly to an aromatic hydrocarbon group (Santana *et al*., 2009). The authors stressed that phenolic compounds are constituents of herbicides, insecticides, and fungicides. Both herbs contain phenols (Table 2) but Siam also has a greater concentration (0.007%) than Mimosa (0.005%). The aggregate higher concentrations of phytochemicals of Siam (Table 2) apparently explain its superior weed control ability than Mimosa. Generally, Siam contains more plant nutrients than Mimosa which is more carbonaceous or liquefied (Table 2).

Agronomic Qualities of the Crop:

Table 3 shows that there were no significant differences between the control (21.25) 10kg Mm/pot (20.25), 20Mm/pot (21.25) and 30kg Mm/pot (20.50), but 40Kg Mm/pot (19.75) and 50kg Mm/pot (19.00) were different at 2weeks after planting. Treatment 20Kg Mm/pot gave the greatest plant height. It was observed that there was no significant difference between the control (7.25), treatment 10kgMm/ha (7.25), treatment 20kgMm/ha (8.00), treatment 30kg/pot (7.25) and treatment 40kgMm/ha (7.00) but treatment 50kgMm/ha was found to be significantly different from others. Treatment 20kgMm/ha (8.00) was found to have the highest mean of leave number/plant at 2WAP. At 2WAP also, it was observed that there was no significant difference between the control (25.75) and treatment 40kgMm/ha (29.00), between treatment 20kgMm/ha (16.75) treatment 30kgMm/ha (13.00) and treatment 50kgMm/pot (17.50). Treatment 10kgMm/ha (18.75) was significantly different from others, but 40kgMm/ha (29.00) was found to have the highest mean value. There were no significant differences among the treatment means except for treatment40kgMm/ha (27.50) which is significantly different from all other means, it also had the highest mean value. There was no significant effect of mimosa meal on number of grasses.

Table 4 shows that there was no significant effect of mimosa meal on plant height for all the treatments at 4WAP. Treatment 10kgMm/ha (44.66) had the highest mean value. There were no significant differences among the leave number/plant of all the treatments. Treatment 40kgMm/ha (15.50) had the highest mean value; which is similar to the mean of the control.

There were also no significant differences in weed counts of treatments 10kgMm/ha (8.66), 20kgMm/ha (7.66), 30kgMm/ha (7.00), 40kgMm/ha (7.25) (Table 4). The control (27.75) and 50kgMm/ha (10.75) were significantly different from each other and the other treatments; with the control having the highest mean value. For broad-leaved weeds, table 4 shows that there was no significant difference between Treatments 10kgMm/ha (7.00),20kgMm/ha (7.33), 30kgMm/ha (5.75), 40kgMm/ha (6.50) and the control and 50kgMm/ha (10.25) were significantly different from each other and the other treatment means with the control having the highest treatment mean. There were significant differences for grasses between the control (3.00) and 10kgMm/ha (1.66), while for the other treatments there were no significant differences between them with control having the highest mean value of 3.00**.** Result of fresh weight of shoot however shows no significant difference between the control (10.75), treatments 20kgMm/ha (2.75), 30kgMm/ha (6.00) and 50kgMm/ha (4.50) respectively. Treatments 10kgMm/ha (5.00) and 40kgMm/ha (6.50) were similar but significantly different from treatments20kgMm/ha, 30kgMm/ha, 50kgMm/ha the highest fresh weight of shoot was the control with a mean of 10.75.

Table 4 also shows that treatment 10kgMm/ha (2.00) and 20kgMm/ha (1.75) fresh weight of root were not significantly different from each other. Treatments 40kgMm/ha (1.75) and 50kgMm/ha (1.75) were not significantly different from each other but significantly different from other means. For dry weight of shoot the control, treatments 10kgMm/ha,

ISSN 2348-313X (Print)
International Journal of Life Sciences Research ISSN 2348-3148 (online)
Vol. 5, Issue 2, pp: (108-122), Month: April - June 2017, Available at: www.researchpublish.com

20kgMm/ha, 40kgMm/ha, 50kgMm/ha were not significantly different from each other while treatment 30kgMm/ha was significantly different from other treatments in terms of shoot. Treatment 30kgMm/ha gave the highest mean yield of 2.26. Control for dry weight of root was significantly different from other treatments while there was no significant difference between treatment 30kgMm/ha, 40kgMm/ha and 50kgMm/ha, treatments 10kgMm/ha and 20kgMm/ha were not significantly different from each other. Treatment 40kgMm/ha had the highest mean dry weight of root.

