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Influence of Incorporated Legumes and Nitrogen Fertilization on Maize (*Zea mays* L.) Nutrient Uptake in a Semi-Arid Environment

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Abstract: *A three year field study was carried out between 2005-2007 wet seasons at the Research Farm of the Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria, to determine the effect of incorporated legumes and nitrogen rates on nutrient uptake of two maize varieties. The treatments consisted of two maize varieties (SAMMAZ 12 and SAMMAZ 27) and five nitrogen rates (0, 30, 60, 90 and 120kg N ha^{-1}) in the main plots while three green manure crops (Lablab , Mucuna and Soybean) and a weedy fallow were accommodated in the sub-plots. The treatments were laid out in a split-plot design with three replicates. The results revealed that SAMMAZ 12 and SAMMAZ 27 were similar in the nutrient uptake. Varying rates of nitrogen significantly increased nutrient uptake in grain, stover and shoot of maize plant. Application of 90 kg N ha^{-1} was adequate for maximum N uptake, and stover and shoot K uptake of maize. However, maximum values for P uptake and grain K uptake were obtained at 120 kg N ha^{-1}. Incorporation of mucuna, lablab and soybean significantly increased uptake of N, P and K in grain, stover and shoot of maize compared with incorporation of weedy fallow.*

Keywords: *Green manure, Incorporation, Legume, Nitrogen, Plant nutrient, Uptake, Varieties.*

I. Introduction

Plant nutrient uptake is a function of the amount of applied and / or soil native nutrients that are available for a plant to accumulate in its biomass. According to Havlin et al. [1], nutrient uptake is the process by which plant roots take up nutrients present in soil solution, with such nutrients subsequently distributed to aerial portions of the plant. The growth and productivity of any plant depend on how effective such a plant is able to absorb and mobilize the available nutrients in the soil for plant growth and dry matter accumulation. Adesoji et al. [2] reported that the favourable growth in maize in the legume green manure-treated plots 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. The uptake of nutrient and their subsequent distribution to various parts of maize plants varied primarily with factors like the native soil fertility, application of chemical fertilizers, the growth stage of the plant and the environmental conditions [3]. In the same vein, Allen and David [4] reported that nutrient uptake is affected by environmental conditions, management practices, the concentration of nutrients and the form in which nutrients are present in the soil.

The potential nutrient contribution of green manure to a subsequent crop depends on both the amount of nutrient accumulated and decomposition rate after incorporation in the soil [5]. Incorporation of short duration legumes and their subsequent decomposition have been reported to improve soil organic matter, soil total N and soil available P but reduced significantly soil pH, soil C:N and soil exchangeable cations [6]. Actually, the type and quality of organic materials incorporated determine the rate of decomposition and nutrient release status of the materials. For chemical fertilizers, the contending factors against nutrient availability in soil are leaching, erosion, volatilization, dilution, soil reactions, etc. Therefore, the objective of this study was to assess the effect of incorporating green manure crops and application of nitrogen on plant nutrient uptake of two maize (Zea mays L.) varieties.

II. Materials And Methods

Experimental Site and Soil Characteristics: The study was carried out in the rainy seasons of 2005, 2006 and 2007 at the Research Farm of the Institute for Agricultural Research, Samaru (11^0 11^1 N, 07^0 38^1 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, 5.3 g kg $^{-1}$; total nitrogen, 0.53 g kg $^{-1}$; available phosphorus, 12.25 mg 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, 4.8 cmol kg $^{-1}$. The chemical analysis of the incorporated green manure crops is shown in Table 1.

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

Treatments and Experimental Design: The treatments consisted 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 laid out in a split-plot design with nitrogen and variety as main plot treatment and green manure as the sub plot treatment. 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 2 stands per hole at 20cm within row and mucuna was sown at a stand per hole at 20cm within row. The soybean was planted drilled. The leguminous green manure crops were incorporated at 49 days (7weeks) 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 (9m^2).The green manure crops were fertilized using 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 carried out 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 Collection: Maize grain and stover samples were taken and their nitrogen (N), phosphorus (P) and potassium (K) concentrations chemically determined. The total nitrogen concentration was determined by the micro-Kjeldahl method [7] while phosphorus and potassium contents were determined by wet digestion[8]. From the digest, P and K were read using the relevant procedures. The P in the solution was determined colorimetrically using a spectrophotometer and the procedure involved the use of the molybdate blue colour method [9, 10]. Total plant potassium in solution was determined by using flame photometer. Nitrogen, phosphorus or potassium uptake in grain is the product of grain yield (kg ha^{-1}) and N, P or K concentration in grain (g kg^{-1}). Nitrogen, phosphorus or potassium uptake in stover is the product of stover yield (kg ha^{-1}) and N, P or K concentration in stover (g kg^{-1}). Shoot N, P or K uptake is the sum of Grain uptake and Stover uptake.

