

1 *Original Research Article*

2 **EFFECT OF MAIZE –LEGUME INTERCROP AND FERTILIZER ON WEED**
3 **SUPPRESSION AND MAIZE PERFORMANCE IN SOUTH EASTERN,**
4 **NIGERIA.**
5
6

7 **ABSTRACT**

8 Maize is one of the most commonly cultivated arable crop in the rain forest zone of South
9 Eastern Nigeria. Globally soil fertility and weed pressure are the most important
10 constraints limiting increase productivity of Maize especially in Sub Saharan Africa
11 (SSA). Unavailability and cost of inorganic fertilizer as well as cost of labour for
12 weeding have engendered low productivity of maize. Hence this trial was conducted to
13 evaluate the efficacy of maize-legume systems on weed suppression and maize
14 performance. The trial was carried out at the Teaching and Research Farm of Faculty of
15 Agriculture, University of Port Harcourt, Nigeria located within latitude 04⁰ 54'N and
16 longitude 6⁰ 55' E). The trial was conducted between April 4th and July 5th, 2017. The
17 experiment was a 3 x 3 factorial arrangement fitted into a randomized complete block
18 design (RCBD) consisting of 3 types of legume systems (*Mucuna pruriens*, *Lablab*
19 *purpurens* and No legume) and three levels of NPK 15:15:15 fertilizer (0, 15, and 30kg
20 NPK/ha). The 9 treatment combinations were replicated thrice to give 27 plots. Data
21 collected were maize yield and yield components, weed and legume parameters at 4, 8
22 and 16 weeks after planting (WAP). Result showed that legume significantly reduced
23 weed biomass when compared to the natural fallow. The effect of weed biomass
24 reduction was *Mucuna* 34.8% >*Lablab* 29.2%. The legume system significantly
25 suppressed weed compared to natural fallow and the weed suppression ability average
26 56% and 30% respectively for *Mucuna* and *Lablab* whether or not they received NPK.
27 Result of this trial also revealed that within 8 weeks after planting legumes (8 WAPL)
28 26% N and 22% N can be harvested by integrating this legume cover in cropping system
29 and that NPK application has little or no effect in the performance of this legumes.
30 *Mucuna* was not sensitive to fertilizer application while *Lablab* responded to fertilizer
31 application. Maize was sensitive to *Mucuna* due to early integration, hence, it is
32 recommended that these legumes be integrated at six weeks after planting maize.

33 **Keywords: Maize, Mucuna, Lablab, NPK-Fertilizer, Weed**
34

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Comment [LR2]: Use a punctuation

36

INTRODUCTION

37 Maize (*Zea mays* L.) is the World's third most important cereal crop after wheat and rice
38 [1]. Maize is a member of Poaceae (grass family) which requires much nitrogen to
39 achieve optimum yield. Maize has the potential to supply large amounts of energy-rich
40 storage for animal diet and its fodder can safely be fed at all stages of growth [2].
41 Maize has been put to wide range of uses which include but not limited to feed and
42 fodder for livestock and oil also used in food industry where they are used for margarine,
43 maize syrup and sweeteners. Furthermore, maize is use in the manufacture of candy bar
44 and industrial chemical [3]. The demand for maize is constantly increasing in global
45 market in response to the multiple uses. The national demand for maize starch is
46 increasing and is estimated at about 500,000 tonnes per annum while the current national
47 supply is estimated at 350,000 tonnes per annum. To meet the global demand for maize,
48 intensive cultivation has led to decrease in soil fertility, build-up of weeds and other pests
49 and fallow period have drastically been shortened. Due to this circumstances soil that
50 was once fertile has become unproductive and also environmental degradation has
51 occurred and crop yield has become low [4]. Maize requires a lot of nitrogen for
52 maximum yield and this can be achieved by application of inorganic fertilizer. However,
53 chemical nitrogenous fertilizer seems to be unaffordable to small scale farmers producing
54 maize for their food security [5]. Therefore, maize/legume intercropping has become one
55 of the solution for food security among small scale maize producers [6]. Intercropping is
56 defined as the system where two or more crops are grown on a piece of land within the
57 same year to promote the interaction of component crops and maximize land productivity
58 [7] Intercropping of cereal/legume is being practiced in many areas of Southern Nigeria.

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59 Systems of intercropping maize with legumes are capable of reducing the amount of
60 nutrient taken from the soil as compared to a sole maize production. However when
61 nitrogen fertilizer is added to the field, intercropped legume use the inorganic nitrogen
62 instead of fixing nitrogen and this compete with maize for nitrogen, but when nitrogen
63 fertilizer is not applied, intercropped legume will fix most of their nitrogen requirement
64 from the atmosphere and not compete with maize for nitrogen resources [8]. Mucuna and
65 lablab are among the legumes that can be intercropped with maize. However timing is
66 of great importance because it has been observed that farmers intercrop legume with
67 maize at their convenient time. According to [9] growing mucuna early could result in
68 reduced maize yield while [10] reported that intercropping mucuna with maize at 6
69 weeks after planting (WAP) gave higher maize grain yield than 8 and 10 (WAP)
70 respectively. Therefore, it is important that in depth look at planting date of legume as
71 component in a maize-legume intercrop should be taken into consideration.