Table 5 shows that at 6 weeks after planting there were significant differences between control and treatment 20kgMm/ha for plant height, while treatment 10kgMm/ha, 30kgMm/ha, 40kgMm/ha and 50kgMm/ha showed no significant differences from each other. Treatment 20kgMm/ha was significantly different from all other treatments; with control having the highest mean plant height. At 6 weeks after planting it was observed that control for leaf number/plant was significantly different from treatments 10kgMm/ha, 20kgMm/ha, 30kgMm/ha, 40kgMm/ha and 50kgMm/ha with control having the highest mean leaf number of 27.50. At 6 weeks after planting Treatment 20kgMm/ha and 30kgMm/ha for weed count are significantly different to the control, treatments 10kgMm/ha, 40kgMm/ha and 50kgMm/ha, with treatment 10kgMm/ha having the highest mean weed count. Among the treatment means at 6 weeks after planting, there were no significant differences among the mean leave number/plant for broad leaf weeds. For grasses control was significantly different from all other treatment with the highest mean value at 12.25, while treatments 10kgMm/ha and 20kgMm/ha were not significantly different from each other. Treatments 30kgMm/ha and 40kgMm/ha were not significantly different from each other while treatment 50kgMm/ha was significantly different from all other treatments with the lowest mean value of 5.25. Fresh shoot data shows that the control, treatments 10kgMm/ha and 50kgMm/ha were significantly different from treatments, 20kgMm/ha, 30kgMm/ha and 40kgMm/ha. Treatments 20kgMm/ha, 30kgMm/ha and 40kgMm/ha were not significantly different from each other. The control gave the highest mean fresh weight of shoot of 11.25.

Control and treatment 40kgMm/ha for dry weight of shoot were n ot significantly different from each other but significantly different from other means. Treatments 10kgMm/ha, 20kgMm/ha, 30kgMm/ha and 50kgMm/ha were not significant different from each other. Treatment 12.60 had the highest dry weight of shoot mean of 12.60.For dry weight of root at 6 weeks after planting however there were no significant differences between treatment means.

For plant height at 8 weeks after planting (Table 6), the control and treatments 20kgMm/ha were not significantly different from each other. Also treatments 30kgMm/ha, 40kgMm/ha and 50kgMm/ha were not significantly different, while treatment 10kgMm/ha was significantly different from all other treatments. Control was significantly different from all other treatments for leaf number per plant, while all other treatments were not significantly different from each other. Weed counts for control, Treatments 10kgMm/ha, 40kgMm/ha and 50kgMm/ha were not significantly different from each other but were significantly different from other treatments. In broadleaf weeds, control and treatment 50kgMm/ha were not significantly different from each other but are significantly different from all other treatments. Treatments 10kgMm/ha, 20kgMm/ha, 30kgMm/ha and 40kgMm/ha are not significantly different from each other. While in grasses control and Treatment 50kgMm/ha were not significantly different from each other. Treatments 10kgMm/ha, 20kgMm/ha, 30kgMm/ha and 40kgMm/ha were also not significantly different from each other. It was observed that the fresh shoot of control and treatments 50kgMm/ha were not significantly different from each other; and also different from other means while treatments 10kgMm/ha, 20kgMm/ha, 30kgMm/ha and 40mm/pot were not significantly different from each other. However, the fresh shoot weight of control treatment was significantly different from that of other treatments, while means of all other treatments were not significantly different from each other. The dry shoot weight of control at 8WAP and treatments 10kgMm/ha and 20kgMm/ha were not significantly different from each other but were significantly different for treatments 30kgMm/ha, 40kgMm/ha and 50kgMm/ha. However, there was no significant difference in the dry root weight of all treatments at 8WAP (Table 6).

4. RECOMMENDATION FOR MIMOSA MEAL

At 2WAP and 4WAP the most highly recommended treatment is 30kgMm/ha because the lowest weed population was recorded at this rate of mimosa application. At 6WAP however, treatment 40kgMm/ha is recommended because of its weed control efficacy. At this level, plant height, fresh shoot weight and fresh root weight were significantly higher. At 8WAP, treatment 40kgMm/ha is also recommended because of its weed control efficacy; where plant height among other characters was significantly higher. Hence, it is thus recommended that an average of 35kgMm/plot application of Mimosa will give optimum results.

