Available online at www.notulaebotanicae.ro

Print ISSN 0255-965X; Electronic ISSN 1842-4309

Not. Bot. Hort. Agrobot. Cluj 37 (1) 2009, 199-203

AcademicPres

Notulae Botanicae Horti Agrobotanici Cluj-Napoca

Growth and Yield of Maize as Influenced by Sowing Date and Poultry Manure Application

Kolawole Edomwonyi LAW-OGBOMO [1], Samson Uduzei REMISON [2]

[1] *Department of Agriculture, Benson Idahosa University, Pmb 1100, Benin City, Nigeria; kolalawogbomo@yahoo.com*
[2] *Department of Crop Science, Faculty Of Agriculture, Ambrose Alli University, Benin City*

Abstract

Two field's experiments were conducted in 2004 and 2005 at Evboneka in Edo State, Nigeria to determine optimum sowing date and poultry manure requirement of maize (*Zea mays*) for the forest ultisol location. We examined the biomass production and yield, besides growth parameters under three sowing dates (April 7, May 7 and June 7) and four levels of poultry manure (0, 2.5, 5.0 and 7.5 tonnes per hectare (tha^{-1})) in factorial arrangement fitted into randomized complete block design with three replications. Plant heights, leaf area index (LAI), days to 50% flowering and biomass were significantly affected by sowing date and poultry manure application. The plant height values ranged from 3.9 to 10.80 centimetre (cm) at two weeks after sowing (WAS) to 48.3 cm at six WAS, respectively for the three sowing dates and four levels of poultry manure combinations. Days to 50% flowering was increased when sowing was delayed and with increased in applied poultry level and it vary from 50 to 73 days after sowing. The corresponding value of biomass was 3.32 to 8.80 t ha^{-1} at final harvest. These parameters resulted in higher crop growth rate for April 7 sown plants treated with poultry manure giving higher grain yield and 1000-grain weight. The maximum grain yield of 5.77 t ha^{-1} and 1000-grain weight were obtained from April 7 sown plants treated with 5.0 t ha^{-1} of poultry manure indicating that the best sowing date and poultry level for growth and yield of maize in the rainforest ultisol.

Keywords: Biomass, days to 50% flowering, grain yield, leaf area index and plant height

Introduction

Maize (*Zea mays* Linnaeus) belongs to the family Poaceae and is a widely cultivated annual field in Nigeria (Remison, 2005). It is the most important cereal crop in the sub-sahara Africa due to its high yielding ability, easy to process, readily and cost less than other cereals (Jaliya *et al*. 2008). Maize is produced primarily for human consumption as either a fresh or processed product. In addition, maize is produced for animal feed and industrial uses such as starch, flour, ethanol, cooking syrup and crisp (Remison, 2005).

In Nigeria, its average yield per hectare is low as compared to other countries; this is mainly due to unscientific production practices (Ibude *et al*. 1988). For instance, relying on bush fallow practices to restores soil fertility, loss of site productivity on account of bush burning; intensive cropping often without nutrient supplementary, overgrazing; soil erosion (Law-Ogbomo and Remison, 2008) and not sowing at the right time are important factors that affect maize productivity in Nigeria (Jaliya *et al*. 2008).

Fertilizer application is one of the quickest and easiest ways of increasing yield per unit area. Experimental studies showed increased maize productivity, however, the problem with fertilizer nutrient supplementation is that it leads to pollution of ground water after harvest and does not improved soil structure (Gordon *et al*. 1993). Other problems associated with chemical fertilizers are not readily available to farmers and also costly (Lal and Kang, 1982). Many crop species respond well to the application of organic manure and it can sustain yield under continuous cropping on most soils unlike chemical fertilizer (Maynard, 1991).

Proper selection of sowing date can optimize maize yield. It had been reported that maize grain yield was reduced due to delay in sowing date. The later influenced plant growth and development (Cirilo and Andrade, 1996) as the grain yield is determined by grain number and individual grain weight, which were affected by pre- and – post silking environmental conditions, respectively. In order for crops to best utilize moisture, nutrients and solar radiation, they must been grown on an optimum sowing date.