Comment [LR4]: use a punctuation

72 Maize is one of the most commonly cultivated arable crops in the rainforest zone of
73 Southern Nigeria [11]. It is a staple food for more than 300 million people in Sub Saharan
74 Africa (SSA) [12]. Production is mainly in the hand of over 90% of the small holder
75 farmers who face the constraints of low soil fertility and lack of and high cost of mineral
76 fertilizers. Nigeria is one of the greatest maize producers in SSA [13]. Current yield of
77 maize in farmers field is very low (≤ 1500 kg/ha). In SSA [14], intensive use of synthetic
78 chemical herbicides and inorganic fertilizer for weeds control and soil fertility
79 management has left the soil degraded with the buildup of resistant weed species. Weed
80 problem and soil fertility decline are recognized by farmers as major constraints causing
81 low maize productivity. This is partly due to the unavailability, accessibility and cost of

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82 inorganic nutrient for soil management and the cost and drudgery associated with weed
83 management at this farmer's level. Legume cover crops are reported to suppress weed
84 and improve soil fertility. Therefore intercropping maize with legumes has the capacity to
85 sustain nitrogen requirement of maize in the small holder farming sector. The current
86 study sought to evaluate the effects of two legume cover crops for weed suppression and
87 soil fertility improvement. Velvet bean (*Mucuna pruriens* (L) DC. Var. Utilis) and
88 Lablab (*Lablab purpureus* (L) **sweet**) are two exotic legume species that may suppress
89 weeds and enhance soil fertility. Although cover crops like melon are found in most
90 maize intercrop, they can only provide short season cover and biomass that may not
91 sustain weed suppression and nitrogen accumulation due to low biomass residues. Hence,
92 Lablab and *Mucuna* were chosen for this research because of their ability to establish
93 well in high forest zone and the production of large biomass that will continue to provide
94 residual weed suppression and nitrogen accumulation for maize growth benefit.
95 Therefore, the general objective of the present study was to identify maize legume system
96 that will suppress weed by physical smothering through biomass canopy and enhance
97 maize productivity through nitrogen accumulation.

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98 MATERIALS AND METHODS

99 2.1 Experimental site and description

100 The trial was carried out at the Teaching and Research Farm, of the Faculty of
101 Agriculture, University of Port Harcourt, Nigeria located within latitude $04^{\circ} 54' 53.8''$ N and
102 longitude $006^{\circ} 55' 32.9''$ E (with an altitude of 17 meters above sea level [15]). This trial
103 was conducted between April 4th and July 5th 2017.

Comment [LR7]: ?

104 2.2 Sources of Planting Material

105 The maize cultivar used for this trial was OBA SUPER 2 (yellow) purchased from
106 Premier Seeds Nigeria Limited (A member of seeds association of Nigeria).It is a hybrid
107 line and also a single cross hybrid. It was chosen because it can adapt to rainforest zone
108 and it is also resistant to lodging.

109 2.3 Sources of Legume Cover Crops

110 The two varieties of legume used for the trial were *Mucuna Pruriens* and *Lablab*
111 *Purpurens* and they were purchase from National Animal Production Research Institute
112 (NAPRI), Zaria, Nigeria. These two cover crops were chosen based on earlier screening
113 that showed that they can grow well in the study environment with a good ground cover
114 within a short period of time.

115 2.4 Source of NPK Fertilizer.

116 The NPK 15:15:15 fertilizer was purchased from Agricultural Development Programme
117 (ADP), Port Harcourt Rivers State, Nigeria.

118 2.5 Land Preparation and Experimental Design

119 The study area was tilled to loosen up the soil on 31st March, 2017. Prior to tillage, soil
120 samples were collected diagonally across the plot with the aid of a soil anger at a depth of
121 15cm. The samples were air- dried and taken to the laboratory for physical and chemical
122 analysis. Parameters analysed for were total nitrogen. Total N in which the soil samples
123 passed through a 0.5mm sieve was determined by Micro-kjeldahl method [16]. The
124 experiment was a 3 x 3 factorial arrangement in a randomized complete block design

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125 (RCBD) consisting of three legume systems (*Mucuna Pruriens*, *Lablab purpurens* and
126 No legume) and three levels of NPK 15:15:15 fertilizer (0, 15 and 30kg NPK/ha) giving
127 nine treatment combinations .The nine treatment combination were replicated thrice to
128 give a total of 27 plots. The maize was planted two seeds per hole on 4th April 2017 at a
129 spacing of 100cm x 25cm on a plot size of 4m x 4m giving four (4) rows of maize plant
130 per plot and a total population of approximately 40,000 per hectare. The alley way
131 between each maize plot was 0.75 m and the alley way between replicates was 1.5m.