Plant height at 2WAP (Table 7) was not significant different for treatments 10kgSm/ha and 20kgSm/ha; while the control, treatments 30kgSm/ha, 40kgSm/ha and 50kgSm/ha were not significantly different from each other but significantly different from treatments 10kgSm/ha and 20kgSm/ha. For leaf number per plant at 2WAP, there were no significant differences between all treatment means. Weed count was not different either among most of the treatments.

For plant height at 4 WAP, the control and treatments 10kgSm/ha, 20kgSm/ha, 40kgSm/ha were not significantly different from each other, while treatment 30kgSm/ha was significantly different from all others and treatment 50kgSm/ha was also significantly different from all other treatments (Table 8). There were no significant differences among means of all the treatments for leaf number per plant; while total weed count for control and treatment 10kgSm/ha were significantly different from each other, but no significant difference was observed among treatments 20kgSm/ha, 30kgSm/ha, 40kgSm/ha and 50kgSm/ha. Broadleaf weeds at 4 WAP for control and treatments 10kgSm/ha were significantly different from each other, and there was no significant difference among treatments 20kgSm/ha, 30kgSm/ha, 40kgSm/ha and 50kgSm/ha (Table 8). There were clearly no differences among all treatment means of grasses, fresh root weight, fresh shoot weight, dry root weight and dry shoot weight at 4WAP (Table 8).

For plant height at 6WAP (Table 9), there were no significant differences among all treatment means. A similar result was obtained for leaf number per plant. For weed count however, there were no significant differences among the means of the control, treatments 10kgSm/ha, and 50kgSm/ha which were significantly different from the means of other treatments. While treatments 20kgSm/ha, 30kgSm/ha and 40kgSm/ha were also not significantly different from each other. Results for broadleaf weeds, grasses, fresh shoot weight and fresh root weight showed that control was significantly different from all other treatments, while treatment 10kgSm/ha to 50kgSm/ha were not significantly different from each other (Table 9). Dry root weight was not significantly different in control and treatment 10kgSm/ha; while treatments 20kgSm/ha to 50kgSm/ha were not significantly different from each other. Control and treatments 20kgSm/ha, 30kgSm/ha, 50kgSm/ha were however not different; while treatments 10kgSm/ha and 40kgSm/ha were not also significantly different from each other.

For plant height at 8WAP (Table 10), there were no significant differences among means of all the treatments. Control treatment, treatments 10kgSm/ha, and 50kgSm/ha were significantly different from treatments 20kgSm/ha and 30kgSm/ha for number of leaves per plant; while control and treatment 10kgSm/ha were not significantly different from each other and treatment 50kgSm/ha was significantly different from all the other treatments for weed count parameter. Results for broadleaf character showed also that treatment 10kgSm/ha to 50kgSm/ha were not significantly different from each other, while the control was significantly different from other treatments. Control and treatment 50kgSm/ha were found to be significantly different for grasses, while treatments 10kgSm/ha to 40kgSm/ha were not different. For fresh root at 8WAP, there were no significant differences between treatments 10kgSm/ha, 20kgSm/ha, 40kgSm/ha; and no significant differences also between treatments 20kgSm/ha and 50kgSm/ha.

Recommendation for Siam Meal:

At 2WAP, the most highly recommended treatment is 50kgSm/ha; because at this rate the lowest weed population was recorded. At 4WAP the most highly recommended treatment is 30kgSm/ha because at this rate there was the second to the lowest number of weeds which is not significantly different from the lowest number of weeds and this rate gave the tallest cowpea plant height. At 6WAP the most highly recommended treatment is 50kgSm/ha because at this rate there was the lowest population of weeds and the second tallest plant height that was not significantly different from the tallest plant height. At 8WAP the most highly recommended treatment is 50kgSm/ha because of the same reason given above. The recommended application for siam meal is thus 50kgSm/ha; being the most consistent rate in terms of capacity to suppress weeds.