In this study, it was tried to identify possible causes of yield differences in different sowing dates and cured poultry manure rate in forest ultisol. The relationship obtained in this a study will help to explain the effect of environment and crop management on the yield variation.

Materials and methods

Field experiments were conducted during 2004 and 2005 cropping seasons at Evboneka, Nigeria as on-farm study. Evboneka (latitude 5°45'; longitude 50°4') is in the rainforest agro-ecological zone of Midwestern Nigeria. The weather data of the site obtained from the Nigerian Institute for Oil Palm Research, NIFOR is presented in Tab. 1. The site for the experiments has been previously cropped but there was no history of fertilizer usage. The dominant soil of the experimental area is ultisol (USDA).

Before croping in 2004 and 2005, surface soil samples ($0^{-1}5$cm) were collected from 15 points from the site and were then bulked for routine analysis. The soil reaction, nutrient content and soil particle analysis were presented in Tab. 2. The cured poultry manure (PM) was analysis in the soil and crop science laboratory of Benson Idahosa University, Benin City, Nigeria and the proximately nutrient composition of the manure was 1.95% N, 1.72% P, 1.98% K, 5.24% Ca, 4.95% Mg and pH 7.35.

The experiments were laid out as a 3 x 4 factorial arrangement in randomized complete block design with three replications. The factors were (1) sowing dates: April 7, May 7 and June 7; (2) poultry manure levels: 0, 2.5, 5.0 and 7.5 t ha^{-1}. The treatments comprised all possible combinations of the three sowing dates and four PM levels. The plot size was 4.4m x 4.00m containing six ridges each of four metre length.

Site was cleared, ploughed, harrowed, ridged, and the plots were laid out according to the design of the study. PM was applied a week before sowing. It was uniformly spread on the plots and lightly worked into the soil with hoe. Maize variety sowed was DMR-LSR-W obtained from Edo State Agricultural Development Programme, Benin City. The seeds were sowed at a 3-4 cm depth by hand at one seed per hole to give plant population of 53333 plants per hectare. Weeds were manually controlled by hoe weeding at three and six weeks after sowing (WAS).

Phenology, plant height, leaf area and total dry matter (biomass) were measured biweekly on three to four target plants. Plants were taken from the inner rows at each plot. Leaf area was used to compute leaf area index (LAI) as outlined by Remison (1997). Maize was harvested at maturity and air dried to 12% moisture content. 1000-grain weight was determined on sampled ears and grain yield was computed. Biomass was determined by oven dried the plant at 750C until constant weight was attained. From biomass, harvest index (HI) was computed.

Data regarding the plant height, LAI, days to 50% flowering, biomass, HI and grain yield and 1000-grain weight were statistically analyzed by the combined analysis procedure to test the differences among and within the different factors. The least significant difference (LSD) was applied to detect significant differences among treatment means.

Results and discussion

Soil fertility status

The results of soil analysis presented in Tab. 2 shows that the soil is texturally loamy sand. The soil is also acidic and low in primary nutrients (NPK) since they contain less than the critical levels of thes nutrient in the soil (Ibedu *et al*. 1988).

Plant height

The height of plant is an important growth character directly linked with the productive potential of plant in term of grain yield (Omotosho and Shittu, 2007). An optimum plant height is claimed to be positively correlated with productivity of plant (Saeed *et al*. 2001). Maize plants were tallest in April 7 sown plants followed by May 7 and June 7 in that order throughout the sampling periods (Tab. 3).

