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GROWTH AND DRY MATTER (FODDER) PRODUCTION OF MAIZE (*Zea mays* L.) VARIETIES AS AFFECTED BY TIMING OF NITROGEN SECOND DOSE FERTILIZATION

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ABSTRACT
Field trials were conducted in 2016 wet season at Institute of Agricultural Research IAR, Research Farm(Lat.11° 11' N, Long. 07^{0}38' E, 686m above sea level), Samaru-Zaria and Jaji Military Cantonment Farm located at 30 Km from Zaria along Kaduna – Zaria road (Lat. 10° 49' 25" N, Long. 07° 34' 10" E, 600m above sea level), both in Northern Guinea Savannah of Nigeria, to Investigate the growth of Maize varieties and dry matter produced at varying timing of nitrogen second dose fertilization. The treatments consist of three maize varieties (SAMMAZ 14, SAMMAZ 15 and SAMMAZ 16) and six times of nitrogen second dose fertilization 4 5, 6, 7, 8, 9 weeks after sowing (WAS). Treatments were factorially combined and laid out in a randomized complete block design (RCBD) with three replications. SAMMAZ 16 outperformed SAMMAZ 14 and SAMMAZ 15 in terms of plant height, number of leaves, total leaf area, leaf area index and dry matter production. Time of nitrogen second dose application 6 WAS consistently produced the highest growth attributes of maize ;plant height, number of leaves, total leaf area, leaf area index and dry matter production compared to other timings evaluated. SAMMAZ 16 and 6 WAS in conclusion appeared to be the optimum for increased maize fodder (dry matter) production in the Savannah region where potential for livestock production is high.

Keywords: Maize, dry matter production, time of nitrogen second dose fertilization, savannah ecology, Nigeria.

INTRODUCTION

Among cereals, maize (*Zea mays L.*) is an important food and feed crop which ranks third after wheat and rice in the world (Hokmahpor and Darbandi2011). Maize is one of the most efficient crops which can give high biological yield (dry matter) as well as grainyield (Hokmahpor *et al.* 2010).In Nigeria, maize is an important food, fodder and an industrial crop grown both commercially and at subsistence level (Eleweanya *et al.,* 2005). Chaudhary *et al.,* (1993) reported that maize also contain phosphorus, potassium including Caroteneespecially from the yellow colored varieties which are precursors of vitamin A and others such as ascorbic acid, these are essential for healthy growth and normal functioning of human and animal bodies(Ado *et al.,* 2007). Maize forage is a high energy feed, better than most other tropical forage crops, of which the dry matter (fodder) is often below 40% digestible (Brewbaker,2003).Maize green forage, particularly when it contains the stalks, leaves and ears, is an energy-rich feed for ruminant livestock and grazing whole maize plant also provides green fodder to livestock in periods of scarcity (Newport,2006).In the recent years, maize production in Nigeria has increase and expanded beyond the traditional boundaries due to the development of improved maize varieties with probably better efficiency in carbon assimilation (Bello *et al.,* 2012). Many studies have shown that profitable maize production is only attainable under sufficiently fertile soils (Caitt, 2005 ;Veen, 2007) and this is of particularly importance in the Savannah region where soils are inherently of low fertility which requires frequent and timely fertilization (Lombin, 1987). The International Institute of Tropical Agriculture (IITA, 2007) has reported that limited use of nitrogenous fertilizers and declining soil fertility are among the major problems for maize production in Nigeria (IITA, 2007). Efficient use of nitrogen by maize plant warrants application of an adequate amount at an effective timing which could bring synchronization between N demand and its supply through the fertilizer (Niazh *et al.,* 2015). Anon, (2004) suggested the timing for nitrogen fertilizer Second dose application to be between 4-6 weeks after sowing (WAS), but the recently released improved maize varieties(Nweke and Nsoanya,2013) many not necessarily conform to the above suggested timings, thus the growth and dry matter production of maize may not be at a level that might be expected. If the time that the growing maize crop is expected to be given its second dose fertilization is missed then, the yield in terms of dry matter to be produced may not be attained.Currently, fodder scarcely, especially in dry season is a common feature in the Nigerian savannah, which is endowed with large livestock population, often leading to perennial clash between pastoralist and herdsmen (Ahmed *et al.,* 2014).

