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Influence of Incorporated Short Duration Legume Fallow and Nitrogen on Maize (*Zea mays* L.) Growth and Development in Northern Guinea Savanna of Nigeria

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Abstract: Field experiments were conducted from 2005 to 2007 wet seasons at the Research Farm of the Institute for Agricultural Research, Ahmadu Bello University, Zaria, to evaluate the influence of incorporated short duration legume fallow and nitrogen on Maize (*Zea mays* L.) growth and development in northern Guinea Savanna of Nigeria. The treatments consisted of two maize varieties (SAMMAZ 12 and SAMMAZ 27) and five rates of nitrogen (0, 30, 60, 90 and 120kg N ha^{-1}) in the main plots, while three green manure crops (Lablab (*Lablab purpureus*), Mucuna (*Mucuna pruriens*) and Soybean (*Glycine max* (L.)Merrill)) and a weedy fallow were accommodated in the sub-plots. The treatments were laid out in a split-plot design with three replications. SAMMAZ 12 and SAMMAZ 27 were similar in growth attributes except days to 50% tasselling and silking where SAMMAZ 27 exhibited significant reduction in days to 50% tasselling and silking. Nitrogen fertilization significantly increased plant height, number of leaves, total dry weight and leaf area index but significantly reduced days to 50% tasselling and silking. Incorporation of mucuna, lablab and soybean significantly increased plant height, number of leaves, total dry weight and leaf area index of maize but significantly reduced days to 50% tasselling and silking compared with weedy fallow. However, maize plants grown on plots without applied N and weedy fallow were short and stunted with lowest values of all the measured growth parameters with exception of days to 50% tasselling and silking where zero N and weedy fallow delayed flowering.

Key words: Incorporation · Legume · Green manure · Nitrogen · Maize · Growth · Weedy Fallow

INTRODUCTION

Maize (*Zea mays* L.) is one of the important cereal crops grown in Nigeria. World total cereal production in 2010 showed that maize was the first most important cereal in Nigeria followed by sorghum and millet [1]. Maize production is centred in the Savanna zone of Nigeria which accounts for 70% of its production in Nigeria [2]. Maize yield potential is high in Savanna zone compared to wetter and drier environments [3] because of more favourable production conditions such as solar radiation intensities, lower night temperature and low incidence of diseases and pests. Despite the high yield potential, average yield per hectare is still relatively low. Admittedly, poor soil fertility has been a major constraint to maize production in Savanna zone of Nigeria. The Nigerian savanna soils are low in organic carbon, total nitrogen, available phosphorus, effective CEC and exchangeable cations as well as clay and silt contents [4]. Hence, green manure, which is a renewable source of on-farm nutrients especially nitrogen, can be a good option to reduce the problems highlighted above.

Green manure is the practice of incorporating green and immature crops especially leguminous crops into the soil for the purpose of improving and fertilizing the soil. The use of legumes as green manure makes available both biological fixed N and mineralized N to the soil. Apart from this, the soil organic matter is maintained and renewed and the physical and chemical characteristics of soil are improved [5]. Herbaceous legumes that serve the single

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purpose of improving soil fertility however have not been widely adopted by small farmers because they cannot afford to grow them at the expense of food crops in their limited land holdings [6]. For many farmers however, diverting land for green manure crops for 13-19 weeks [7,8] or 1-2 years [9] before incorporation is too long to adopt. This long period will make it difficult to accommodate the subsequent crops like maize within the rain-fed growing season in northern Guinea Savanna of Nigeria. Therefore, short fallow for growing of legumes (40-50 days) as reported by Leonard [10] before incorporation will be more desirable because it allows a main crop like maize to be grown after the incorporation of green manure crop within the same rainy season. It is therefore pertinent to look for a management practice that is environmentally friendly and capable of maintaining or building up soil fertility for sustainable maize production. Bearing in mind the above mentioned facts, this study was designed to evaluate the influence of green manure and nitrogen on growth and development of maize.

