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SHORT COMMUNICATION

Effects of Agroforestry Trees Biomass and Urea on Maize Tasselling and Silking Production

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ABSTRACT

Agroforestry system relies heavily on the choice of suitable tree species that should offer diversity of benefits and show compatibility with food crops. A 3 × 4 × 2 factorial design in a split-split plot design was used for this experiment in three replicates for two years. The considered factors were; biomass species (*Albizia lebbeck* and *Parkia biglobosa,* and control) as main plots, four rates of nitrogen (0, 40, 80, 120 kg N ha^{-1}) as sub-plots, and two maize varieties (DMR-ESR-7 and 2009 EVAT) as sub-sub plots. *A. lebbeck* (45.3, 52.9) attained early days to 50% tasselling and silking than *P. biglobosa* (46, 53.9) in combined means respectively. It is therefore, concluded that incorporation of *A. lebbeck* with application of fertilizer from 40 kg N ha^{-1} to 120 kg N ha^{-1} rate into the soil improved the production of tasselling and silking of 2009 EVAT over DMR-ESR-7 maize variety. And the combinations of *Albizia* and varieties of maize shortened days to 50% tasselling and silking than *Parkia*.

***Keywords*:** Leguminous fixing trees, fertilizer, variety, yield components, maize, productivity, *Albizia lebbeck*, *Parkia biglobosa*, *Zea mays*

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1. INTRODUCTION

Nigeria has a population of over 160 million people with a low per capita income. One of the major worries and concerns of ever dick and harry is how to eradicate poverty and improve food security. Agroforestry is one of the answers that play an important role in increasing food security, improving nutrition and alleviating poverty (Mbwambo *et al.*, 2006). However, success of any Agroforestry system relies heavily on the choice of suitable tree species that should offer diversity of benefits and show compatibility with food crops (Edward *et al.*, 2006).

Maize (*Zea mays* L.) was relatively a major staple food in Africa by 1900 (Manyong *et al.,* 2003), but over the years, maize has gained widespread popularity in its use in human diet and animal feeds across Africa. Maize is the most widely adapted cereal in the world with production of 872.8 million metric tonnes in 2012, followed by rice and wheat (FAO, 2014).

It is important to inform that agricultural production system in Nigeria as well as other developing countries of the world has deteriorated due to decline in soil fertility which has resulted to lack of capacity to produce enough food for their teeming population (Oyebamiji *et al.,* 2014). Soil fertility has been seriously and critically noted to be the primary constraints to productive agriculture in any arid and semi-arid Africa (Gruhn *et al.,* 2000). Declining in soil fertility is the most widespread, dominant limitation on yields of maize and the sustainability of maize-based cropping systems in Africa (Ajayi *et al.,* 2007). The use of organic manure as a means of maintaining and increasing soil fertility has been advocated (Smil, 2000).

The practice of pruning biomass from nitrogen fixing trees called 'leguminous trees' and incorporate to agricultural field to improve, enrich and replenish its fertility for increased growth and yield is an alien approach among farmers in semi-arid, Nigeria. The incorporation of biomass of leguminous tree species therefore is the alternative to the sole use of costly, scarce and expensive inorganic fertilizers to meet the N- requirements of most annual crops. So, leafy biomass and nitrogen fertilizer (urea) has significant effect on soil chemical properties which in consequence affect maize production in semi-arid, Nigeria (Valentini *et al.,* 2000).

Furthermore, leguminous agroforestry trees that are nitrogen fixing trees are known to play complementary role as source of organic fertilizer and have the potential to sustain soil fertility for improved maize production (Adjei-Nsiah *et al.*, 2004). Also, leguminous trees have been discovered to effectively improve soil for maize yield productivity, due to its N fixation and recovery of leached nutrients (Akinnifesi *et al.*, 2008). In other word, biomass transfer has potential to increase yields of crops especially maize (Kuntashula *et al.,* 2004, 2006).

2. MATERIALS AND METHODS

2. 1. Study Area

The study area was Makera, a village in Dutsin-ma Local Government Area of Katsina State (Figure 1). Dutsin-ma has an area of 527 km², it is found within Latitude 12º27'18" N and Longitude 07º29'29" E and it has altitude of 605 m and a population of 169, 829 as at 2006 National Census Federal Republic of Nigeria, (2012). The area receives an annual rainfall of 700 mm, which is spread from May to September. The mean annual temperatures range from 29-31 ºC. The high temperature normally occurs in April/May and the lowest in December through February (Tukur *et al.,* 2013).