132 2.6 Treatments plan and application

133 The details of the 9 treatment are shown below.

- 134 • Maize + 0kg NPK/ha
- 135 • Maize + 15kg NPK/ha
- 136 • Maize + 30kG NPK/ha
- 137 • Maize + lablab + 0kg NPK/ha
- 138 • Maize + lablab +15kg NPK /ha
- 139 • Maize + lablab + 30 kg NPK /ha
- 140 • Maize + mucuna + 0 kg NPK /ha
- 141 • Maize + mucuna +15kg NPK /ha
- 142 • Maize + mucuna +30kg NPK /ha

143 The NPK fertilizers were applied in two splits using NPK15:15:15, on 20th April 2017 (3
144 WAP). This application was done by banding the fertilizer after which it was covered
145 with soil to avoid volatilization or being washed away. The second application was done
146 on 22nd of May, 2017 (6WAP) The legume cover crops were planted four weeks after

147 planting maize (4WAPM) which was on 5th May, 2017 meanwhile the first weeding was
148 done before the planting of the legume cover crops which was on 3rd of May, 2017.
149 Maize emergence count was done one week after planting (1 WAP) and supply done to
150 the ones that did not emerge. The maize was later thinned on 20th April, 2017 to one
151 stand per plant (3 WAM) from two seed that was planted per hole. Second weeding was
152 done on the plot and alley ways to keep off predators from invading the plant.

153 **2.7 Data Collection**

154 **2.7.1 Maize**

155 Maize emergence count was done (1 WAP). This was done by counting the number of
156 maize stand that emerged on each row. Maize height was taken at 7week after planting
157 maize (WAPM) and 3 weeks after planting legumes (WAPL) using meter rule, three
158 plants representing the shortest, medium and tallest plants were chosen from each row per
159 four rows in a plot on 24th May, 2017.

160 **2.7.1.1 Maize Yield and Yield Components**

161 Maize was harvested on 5th July which was 12 weeks after planting maize and 8 weeks
162 after planting legumes.(12 WAPM and 8 WAPL), total biological yield of maize was
163 determined for whole plot. The following yield data was assessed. Total stands at harvest
164 this was done generally by counting the number of standing maize plant at harvest and
165 later the ones to be weighed was chosen from the net- plot area, this is where the
166 unshelled cob weight, was gotten. Maize grain yield was also determined after drying the
167 sample from cobs. This was done by taken the sample gotten from the unshelled cob to
168 the green house for two weeks after it was shelled and the grain weight taken.

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169 **2.7.2 Weed**

170 **2.7.2.1 Weed density and weed biomass**

Comment [LR15]: Spacing?

171 Weed species density and biomass were determined using 50cm x 50cm quadrat thrown
172 at a diagonal transect per treatment plot. In each quadrat the weed species were counted
173 for density data and then clipped above ground for the biomass determination. The
174 samples for biomass determination were oven dried at 80^{0c} to a constant weight. Both
175 density and biomass values were expressed in number and gram per meter square
176 respectively.

177 **2.7.2.2 Weed Suppression Efficiency (WSE)**

178 Weed suppression efficiency of the maize-legume was determined at 14WAPL using
179 treatment weed biomass with the following formula;

Comment [LR16]: ? Mention

180
181
$$\text{WSE (\%)} = \frac{\text{we biomass from natural fallow} - \text{weed biomass from mucuna or lablab}}{\text{weed biomass from natural fallow}} \times \frac{100}{1}$$

182
$$\text{WSE (\%)} = \frac{\text{WBMNF} - \text{WBM Mucuna}}{\text{WBMNF}} \times \frac{100}{1}$$

183
$$\text{WSE (\%)} = \frac{\text{WBMNF} - \text{WBM Lablab}}{\text{WBMNF}} \times \frac{100}{1} \quad [17]$$

184

185

186 **2.7.2.3 Weed and legume cover assessment**

187 The weed and legume cover were assessed monthly using point intercept method [18].
188 The above ground legume biomass was assessed using 50 cm x 50 cm quadrat thrown
189 thrice at a diagonal transect 14 weeks after planting legumes.

190 **2.7.3 Soil Nitrogen determination**

191 Soil samples were collected from each plots before and after planting. The samples were
192 collected diagonal across each plot. These samples were air dried and taken to the
193 laboratory and was analyzed using standard laboratory procedure.

194 **2.8 Statistical Data Analysis**

195 Analysis of variance (ANOVA) was computed for each of the data collected using
196 statistical analysis system [19] model and significant means were separated using least
197 significant difference (LSD) at 5% level of probability.