Data Analysis: Data collected from the observations were subjected to statistical analysis of variance (ANOVA) as described by [11] using SAS package version 9.0 of statistical analysis [12]. The differences among treatment means were separated using Duncan's Multiple Range Test [13]. Effects were considered statistically significant at 5% level of probability.

III. Results

Effect of the Treatments on N Uptake

Variety effect was not significant on grain N uptake (Table 2). Application of nitrogen significantly increased grain N uptake up to 30, 60 and 90 kg N ha^{-1} in 2005, 2007 and combined mean, respectively, while in 2006, application of nitrogen up to 120 kg N ha^{-1} in grain N uptake caused significant increase in this parameter (Table 2). In combined mean, application of 30, 60, 90 and 120 kg N ha^{-1} increased grain N uptake by 83.5, 143.6, 182.4 and 214% (Table 2), over no N treatment, respectively. Incorporation of green manure crops performed significantly better on grain N uptake than incorporation of weedy fallow in all the three years of study and their combined mean (Table 2). However, there was no significant difference between mucuna green manure and lablab green manure on grain N uptake except in 2006 where lablab green manure performed better than other types of green manure on grain N uptake (Table 2). Generally, soybean green manure performed significantly lower than others on grain N uptake. In combined mean, incorporation of mucuna, lablab and soybean produced 78, 88.4 and 66.5% increases in grain N uptake over weedy fallow, respectively (Table 2).

There was no significant variety effect on stover N uptake (Table 2). Increasing application of nitrogen beyond 30, 90, 60 and 90 kg N ha^{-1} was not significantly different on stover N uptake in 2005, 2006, 2007 and combined mean, respectively (Table 2). In combined mean, application of 30, 60, 90 and 120 kg N ha^{-1}

increased stover N uptake by 62.8, 84.3, 113.4 and 121.6% (Table 2) compared to zero N, respectively (Table 2). Incorporation of green manure crops significantly affected stover N uptake in all the three years of study and their combined mean (Table 2). In 2005, incorporation of either lablab or soybean gave higher stover N uptake than incorporation of mucuna or weedy fallow. In 2006, incorporation of either mucuna or lablab produced higher stover N uptake than incorporation of soybean or weedy fallow. In 2007, incorporation of lablab which was at par with incorporation of soybean on stover N uptake had higher stover N uptake than incorporation of mucuna or weedy fallow. In combined mean, lablab green manure performed better than other types of green manure on stover N uptake (Table 2), where incorporation of lablab gave 60.4% higher stover N uptake than incorporation of mucuna and soybean which gave 49.4 and 49.6% stover N uptake over the weedy fallow plots, respectively (Table 2).

Table 2: Grain N and stover N uptake (kg ha^{-1}) of two maize varieties as influenced by nitrogen and short duration legume incorporation in 2005, 2006, 2007 and combined.