The present study was designed to evaluate the effect of varying the timing of nitrogen second dose fertilization on the growth and dry matter production of some improved maize varieties

MATERIALS AND METHODS

Field experiments in two locations were conducted during the 2016 wet season at the Research Farm of Institute for Agricultural Research Farm(Lat.11^{o} 11' N, Long. 07^{0}38' E, 686m above sea level), Samaru-Zaria and Jaji Military Cantonment Farm located at 30 Km from Zaria along Kaduna – Zaria road (Lat. 10^{o} 49' 25" N, Long. 07^{o} 34' 10" E, 600m above sea level), both in Northern Guinea Savannah of Nigeria, to Investigate the growth of Maize varieties and dry matter produced at varying timing of nitrogen second dose fertilization. The treatments consist of three maize varieties obtained from the seed unit of Institute of Agricultural Research, A,B,U-Zaria (SAMMAZ 14, SAMMAZ 15 and SAMMAZ 16) and six times of nitrogen second dose fertilization at 4 5, 6, 7, 8, 9 weeks after sowing (WAS). Treatment combination were laid out in a randomized complete block design (RCBD) with three replications. The gross plot size was 4.5m x4.0m (18m^2) and the net plot size was 4.0m x3.0m(12m^2).The gross plot consisted of six rows spaced 75cm apart and 4.5m in length and 4.0m width (4.0m x 4.5m= 18m^2).The net plot consisted of four inner rows spaced 75cm apart with 4.0m in length and 3.0m width(4.0mx3.0m=12m^2). Details of physical and chemical properties of the soil taken from the experimental sites (Samaru and Jaji) for analysis during 2016 rainy season are shown in Table 1. Appendixes I and II are the 2016 wet season meteorological data for both Samaru and Jaji which will also be used to analyze the results.SAMMAZ 14 stayed 106 days to harvest while SAMMAZ 15 spent 110 days in the field and SAMMAZ 16 took 122 days to harvest.

CULTURAL PRACTICES

Two seeds were sown per hole and later thinned to one seedling par hole at 2 WAS at a spacing of 25cm by 75cm in all location. Split fertilizer at the rate of 120kgN, 60kgP_20_5 and 60kgK_20 (NPK15-15-15) was applied as follows; basal fertilizer application at the rate of 74kg N, 60kgP_20_5 and 60kg k_20 (75% N, 100% P_20_5 and 100% K_20) was carried out two weeks after sowing by side placement (banded) 5cm away from the base of the plantstand. The remaining 25% N as the second dose application with nitrogen (Urea 46% N) was applied in five split doses at 5 WAS, 6 WAS, 7 WAS, 8 WAS and 9 WAS while 4 WAS serves as the control for the trial. The crop production system for both location is subsistence farming. Sowing of maize was carried out on 11th June and 18th June for Samaru and Jaji respectively. Manual weeding was carried out using hoe at 6 and 10 WAS followed by earthing up after each weeding. There was no incidence of pests and diseases observed at both locations. Harvesting was also carried out at physiological maturity. Data were recorded on plant height, number of leaves per plant, total leaf area per plant, leaf area index and dry matter production. The data collected at 4, 8 and 12 WAS from both locations were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967). Where F-values were found to be significant, the treatment means were compared using Duncan's Multiple Range Test (DMRT) (Duncan, 1955).

RESULTS

SAMMAZ 16 has the tallest plants in all locations and at all sampling periods (Table 1). At both locations and at all sampling periods SAMMAZ 15 produced the shortest plants. SAMMAZ 16 had statistically similar plants height with SAMMAZ 14 at 8 and 12 WAS at Samaru and 12 WAS at Jaji where both are taller than SAMMAZ 15. The time of nitrogen second dose fertilization 6 WAS had the tallest plants in both locations and at all sampling periods.Similarly, SAMMAZ 16 had the highest number of leaves per plant at all sampling periods over other varieties. SAMMAZ 16 had plants with statistically similar number of leaves with SAMMAZ 14 at 4 and 8 WAS at Samaru and SAMMAZ 15 had plants with least number of leaves. Time 6 WAS proved to be the time that had the highest number of leaves per plant at all sampling periods at all location (Table 2).