198 **3 RESULTS**

201 **3.1 Effect of legume system and NPK on weed growth**

202 Results obtained from the study showed that there was no significant ($P > 0.05$) difference
203 in weed density among the treatments at 8 WAPL but the highest weed number (523
204 no/m²) was obtained in mucuna-maize while the lowest (373 no/m²) was in sole maize
205 (Table 1). The legume systems however significantly influenced the weed biomass at
206 8WAPL Mucuna significantly ($P < 0.05$) reduced weed biomass when compared to the no
207 legume system, but was not significantly superior to lablab in reducing weed biomass.
208 The highest weed biomass was seen in sole maize followed by lablab-maize and mucuna-
209 maize ($353.2 \text{ g/m}^2 > 249.9 \text{ g/m}^2 > 229.6 \text{ g/m}^2$) respectively. Weed biomass of lablab-

210 maize was not significantly different from weed biomass of sole maize although it was
211 lower ($249.9 \text{ g/m}^2 < 353.2 \text{ g/m}^2$) (Table 1). At 14 WAPL the legume system significantly
212 influenced the weed density and biomass ($P < 0.05$). The weed densities and biomass of
213 Mucuna-maize and lablab-maize intercropping were both significantly lower than sole
214 maize (146 no/m^2 and $159.3 \text{ g/m}^2 < 408 \text{ no/m}^2$ and 379.9 g/m^2) and (205 no/m^2 and
215 $230.5 \text{ g/m}^2 < 408 \text{ no/m}^2$ and 379.9 g/m^2) respectively. The NPK rates and legume x
216 NPK interaction did not influence the density and biomass significantly. The 0 kg
217 NPK/ha and 15 kg NPK/ha rates had the same weed density at this period which was
218 higher than the weed density of 30 kg NPK/ha while 30 kg NPK/ha had the highest weed
219 biomass followed by 0 kg NPK and 15 kg NPK/ha although not significant at 5% level of
220 probability.

Table 1: Effect of legume system and NPK on weed growth

Legume system	8 WAPL						14 WAPL					
	Weed Density(No/m ²)			Weed Biomass(g/m ²)			Weed Density(No/m ²)			Weed Biomass (g/m ²)		
	0kg	15kg	30kg	0kg	15kg	30kg	0kg	15kg	30kg	0kg	15kg	30kg
<i>M. pruriens</i>	578	636	354	240.5	188.8	259.4	156	170	112	135.0	193.8	149.2
<i>L. purpureus</i>	549	352	650	197.2	309.5	243.1	310	233	73	201.4	281.9	208.1
No legume	502	316	301	373.9	335.4	350.1	378	439	407	343.0	289.8	506.8
<u>Means for legumes</u>												
<i>M. pruriens</i>	523 ^a			229.6 ^b			146 ^b			159.3 ^b		
<i>L. purpureus</i>	517 ^a			249.9 ^{ab}			205 ^b			230.5 ^b		
No legume	373 ^a			353.2 ^a			408 ^a			379.9 ^a		
LSD (5%)	274.86 ^{ns}			107.81 [*]			147.88 ^{**}			147.75 ^{**}		
<u>Means for NPK</u>												
0 kg NPK/ha	543 ^a			270.5 ^a			281 ^a			226.5 ^a		
15 kg NPK /ha	435 ^a			277.9 ^a			281 ^a			255.2 ^a		
30 kg NPK/ha	435 ^a			284.1 ^a			197 ^a			288.0 ^a		
LSD (5%)	274.86 ^{ns}			107.81 ^{ns}			147.88 ^{ns}			147.75 ^{ns}		
LSD (Legume x NPK)	476.09 ^{ns}			186.74 ^{ns}			256.14 ^{ns}			255.93 ^{ns}		

222 WAPL: Weeks After Planting Legume

223 Means within the same column followed by the same alphabet are not significantly different at 5% level probability by LSD

224 test

225 *, ** Significant at 0.05, 0.01 level of probability

226 **3.2 Weed Suppression Efficiency (WSE) of the legumes**

227 At 14 WAPL all legume systems were significantly better than the sole maize plots in
228 terms of weed suppression efficiency. The mucuna-maize had significantly higher
229 efficiency on weed suppression (55.6%) than the lablab-maize (39.4%) which was better
230 than the sole maize plots (Table 2). Suppression efficiency of mucuna-maize was not
231 significantly different from the suppression efficiency of lablab-maize ($P>0.05$) but both
232 was significantly different from that of sole maize ($P<0.05$). Similarly the suppression
233 efficiency of lablab-maize was significantly higher than that of sole maize ($P<0.05$). The
234 NPK rates did not significantly influence weed suppression efficiency of the legumes.
235 However, the 30 kg NPK/ha had higher suppression efficiency (42%) followed by 0 kg
236 NPK/ha (33.9%) and 15 kg NPK/ha (19.1%). The legume x maize interaction did not
237 significantly influence the weed suppression.