MATERIALS AND METHODS

Experimental Site and Soil Characteristics: The research was carried out in the wet seasons of 2005, 2006 and 2007 at the Institute for Agricultural Research(IAR) experimental farm, Ahmadu Bello University, Zaria (11° 11' N, 07° 38' E, 686 m above sea level) in the northern Guinea Savanna ecological zone of Nigeria. The annual rainfall for the duration of the study was 790.4, 1086.7 and 900.4mm for 2005, 2006 and 2007, respectively. The physico-chemical analysis of the top soil (0-30cm depth) of the experiment site before planting in 2005 as determined by standard procedures showed that the soil was loam with the following properties: pH (0.01M $CaCl_2$), 5.0; organic carbon, 5.3g kg^{-1}; total nitrogen, 0.53g kg^{-1}; available phosphorus, 12.25mg kg^{-1}; and exchangeable cations (cmol kg^{-1}) of Ca^{2+}, 1.80; Mg^{2+}, 0.36; K^+, 0.14; and Na^+, 0.11; and CEC, 4.8cmol kg^{-1}. The soil was loam. The chemical analysis of the incorporated green manure crops is presented in Table 1.

Treatments and Experimental Design: The treatments were factorial combinations of two maize varieties (SAMMAZ 12 and SAMMAZ 27), five levels of N (0, 30, 60, 90 and 120 kg N/ha) and three green manure crops (*Lablab purpureus, Mucuna pruriens and Glycine max* (L.) Merrill) and a weedy fallow. The experiment was a split-plot design where nitrogen and variety represented the main plot and green manure represented the sub plot. The experiment was replicated three times.

Crop Management Practices: Leguminous green manure crops were planted on the flat with narrower inter-row spacing of 37.5 cm. The lablab was sown at two stands per hole at 20cm within row and mucuna was sown at one stand per hole at 20cm within row. The soybean was planted drilled. The green manure crops were incorporated at 49 days (7 weeks) after planting. After 3 days of incorporation, maize seeds were planted with two or three seeds per hole at a spacing of 25cm on the ridges of 75cm apart. The maize seedlings were thinned to one seedling per stand at two weeks after sowing. The experimental plot consisted of six ridges of 4.5m apart and 4m long (gross plot) and net plot was 3m x 3m (9 m^2).

The green manure crops were fertilized with 20kg P_2O_5 ha^{-1} and 10kg N ha^{-1} to boost their growth. Nitrogen fertilizer as urea (46%N) was applied to the maize at 2 and 6 weeks after sowing (WAS) according to treatment. Basal applications of 60kg P_2O_5 ha^{-1} and 60kg K_2O ha^{-1} were done at sowing. Weeds were controlled using Paraquat (Gramaxone) at 3 litres ha^{-1} to kill weeds that were not properly incorporated and hoe weeding was done at 6WAS.

Data Collected: Data on growth parameters were taken on plant height, number of leaves, leaf area index (LAI), days to 50% tasselling and days to 50% silking. Samplings were done at 6, 9 and12WAS from five randomly selected plants in each net plot. Plant height of each of the five randomly tagged plants of maize in each net plot was measured using a meter rule from the ground level to the tip of the topmost leaf but during the reproductive stage,

Table 1: Chemical analysis of the shoot of the green manure crops used in the study from 2005-2007

	N%	P%	K%	C%	C:N
Weedy Fallow	1.64	0.86	1.80	62.11	38
Mucuna	3.32	0.59	0.88	43.94	14
Lablab	3.53	0.61	1.17	49.79	14
Soybean	3.34	0.64	1.25	44.97	13

the height was measured from the ground level to the tip of the tassel. Number of leaves per plant was obtained by counting the number of leaves from the five randomly tagged plants from each net plot and the average number of leaves was recorded per plant. Days to 50% tasselling and silking were counted as number of days in which 50% of the plants in each net plot took from sowing to tasselling and silking, respectively. Data on total dry matter per plant were collected from three randomly selected plants from each plot (border rows). The samples were oven dried at a temperature of 70ºC to a constant weight and weighed using a top loading Meltler-P 1210 weighing balance and the mean weight was recorded as total dry matter (g) per plant. Leaf area was calculated by multiplying the length of the leaf by its width and a factor of 0.75 as described by Lazarov [11]. Leaf area index was calculated as the ratio of leaf area to the area of ground cover at 6, 9 and 12WAS as described by Watson [12, 13] using the following formula,

$$LAI = \frac{\text{Total leaf area per plant x 0.75 (cm}^2\text{)}}{\text{Area of ground covered per plant (cm}^2\text{)}}$$

Statistical Analysis: Data collected from the observations were subjected to statistical analysis of variance (ANOVA) as described by Gomez and Gomez [14] using SAS package version 9.0 of statistical analysis [15]. The differences among treatment means were separated using Duncan's Multiple Range Test [16]. Effects were considered statistically significant at 5% level of probability.