Maize plants were tallest in those plants that received 7.5 t PM ha^{-1} followed by 5.0 t PM ha^{-1} and the shortest plants were those plants without PM treatment. The deficiency of major nutrients in the plots without PM treat-

Tab. 1. Weather data at Evboneka (Forest zone)

	2004							2005						
Month	Rainfall	Sunshine	Relative	humidity (%)	Solar radiation	Temperature (%)		Rainfall	Sunshine	Relative humidity (%)		Solar Radiation	Temperature (%)	
	(mm)	(hours)	900H	1500H		Max.	Min.	(mm)	(hours)	900H	1500H		Max.	Min.
January	35.200	224.80	78.40	50.70	365.10	33.30	21.60	0.00	NA	61.70	45.00	NA	33.30	19.60
February	13.50	101.70	72.80	50.40	406.80	35.60	22.50	15.70	NA	79.80	52.40	NA	35.10	24.10
March	55.30	33.00	72.60	50.60	392.20	30.60	24.40	167.20	NA	81.70	65.20	NA	33.70	22.00
April	104.40	109.20	83.30	69.00	369.90	33.50	22.60	114.40	NA	81.80	67.10	NA	34.60	22.00
May	323.40	139.50	84.80	67.00	384.90	31.50	23.00	132.90	NA	83.40	68.20	NA	31.90	20.90
June	355.70	126.60	89.80	65.20	359.60	30.70	22.80	292.76	NA	85.90	75.50	NA	31.60	2..8
July	214.30	83.40	87.50	79.30	294.30	30.70	21.60	409.80	NA	86.40	81.00	NA	27.40	19.90
August	298.60	41.00	90.00	85.20	294.80	29.80	21.80	80.90	NA	89.00	68.00	NA	27.70	20.90
September	251.10	67.10	86.10	75.10	324.60	30.40	21.50	177.30	NA	86.30	73.80	NA	29.40	21.60
October	247.00	111.50	82.90	70.30	379.30	31.30	22.10	167.20	NA	84.80	69.10	NA	32.30	19.60
November	28.30	162.10	82.50	64.80	386.00	32.40	22.70	33.90	NA	80.10	56.40	NA	32.00	20.90
December	0.00	154.70	82.90	56.30	396.10	33.70	22.80	0.00	NA	83.40	61.50	NA	32.90	21.10
Total	1928.80	1493.80	991.60	783.90	4353.60	383.50	270.00	1595.00	NA	984.00	794.00	NA	381.90	253.40
Mean	160.70	124.50	82.60	65.30	362.80	32.00	22.5	132.90	NA	82.03	66.20	NA	31.80	21.10

Source: Documentation and Information Department, Nigerian Institute for Oil Palm Research, NIFOR.

Tab. 2. Physio- chemical properties of the experimental sites before cropping maize in 2004 and 2005

Soil properties	Year	
	2004	2005
Chemical properties		
pH (H2O)	4.6	4.40
Organic carbon (%)	2.11	2.44
Total nitrogen (%)	0.084	0.056
Available phosphorus (mg kg^{-1})	28.00	24.00
Calcium (cmol kg^{-1})	0.55	0.30
Magnesium (cmol kg^{-1})	0.10	0.20
Potassium (cmol kg^{-1})	0.60	0.5
Physical properties (g kg^{-1})		
Clay	100.00	150.00
Silt	30.00	10.00
Sand	870.00	840.00

ment stunted the plants growth. The tallest plants were observed in April 7 sown plants treated with 7.5 t PM ha^{-1}.

Leaf area index

Different sowing date and PM level had significant effect on LAI throughout the sampling period. Maximum LAI was observed in April 7 sown plants, followed by May 7 and June 7 (Tab. 4). As PM decreased LAI also decreased and plant receiving no PM produced minimum LAI throughout the sampling periods (Tab. 4). The greatest LAI were given by April 7 sown plants treated with 7.5t PM ha^{-1} (Tab. 4). LAI observed in April 7 sown plants showed longer duration than in May 7 and June 7 sown plants. Higher LAI associated with PM treated plants have been probably due to increased leaf production and leaf area duration. As a consequence, a high amount of radiation was intercepted.