238

239 **Table 2: Weed Suppression Efficiency (WSE) of the legumes**

Legume system	WSE 14 WAPL		
	0kg	15kg	30kg
<i>M. pruriens</i>	60.9	31.8	74.1
<i>L. purpureus</i>	40.7	25.5	52.0
No legume	0.0	0.0	0.0
Means for legumes			
<i>M. pruriens</i>		55.6 ^a	
<i>L. purpureus</i>		39.4 ^a	
No legume		0.0 ^b	
LSD (5%)		32.42 ^{**}	
Means for NPK			
0 kg NPK/ha		33.9 ^a	
15 kg NPK /ha		19.1 ^a	
30 kg NPK/ha		42.0 ^a	
LSD (5%)		32.42 ^{ns}	
LSD (Legume x NPK)		56.16 ^{ns}	

240 *WAPL: Weeks after Planting Legume*

241 *Means within the same column followed by the same alphabet are not*
 242 *significantly different at 5% level probability by LSD test*

243 *** Significant at 0.01 level of probability*

244 **3.3 Effect of legume system on Maize yield components and Grain yield.**

245 The legume system, NPK rates did not influence the emergence significantly, however,
 246 their interaction significantly influence the emergence of the maize plant (Table 3). The
 247 final stand at harvest was not influenced by the legume system, NPK rates and their
 248 interaction ($P>0.05$). At 7 WAPM and 3 WAPL there was significant difference ($P=0.05$)

249 in the height of the maize within the legume system only. The mean height of Mucuna-
250 maize plots was higher with value of 141.4 cm followed by the sole-maize with value of
251 140.8 cm and lablab-maize with value 131.0 cm (Table 3). The height of the mucuna-
252 maize intercropping was not significantly different from that of sole-maize. However,
253 both mucuna-maize intercrop and sole maize were significantly different from that
254 lablab-maize. Maize stand at harvest was not influenced by legume cover or NPK rates.
255 The result also revealed no significant difference in the unshelled cob weight within the
256 legume system, NPK rates and their interaction ($P>0.05$). However, the sole-maize had
257 higher unshelled cob weight than the legume-maize plots (Table 4). The trend was
258 different in the grain weight within the legume system. The sole-maize was significantly
259 higher than the legume-maize ($P<0.05$). Grain yield advantage of sole maize to lablab-
260 maize and mucuna-maize was seen to be 19.5% and 34.3% respectively. The NPK rates
261 and legume x NPK interaction did not significantly influence the grain weight (Table 4).
262 Similarly the biological yield of maize in sole-maize plots were significantly different
263 from that in legume intercrop system ($P<0.05$). The sole-maize had biological yield
264 advantage of 15.9% and 29.3% over lablab-maize and mucuna-maize respectively.
265 Biological yield of lablab-maize was significantly higher than that of mucuna-maize
266 system. The NPK rates and the legume x NPK interaction did not significantly ($P>0.05$)
267 influence the biological yield of maize.

268

269 **Table 3: Effect of legume system on Maize Yield components**

Legume System	Emergence count (No ha ⁻¹)			Stand at Harvest (No ha ⁻¹)			Maize height at 7 WAPM (cm plant ⁻¹)		
	0 kg	15 kg	30 kg	0 kg	15 kg	30 kg	0 kg	15 kg	30 kg
<i>M. pruriens</i>	33958	28958	35208	33750	33958	31250	140.4	145.6	138.1
<i>L. purpureus</i>	36667	31042	36667	31875	32708	33750	130.5	137.6	125.0
No legume	28125	34167	29792	28958	33958	31458	147.4	134.6	140.4
<u>Means for legumes</u>									
<i>M. pruriens</i>		32708a			32986 ^a			141.4 ^a	
<i>L. purpureus</i>		34792a			32778 ^a			131.0 ^b	
No legume		30694a			31458 ^a			140.8 ^a	
LSD (5%)		4119.80 ^{ns}			3993.60 ^{ns}			8.38 [*]	
<u>Means for NPK</u>									
0 kg NPK/ha		32917 ^a			31528 ^a			139.4 ^a	
15 kg NPK /ha		31389 ^a			33542 ^a			139.3 ^a	
30 kg NPK/ha		33889 ^a			32153 ^a			134.5 ^a	
LSD (5%)		4119.80 ^{ns}			3993.60 ^{ns}			8.38 ^{ns}	
LSD (Legume x NPK)		7136.10 [*]			3161.71 ^{ns}			14.52 ^{ns}	

270 *Means within the same column followed by the same alphabet are not significantly different at 5% level probability by LSD*
 271 *test*