RESULTS

Plant Height: The effect of variety on plant height was significant only at 6WAS in 2005 and in all the sampling stages in 2007 where SAMMAZ 27 produced significantly taller maize plant than SAMMAZ 12 (Table 2).

Application of nitrogen significantly affected the plant height at 6, 9 and 12WAS in all sampling stages of the three years of study with exception of 6WAS in 2005 (Table 2). At 9 and 12WAS in 2005 and 6, 9 and 12WAS in 2006, increasing of N rate from 0 to 30kg N ha^{-1} produced significantly taller plants but a further N addition did not produce significant increase in plant height. At 6WAS in 2007, application of 90 kg N ha^{-1} produced significantly taller plants than 30 kg N ha^{-1} and the control while at 9 and 12WAS in 2007, application of 90 and 120kg N ha^{-1} produced significantly taller plants than 30 kg N ha^{-1} and the control.

Table 2: Influence of nitrogen and green manure on plant height (cm) of two maize varieties in 2005, 2006 and 2007

	2005			2006			2007		
Treatment	6WAS	9WAS	12WAS	6WAS	9WAS	12WAS	6WAS	9WAS	12WAS
Variety(V)									
SAMMAZ 12	116.7b	179.0	176.2	133.1	193.7	194.8	133.0b	208.8b	209.9b
SAMMAZ 27	142.5a	184.9	182.8	137.0	197.5	195.5	153.3a	217.1a	219.2a
SE±	3.34	3.19	2.89	3.23	3.74	3.73	2.65	2.57	5.34
Significance	**	NS	NS	NS	NS	NS	**	*	*
Nitrogen(N) Kg ha^{-1}									
0	116.8	163.3b	163.1b	114.3b	168.5b	167.8b	121.2c	186.0c	190.8c
30	129.6	185.0a	182.1a	131.9a	195.5a	194.2a	140.7b	209.0b	208.1b
60	130.2	185.0a	183.5a	139.3a	200.0a	203.1a	147.6ab	216.9ab	218.5ab
90	134.8	188.8a	185.2a	145.6a	206.0a	204.7a	155.7a	225.7a	226.7a
120	136.8	187.5a	183.6a	144.2a	208.1a	205.9a	150.4ab	227.3a	228.5a
SE±	5.29	5.04	4.56	5.10	5.92	5.89	4.19	4.06	3.65
Significance	NS	*	*	*	*	*	*	**	**
Green manure(G)									
Weedy fallow	115.6c	169.6c	168.9b	110.6b	172.1c	172.5c	113.1c	187.7c	188.3c
Mucuna	137.2a	187.9a	184.6a	142.5a	200.7b	197.9b	150.7b	220.7ab	221.6ab
Lablab	140.0a	187.9a	184.4a	147.1a	208.8a	207.7a	161.0a	226.5a	229.3a
Soybean	125.7b	182.4b	180.3a	139.9a	200.7b	202.5ab	147.8b	216.9b	218.9b
SE±	2.13	1.69	1.83	2.48	2.54	2.89	2.52	2.94	3.15
Significance	**	**	**	**	**	**	**	**	**

WAS: Weeks after sowing. *: Significant at 5% level of probability. **: Significant at 1% of probability. NS: Not-significant.

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT.

Table 3: Influence of nitrogen and green manure on number of leaves per plant of two maize varieties in 2005, 2006 and 2007