The effect of maize varieties and time of nitrogen second dose fertilization on total leaf area maize varieties is presented in Table 2. SAMMAZ 16 consistently recorded the highest total leaf area at all locations at all sampling periods. This was statistically similar with SAMMAZ 15 at 4, and 12 WAS at Samaru and at 12 WAS at Jaji while SAMMAZ 14 had least leaf area values all through. The time of Nitrogen second dose fertilization 6 WAS had the highest total leaf area values at all sampling periods and at both locations.Table 2 further showed the effect of time of nitrogen second dose fertilization on leaf area index of maize varieties. SAMMAZ 16 WAS statistically significant only at 12 WAS (Samaru) and at 4, 12 WAS (Jaji) where SAMMAZ 16 and 14 were significantly at par with each other in term of leaf area index values at both locations. Time 6 WAS recorded the highest leaf area index values at both locations at all sampling periods relative to other timings evaluated(Table2).

The effect of maize varieties and time of Nitrogen second dose fertilization on dry matter production is presented in Table 3. SAMMAZ 16 had the heaviest dry matter produced followed by SAMMAZ 14 with SAMMAZ 15 with the lightest dry matter production. SAMMAZ 16 was statistically at par with SAMMAZ 14 at 4 and 12 WAS sampling period only at Jaji. Time 6 WAS purchased the heaviest dry matter at both locations and at all sampling period relation to other times evaluated(Table3).

Table 4 showed an interaction between maize variety and time of Nitrogen second dose fertilization on plant height at 8 WAS at Samaru. It showed that across all maize varieties evaluated, delaying application of second dose of N fertilizer from 4-6 WAS induced a progression increase in plant height but application beyond 6 to 9 WAS induced a reduction in plant height for all the varieties. While across the time of N fertilizer second dose application at 4 WAS (control) SAMMAZ 14 had the shortest plant while SAMMAZ 16 had the tallest plant at 6 WAS relative to other timings evaluated(Table4)

Table 5 showed an interaction between maize varieties and time of N second dose fertilization on total leaf area at 12 WAS at Jaji. It showed that among all the varieties, delaying application of N fertilizer second dose from 4 to 6 WAS resulted in an increase in total leaf area values while its application beyond 6, 7, 8, and 9 WAS resulted in decrease in total leaf area values. While SAMMAZ 16 had the highest total leaf area at application time 6, 7, 8 and 9 WAS. Table 6 further showed the interaction between maize varieties at time of N second dose fertilization on leaf area index at 12 WAS at Jaji. Fertilization at 6 WAS significantly recorded the highest leaf area index value followed by SAMMAZ 14 and 15, while fertilization prior to and beyond 6 WAS showed all varieties to have a statistically similar leaf area index value(Tables5and6).

Table 7 also showed the interaction between maize varieties and time of N second dose fertilization on total dry matter production. The result indicated that delaying N second dose fertilization from 4 to 6 weeks induce an increase in weight dry matter production across all varieties. Application beyond 6 to 9 WAS showed a decrease in weight of dry matter production. This is similar to application prior to 6 WAS(Table7).

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Table 1. Physical and chemical properties of soils (0-30 cm) taken from Samaru and Jaji during 2016 wet season.

Particle size distribution gkg^{-1}			
Sand	580	410	410
Silt	340	460	460
Clay	80	130	130
Textural class	Sandy loam	Loam	Loamy soil
Chemical composition			
pH in water (1:2.5)	6.05	6.15	6.15
pH in 0.01M$CaCl_2$ (1:2.5)	5.60	5.78	5.78
Organic carbon (g kg^{-1})	1.04	1.19	1.19
Total nitrogen (g kg^{-1})	0.27	0.30	0.30
Available phosphorus (mg kg^{-1})	6.00	9.29	9.29
Exchangeable bases (cmol kg^{-1})			
Calcium (Ca)	2.61	3.91	3.91
Magnesium (Mg)	0.41	0.71	0.71
Potassium (K)	0.09	0.13	0.13
Sodium (Na)	0.17	0.26	0.26
Cation Exchange Capacity (C.E.C)	3.21	4.90	4.90

Source: Soil Analytical Laboratory, Department of Agronomy, ABU Zaria.