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APPENDIX - A

Table 1: Pre-cropping Soil Physico-chemical Properties

Properties	**Values**
pH (1:1 Soil/Water ratio)	6.29
Available P (mg Kg^{-1})	36.73
Nitrogen (%)	0.09
Organic Carbon (%) Organic Matter (%)	0.85 1.47
Exchangable Bases	
Calcium (C mol/kg)	1.24
Magnessium (C mol/kg)	1.32
Potassium (C mol/kg)	0.21
Sodium (Cmol/kg) C.E.C. Ex. Acidity H^{+1}	0.55 3.42 0.10
Sand (%)	88.8
Silt (%)	5.2
Clay (%)	6.0
Textural Class	Sandy loam

Table 2: Phytochemical and Nutrient status of Siam and Mineral Meals

Minerals	**Siam**	**Mimosa**
%N	2.879	2.692
%P	0.354	0.328
%C	28.79	31.29
%K	0.867	0.698
%Na	0.254	0.229
%Mg	0.289	0.267
%Ca	0.247	0.218
Fe(mg/kg)	187.49	178.56
Mn(mg/kg)	38.76	29.85
Zn(mg/kg)	51.28	42.39
Cu(mg/kg)	4.76	3.57
Alkaloids	0.447	0.323
Tannin	0.0044	0.0022
Phlobatannin	0.0017	0.0011
Saponin	0.377	0.232
Phenol	0.0071	0.0052

Table 3. Plant and Weed Growth Variables as Influenced by Application of Mimosa Meals

	PLANT HEIGHT	LEAF NUMBER/PLANT	TOTAL WEED COUNT/POT	TOTAL BROAD LEAF WEEDS	GRASSES
CONTROL	21.25^{a}	7.25^{a}	25.75^{a}	23.50^{ab}	2.25^{a}
10 kg Mm/ha	20.75^{a}	7.25^{a}	18.75^{b}	16.25^{ab}	2.50^{a}
20 kg Mm/ha	21.25^{a}	8.00^{a}	16.75^{ab}	15.25^{ab}	1.50^{a}
30 kg Mm/ha	20.50^{a}	7.25^{a}	13.00^{ab}	11.50^{ab}	1.50^{a}
40 kg Mm/ha	19.75^{ab}	7.00^{a}	29.00^{a}	27.50^{a}	1.50^{a}
50 kg Mm/ ha	19.00^{ab}	5.25^{b}	17.50^{ab}	15.50^{ab}	2.00^{a}

Table 4. Plant and Weed Growth Variables as Influenced by Application of Mimosa Meals at 4 wap

	Plant Height	Leaf Number/Plant	Weed Count	Broad Leaf Weeds	Grasses	Fresh Weight Shoot	Fresh Weight Root	Dry Weight Shoot	Dry Weight Root
CONTROL	38.25^{a}	15.50^{a}	27.75^{a}	24.75^{a}	3.00^{a}	10.75^{ab}	2.00^{b}	1.53^{ab}	1.20^{ab}
10 kg Mm/ha	44.66^{a}	13.25^{a}	8.66^{bc}	7.00^{bc}	1.66^{ab}	5.00^{a}	2.00^{bc}	1.04^{ab}	1.12^{bc}
20 kg Mm/ha	35.00^{a}	11.66^{a}	7.66^{bc}	7.33^{bc}	0.33^{bc}	5.75^{ab}	1.75^{bc}	0.93^{ab}	1.16^{bc}
30 kg Mm/ha	39.75^{a}	14.50^{a}	7.00^{bc}	5.75^{bc}	1.25^{bc}	6.00^{ab}	1.75^{a}	2.26a	1.30^{a}
40 kg Mm/ha	34.75^{a}	15.50^{a}	7.25^{bc}	6.50^{bc}	0.75^{bc}	6.50^{a}	1.75^{ab}	1.60^{ab}	1.60^{a}
50 kg Mm/ha	43.75^{a}	13.50^{a}	10.75^{b}	10.25^{b}	0.50^{bc}	4.50^{ab}	1.75^{ab}	1.79^{ab}	1.25^{a}

Table 5: Plant and Weed Growth Variables as Influenced by Application of Mimosa Meals at 6 wap