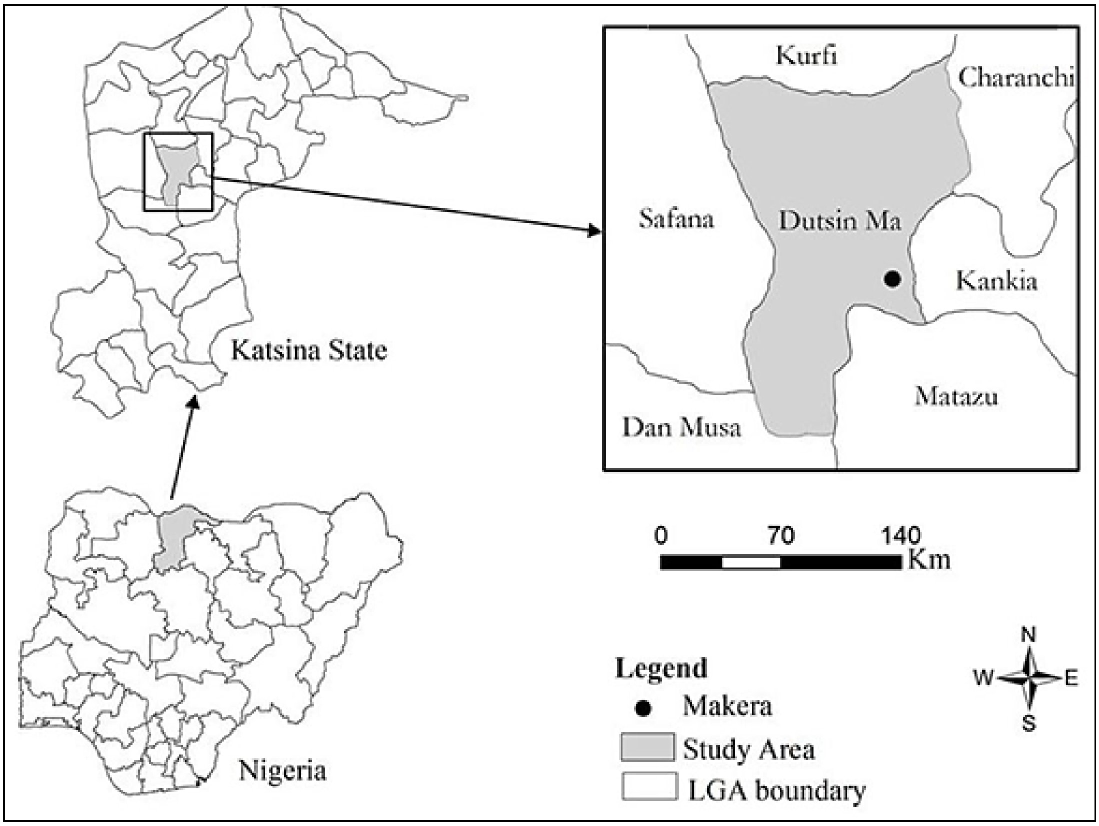

Figure 1. Map of Dutsinma Showing Makera (the Study Site)

2. 2. Experimental Design and Data Analysis

The experimental design adopted for the experiment was a 3 × 4 × 2 factorial with three replicates in split-split plot design arrangement. The plot contained 4 m × 3 m dimensions. Leafy biomass of *Albizia lebbeck* and *Parkia biglobosa* were pruned and incorporated fresh into the soil at the rate of 5000 kg ha^{-1} of the *Albizia* and *Parkia* biomass plots (B_1 and B_2) respectively and plots without incorporation of leafy biomass (B_0). The leafy biomass was incorporated into the soil for two cropping seasons (2014 and 2015). Four levels of N fertilizers were split applied as: N_0, 0 kg N ha^{-1} (control); N_1, 40 kg N ha^{-1}; N_2, 80 kg N ha^{-1}; N_3, 120 kg N ha^{-1} and half were applied at 2 weeks after planting (WAP). The remaining amount was applied 5 (WAP). The two varieties of maize used were (DMR-ESR-7 (Yellow Maize) and 2009 EVAT (White Maize) were obtained from Katsina State Agricultural and Rural Development Authority (KTARDA) two maize seeds were planted per hole, at equal depth of 4 cm and it was later thinned to one, two weeks after incorporation of leafy biomass of *A. lebbeck* and *P. biglobosa* into the soil, using conventional spacing of 75 cm × 25 cm to make the total (gross) plant population of 64 stands and net plot of 32 stands per plot. Data were analysed using Analysis of Variance (ANOVA) Statistical Analysis System (SAS, 2003) computer package at 5% level of significance to determine differences in the treatment effect. The Duncan's Multiple Range Test (Duncan, 1955) was used to separate means of differences among the treatments.