	2005			2006			2007		
Treatment	6WAS	9WAS	12WAS	6WAS	9WAS	12WAS	6WAS	9WAS	12WAS
Variety(V)									
SAMMAZ 12	11.5	12.5	12.1	13.7	12.0	11.7	11.8	14.0	14.1
EV 99 QPM	11.5	12.4	12.1	13.4	12.2	11.8	11.7	14.1	14.1
SE± (0.05)	0.09	0.07	0.05	0.12	0.11	0.11	0.1	0.08	0.08
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen(N)(Kg ha^{-1})									
0	10.8b	12.1b	11.6c	12.7b	11.6	11.4	11.2c	14.4	14.6a
30	11.4a	12.2b	12.0b	13.6a	12.1	11.7	11.6b	14.1	14.1b
60	11.8a	12.6a	12.3a	13.7a	12.2	11.9	11.8ab	13.9	13.9b
90	11.7a	12.6a	12.1ab	13.9a	12.4	12.1	12.2a	14.0	14.0b
120	11.9a	12.7a	12.2ab	13.8a	12.2	11.7	12.2a	14.2	14.0b
SE± (0.05)	0.14	0.1	0.08	0.18	0.17	0.17	0.15	0.13	0.12
Significance	*	*	*	*	NS	NS	*	NS	*
Green manure(G)									
Fallow plot	10.7b	12.0b	11.7b	12.6b	11.0b	10.7b	10.9c	13.3b	13.4b
Mucuna	11.8a	12.7a	12.3a	13.9a	12.3a	12.1a	11.9b	14.4a	14.3a
Lablab	11.9a	12.6a	12.1a	14.0a	12.6a	12.2a	12.3a	14.3a	14.5a
Soybean	11.7a	12.5a	12.1a	13.7a	12.4a	12.0a	12.1ab	14.3a	14.2a
S± (0.05)	0.13	0.1	0.09	0.11	0.11	0.12	0.1	0.12	0.11
Significance	**	**	**	**	**	**	**	**	**

WAS: Weeks after sowing. *: Significant at 5% level of probability. **: Significant at 1% of probability. NS: Not-significant.
Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT

Incorporation of mucuna, lablab and soybean produced significantly higher plant height than weedy fallow throughout the sampling periods of all the three years of study (Table 2). At 6, 9 and 12WAS in 2005, incorporation of mucuna and lablab gave significant taller plants than incorporation of soybean except at 12 WAS where there was no significant difference among green manure crops on plant height. At 6WAS in 2006, there was no significant difference among green manure crops on plant height while at 9WAS in 2006, lablab green manure was significantly higher than both mucuna and soybean green manures on plant height. At 12WAS in 2006, mucuna green manure was significantly lower than lablab green manure on plant height. At 6WAS in 2007, lablab green manure was significantly higher than both mucuna and soybean green manure on plant height. At 9 and 12 WAS in 2007, soybean green manure was significantly lower than lablab green manure on plant height.

Number of Leaves per Plant: The effect of variety on number of leaves per plant was not significant in all the sampling periods of the three years of study (Table 3).

Nitrogen application significantly increased number of leaves per plant at 6, 9 and 12 WAS in 2005, at 6 WAS in 2006 and at 6 and 12 WAS in 2007 (Table 3). At 6WAS in 2005, increasing N level from 0 to 30kg N ha^{-1} increased significantly number of leaves per plant. A further increase in N level from 30kg N ha^{-1} upwards had no significant effect on number of leaves per plant. At 9WAS in 2005, application of N up to 60kg N ha^{-1} significantly increased number of leaves per plant. Application of nitrogen higher than 60kg N ha^{-1} did not increase number of leaves per plant. At 12WAS in 2005, increasing N level from 0 kg N ha^{-1} up to 60kg N ha^{-1} significantly increased number of leaves per plant but further N addition did not significantly increase number of leaves per plant. At 6 WAS in 2006, application of 30kg N ha^{-1} significantly increased number of leaves per plant but a further increase in N level from 30kg N ha^{-1} upwards did not produce significant increase in number of leaves per plant. At 6WAS in 2007, application of 90 and 120kg N ha^{-1} produced significantly higher number of leaves per plant than 30kg N ha^{-1} and the control. At 12WAS in 2007, increasing N level from 0 to 30kg N ha^{-1} significantly decreased number of leaves per plant but a further increase in nitrogen level had no significant effect on number of leaves per plant.

Incorporation of green manure crops significantly affected number of leaves per plant in all the sampling stages of the three years of study compared with weedy fallow (Table 3). In all the sampling stages of the three years of study, there was no significant difference among green manure crops on number of leaves per plant except

Table 4: Influence of nitrogen and green manure on leaf area index of two maize varieties in 2005, 2006 and 2007