	Plant Height	Leave Number/Plant	Weed Count	Broad Leaf Weeds	Grasses	Fresh Weight Shoot	Fresh Weight Root	Dry Weight Shoot	Dry Weight Root
CONTROL	142.25^{a}	27.50^{a}	24.65^{ab}	8.29^{a}	12.25^{a}	11.25^{a}	8.00^{a}	10.99^{b}	6.85^{a}
10 kg Mm/ha	95.75^{ab}	16.00^{ab}	28.17^{ab}	8.05^{a}	6.99^{b}	5.50^{b}	8.00^{a}	11.26^{a}	7.12^{a}
20 kg Mm/ha	87.50^{b}	19.25^{ab}	20.98^{b}	7.51^{a}	6.00^{b}	6.00^{ab}	6.75^{a}	11.09^{a}	6.27^{a}
30 kg Mm/ha	121.75^{ab}	15.25^{ab}	33.24^{a}	12.66^{a}	7.00^{ab}	6.75^{ab}	7.75^{a}	12.60^{a}	7.35^{a}
40 kg Mm/ha	107.25^{ab}	18.50^{ab}	24.55^{ab}	9.26^{a}	8.00^{ab}	7.25^{ab}	7.25^{a}	10.96^{b}	6.60^{a}
50 kg Mm/ha	114.00^{ab}	17.25^{ab}	14.59^{ab}	8.53^{a}	5.25^{bc}	4.75^{bc}	7.00^{a}	11.26^{a}	6.53^{a}

TABLE 6: Plant And Weed Growth Variables As Influenced By Application Of Mimosa Meals At 8 Wap

	Plant Height	Leave Number/Plant	Weed Count	Broad Leaf Weeds	Grasses	Fresh Weight Shoot	Fresh Weight Root	Dry Weight Shoot	Dry Weight Root
CONTROL	158.50^{a}	30.00^{a}	35.56^{b}	13.75^{a}	3.75^{a}	11.50^{a}	19.00^{a}	21.93^{ab}	17.29^{a}
10 kg Mm/ha	111.75^{bc}	17.75^{ab}	37.84^{b}	7.25^{ab}	1.00^{abc}	6.50^{ab}	17.75^{b}	22.21^{ab}	17.39^{a}
20 kg Mm/ha	100.25^{a}	20.00^{ab}	31.88^{c}	6.50^{ab}	2.00^{abc}	6.75^{ab}	18.00^{b}	22.28^{ab}	17.29^{a}
30 kg Mm/ha	133.0^{ab}	18.75^{ab}	43.06^{a}	8.25^{ab}	2.00^{abc}	7.50^{ab}	18.00^{b}	26.22^{a}	17.62^{a}
40 kg Mm/ha	118.5^{ab}	18.75^{ab}	34.35^{b}	8.25^{ab}	2.00^{abc}	7.25^{ab}	17.25^{b}	22.53^{ab}	16.54^{a}
50 kg Mm/ha	115.50^{ab}	17.50^{ab}	35.51^{b}	10.00^{a}	2.50^{a}	9.25^{a}	18.00^{b}	22.55^{ab}	17.13^{a}

TABLE 7: Plant And Weed Growth Variables As Influenced By Application Of Siam Meals At 2wap

	Plant Height	Leave Number/Plant	Weed Count	Broad Leaf Weeds	Grasses
CONTROL	21.5^{ab}	8.00^{a}	34.50^{a}	33.50^{a}	1.00^{a}
10 kgSm/ha	22.25^{a}	8.25^{a}	17.25^{b}	16.25^{b}	11.00^{a}
20 kg Sm/ha	23.00^{a}	7.25^{a}	7.75^{c}	7.00^{c}	3.00^{a}
30 kgSm/ha	20.25^{ab}	8.00^{a}	7.00^{c}	5.50^{c}	1.50
40 kgSm/ha	21.25^{ab}	7.75^{a}	7.25^{c}	6.25^{c}	1.00^{a}
50 kgSm/ ha	20.25^{ab}	8.00^{a}	6.25^{c}	4.75^{c}	1.50a

TABLE 8: Plant And Weed Growth Variables As Influenced By Application Of Siam Meals At 4 Wap