	Grain N				Stover N			
Treatment	**2005**	**2006**	**2007**	**Combined**	**2005**	**2006**	**2007**	**Combined**
Variety(V)								
SAMMAZ 12	30.34	68.29	37.86	45.50	44.35	40.62	40.66	41.88
SAMMAZ 27	30.28	62.00	37.13	43.14	41.28	38.32	42.04	40.55
SE±	1.956	3.141	2.2	1.435	1.454	1.767	1.236	0.867
Nitrogen(N) Kg ha^{-1}								
0	19.36b	23.99e	15.83c	19.72d	26.36b	19.17d	24.57c	23.36d
30	29.14a	48.98d	30.44b	36.19c	44.33a	31.63c	38.14b	38.03c
60	33.86a	67.56c	42.67a	48.03b	43.89a	40.23b	45.05a	43.06b
90	34.62a	84.84b	47.60a	55.69a	50.41a	49.77a	49.35a	49.84a
120	34.57a	100.35a	50.93a	61.95a	49.09a	56.55a	49.64a	51.76a
SE±	3.093	4.967	3.479	2.269	2.299	2.794	1.955	1.371
Green manure (G)								
Weedy fallow	22.19c	38.34c	23.49b	28.01c	33.84c	24.29c	30.26c	29.47c
Mucuna	35.13a	72.80b	41.63a	49.85a	41.86b	46.80a	43.43b	44.03b
Lablab	33.44ab	80.11a	44.75a	52.76a	48.29a	46.34a	47.14a	47.26a
Soybean	30.48b	69.33b	40.11a	46.64b	47.27a	40.44b	44.57ab	44.09b
SE±	1.24	2.478	1.934	1.126	1.221	1.114	1.239	0.689

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

Variety effect was not significant on shoot N uptake (Table 3). Application of nitrogen significantly increased shoot N (Table 3) uptake up 30, 60 and 90 kg N ha^{-1} in 2005, 2007 and combined mean, respectively. In 2006, increasing N rate significantly increased total N uptake up to 120 kg N ha^{-1}. In combined mean, application of 30, 60, 90 and 120 kg N ha^{-1} increased shoot N uptake by 72.2, 111.4, 144.9 and 163.9% (Table 3) over zero N control, respectively. Incorporation of green manure crops significantly affected shoot N uptake in all the three years of study and their combined mean (Table 3). In 2005, 2006 and 2007, incorporation of any of the green manure crops resulted in higher shoot N uptake than the weedy fallow. In combined mean, incorporation of lablab gave 74% higher shootl N uptake than incorporation of mucuna and soybean which gave 63.4 and 57.9% shoot N uptake over the weedy fallow plots, respectively (Table 3).

Table 3. Shoot N uptake (kg ha^{-1}) of two maize varieties as influenced by nitrogen and short duration legume incorporation in 2005, 2006, 2007 and combined.

	Shoot N			
Treatment	**2005**	**2006**	**2007**	**Combined**
Variety(V)				
SAMMAZ 12	74.69	108.90	78.52	87.37
SAMMAZ 27	71.56	100.32	79.17	83.68
SE±	3.354	4.731	3.337	2.23
Nitrogen(N) Kg ha^{-1}				
0	45.72b	43.15e	40.39c	43.09d
30	73.47a	80.61d	68.57b	74.22c
60	77.76a	107.79c	87.73a	91.09b
90	85.03a	134.61b	96.95a	105.53a
120	83.65a	156.90a	100.58a	113.71a
SE±	5.303	7.481	5.276	3.526
Green manure (G)				
Weedy fallow	56.03b	62.63b	53.75b	57.47c
Mucuna	76.99a	119.61a	85.06a	93.88b
Lablab	81.72a	126.45a	91.89a	100.02a
Soybean	77.75a	109.77a	84.67a	90.73b
SE±	2.261	3.362	3.053	1.691

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 the Treatments on P Uptake

There was no significant variety effect on grain P uptake (Table 4). Application of nitrogen beyond 30 and 60 kg N ha^{-1} did not significantly increase grain P uptake in 2005 and 2007, respectively (Table 4). In 2006 and combined mean, increasing N rate from 0 to 30kg N ha^{-1} significantly increased grain P uptake but a further increase of N rate to 60 kg N ha^{-1} resulted in no significant difference on grain P uptake while application of 90 and 120kg N ha^{-1} significantly increased grain P uptake. Application of 30, 60, 90 and 120 kg N ha^{-1} in combined mean significantly increased grain P uptake by 105.7, 134.8, 183.8 and 222.3% (Table 4) compared to no N treatment, respectively. Incorporation of green manure crops performed significantly better on grain P uptake than incorporation of weedy fallow in all the three years of study and their combined mean (Table 4). In 2005, incorporation of mucuna and lablab resulted in higher grain P uptake than incorporation of soybean and weedy fallow (Table 4). However, in 2006 and combined mean, incorporation of lablab produced higher grain P uptake than incorporation of mucuna and soybean. In 2007, green manure crops had similar but higher grain P uptake than weedy fallow (Table 4). In combined mean, incorporation of mucuna, lablab and soybean gave 60.4, 78.5 and 55.9% increases on grain P uptake compared to incorporation of weedy fallow, respectively (Table 4).