3. RESULTS

3. 1. Days to 50% Tasselling

Albizia and *Parkia* amended plots showed no significance on days to 50% tasselling in 2014 and 2015 cropping seasons. But, *Parkia* amended plots had significant higher value (46 kg ha^{-1}) days to 50% tasselling in combined means. In 2014, control treatment produced significantly higher (46.3 kg ha^{-1}) days to 50% tasselling than other plots supplied with nitrogen. However, there was no significant difference in 2015 and in their combined means.

In consequence, 2014, 2015 and the combined means with 2009 EVAT had significant higher values (46.4 kg ha^{-1}, 46.8 kg ha^{-1}, 46.6 kg ha^{-1}) days to 50% tasselling than DMR-ESR-7 (Table 1).

Table 1. Influence of biomass and nitrogen rate on days to 50% tasselling of two maize varieties in 2014 and 2015.

Days to 50% tasselling			
Treatment	2014	2015	Combined
Biomass (B)			
Control	44.7	43.4	44.1b
Albizia	45.0	45.6	45.3ab
Parkia	45.6	46.4	46.0a
SE±	0.47	0.94	0.53
Nitrogen (N) Kg ha^{-1}			
0	46.3a	44.3	45.3
40	44.8bc	45.4	45.1
80	45.6ab	45.7	45.7
120	43.8c	45.0	44.4
SE±	0.50	1.03	0.59
Variety (V)			
DMR- ESR-7	43.7b	43.4b	43.6b
2009 EVAT	46.4a	46.8a	46.6a
SE±	0.32	0.80	0.43

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

3. 2. Biomass and Variety Interaction

Table 2. Interaction between biomass and variety on days to 50% tasselling of maize in combined analysis.

	Variety	
Treatment	DMR ESR-7	2009 EVAT
Biomass (B)		
Control	41.9c	46.3ab

Albizia	44.2b	46.3ab
Parkia	44.7b	47.3a
SE±	0.63	

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

Interaction between biomass incorporation and variety was comparable on days to 50% tasselling of maize except in *Parkia* amended plots sown to 2009 EVAT which had significantly higher (47.3 kg ha^{-1}) days than DMR-ESR-7 at all biomass treatment (Table 2).

3. 3. Variety and Nitrogen Interaction

2009 EVAT produced significant higher value (47.9 kg ha^{-1}) days to 50% tasselling of maize at 0 kg N ha^{-1} than at other N rates, and also than DMR-ESR-7 at all N rate (Table 3).

Table 3. Interaction between variety and nitrogen rate on days to 50% tasselling of maize in combined analysis.

	Nitrogen (Kg ha^{-1})			
Treatment	0	40	80	120
Variety (V)				
DMR- ESR-7	42.7d	43.8cd	44.6bcd	43.3d
2009 EVAT	47.9a	46.4abc	46.8ab	45.5bcd
SE±		0.69		

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

3. 4. Days to 50% Silking

There was no significance on days to 50% silking in 2014 and 2015 cropping seasons in *Albizia* and *Parkia* amended plots. Meanwhile, in combined means *Albizia* had lower value (52.9 kg ha-1) days to 50% silking. There was no significant difference in 2014, 2015 and their combined means on days to 50% silking in fertilizer applied and varieties of maize (Table 4).

Table 4. Influence of biomass and nitrogen rate on days to 50% silking of two maize varieties in 2014 and 2015.