Table 2: Effect of maize variety and time of second dose of fertilizer application on plant height (cm) and number of leaves at Samau and Jaji during 2016 wet season

Treatments	Plants height (cm)						Number of Leaves					
	4 WAS		8 WAS		12 WAS		4 WAS		8 WAS		12 WAS	
	Samaru	Jaji	Samaru	Jaji	Samaru	Jaji	Samaru	Jaji	Samaru	Jaji	Samaru	Jaji
Variety (v)												
SAMMAZ 14	60.11b	45.44b	203.98ab	166.39b	241.17a	221.32a	8.77a	8.21	12.14ab	12.66b	12.82	12.07b
SAMMAZ 15	54.36c	45.22b	193.94b	160.98b	230.89b	210.13b	8.19b	7.93	11.72b	12.05c	12.56	12.61c
SAMMAZ 16	63.79a	51.56a	210.37a	181.06a	241.49a	230.82a	9.11a	8.36	12.67a	13.38a	13.28	13.27a
SE ±	1.265	0.616	3.717	2.991	2.944	3.77b	0.136	0.135	0.250	0.085	0.334	0.047
Significance	**	**	*	*	*	*	*	NS	*	**	NS	**
Time of Second Dose Fertilizer Application (T)												
4 WAS	50.22d	41.11e	149.11c	146.24d	219.33b	201.80c	8.26	8.00	9.50d	11.92d	10.99c	13.30d
5 WAS	63.20ab	49.78b	206.60b	181.12b	240.53a	288.34b	8.67	8.11	12.78b	12.96b	13.93b	14.28b
6 WAS	67.31a	55.67a	277.49a	207.03a	250.33a	251.22b	8.86	8.56	13.61a	13.58a	15.37b	14.88a
7 WAS	59.98bc	47.90c	213.60ab	170.40bc	238.67a	223.39b	8.62	8.09	12.90b	12.83b	13.51b	14.21b
8 WAS	59.18bc	47.11c	208.22b	162.08c	238.56a	214.42bc	8.58	8.03	12.27b	12.46c	13.92b	13.60c
9 WAS	56.69c	43.78d	211.56b	149.88d	239.67a	205.38c	8.44	8.03	11.02c	12.42c	13.62b	13.53c
SE ±	1.78a	0.877	5.249	4.299	4.159	5.340	0.190	0.192	0.356	0.124	0.479	0.067
Significance	**	**	**	**	*	**	NS	NS	**	**	**	**
Interaction												
VXT	NS	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by same letters (s) within the treatment group and location were statistically the same using DMRT at 5% level of significance.

Table 3: Effect of maize variety and time of second dose of fertilizer application on total leaf area and leaf area index at Samaru and Jaji during 2016 wet season.

Treatments	Total Leaf Area						Leaf Area Index					
	4 WAS		8 WAS		12 WAS		4 WAS		8 WAS		12 WAS	
	Samaru	Jaji	Samaru	Jaji	Samaru	Jaji	Samaru	Jaji	Samaru	Jaji	Samaru	Jaji
Variety (v)												
SAMMAZ 14	180.07b	971.33	4622.30	4759.44	4022.81b	4240.09b	0.6351	0.5646a	2.4278	2.7201	2.2233a	2.404a
SAMMAZ 15	1272.88a	1013.55	4504.34	4776.22	4370.83a	4486.76a	0.6965	0.5307b	2.361	2.6508	2.0287b	2.2040b
SAMMAZ 16	1380.74a	1025.64	47534.73	4776.22	4413.87a	4512.90a	0.7253	0.5814a	2.4667	2.7611	2.3108a	2.5873a
SE ±	57.993	61.003	112.063	162.251	154.025	157.852	0.0310	0.0166	0.667	0.0734	0.0557	0.0370
Significance	*	NS	NS	NS	*	*	NS	*	NS	NS	*	*
Time of Second Dose Fertilizer Application (T)												
4 WAS	806.21d	753.85d	3462.66d	3655.51d	3175.55e	354.36e	0.455ed	0.3687d	1.8715d	2.2408d	1.6820e	1.9453d
5 WAS	1555.36b	1208.01b	4934.59b	5180.96b	4832.32b	5020.26	0.8317b	0.6338b	2.6314b	2.9421b	2.4326b	2.4133b
6 WAS	1894.61a	1376.65a	5842.64a	5959.03a	5795.48a	5869.31a	1.0364a	0.7832a	2.9879a	3.4308a	2.8983a	2.7599a
7 WAS	1398.35b	1071.21bc	4677.56b	4686.98bc	4501.45c	4503.79c	0.6929c	0.5792b	2.4611bc	2.7317bc	2.35069c	2.3704c
8 WAS	1102.81c	861.88cd	4420.86bc	4262.64cd	4376.87cd	4102.10cd	0.5859c	0.4913c	2.3568bc	2.4852cd	2.1989cd	2.3008c
9 WAS	910.40cd	749.55d	4060.54c	4079.81cd	3918.45de	3951.60d	0.5113d	0.4175d	2.2024c	2.3335d	2.0686d	2.1675d
SE ±	82.015	86.271	172.624	229.599	217.825	134.141	0.0493	0.0234	0.0944	0.1038	0.0789	0.0524
Significance	**	**	**	**	**	**	**	**	**	**	**	**
Interaction												
VXT	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS	NS

Means followed by same letters (s) within the treatment group and location were statistically the same using DMRT at 5% level of significance.