Days to 50% flowering

Days to 50% flowering varied from 50 to 73 days (Fig. 1). Days to 50% flowering increased with delayed sowing. The April 7 sown plants had the days to 50% flowering (Fig. 1). Gradual increase in PM levels increased days taken to 50% flowering as it prolonged the vegetative phase of the plants leading to longer duration and ensuring higher yield.

Biomass

Sowing date and PM levels significantly affected biomass production (Fig. 2). Biomass production at final harvest was highest in April 7 sown plants (6.40t ha^{-1}) and was 3.72% and 7.28% higher than May 7 sown plants (6.17t ha^{-1}) and June 7 sown plants (5.97t ha^{-1}), respectively.

Biomass production was highest in plants that received 7.5t ha^{-1} (7.84t ha^{-1}) than those that received 0 (3.57 tha^{-1}) to 5.0 t PM ha^{-1} (6.86t ha^{-1}). The plants treated with 7.5t PM $ha^{-1}$was 14.29%, 21.55% and 119.60% higher than in plants treated with 0, 2.5 and 5.0t PM ha^{-1}, respectively.

Tab. 3. Effects of different sowing date and poultry manure application rate on maize plant height

Sowing date	Two weeks after sowing					Four weeks after sowing					Six weeks after sowing				
	Poultry manure application rate (t ha^{-1})					Poultry manure application rate (t ha^{-1})					Poultry manure application rate (t ha^{-1})				
	0	2.5	5.0	7.5	Mean	0	2.5	5.0	7.5	Mean	0	2.5	5.0	7.5	Mean
April 7	4.60	10.10	10.80	12.20	9.43	16.20	28.00	29.80	33.90	26.98	23.60	37.90	42.20	48.30	38.00
May 7	4.20	9.50	10.40	12.00	9.03	15.90	26.30	27.70	31.20	25.28	21.70	36.30	40.20	46.30	36.13
June 7	3.90	9.30	10.30	11.80	8.83	15.70	24.90	26.90	27.80	23.83	20.30	36.80	40.50	43.90	35.38
Mean	4.23	9.63	10.50	12.00	9.09	15.93	26.40	28.13	30.97	21.87	21.87	37.80	40.97	46.17	36.50
LSD(0.05) sowing date					0.231					0.654					0.742
LSD(0.05) Poultry manure					0.231					0.674					0.742
LSD(0.05) sowing date x poultry manure					ns					ns					ns

Tab. 4. Effects of different sowing date and poultry manure application rate on the leaf area index of maize

Sowing date	Four weeks after sowing					Six weeks after sowing					Eight weeks after sowing				
	Poultry manure application rate (t ha⁻¹)					Poultry manure application rate (t ha⁻¹)					Poultry manure application rate (t ha⁻¹)				
	0	2.5	5.0	7.5	Mean	0	2.5	5.0	7.5	Mean	0	2.5	5.0	7.5	Mean
April 7	0.01	0.03	0.09	0.07	0.05	0.01	0.12	0.33	1.24	0.43	0.03	0.33	0.84	1.84	0.76
May 7	0.02	0.02	0.06	0.07	0.04	0.01	0.11	0.28	1.20	0.40	0.03	0.30	0.80	1.65	0.70
June 7	0.01	0.02	0.04	0.07	0.04	0.02	0.09	0.24	1.17	0.38	0.02	0.28	0.77	1.52	0.65
Mean	0.01	0.02	0.06	0.07	0.04	0.01	0.11	0.28	1.20	0.40	0.03	0.30	0.80	1.67	0.70
LSD(0.05) sowing date					0.01					0.05					0.063
LSD(0.05) Poultry manure					0.01					0.05					0.063
LSD(0.05) sowing date x poultry manure					ns					ns					ns

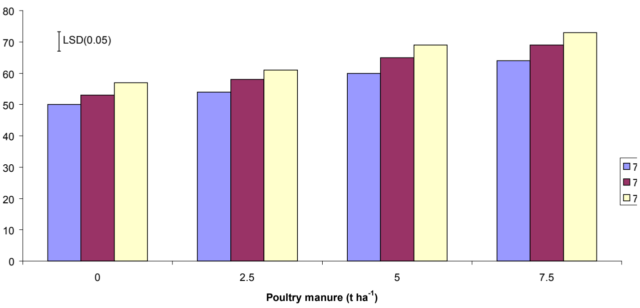

Fig. 1. Effects of different sowing date and poultry manure application rate on days to 50% flowering of maize plants.