	2005			2006			2007		
Treatment	6WAS	9WAS	12WAS	6WAS	9WAS	12WAS	6WAS	9WAS	12WAS
Variety(V)									
SAMMAZ 12	2.83b	3.57	2.88	4.20	3.34	2.71	3.31b	4.15	3.85
SAMMAZ 27	3.17a	3.57	2.92	3.97	3.29	2.65	3.65a	4.19	3.83
SE±	0.077	0.08	0.054	0.091	0.084	0.081	0.078	0.067	0.062
Significance	*	NS	NS	NS	NS	NS	*	NS	NS
Nitrogen(N) Kg ha^{-1}									
0	2.48b	3.15b	2.56b	3.26b	2.58c	2.10c	2.90c	3.51c	3.34c
30	2.96a	3.54a	2.95a	4.08a	3.21b	2.60b	3.40b	4.00b	3.68b
60	3.17a	3.59a	2.95a	4.29a	3.52ab	2.88ab	3.66ab	4.31ab	3.94ab
90	3.18a	3.77a	3.00a	4.36a	3.64a	3.01a	3.82a	4.41a	4.07a
120	3.20a	3.80a	3.01a	4.45a	3.61ab	2.80ab	3.63ab	4.61a	4.19a
SE±	0.122	0.127	0.085	0.143	0.133	0.128	0.123	0.106	0.098
Significance	*	*	*	**	**	*	*	**	**
Green manure(G)									
Weedy fallow	2.42c	3.05c	2.53b	3.40b	2.47b	1.95b	2.55c	3.23c	2.97c
Mucuna	3.22a	3.84a	3.07a	4.26a	3.57a	2.90a	3.75ab	4.46ab	4.08b
Lablab	3.34a	3.80a	2.97a	4.44a	3.64a	2.97a	3.99a	4.64a	4.34a
Soybean	3.03b	3.59b	3.02a	4.25a	3.57a	2.89a	3.64b	4.33b	3.99b
SE±	0.067	0.067	0.06	0.089	0.075	0.067	0.09	0.081	0.076
Significance	**	**	**	**	**	**	**	**	**

WAS: Weeks after sowing. *: Significant at 5% level of probability. **: Significant at 1% of probability. NS: Not-significant.

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT

at 6WAS in 2007 where lablab green manure produced significantly higher number of leaves than mucuna green manure. However, all the green manure crops produced significantly higher number of leaves than weedy fallow in all three years of study.

Leaf Area Index (LAI): The effect of variety on leaf area index was significant at 6 WAS in 2005 and 2007 where SAMMAZ 27 gave significantly higher LAI than SAMMAZ 12 (Table 4).

Nitrogen application significantly affected LAI at 6, 9 and 12 WAS of all three years of study (Table 4). At 6, 9 and 12 WAS in 2005, application of 30kg N ha^{-1} significantly increased leaf area index but a further increase in N rates did not produce any significant increase in leaf area index. At 6WAS in 2006, application of 30kg N ha^{-1} significantly increased leaf area index but a further N addition did not significantly increase leaf area index. At 9 and 12WAS in 2006, application of 90kg N ha^{-1} produced significantly higher leaf area index than 30kg N ha^{-1} and the control but it was statistically similar with application of 60 and 120 kg N ha^{-1}. At 6 WAS in 2007, application of 90kg N ha^{-1} produced significantly higher leaf area index than 30kg N ha^{-1} and the control but at par with application of 60 and 120 kg N ha^{-1}. At 9 and 12 WAS in 2007, application of 90 and 120kg N ha^{-1} produced significantly higher leaf area index than 30kg N ha^{-1} and the control but at par with application of 60 kg N ha^{-1}.

Incorporation of green manure crops significantly affected leaf area index in all sampling periods of the three years of study compared with weedy fallow (Table 4). In 2005, incorporation of mucuna and lablab produced significantly higher leaf area index than incorporation of soybean and weedy fallow at 6 and 9 WAS. At 12 WAS, the green manure crops had similar LAI which was higher than weedy fallow. In 2006, the green manure crops had similar leaf area index which was higher than weedy fallow in all the sampling periods. At 12 WAS in 2007, incorporation of lablab produced significantly higher leaf area index than incorporation of mucuna, soybean and weedy fallow while at 6 and 9 WAS, the incorporation of lablab was significantly higher than incorporation of soybean and weedy fallow on LAI.

Total Dry Matter (TDM) per Plant: The effect of variety on total dry matter per plant was significant at 6 WAS in both 2005 and 2007 (Table 5) where SAMMAZ 27 produced significantly higher TDM per plant than SAMMAZ 12.