Table 4: Effect of maize variety at time of second dose of N fertilizer application on total dry matter production (g) at Samaru and Jaji during 2016 wet season.

Treatments	Total dry matter production (g)					
	Samaru			Jaji		
	4 WAS	**8 WAS**	**12 WAS**	**4 WAS**	**8 WAS**	**12 WAS**
Variety (v)						
SAMMAZ 14	23.90b	159.50b	191.73b	22.30	154.65a	168.18ab
SAMMAZ 15	16.84c	133.67c	169.13c	19.53	126.62b	160.42b
SAMMAZ 16	31.41a	183.96a	214.78a	23.03	161.11a	175.84a
SE ±	0.943	3.847	3.959	1.172	2.844	3.399
Significance	**	**	**	NS	**	*
Time of Second Dose Fertilizer Application (T)						
4 WAS	16.78d	97.64f	122.40f	16.29c	117.51d	134.93e
5 WAS	27.56b	185.61b	225.48b	25.23ab	160.59b	186.97b
6 WAS	32.58a	227.81a	266.54c	28.62a	183.84a	211.28a
7 WAS	24.42bc	168.74c	203.97c	21.27bc	153.23bc	169.76c
8 WAS	22.56c	147.11d	179.36d	19.73c	142.64c	158.21cd
9 WAS	20.41cd	123.31e	153.52e	18.57c	127.97d	147.38de
SE ±	1.334	5.441	5.599	1.658	4.021	4.807
Significance	**	**	**	**	**	**
Interaction						
VXT	NS	*	NS	NS	NS	NS

Means followed by same letters (s) within the treatment group and location were statistically the same using DMRT at 5% level of significance.

Table 5: Interaction effect between maize variety and time of second dose of fertilizer application on plant height (cm) at 8 WAS during 2016 wet season at Samaru

Maize Variety	Time of N Fertilizer Secondary Dose Application (WAS)					
	4	**5**	**6**	**7**	**8**	**9**
SAMMAZ 14	109.33i	210.67d	225.33b	210.67d	199.33f	208.33e
SAMMAZ 15	160.00h	210.80d	220.80bc	215.67cd	215.40cd	214.00cd
SAMMAZ 16	178.00g	198.33f	241.33a	209.47de	209.93d	212.33d
SE ±			2.395			

Means followed by same letters (s) within the treatment group and location were statistically the same using DMRT at 5% level of significance.

Table 6: Interaction effect between maize variety and time of N second dose fertilization on total leaf area (cm^2) at 12 WAS at Jaji leaf area index (12 WAS) at Jaji and total dry matter production at 8 WAS at Samaru during 2016 wet season.

Maize Variety	Total Leaf area cm^2 at 12 WAS Jaji					
	Time of N fertilizer second dose application (WAS)					
	4	5	6	7	8	9
SAMMAZ 14	4368.99f	5898.33b	7261.14a	5078.58g	4393.23f	4330.39f
SAMMAZ 15	4194.70g	5777.4c	5759.99c	5126.58f	4662.27f	4583.22f
SAMMAZ 16	4049.11g	5484.29d	7462.69a	5405.99d	4904.26e	4935.71e
SE ±			8.523			

Mean followed by different letters(s) in a column or row of any set of treatment are significantly different P≤0.05 using DMRT

WAS weeks after sowing

Table 7: Interaction effect between maize variety and time of N second dose fertilization on total leaf area (cm^2) at 12 WAS at Jaji leaf area index (12 WAS) at Jaji and total dry matter production at 8 WAS at Samaru during 2016 wet season.