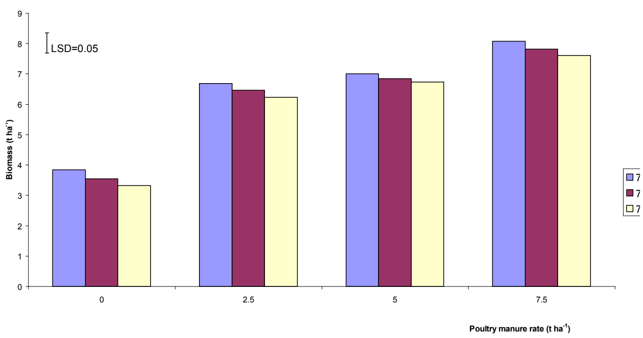

Fig. 2. Effects of different sowing date and poultry manure application rate on the biomass of maize at final harvest.

April 7 sown plants fertilized with 7.5t PM ha^{-1} had the highest biomass (8.08t ha^{-1}). LAI and biomass were significantly correlated ($r=0.57$, $p<0.05$) demonstrating that LAI is an indicator of its photosynthetic capacity and translocation. As consequence, a high amount of radiation associated with higher LAI contributed to an increased in biomass.

Harvest index

HI was increased from 48.65% in April 7 sown plants to 55.60% in the June 7 sown plants (Tab. 5). HI increased as the PM level increase. The greatest HI was produced from 5.0t PM treated plants (56.50%) and was 11.28%, 35.92% and 44.34% higher than 7.6, 2.5 and 0 PM treated plants, respectively.

Grain yield

Both sowing date and PM levels had significant effect on grain yield (Tab. 5). Similar findings have been observed by Jaliya *et al* (2008) in Samaru, Zaria. The highest grain yield was produced from the April 7 sown plants (3.81t ha^{-1}) and was 3.41 and 7.21% higher than in May 7 (3.68t ha^{-1}) and June 7 (3.54t ha^{-1}), respectively. This observation is conformity with Mendhe *et al* (1992) who postulated that grain yield increased with early sowing. Increase in PM level from 0 to 5.0t PM ha^{-1} significantly increased

Tab. 5. Effects of different sowing date and poultry manure application rate on yield and yield components of maize

Sowing date	Harvest index (%)					Grain yield (t ha⁻¹)					1000-grain weight (mg)				
	Poultry manure application rate(t ha⁻¹)					Poultry manure application rate (t ha⁻¹)					Poultry manure application rate (t ha⁻¹)				
	0	2.5	5.0	7.5	Mean	0	2.5	5.0	7.5	Mean	0	2.5	5.0	7.5	Mean
7th April	40.30	43.50	58.30	52.50	48.65	1.05	3.23	5.77	5.18	3.18	1244.00	1373.00	1808.00	1723.00	1535.75
7th May	42.10	46.20	63.50	56.80	52.15	1.05	3.06	5.53	5.09	3.68	1183.00	1326.00	1728.00	1659.00	1474.00
7th June	45.80	49.30	67.10	60.20	55.60	1.03	2.95	5.24	5.00	3.54	1080.00	1254.00	1618.00	1537.00	1372.25
Mean	42.73	46.33	62.97	56.50	52.13	1.03	3.08	5.51	5.09	3.68	1169.00	1317.67	1716.00	1639.67	1460.67
LSD(0.05) sowing date					2.255					0.43					34.683
LSD(0.05) Poultry manure					2.255					0.43					34.683
LSD(0.05) sowing date x poultry manure					ns					ns					ns

grain yield from 1.05 to 5.51t ha^{-1} while further increase to 7.5t PM ha^{-1} significantly reduced the grain yield to 5.09t ha^{-1} indicating that addition of more quantity of PM was unnecessary beyond 5.0t ha^{-1}.