	Plant Height	Leave Number/ Plant	Weed Count	Broad Leaf Weeds	Grasses	Fresh Weight Shoot	Fresh Weigh t Root	Dry Weight Shoot	Dry Weight Root
CONTROL	45.50^{ab}	12.50^{a}	25.25^{a}	23.25^{a}	2.75^{a}	11.75^{a}	1.50^{a}	1.92^{a}	1.18^{a}
10 kgSm/ha	52.25^{ab}	13.75^{a}	15.25^{b}	12.00^{b}	3.25^{a}	4.75^{b}	1.75^{a}	2.92^{a}	1.35^{a}
20 kgSm/ha	55.00^{ab}	8.50^{a}	7.50^{bc}	6.00^{bc}	1.25^{a}	3.75^{bc}	1.50^{a}	2.83^{a}	1.22^{a}
30 kgSmha	60.50^{a}	10.50^{a}	6.75^{bc}	5.00^{bc}	1.00^{a}	3.75^{b}	1.50^{a}	2.76^{a}	1.30^{a}
40 kgSm/ha	45.25^{ab}	11.00^{a}	7.75^{bc}	6.75^{bc}	1.00^{a}	4.25^{b}	1.50^{a}	2.53^{a}	1.23^{a}
50 kgSm/ ha	30.75^{bc}	11.50^{a}	4.75^{bc}	4.25^{bc}	0.50^{a}	3.25^{bc}	1.75^{a}	1.68^{a}	1.25^{a}

TABLE 9: Plant And Weed Growth Variables As Influenced By Application Of Siam Meals At 6 Wap

	Plant Height	Leave Numbe r/Plant	Weed Count	Broad Leaf Weeds	Grasses	Fresh Weight Shoot	Fresh Weight Root	Dry Weight Shoot	Dry Weight Root
CONTROL	84.75^{a}	15.75^{a}	19.19^{b}	13.00^{a}	3.00^{ba}	12.75^{a}	7.25^{a}	10.47^{ab}	6.71^{a}
10 kg Sm/ha	105.50^{a}	14.50^{a}	19.61^{b}	5.57^{b}	2.00^{a}	5.75^{b}	7.25^{a}	9.71^{ab}	6.30^{ab}
20 kg Sm/ha	91.75^{a}	10.25^{a}	28.30^{a}	4.75^{b}	1.00^{a}	4.75^{b}	7.13^{a}	11.45^{a}	6.53^{a}
30 kg Sm/ha	100.75^{a}	12.50^{a}	22.86^{a}	4.75^{b}	1.00^{a}	4.75^{b}	7.75^{a}	10.71^{a}	6.45^{a}
40 kg Sm/ha	91.33^{a}	19.25^{a}	27.85^{a}	5.00^{b}	1.00^{a}	4.75^{b}	7.75^{a}	10.74^{a}	6.30^{ab}
50 kg Sm/ha	100.75^{a}	13.50^{a}	15.02^{b}	3.50^{b}	1.00^{a}	3.75^{b}	7.50^{a}	10.70^{a}	6.41^{a}

TABLE 10: Plant And Weed Growth Variables As Influenced By Application Of Siam Meals At 8 Wap

	Plant Height	Leave Number /Plant	Weed Count	Broad Leaf Weeds	Grasses	Fresh Weight Shoot	Fresh Weight Root	Dry Weight Shoot	Dry Weight Root
CONTROL	92.00^{a}	15.75^{a}	13.21^{b}	15.01^{a}	14.25^{a}	21.00^{a}	18.50^{a}	13.48^{a}	16.28^{a}
10 kgSm/ha	118.00^{a}	16.50^{a}	29.76^{b}	9.72^{b}	7.25^{b}	20.55^{a}	18.50^{a}	13.56^{a}	16.36^{a}
20 kgSm/ha	98.25^{a}	12.25^{ab}	39.92^{a}	10.61^{b}	5.00^{b}	20.95^{a}	18.25^{a}	21.28^{a}	16.74^{a}
30 kgSm/ha	103.25^{a}	13.00^{ab}	37.89^{a}	8.29^{b}	5.50^{b}	24.52^{a}	18.75^{a}	18.13^{a}	16.14^{a}
40 kgSm/ha	92.25^{a}	19.50^{a}	39.27$_{a}$	8.40^{b}	5.50^{b}	20.45^{a}	18.75^{a}	19.30^{a}	16.45^{a}
50 kgSm/ha	105.00^{a}	14.25^{a}	27.11^{bc}	6.50^{b}	4.25^{bc}	21.86^{a}	18.50^{a}	12.33^{a}	16.06^{a}