Maize Variety	Leaf Area of Index at 12 WAS Jaji					
	Time of N fertilizer second dose application (WAS)					
	4	5	6	7	8	9
SAMMAZ 14	2.33d	3.08c	3.61b	2.61cd	2.41d	2.36d
SAMMAZ 15	2.28d	3.03c	3.15bc	2.71c	2.66d	2.38d
SAMMAZ 16	2.39d	2.93c	3.91a	2.66d	2.66d	2.36d
SE ±			0.162			

Mean followed by different letters(s) in a column or row of any set of treatment are significantly different P≤0.05 using DMRT

WAS weeks after sowing

Table 8: Interaction effect between maize variety and time of N second dose fertilization on total leaf area (cm^2) at 12 WAS at Jaji leaf area index (12 WAS) at Jaji and total dry matter production at 8 WAS at Samaru during 2016 wet season.

Maize Variety	Total dry matter production (g) at 8 WAS Samaru					
	Time of N fertilizer second dose application (WAS)					
	4	5	6	7	8	9
SAMMAZ 14	96.17i	145.83f	229.37a	138.20j	118.27h	105.17h
SAMMAZ 15	100.73h	191.30d	198.70b	163.20e	149.73f	122.30g
SAMMAZ 16	96.03	231.70b	255.36a	204.83c	173.33e	142.47f
SE ±			3.855			

Mean followed by different letters(s) in a column or row of any set of treatment are significantly different P≤0.05 using DMRT

WAS weeks after sowing

DISCUSSION

Physical and Chemical Properties of the Soil

Details of physical and chemical properties of the soil taken from the experimental sites (Samaru and Jaji) for analysis during 2016 rainy season are shown in Table 1.The soil textural classes were found to be sandy loam and loamy soil for Samaru and Jaji respectively. Soils from both locations were also found to be low in organic and inorganic mineral nutrients i.e. organic carbon (1.04% forSamaru soil and 1.19% for Jaji soil),while the total N content of soils from Samaru and Jaji were 0.27% and 0.30% respectively. Available phosphorus content from both Samaru and Jaji soils were found to be 6.00 mg kg^{-1} and 9.29 mg kg^{-1} respectively while the exchangeable cations were also low as is the characteristics of most savannah soils (Uruk, 2015), with calcium(Ca) being 2.61 meq/100g and 3.91, magnesium(Mg) content are 0.41 meq/100g(Samaru) and 0.71meq/100g(Jaji), potassium(K) content for Samaru was 0.09 meq/100g while that of Jaji was 0.13 meq/100g and the sodium(Na) content for Samaru was 0.17 meq/100g while that of Jaji was 0.26 meq/100g. The cation exchange capacity of Jaji soil had a higher value at 4.90 than that of Samaru with a value of 3.21. The result of soil analysis indicates that soil at both location will requireaddition of moderate inorganic fertilizer to augument and improve on their fertility levels.

Performance of maize varieties

The weather (rainfall, temperature, humidity and sunshine hours) as well as the soil type including it's fertility level at both locations play an important role in explaining the varied responses observed in terms of growth indicators like plant height, number of leaves, total leaf area, leaf area index and total dry matter production at both Samaru and Jaji. This could probably explain why SAMMAZ 16 produced the tallest plants, had more leaves per plant and heavier dry matter produced than other varieties evaluated at Samaru than Jaji probably due to higher amount of rainfall (moisture). SAMMAZ 16 as a late maturing variety, took a longer time to grow due to its genetic makeup thereby expressing its full growth potential as a result of its inherent growth characteristics which led to an increase in plant height number of leaves, leading to taller and bigger plants, with higher values of leaf area, and leaf area index, thus more dry matter produced (Hassan, 2011). The significant taller plants produced by SAMMAZ 16 over SAMMAZ 14 and 15 could be attributed to its genetic makeup, wider adaptation and response to the savannah environment as well as higher responses to timing of N second dose fertilization. In a similar study, Yakakawa *et al*(2006), attributed significant increase in plant height with more leaves for more dry matter has been observed to be controlled by length of growing season which is an integral part of the expression of many genes and the interaction between these genes. Many researchers have shown that there is a highly significant variability in plaint height, number of leaves and total dry matter production in various maize varieties genotype In terms of the length of growing season among maize varieties (Nazir *et al.*, 2010,Igbal *et al.*, 2010a and Igbal *et al.*,2010b).

Effect of time of second dose of N fertilizer application on growth and

dry matter production of maize.