Variety effect was not significant on stover P uptake (Table 4). Application of 90 and 120 kg N ha^{-1} had significantly higher stover P uptake than the no N control in 2005 and 2006, respectively (Table 4). In 2007, application of 30 kg N ha^{-1} significantly increased stover P uptake which was at par with application of 60 and 90 kg N ha^{-1} but further increase of N level to 120 kg N ha^{-1} significantly increased stover P uptake. Application of 30 and 60 kg N ha^{-1} had similar stover P uptake in combined mean but higher than no N treatment and lower than addition of 90 and 120 kg N ha^{-1} on stover P uptake (Table 4). In combined mean, Application of 30, 60, 90 and 120kg N ha^{-1} significantly increased stover P uptake by 17.5, 22.7, 37.4 and 62.8% compared to no N treatment, respectively (Table 4). Incorporation of green manure crops produced significantly higher stover P uptake than incorporation of weedy fallow in all the three years of study and their combined mean (Table 4). In 2005, mucuna incorporation resulted in higher stover P uptake than incorporation of lablab, soybean and weedy fallow. In 2006 and combined mean, incorporation of mucuna and lablab resulted in higher stover P uptake than incorporation of soybean and weedy fallow (Table 4). In 2007, incorporation of lablab produced higher stover P uptake than incorporation of mucuna and soybean. In combined mean, incorporation of mucuna, lablab and soybean gave 49, 54 and 36.2% increases on stover P uptake compared to incorporation of weedy fallow, respectively (Table 4).

Table 4: Grain P and stover P uptake (kg ha^{-1}) of two maize varieties as influenced by nitrogen and short duration legume incorporation in 2005, 2006, 2007 and combined.

	Grain P				Stover P			
Treatment	**2005**	**2006**	**2007**	**Combined**	**2005**	**2006**	**2007**	**Combined**
Variety(V)								
SAMMAZ 12	4.05	8.42	5.07	5.85	5.44	7.12	6.87	6.48
SAMMAZ 27	4.11	7.53	4.81	5.48	5.27	6.59	7.37	6.41
SE±	0.275	0.376	0.297	0.184	0.202	0.324	0.202	0.144
Nitrogen(N) Kg ha^{-1}								
0	2.73b	2.48d	2.20c	2.47d	4.56b	6.15bc	4.37c	5.03d
30	4.37a	6.70c	4.17b	5.08c	5.58ab	5.56c	6.58b	5.91c
60	4.45a	7.70c	5.25ab	5.80c	5.28ab	6.04bc	7.20b	6.17c
90	4.66a	9.79b	6.57a	7.01b	6.20a	7.44b	7.11b	6.91b
120	4.19a	13.19a	6.50a	7.96a	5.19ab	9.06a	10.33a	8.19a
SE±	0.435	0.595	0.47	0.291	0.32	0.512	0.319	0.228
Green manure (G)								
Weedy fallow	3.05c	5.12c	3.28b	3.81c	4.83c	4.49c	5.00c	4.78c
Mucuna	4.57a	8.36b	5.39a	6.11b	5.95a	8.18a	7.24b	7.12a
Lablab	4.66a	9.91a	5.82a	6.80a	5.44b	7.97a	8.68a	7.36a
Soybean	4.04b	8.51b	5.27a	5.94b	5.21bc	6.76b	7.55b	6.51b
SE±	0.179	0.317	0.258	0.149	0.165	0.42	0.213	0.166