Table 5: Influence of nitrogen and green manure on total dry matter per plant (g) of two maize varieties in 2005, 2006 and 2007

	2005			2006			2007		
Treatment	6WAS	9WAS	12WAS	6WAS	9WAS	12WAS	6WAS	9WAS	12WAS
Variety(V)									
SAMMAZ 12	41.4b	108.9	114.0	48.7	103.1	199.5	41.7b	112.3	145.7
SAMMAZ 27	51.7a	118.6	131.4	48.5	104.8	194.8	46.6a	110.1	144.6
SE±	2.72	3.58	6.6	4.36	4.13	6.23	1.35	3.76	5.21
Significance	*	NS	NS	NS	NS	NS	*	NS	NS
Nitrogen(N) Kg ha^{-1}									
0	32.9b	92.4b	92.7b	38.5b	69.6c	120.9c	34.1b	69.7c	103.4c
30	44.2ab	115.9a	126.5a	47.9ab	93.7b	185.4b	43.1a	109.6b	132.2b
60	55.2a	118.1a	124.6a	49.1a	109.7ab	203.5b	46.2a	113.0b	158.5a
90	52.1a	122.4a	134.3a	54.5a	121.6a	233.4a	48.4a	126.6ab	158.0a
120	48.3a	120.1a	135.3a	53.0a	125.0a	242.4a	48.9a	137.1a	173.6a
SE±	4.3	5.67	10.44	3.3	6.53	9.85	2.13	5.95	8.23
Significance	*	*	*	*	**	**	*	**	**
Green manure(G)									
Weedy fallow	36.5c	99.0b	102.8b	30.3c	72.0b	148.1c	29.9c	75.9c	100.8b
Mucuna	51.7a	127.8a	131.9a	54.8ab	115.0a	225.3a	49.6ab	121.7ab	159.6a
Lablab	52.9a	114.6a	122.0a	59.4a	120.3a	215.5ab	51.1a	132.4a	163.8a
Soybean	45.1b	113.8a	134.0a	49.8b	108.5a	199.6b	45.9b	114.8b	156.4a
SE±	2.21	5.08	5.3	1.81	4.02	7.56	1.35	4.28	5.54
Significance	**	*	*	**	**	**	**	**	**

WAS: Weeks after sowing. *: Significant at 5% level of probability. **: Significant at 1% of probability. NS: Not-significant.
Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT.

Effect of N fertilization was significant on total dry matter per plant at 6, 9 and 12 WAS in all the years of study (Table 5). In 2005, increasing N level from 0 to 30kg N ha^{-1} significantly increased total dry matter per plant at 9 and 12 WAS while further increase in N rate had no significant effect. At 6WAS, application of either 60 or 90 or 120kg N ha^{-1} produced significantly higher TDM per plant than the control. At 6 WAS in 2006, application of 30kg N ha^{-1} had no significant effect on TDM per plant but application of any of 60, 90 and 120 kg N ha^{-1} resulted in significantly higher TDM per plant than the control. At 9 WAS in 2006, application of either 90 or 120kg N ha^{-1} produced significantly higher TDM per plant than 30kg N ha^{-1} and the control. At 12 WAS in 2006, application of 90 or 120 kg N ha^{-1} resulted in significantly higher TDM per plant than 30-60 kg N ha^{-1} and the control. At 6 WAS in 2007, increasing N level from 0 to 30kg N ha^{-1} significantly increased TDM per plant but further increase in N level had no significant effect. At 9 WAS in 2007, application of 120kg N ha^{-1} produced significantly higher TDM per plant than 30-60 kg N ha^{-1} and the control. At 12 WAS 2007, application of nitrogen increased significantly TDM per plant up to 60 kg N ha^{-1} but further increase of nitrogen beyond 60 kg N ha^{-1} did not significantly increase TDM per plant.

Incorporation of green manure crops significantly increased total dry matter per plant in all the sampling periods of the three years of study compared with weedy fallow (Table 5). In 2005, there was no significant difference among green manure crops on TDM per plant at 9 and 12 WAS but soybean green manure was significantly lower than both mucuna and lablab green manure on TDM per plant at 6 WAS. At 6 WAS in 2006, lablab green manure was significantly higher than soybean green manure on TDM per plant. At 9 WAS in 2006, there was no significant difference among green manure crops on TDM per plant. At 12 WAS in 2006, mucuna green manure was significantly higher than soybean green manure on TDM per plant. In 2007, soybean green manure was significantly lower than lablab green mucuna on TDM per plant but at par with mucuna green manure which was higher than weedy fallow at 6 and 9 WAS. However, there was no significant difference among green manure crops on TDM per plant which was higher than weedy fallow at 12 WAS.