The study revealed that time of second dose of nitrogen fertilization at 6 WAS resulted in positive response in virtually all growth, yield and yield components at both locations. Application of N fertilizer at 6 WAS seem to be the best and seem ideal as most of the fertilizer applied earlier (Basal or first fertilizer dose) including those residual fertilizer in the soil if any, most have been used up by the rapidly growing crop. While those nutrients not accessed by the crop might have been washed or leached away beyond the root zone or volatilized not the atmosphere, thus leaving the soil barren with no nutrients hence the requirement of the second dose.

Application at 6 WAS coincide with the most appropriate time N fertilizer is needed by the growing crop, as it was the period of robust vegetative growth leading to reproductive growth (post an-thesis) stage as described by Valero *et al.*, (2005). It is also at this stage where the roots, rootlets development of the plant is enhanced for anchorage and water/nutrients uptake for photosynthesis.

Hafiz *et al.,* (2011) further reported that application at 6 WAS was for further development of roots and other photosynthetic apparatuses first prior to commencement of reproductive growth stage leading to higher and longer accumulation of higher pre an-thesis assimilates stored within the plant which can be shifted or translocated into higher dry matter yield and grain yield during grain filling stage. Application prior to 6 WAS may be ascribed to luxuriant consumption of Nitrogen during vegetation growth, which may prolong this growth stage against easily commencement of reproduction growth stage (Song *et al.,* 2010). While Application beyond 6 WAS may not be effective as it was applied after the period of need as the effective period of fertilizer use may have passed at this time, application of N fertilizer may be too late for further development of appropriate photosynthetic apparatuses for the plant to attain full growth development (Wang *et al.,* 2011).

CONCLUSION

From the results of the studies, it could be concluded that SAMMAZ 16 had higher potentials to produce high dry matter yield (production) compare to SAMMAZ 14 and 15 application of fertilizer at time 6 WAS had the chance of producing the heaviest dry matter than other varieties. These agronomic findings demonstrated the potential for improving fodder (dry matter) production.It is therefore recommended that SAMMAZ 16 and time of fertilizer second dose application 6WAS be combined and adopted to produce the heaviest fodder (dry matter) production.

Appendix I: Meteorological data showing monthly and mean annual rainfall, monthly air temperature, relative humidity and sunshine hours in 2016 wet season at Samaru.

Month	Rainfall (mm)	Temperature (^0C)		Relative humidity (%)	Average monthly Sunshine hours(from 6am-6pm)
		Max.	Min.		
January	0.00	31.1	14.31	20.11	124.2
February	0.00	33.2	16.68	22.06	116.1
March	24.34	35.19	18.13	46.51	123.8
April	15.16	36.27	21.53	52.92	118.5
May	132.21	32.35	23.5	64.82	120.3
June	249.93	30.63	20.13	74.20	113.8
July	307.06	28.63	19.79	66.21	102.5
August	349.90	27.67	19.50	68.52	89.5
September	282.81	29.62	19.45	69.31	110.8
October	16.97	31.23	18.23	54.45	123.5
November	0.00	30.83	12.80	20.83	9.30
December	0.00	29.10	14.58	20.94	8.86
Mean	134.25	31.44	19.06	53.88	114.2

Source: Meteorological Unit of Institute for Agricultural Research (IAR), Ahmadu Bello University, Samaru, Zaria

Appendix II: Meteorological data showing monthly and mean annual rainfall, monthly air temperature, relative humidity and sunshine hours in 2016 wet season at Jaji.

Month	Rainfall (mm)	Temperature (^{0}C)		Relative humidity (%)	Average monthly Sunshine hours(from 6am-6pm)
		Max.	Min.		
January	0.00	30.44	18.93	23.43	124.1
February	0.00	34.89	17.76	27.32	114.5
March	95.11	36.84	22.23	47.03	122.4
April	29.40	36.67	23.10	54.80	117.5
May	24.40	33.94	22.58	68.39	120.1
June	215.80	30.23	21.33	79.73	97.3
July	298.80	29.42	21.06	66.74	71.6
August	304.20	28.16	20.32	72.83	66.4
September	208.41	30.04	21.44	70.34	92.5
October	54.40	32.81	21.52	58.68	121.4
November	0.00	30.53	18.23	28.83	10.51
December	0.00	26.97	14.42	28.61	9.98
Mean	129.01	32.17	21.23	56.04	104.6

Source: Meteorological Unit of Jaji military sub aerodrome,Jaji-Kaduna.

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