272 *NS: not significant at 5% level of probability*

273 ** Significant at 0.05 level of probability*

274

275

276 **Table 4: Effect of legume system on Maize Yield**

Legume System	Unshelled Cob Weight (Kg ha ⁻¹)			Grain Weight (Kg ha ⁻¹)			Total Plant Yield (Kg ha ⁻¹)		
	0 kg	15 kg	30 kg	0 kg	15 kg	30 kg	0 kg	15 kg	30 kg
<i>M. pruriens</i>	3507.6	3495.6	3519.5	2636.4	2631.0	2669.1	15888.9	13444.4	14722.2
<i>L. purpureus</i>	3654.3	4592.2	4572.7	2954.3	3457.3	3311.6	16666.7	17333.3	18388.9
No legume	5311.7	5351.6	5079.5	4120.7	4132.1	3832.5	21388.9	21388.9	19500.0
Means for legumes									
<i>M. pruriens</i>		36852 ^a			2645.5 ^b			14685 ^c	
<i>L. purpureus</i>		40000 ^a			3241.1 ^b			17463 ^b	
No legume		41111 ^a			4028.4 ^a			20759 ^a	
LSD (5%)		6392.70 ^{ns}			696.46 ^{**}			2693.90 ^{***}	
Means for NPK									
0 kg NPK/ha		39815 ^a			3406.8 ^a			17981.0 ^a	
15 kg NPK /ha		40185 ^a			3271.1 ^a			17389.0 ^a	
30 kg NPK/ha		37963 ^a			3237.1 ^a			17537.0 ^a	
LSD (5%)		6392.70 ^{ns}			696.46 ^{ns}			2693.90 ^{ns}	
LSD (Legume x NPK)		11072.92 ^{ns}			1206.35 ^{ns}			4666.20 ^{ns}	

277 WAPL: Weeks After Planting Legume

278 Means within the same column followed by the same alphabet are not significantly different at 5% level probability by LSD
 279 test

280 NS: Not significant at 5% level of probability.

281 **, *** Significant at 0.01, 0.001 level of probability respectively

282

283 **3.4 Effect of legume system on soil nitrogen level**

284 At 0 WAPL, the soil Nitrogen level of the plots differ significantly ($P>0.05$) (Table 5),
 285 however the NPK rates applied significantly influenced the soil ($P=0.04$). There was no
 286 significant difference in the soil nitrogen level at 14 WAPL within the legume system,
 287 NPK rates and their interaction. However the legume system plots had some advantages
 288 irrespective of NPK level applied when compared to the natural fallow without legumes.
 289 The N-level gains by the cover crops as against the system without cover crop intercrop
 290 at 14 WALP without NPK application were as follows 22% N(0 kg/ha) and 26.5% N (0
 291 kg/ha) for Lablab and Mucuna respectively (Table 5). At 15 kg NPK/ha and 30 kg
 292 NPK/ha, both legumes slightly gained Nitrogen as follows 16.6% N and 11.1% N
 293 respectively for Lablab and 24.2% N and 10.3% N respectively for Mucuna (Table 5).

294 **Table 5: Effect of legume system on soil nitrogen level**

Legume system	Total Soil Nitrogen					
	0 WAPL			14 WAPL		
	0kg	15kg	30kg	0kg	15kg	30kg
<i>M. pruriens</i>	42.0	47.6	56.0	68.5	71.8	61.3
<i>L. purpureus</i>	50.8	52.0	59.7	72.8	68.6	77.1
No legume	68.0	38.1	73.6	57.8	63.9	63.6
Means for legumes						
<i>M. pruriens</i>	48.5 ^a			67.2 ^{ab}		
<i>L. purpureus</i>	54.1 ^a			72.8 ^a		
No legume	59.9 ^a			61.8 ^b		
LSD (5%)	13.10 ^{ns}			9.96 ^{ns}		

Means for NPK

0 kg NPK/ha	53.6 ^{ab}	66.4 ^a
15 kg NPK /ha	45.9 ^b	68.1 ^a
30 kg NPK/ha	63.1 ^a	67.3 ^a
LSD (5%)	13.10*	9.96 ^{ns}
LSD (5%) (Legume x NPK)	22.69 ^{ns}	17.25 ^{ns}

295 Means within the same column followed by the same alphabet are not significantly
296 different at 5% level probability by LSD test

297 NS: Not significant at 5% level of probability.

298 * Significant at 0.05 level of probability

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302 3.5 Response of weed to legume cover crop.

303 At 4WAPL, there was no significant ($p > 0.05$) difference between weed cover and the

304 legume cover in both *Mucuna* and *Lablab* systems. However, the natural fallow system

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305 without legumes had a significantly ($p < 0.05$) higher weed cover compared to the legume

306 system (Figure 1)

307 At 8WAPL, the trend was similar to that of 4WAPL, but *Lablab* had a slightly higher

308 ground cover and lower weed cover compared to *Mucuna*.

309 *Mucuna* 12 WAPL had a significantly ($P < 0.05$) higher ground cover and lower weed

310 cover compared to *Lablab*. Both *Mucuna* and *Lablab* systems at this period had a

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311 significantly ($p < 0.05$) lower weed cover compared to the natural fallow system (Figure 1).