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

Variety effect was not significant on shoot P uptake (Table 5). In 2005, application of nitrogen beyond 30 kg N ha^{-1} did not significantly increase shoot P uptake (Table 5). In 2006 and combined mean, increasing N level significantly increased total P uptake up to 120 kg N ha^{-1}. However, both 30 kg and 60 kg N ha^{-1} did not differ in their effects on shoot P uptake. In 2007, application of 30 kg N ha significantly increased shoot P uptake which was at par with application of 60 kg N ha^{-1} that was statistically the same with application of 90 kg N ha^{-1} but further application to 120 kg N ha^{-1} significantly increased shoot P uptake. Application of 30, 60, 90 and 120kg N ha^{-1} in combined mean significantly increased shoot P uptake by 46.5, 59.7, 85.6 and 115.3% compared to no N treatment, respectively (Table 5). Incorporation of green manure crops performed significantly better on shoot P uptake than incorporation of weedy fallow in all the three years of study and their combined mean (Table 5). In 2007 and combined mean, lablab green manure performed significantly better on shoot P uptake than other types of green manure (Table 5) but at par with mucuna green manure in 2006. However in 2005, mucuna green manure did better on shoot P uptake than others but at par with lablab green manure. In combined mean, incorporation of mucuna, lablab and soybean gave 54, 64.8 and 44.9% increases on shoot P uptake compared to weedy fallow incorporation, respectively (Table 5).

Table 5: Shoot P uptake (kg ha^{-1}) of two maize varieties as influenced by nitrogen and short duration legume incorporation in 2005, 2006, 2007 and combined.

	Shoot P			
Treatment	**2005**	**2006**	**2007**	**Combined**
Variety(V)				
SAMMAZ 12	9.5	15.54	11.93	12.32
SAMMAZ 27	9.39	14.11	12.18	11.89
SE±	0.47	0.643	0.482	0.31
Nitrogen(N) Kg ha^{-1}				
0	7.30b	8.63d	6.57d	7.50d
30	9.95a	12.26c	10.75c	10.99c
60	9.73a	13.75c	12.45bc	11.98c
90	10.85a	17.23b	13.68b	13.92b
120	9.38ab	22.25a	16.84a	16.15a
SE±	0.743	1.017	0.763	0.491
Green manure (G)				
Weedy fallow	7.88c	9.61c	8.28c	8.59d
Mucuna	10.53a	16.54ab	12.63b	13.23b
Lablab	10.11ab	17.88a	14.50a	14.16a
Soybean	9.25b	15.27b	12.82b	12.45c
SE±	0.309	0.622	0.455	0.277

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

There was no significant different variety effect on grain K uptake (Table 6). In all the years and combined mean, increasing N level from 0 to 30 kg N ha^{-1} significantly increased grain K uptake (Table 6) while application of 60 and 90 kg N ha^{-1} was statistically similar on grain K uptake in 2005, 2006, 2007 and combined mean (Table 6) but further application beyond 90 kg N ha^{-1} increased grain K uptake except in 2005. Application of 30, 60, 90 and 120 kg N ha^{-1} in combined mean significantly increased grain K uptake by 96.9, 149.8, 159.1 and 222.2% compared to no N treatment, respectively (Table 6). Incorporation of green manure crops produced significantly higher grain K uptake than incorporation of weedy fallow in all the three years of study and their combined mean (Table 6). In 2005 and combined mean, lablab and mucuna green manure performed similarly on grain K uptake (Table 6) while in 2006, lablab green manure performed better than others on grain K uptake but there was no significant different among green manure crops on grain K uptake in 2007 (Table 6). Incorporation of green manure crops in combined mean significantly increased grain K uptake by 57.5, 67.4 and 51.7% compared with weedy fallow incorporation for mucuna, lablab and soybean, respectively (Table 6). Variety effect was not significant on stover K uptake (Table 6). In 2005 and 2006, increasing N level from 0 to 30kg N ha^{-1} significantly increased stover K uptake but further N addition did not produce significant increase in stover K uptake (Table 6). In 2007 and combined mean, increasing N level from 0 to 30kg N ha^{-1} produced a significant increase on stover K uptake but a further increase of N from 30 to 60 kg N ha^{-1} produced no significant increase in stover K uptake (Table 6). Application of 90 and 120 kg N ha^{-1} resulted in significantly higher K uptake than application of 60 kg N ha^{-1} in combined mean and 2007, respectively. In combined mean, Application of 30, 60, 90 and 120 kg N ha^{-1} significantly increased stover K uptake by 45.3. 57.9, 73 and 76.9% compared to no N control, respectively (Table 6). Incorporation of green manure crops significantly increased stover K uptake in all the three years and their combined mean (Table 6).

Table 6: Grain K and stover K uptake (kg ha^{-1}) of two maize varieties as influenced by nitrogen and short duration legume incorporation in 2005, 2006, 2007 and combined.