Days to 50% Tasselling: The effects of variety on days to 50% tasselling for each of the three years of study were significant (Table 6). The table shows that SAMMAZ 27 had significantly lesser days to 50% tasselling than SAMMAZ 12 in all the three years and combined mean.

Table 6: Influence of nitrogen and green manure on days to 50% tasselling and silking of two maize varieties in 2005, 2006, 2007 and combined

	Days to 50% tasselling				Days to 50% silking			
Treatment	2005	2006	2007	Combined	2005	2006	2007	Combined
Variety(V)								
SAMMAZ 12	54.3a	52.5a	55.5a	54.1a	59.8a	59.4	60.0a	59.7a
SAMMAZ 27	50.8b	51.3b	53.4b	51.8b	55.8b	58.1	58.0b	57.3b
SE±	0.21	0.27	0.19	0.13	0.51	0.53	0.33	0.27
Significance	**	*	**	**	**	NS	*	**
Nitrogen(N) Kg ha^{-1}								
0	52.9	53.2a	55.2	53.8a	59.9	62.4a	62.5a	61.6a
30	52.5	51.8b	54.5	52.9b	58.0	58.9b	58.9b	58.6b
60	52.5	51.9b	54.3	52.9b	57.7	58.4b	58.0b	58.0bc
90	52.2	51.0b	54.1	52.4b	56.9	56.4b	57.7b	57.0c
120	52.5	51.6b	54.0	52.8b	56.5	57.7b	57.8b	57.3c
SE±	0.33	0.42	0.3	0.2	0.8	0.84	0.52	0.42
Significance	NS	*	NS	*	NS	*	**	**
Green manure (G)								
Weedy fallow	52.9a	53.4a	55.4a	53.9a	59.4a	61.7a	60.8a	60.6a
Mucuna	51.9b	51.1b	54.1c	52.4c	56.9c	57.4c	58.1c	57.5c
Lablab	52.0b	51.1b	53.3d	52.2c	56.5c	57.1c	57.9c	57.2c
Soybean	53.3a	51.1b	54.8b	53.3b	58.3b	58.8b	59.2b	58.8b
SE±	0.22	0.28	0.21	0.14	0.34	0.44	0.29	0.21
Significance	**	**	**	**	**	**	**	**

*: Significant at 5% level of probability. **: Significant at 1% of probability. NS: Non-significant.

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability using DMRT.

Application of nitrogen was significant only on days to 50% tasselling in 2006 and combined mean (Table 6) where application of 30kg N ha^{-1} resulted in lesser days to 50% tasselling than control. Subsequent higher application of N did not affect days to 50% tasselling.

Days to 50% tasselling were significantly influenced by the incorporation of green manure crops over the years and combined mean (Table 6). In 2005, incorporation of mucuna and lablab green manure resulted in similar but less days to 50% tasselling than weedy fallow and soybean which were at par with each other. In 2006, the green manure crops had similar but fewer days to 50% tasselling than weedy fallow. In 2007 and combined mean, the weedy fallow had significantly higher 50% tasselling than green manure crops. Lablab had the least days to 50% tasselling in 2007 whereas mucuna and lablab had the least number of days to 50% tasselling in combined mean.

Days to 50% Silking: The varietal response on days to 50% silking was significant in 2005, 2007 and combined mean (Table 6). The result showed that SAMMAZ 27 had significantly less days to 50% flowering than SAMMAZ 12 in 2005, 2007 and in the combined mean of the three years.

Nitrogen fertilization was significant on days to 50% silking in 2006 and 2007 seasons and combined mean compared with weedy fallow (Table 6). Application of nitrogen significantly reduced the days to 50% silking in 2005 and 2006 seasons at 30kg ha^{-1} but additional fertilizer beyond this level did not reduce the days to 50% silking. The combined mean of the three years showed that application of 90 and 120kg N ha^{-1} was significantly different from application of 30kg N ha^{-1} on days to 50% silking.

Incorporation of green manure significantly reduced the days to 50% silking in each of the three years and their combined mean compared with weedy fallow (Table 6). Incorporation of mucuna and lablab green manure resulted in similar days to 50% silking while soybean green manure gave significantly higher days to 50% silking than mucuna and lablab green manure in 2005 season. Similar trend was observed in 2006 and 2007 seasons as well as combined means.