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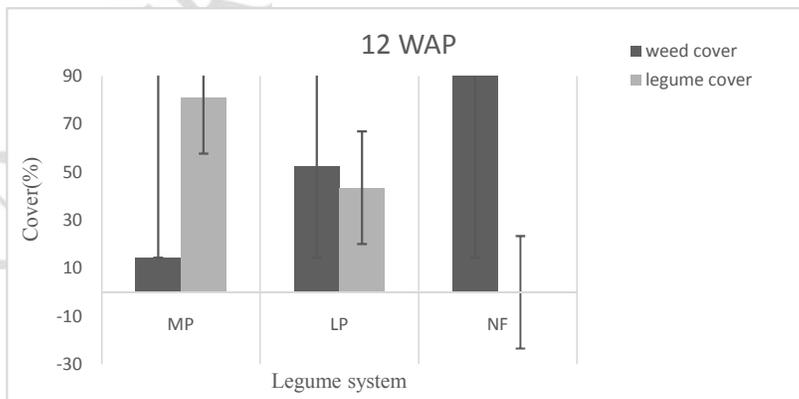
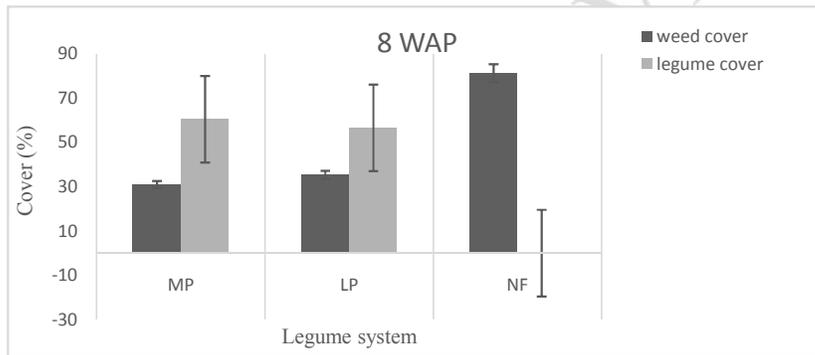
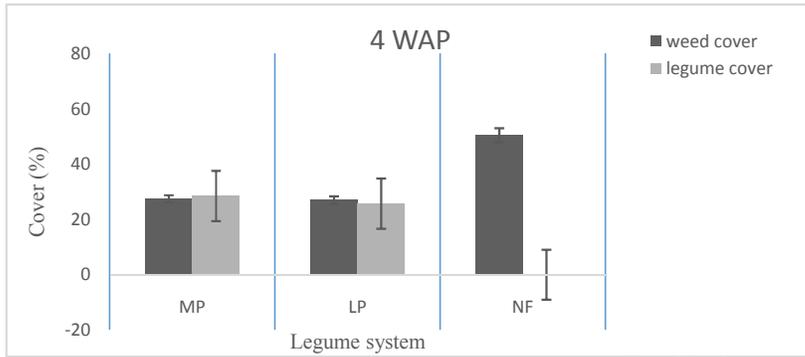
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356 Figure 1: Response of weed to legume cover crop. MP = *Mucuna pruriens*, LP =
357 Lablab purpureus, NF = Natural fallow. Vertical bar are the standard error
358 of mean.
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361 4.2 Discussion

362 4.2.1 Effect of legume cover and NPK on weed growth.

363 Traditional intercropping system is often believed to be better than monocrops in weed,
364 pest and disease control. Weed growth in intercropping largely depends on the
365 competitive abilities of the component crops and their respective plant populations [20].

366 Significant reduction in *Striga* infestation was observed in cereal/cowpea intercropping
367 [21]. This was attributed to cover placed on the soil by the intercropped cowpea [22; 23].

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368 The result of this study did not show significant reduction in the weed density at 8 WAPL
369 but showed significant reduction in weed density at 14 WAPL. This could be because the
370 legumes have not developed enough canopies to suppress weeds [24], and [25] in their
371 studies attributed differential rate of weed suppression to how early the canopy of the
372 cover crop develops to cover the soil and also to the duration of the cover crops' shading.
373 [26] reported a reduction in the density of weed and dry matter with maize-legume
374 intercrop compared to sole maize, which they attributed to decrease in light available to
375 the weeds in the maize-legume intercrops. The superiority of mucuna in weed density and
376 weed biomass reduction at 14 WAPL over lablab is in agreement with the findings of
377 [27] in Kenya where farmers ranked mucuna as the best green manure cover crop, which
378 they based on its high biomass accumulation and quick crop establishment.

379 4.1.2 Weed Suppression Efficiency (WSE) of the legumes

380 All legume systems were better than the sole maize plots on weed suppression efficiency
381 at 14 WAPL probable because the legume systems had developed enough canopies to
382 suppress weed growth by acting as a physical barrier such as preventing direct sun light
383 penetration that could had stimulated weed growth. Although, *M. pruriens* and *L.*
384 *purpureus* had similar weed suppression efficiency, weed suppression efficiency was
385 higher in *M. pruriens* than *L. purpureus* probable due to better weed control. [28], [29]
386 and [30] noted that herbaceous cover crops smother weeds. [24] also noted that legumes
387 suppressed weed growth by secreting chemical substances (Allelopathy compounds). The
388 different rates of NPK fertilizer had identical weed suppression efficiency probable due
389 to lack of treatment effect. Although, the different rates of NPK fertilizer had identical
390 weed suppression efficiency, weed suppression efficiency was higher in 30 NPK kg/ha
391 than others NPK fertilizer rates probable due to better weed control.