	Days to 50% silking		
Treatment	2014	2015	Combined
Biomass (B)			
Control	54.1	53.9	54.0a
Albizia	52.6	53.1	52.9b
Parkia	54.0	53.8	53.9a
SE±	0.36	0.31	0.24
Nitrogen (N) Kg ha^{-1}			
0	54.0	53.9	54.0

40	53.8	53.5	53.6
80	53.3	53.8	53.5
120	53.3	53.3	53.3
SE±	0.49	0.37	0.32
Variety (V)			
DMR- ESR-7	53.1	53.9	53.5
2009 EVAT	54.0	53.4	53.7
SE±	0.33	0.26	0.24

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

3. 5. Biomass and Nitrogen Interaction

In Table 5, days to 50% silking of maize was comparable in biomass incorporated plots at each N rate, between 40 and 80 kg N ha^{-1} where plots incorporated with *Parkia* had higher value (54 kg ha^{-1}) days to 50% silking than those incorporated with *Albizia*.

Table 5. Interaction between biomass and nitrogen rate on days to 50% silking of maize in combined analysis.

	Nitrogen (Kg ha^{-1})			
Treatment	0	40	80	120
Biomass (B)				
Control	54.1a	54.0a	53.8ab	54.1a
Albizia	53.9a	52.9ab	52.7ab	52.0b
Parkia	53.8ab	54.0a	54.0a	53.8ab
SE±		0.46		

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

3. 6. Biomass and Variety Interaction

Interaction between biomass incorporation and variety reveals that days to 50% silking of maize were comparable in all treatments except in plots amended with *Albizia* and sown to DMR-ESR-7 which had lower value (52.7 kg ha^{-1}) days than other treatments (Table 6).

Table 6. Interaction between biomass and variety on days to 50% silking of maize in combined analysis.

	Variety	
Treatment	DMR ESR-7	2009 EVAT
Biomass (B)		
Control	54.0a	54.0a
Albizia	52.7b	53.1ab
Parkia	53.9a	53.9a
SE±	0.34	

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

4. DISCUSSION

Green manure in form of biomass generally has the capacity to improve soil nitrogen content (Pushpavalli *et al.*, 1994) because nitrogen is widely recognized as the major macro nutrient required for plant growth. Growth in biomass treated plots with respect to the crop reproductive organs performed better and this contributed to the increase in the amount of N fixed by the biomass and quantity of N derived from the decomposition of the incorporated biomass (Oyebamiji *et al.*, 2017). The significant shortening in days to 50% tasselling and silking in *Albizia* was as a result of the incorporation of biomass that improve and increase soil nitrogen and organic matter which led to rapid growth of maize plants, which invariably quickened various parts of maize plants (Oyebamiji *et al.*, 2016). Fertilization of maize crops with nitrogen caused significant reduction in days to 50% tasselling and silking. This could be possible as a result of optimal utility of nitrogen by maize crops at the meristematic sites which aided the vegetative development and reproductive structures (Jyotirmaya *et al.*, 2016). Buah *et al.* (2009) reported that early silking due to addition of N might contribute to the rapid growth of plant parts which eventually leads to final plant development. The response of maize to nitrogen application agrees with (Cherr *et al.*, 2006) that maize growth has significant effect on biomass used. The improvement of the soil also caused the maize plants in biomass incorporated plots to attain flowering stage earlier than those maize plants in control plots.

2009 EVAT had longer days to 50% tasselling. The higher number of days to 50% tasselling exhibited by 2009 EVAT over DMR-ESR-7 meant that 2009 EVAT had longer growth cycle. Interaction between biomass and nitrogen rate on days to 50% silking revealed that the combinations of *Parkia* and N rate applied reduced days to 50% silking compared with combinations of *Albizia* at any N rate. This could be as a result of combined effects of *Parkia* and nitrogen which generated more mineralized nutrients and the added N to cause rapid growth and development of various plant parts compared with *Albizia* and any of N rates.

5. CONCLUSIONS

Incorporation of *A. lebbeck* with application of fertilizer from 40 kg N ha^{-1} to 120 kg N ha^{-1} rate into the soil improved the production of tasselling and silking of 2009 EVAT over DMR-ESR-7 maize varieties. Days to 50% tasselling and silking were comparable in that the combinations of *Albizia* and varieties of maize shortened days to 50% tasselling and silking than *Parkia*.

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