DISCUSSION

Response to Variety: SAMMAZ 12 took longer days to 50% tasselling and days to 50% silking than SAMMAZ 27. The superiority of SAMMAZ 12 to SAMMAZ 27 on the above mentioned characters could be ascribed to the genetic differences between them. This means SAMMAZ 12 is genetically superior to SAMMAZ 27 on these characters. The higher number of days to 50% tasselling and silking exhibited by SAMMAZ 12 over SAMMAZ 27 meant that SAMMAZ 12 had longer growth cycle. On the other hand, SAMMAZ 27 was superior in plant height to SAMMAZ 12. The SAMMAZ 27 which was taller than SAMMAZ 12 was an indication that it was genetically superior in plant height. Virtually, both SAMMAZ 12 and SAMMAZ 27 were similar in most of their vegetative characters except plant height hence none of such characters that represented genetic variations could translate such superiority into grain yields.

Response to Nitrogen: Application of nitrogen enhanced vegetative growth of maize as expressed by the increases observed in the plant height, number of leaves, leaf area index and total dry matter. These increases in growth parameters confirmed the importance of nitrogen as a constituent of protein and also integral component of many other compounds essential for plant growth processes including chlorophyll and many enzymes [17]. Generally, the effect of nitrogen on growth of maize is attributed to increase in cell division, cell expansion and increase in size of all morphological parts [18]. Besides, it was reported that increasing N levels from 75 to 175 kg N ha^{-1} increased significantly plant height, number of leaves, stem girth, LAI, dry matter accumulation per plant and crop growth rate of maize [19]. N fertilization of maize plants caused significant reduction in days to 50% tasselling and days to 50% silking. This could be attributed to the well utilization of nitrogen by the maize plants in metabolic and meristematic activities which quickened the development of vegetative and reproductive structures. It has been reported that early silk production due to added N might have resulted from rapid growth of plant parts leading to early development of final organelles [20]. The plots with N caused the production of bigger and more robust maize plants. However, maize plants grown on plots without applied N were short and stunted with lowest values of all the measured growth parameters. The leaves of maize plants in zero N control plots were light yellowish green, their growth were slow and their flowering was delayed This type of symptoms was equally reported by Buah *et al.* [20].

Response to Green Manure: The technology of using green manure is one of the most environmental friendly agricultural technologies which could provide better conditions of soil by improving the physical properties, fertilization of soil and micro flora of soil [21]. This is why it has positive consequences on growth and yield of crops especially maize. Maize plants in plots that received incorporated leguminous green manure crops produced a better growth as exemplified by their taller plants, larger number of leaves, larger leaf area index, more total dry matter and earlier attainment of days to 50% tasselling and 50% silking than maize plants grown in plots with weedy fallow. The favourable growth in the legume green manure-treated plots in this study could be attributed to the increases in the amount of N fixed by legumes and quantity of N and P derived from the decomposition of the incorporated green manure crops. Green manure has ability to improve soil nitrogen [22] and to release P [23, 24]. Nitrogen is widely known to be the most required nutrients for plant growth. This is evident in the response of maize to nitrogen application in this study. Significant maize growth as a result of green manure was reported by Tanimu [9], Muhr *et al.* [25], Daudu [26] and Cherr *et al.* [27].

The significant reduction in days to 50% tasselling and silking after incorporation of leguminous green manure could be attributed to increases in soil nitrogen and improvement in soil organic matter which led to rapid growth of maize plants and quick development of various parts of maize plants. These roles caused the maize plants in plots treated with leguminous green manure to attain flowering stage earlier than those maize plants in weedy fallow plots. The similarity observed among the green manure crops could be that all the green manure crops increased the growth parameters to the same magnitude and responded similarly to the inputs.

CONCLUSION

This study has shown that the two varieties (SAMMAZ 12 and SAMMAZ 27) were similar in growth attributes studied except days to 50% tasselling and silking where SAMMAZ 27 exhibited significant reduction in days to 50% tasselling and silking. Application of nitrogen improved maize growth and development in all the growth parameters studied but significantly reduced days to 50% tasselling and silking. Incorporation of mucuna, lablab and soybean is a very useful organic fertilizer for maize growth and development as exemplified by significant increases observed in the growth parameters studied with exception of days to 50% tasselling and silking where significant reduction was observed.

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