392 **4.2.3 Effect of legume system on Maize yield**

393 The height of the sole maize was not significantly different from that of mucuna-maize.
394 The result suggested that plant height was associated with population and competition per
395 unit area where less populated plot with minimum competition showed high plant height.
396 The present findings was in agreement with the findings by [31] who observed taller
397 plant height in sole cropped maize while the minimum in maize intercropped with faba
398 bean. [32] stated that plant density may affect both intra- and interspecific competition
399 and has particularly a direct effect on grain yield of maize. The result of this study
400 showed that maize grain yield was reduced with increasing competition of the component
401 crops as seen in reduced grain yield with mucuna-maize intercrop. This results disagrees
402 with the findings documented by [33] who reported that grain yield of 6496.0 kg ha⁻¹ was

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403 obtained when common bean intercropped with maize. Furthermore, intercropping effect
404 on grain yield of maize was reported by [34] and [35] when haricot bean was
405 intercropped with maize. [36] also reported that maize grain yield was 16% more on
406 maize-narrow leaf lupine intercropping relative to sole crop maize studied on Maize-
407 common bean/lupine intercrop productivity and profitability in maize-based cropping
408 system of North western Ethiopia. Low grain yield under simultaneous cropping of
409 legume cover crops with food crops has earlier been attributed to competition and the
410 aggressive nature of cover crops by [37] [38, 39] and [40]. *Mucuna* (*Mucuna utilis*)
411 when intercropped with maize was found lowering down the maize yields, while cowpeas
412 (*Vigna sinensis*) and greengram (*Phaseolus aureus*) had much less effect on maize and
413 where themselves tolerant to maize shade. [41] observed that the grain yield of maize was
414 not significantly influenced by the different intercropping treatments at Pantnagar. The
415 lablab-maize yield was significantly lower than the sole maize yield, this result is
416 consistent with the findings of [42] who found that the dry matter of maize was reduced
417 with increasing Lablab population.

418 **4.2. 4 Response of weed to legume cover crop.**

419 The result of this study revealed that a progressive increase in legume cover led to a
420 significant decrease in the weed cover in mucuna-maize and lablab-maize plots. [32]
421 reported that residues of legumes creates mulching layer that increases the physical
422 barrier of early germination and that such effect required sufficient organic material
423 residue on the soil surface. This explains the reason for reduction in weed cover with
424 increase in legume cover. Furthermore, [43] reported that lablab bean suppressed weeds

Comment [LR23]: North-Western

425 by up to 40% with its vine morphology when intercropped with sorghum-sudangrass as
426 compared to weedy sole sorghum-sudangrass.

427

428 **CONCLUSION**

429 The result of this study has shown that the maize-legume system has the ability to
430 suppress weed and improve or enhance soil fertility, with or without additional fertilizer
431 in the form of NPK. The result also showed that the system may have the ability to
432 improve upon maize crop performance, but this might be influenced by the timing of the
433 legume introduction or integration into the system. In this study, the legumes were
434 introduced at 4 weeks after planting maize. However, this appeared to be too early for the
435 maize, following the aggressive growth habit of the legume. Hence, the effect on the
436 performance of the maize.

437 The integration of legumes into maize cropping system may be a cheaper alternative for
438 weed suppression and soil fertility improvement. This system will be more sustainable to
439 the agroecosystem compared to the use of herbicides and more inorganic amendment
440 which in the long run will leave the soil with a buildup of resistant weed species. That the
441 integration of legumes into the maize should not be too earlier than 5WAPM and not later
442 than 7WAPM so as to achieve good ground cover for weed suppression and biomass
443 accumulation for soil improvement. In this system additional fertilizer use to boost and
444 enhance both maize and legume performance should not be more than 30 kg NPK/ha.

445 Since this legumes are forage legumes and are aggressive in their growth, it is
446 recommended that *Mucuna and Lablab* be integrated into maize system at about 6 weeks
447 after planting maize. This method will reduce the aggressive effect on the maize and also

Comment [LR24]: ?

448 enable enough time for the legumes to form enough canopy for weed suppression and
449 biomass accumulation for nitrogen accumulation in the system subsequently.

450 Based on other strategies available in the literature, it can also be recommended that the
451 legume be established earlier in the season between 8 and 10 WAP and terminated as
452 short fallow that will be followed by maize.

453 The research has the benefit of farmers increasing productivity without bearing
454 unnecessary cost of fertilizer, beside its unavailability.

455 The cost of cropping and subsequent cost of weeding will be reduced.

456 The legume-maize system is environmentally friendly and will lead to sustainable soil
457 productivity and weed management.

458 Fallow length for soil fertility regeneration will be reduced, as the legume will contribute
459 to soil fertility enhancement.

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