	Grain K				Stover K			
Treatment	**2005**	**2006**	**2007**	**Combined**	**2005**	**2006**	**2007**	**Combined**
Variety(V)								
SAMMAZ 12	3.99	9.15	4.50	5.88	32.99	42.41	35.86	37.09
SAMMAZ 27	4.12	8.30	4.71	5.71	34.39	39.11	34.89	36.13
SE±	0.274	0.432	0.286	0.195	1.14	1.805	0.982	0.783
Nitrogen(N) Kg ha^{-1}								

0	2.61b	3.30d	1.81c	2.57d	24.61b	24.94c	23.37d	24.30c
30	4.03a	7.05c	4.11b	5.06c	35.61a	36.96b	33.38c	35.32b
60	4.69a	9.41b	5.15b	6.42b	35.69a	42.83ab	36.60bc	38.37b
90	4.25a	10.42b	5.30b	6.66b	36.70a	49.24a	40.20ab	42.05a
120	4.70a	13.47a	6.65a	8.28a	35.84a	49.84a	43.31a	42.99a
SE±	0.434	0.683	0.452	0.309	1.803	2.854	1.553	1.239
Green manure (G)								
Weedy fallow	3.24c	5.84c	2.99b	4.02c	27.20b	27.14b	25.15c	26.50c
Mucuna	4.53a	9.21b	5.25a	6.33ab	36.54a	43.99a	37.15b	39.23b
Lablab	4.46ab	10.45a	5.28a	6.73a	35.83a	47.06a	42.31a	41.74a
Soybean	3.99b	9.41b	4.90a	6.10b	35.19a	44.85a	36.88b	38.97b
SE±	0.172	0.340	0.240	0.150	0.925	1.181	1.060	0.612

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

In 2005 and 2006, there was no significant difference among green manure crops on stover K uptake (Table 6). In 2007 and combined mean, lablab green manure had higher stover K than mucuna and soybean green manures which were at par with each other. In combined mean, incorporation of mucuna, lablab and soybean gave 61.4, 71.8 and 60.4% increase on stover K uptake over weedy fallow, respectively (Table 6).

There was no significant variety effect on shoot K uptake (Table 7). In 2005, application of nitrogen beyond 30 kg N ha^{-1} did not significantly increase shoot K uptake (Table 7). In 2006 and 2007, increasing N level from 0 to 30 kg N ha^{-1} produced significant increase on total K uptake but a further increase to 60 kg N ha^{-1} produced no significant increase in shoot K uptake (Table 7). Application of 120 kg N ha^{-1} produced significantly higher shoot K uptake than application of 60 kg N ha^{-1}. In combined mean, increasing N rate up to 60 kg N ha^{-1} significantly increased total K uptake but a further increase of N rate from 60 to 90 kg N ha^{-1} produced no significant effect on shoot K uptake which was at par with application of 120 kg N ha^{-1}. Application of 30, 60, 90 and 120 kg N ha^{-1} in combined mean gave 50, 66.6, 81.2 and 90.7% increase in shoot K uptake over no N control, respectively (Table 7). Incorporation of mucuna, lablab and soybean significantly increased total K uptake in all three years of study and their combined mean (Table 7). In 2005, there was no significant difference among green manure crops on shoot K uptake. In 2006, incorporation of lablab and soybean was at par on shoot K uptake but incorporation of lablab produced a significant higher shoot K uptake than incorporation of mucuna. In 2007 and combined mean, lablab green manure produced a significant higher shoot K uptake than both mucuna and soybean green manure which were at par on shoot K uptake. Incorporation of green manure crops in combined mean significantly increased shoot K uptake by 49.3, 58.8 and 47.7% compare with weedy fallow for mucuna, lablab and soybean, respectively.

Table 7: Shoot K uptake (kg ha^{-1}) of two maize varieties as influenced by nitrogen and short duration legume incorporation in 2005, 2006, 2007 and combined.

	Shoot K			
Treatment	**2005**	**2006**	**2007**	**Combined**
Variety(V)				
SAMMAZ 12	36.98	51.57	40.35	42.97
SAMMAZ 27	38.51	47.41	39.59	41.84
SE±	1.401	2.187	1.249	0.961
Nitrogen(N) Kg ha^{-1}				
0	27.22b	28.23d	25.18d	26.88d
30	39.64a	44.01c	37.49c	40.38c
60	40.38a	52.24bc	41.75bc	44.79b
90	40.95a	59.66ab	45.50ab	48.70ab
120	40.54a	63.31a	49.96a	51.27a
SE±	2.215	3.458	1.974	1.519
Green manure (G)				
Weedy fallow	30.45b	32.97c	28.14c	30.52c
Mucuna	41.06a	53.21b	42.40b	45.56b
Lablab	40.29a	57.52a	47.59a	48.47a
Soybean	39.18a	54.26ab	41.78b	45.07b
SE±	1.053	1.438	1.267	0.729

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

IV. Discussion

Similarity exhibited by SAMMAZ 12 and SAMMAZ 27 in nutrient uptake could be an indication that both varieties were similar in accumulation of these nutrients. This could also be attributed to their inherent ability of earliness. The marked increases observed in the grain N, stover N and shoot N uptake of maize could be attributed to the enhanced growth of maize plants as earlier reported from another aspect of this study [2], which in turn enhanced the uptake of the nutrient. This result further revealed that the added nitrogen was sufficiently available and enough for highest uptake of N in grain, stover and entire maize plant with the maximum at 90 kg N ha^{-1}. El-Gizawy [14] reported that grain N uptake markedly increased with the increase in N rates while Hussaini et al. [15] stated that application of 180 kg N ha^{-1} gave highest increase in grain, stover and shoot N uptake in maize.

Significant increases obtained in grain P, stover P uptake and shoot P uptake after application of nitrogen followed the pattern of the increase in nitrogen rates. This was an indication of improved soil conditions brought about by N treatment as explained by [16] that the utilization of phosphorus, potassium and other elements are enhanced by N availability. This means the more the N the larger the growth of the plant and therefore such plant took up more N, P, and K. This explained why the application of 120 kg N ha^{-1} gave the highest P uptake in maize in this study. This result is in consonance with report of [15] who also found that application of 120 kg N ha^{-1} gave highest increase in stover P and shoot P uptake in maize but further increase to 180 kg N ha^{-1} gave the highest grain P uptake.

Positive effects of nitrogen application on grain K uptake, stover K uptake and shoot K uptake showed how nitrogen mediated in the utilization of potassium just like phosphorus and other elements in plants [16]. This result might have demonstrated the synergistic relationship between nitrogen and potassium. In this study, application of 120 kg N ha^{-1} gave the highest grain K uptake but application of 90 kg N ha^{-1} was adequate for highest stover K and shoot K uptake. In investigation conducted by [15], application of 120 kg N ha^{-1} gave highest increase in grain and stover K uptake but application of 180 kg N ha^{-1} gave the highest shoot K uptake.

Significant increases observed in grain N, stover N and shoot N uptake of maize plants in plots where legumes were incorporated showed that both the fixed N and mineralized N from the legumes were available for plant use. Sharma and Bahera [17] reported that nitrogen uptake by maize grain and stover increased significantly following summer legumes compared with that after fallow. Positive effect of legume incorporation on grain P uptake, stover P uptake and shoot P uptake suggests improvements in the supply and availability of nutrients especially phosphorus for subsequent accumulation by maize plants. This might be due to high microbial activity induced by the added organic residues which speed up P cycling [18]. Significant increases observed in grain K uptake, stover K uptake and shoot K uptake indicated that the incorporation of legumes could have stimulated development of massive root system which enhanced K uptake as also found by [19] who reported that better root growth is responsible for increased nutrient uptake in plants.

V. Conclusion

Based on the results obtained from this study, it can be concluded that SAMMAZ 12 and SAMMAZ 27 were similar in the accumulation of nutrients. Nitrogen fertilization significantly enhanced accumulation of N, P and K in grain, stover and shoot of maize plant. Incorporation of mucuna, lablab and soybean significantly increased the uptake of N, P and K in grain, stover and shoot of maize compared with incorporation of weedy fallow which showed lowest values of N, P and K uptake in grain, stover and shoot of maize plant. Decomposition and consequent mineralization of the incorporated legumes enhanced the accumulation of nutrients by the maize plant.

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References

[1]. Havlin, J.L., J. D. Beaton, S. L. Tisdale and W. L. Nelson, Soil fertility and fertilizers. An introduction to Nutrient Management 7th Ed. (Pearson Education Inc. Upper Saddle River, New Jersey, 2005).

[2]. Adesoji, A.G., I. U. Abubakar, B. Tanimu, and D.A. Labe, Influence of Incorporated Short Duration Legume Fallow and Nitrogen on Maize (Zea mays (L.) Growth and Development in Northern Guinea Savanna of Nigeria. American- Eurasian Journal of Agricultural and Environmental Sciences13 (1), 2013, 58-67. DOI: 10.5829/idosi.aejaes.2013.13.01.1885.

[3]. Ologunde, O. O., Effect of nitrogen and population on yield and yield components of maize (Zea mays L.). M.Sc. thesis submitted to graduate school, university of Missouri, Columbia, Missouri, 1974.

[4]. Allen, V.B. and J. P. David, Handbook of plant nutrition. (CRC Press, 2007) 632.

[5]. Muhr, L., S. A. Tarawali, M. Peters and R. Schultze-Kraft, Forage legumes for improved fallows in agropastoral systems of subhumid West Africa. III. Nutrient import and export by forage legumes and their rotational effects on subsequent maize, Tropical Grasslands 33, 1999, 245-256.

[6]. Adesoji, A.G., Abubakar, I.U. and D. A. Labe, Soil chemical properties as affected by incorporated legumes and nitrogen in soil with maize (Zea mays L.) in a semi-arid environment, International Journal of Agriculture Innovations and Research 3(3), 2014, 888-894.
[7]. Bremner, J. M., Total nitrogen. In Black, C.A. (ed.) Methods of soil analysis part 2: chemical and microbiological properties. (American Society of Agronomy, Madison, Wisconsin, 1965)1149-1178.
[8]. Mehlich, A., Mehlich-3 Soil Test Extractant.A Modification of Mehlich 2 Extractant. Communications in Soil Science and Plant Analysis,15 (12), 1984, 1409-1416.
[9]. Bray, R.H. and L. T. Kurtz, Determination of total organic and available form of P in soil. Soil Science 59, 1945, 39-45.
[10]. Murphy, J. and J. R. Riley, A modified single solution method for the determination of P in natural waters. Annal of Chemistry Acta 27, 1962, 31-36.
[11]. Gomez, K.A. and A. A. Gomez,. Statistical procedures for agricultural research. 2nd Edition, (John Willey and Sons, New York, 1984).
[12]. SAS Institute, Statistical Analysis System (SAS) User's Guide (Version 9.0). (SAS Institute, Inc., North Carolina. USA, 2002).
[13]. Duncan, D.B., Multiple range and multiple F-test. Biometrics 11, 1955, 1-42.
[14]. [El-Gizawy, N. Kh. B., Effects of nitrogen rate and plant density on agronomic nitrogen efficiency and maize yields following wheat and faba bean. American-Eurasian Journal of Agricultural and Environmental Sciences 5(3), 2009, 378-386.
[15]. Hussaini, M. A., V. B. Ogunlela, A. A. Ramalan and A. M. Falaki, Mineral composition of dry season maize (Zea mays L.) in response to varying levels of nitrogen phosphorus and irrigation at Kadawa, Nigeria. World Journal of Agricultural Sciences 4(6), 2008, 775 – 780.
[16]. Brady, N.C. The nature and properties of soils. (Macmillan Publishing Company, New York, 1984) 152 – 154.
[17]. Sharma, A.R. and U.K. Behera, Nitrogen contribution through Sesbania green manure and dual – purpose legumes in maize–wheat cropping systems: agronomic and economic considerations. Plant Soil, 325, 2009, 289 – 304.
[18] Melero, S ., Madejon, E., Ruiz, J.C. and J.F. Herencia, Chemical and biochemical properties of a clay soil under dryland agriculture system as affected by organic fertilization. European Journal of Agronomy 26, 2007, 327 – 334.
[19] Aziz, T., M. A. Rahimatullah, M. A. Maqsood, M. A. Tahir, I. Ahmad and M. A .Cheema,., Phosphorous utilization by six Brassica cultivars (Brasicajuncea L.) from tri-calcium phosphate; a relatively insoluble P compound. Pakistan Journal of Botany, 38, 2006, 1529 -1538.