1000-Grain weight

1000-grain weight was reduced from 1535.75 mg in the April 7 sown plants to 1474 and 1372 mg in May 7 and June 7 sown plants, respectively, which represented 4.02 and 10.65% grain yield reduction (Tab. 5). The 1000-grain weight resulting from delayed sowing was probably due to low daily incident radiation, which is consistent with findings of Cirilo and Andrade (1996). The significant correlation between grain yield and 1000-grain weight ($r=0.62$, $p<0.05$) revealed that grain yield reduction associated with decayed sowing was probably due to reduction in 1000-grain weight.

Increasing PM level from 0 to 5.0t ha^{-1} significantly increased 1000-grain weight from 1169 to 1716.33 mg. This confirmed earlier findings from Adediran and Banjoko (2003) which showed that application of PM is important input for enhancing yield of maize. However, further increase up to 7.5t PM ha^{-1} significantly reduced 1000-grain weight to 1639.67 mg.

Conclusions

Overall, this study confirms that early sowing and PM application are necessities for improving crop productivity. Grain yield differences between early sown and late sown plants have been attributed to decreased dry matter partitioning to grain resulting in decreased grain weight. Higher grain yield accrued to the PM treated plants have been attributed among other factors to higher plant height, LAI and efficient transfer of assimilates to sink leading to greater biomass. This study revealed that plants sown early (April 7) and given 5.0t PM ha^{-1} gave the highest grain yield of 5.77t ha^{-1}. it is therefore recommended for maize producing farmers in forest ultisol location.

References

Adediran, J. A. and V. A. Banjoko (2003). Comparative effectiveness of some compost fertilizer formulations for maize in Nigeria. Nig. J. Soil Sci. 13:42-48.

Cirilo, A. G and F. H. Andrade (1996). Sowing date and kernel weight in maize. Crop Sci. 36:325-330.

Gordon, W. R., D. A. Whitney and R. J. Raney (1993). Nitrogen management in furrow irrigated, ridge-tilled corn. J. Prod. Agric. 6:213-217.

Ibedu, M. A, R. P. A Unambra and A. Udealor (1988). Soil management strategies in relation to farming system development in the south eastern agricultural zone of Nigeria. Paper presented at the National Farming system Research Workshop, Jos, Plateau State, Nigeria.

Jaliya, M. M, A. M. Falaki, M. Mahmud, and Y. A. Sani (2008). Effect of sowing date and NPK fertilizer rate on yield and yield components of quality protein maize (Zea mays L.). ARPN J. Agric. And Biol. Sci. 3(2): 23-29.

Law-Ogbomo, K. and S. U. Remison (2008). Growth and yield of white guinea yam (Dioscorea rotundata Poir) influenced by NPK fertilization on a forest site of Nigeria. J. Trop. Agric. 46(1-2):9-12.

Lal, R. and B. T. Kang (1982). Management of organic matter in soils of the tropics and subtropics. International. Soil Soe. 3:153-178.

Maynard, A. A. (1991). Intensive vegetable production using composed animal manure. Conneticut Bul. Agic. Expt Station.

Mendhe, S. N., S. H. Gawande, R. J. Kukole and M. V. Nimbulkar (1992). Studies on combinations of cereal and legume forage crops. J. Soil and Crop. 1:53-55.

Omotosho, S.O. and O. S. Shittu (2007). Effects of NPK fertilizer rates and method of application on growth and yield of okra (Abelmoschus esculentus (L.). International J. Agric. Res. 2(7):614-619.

Remison, S. U. (1997). Basic principles of crop physiology. Sadoh Press (Nig.), Benin City.

Remison, S. U. (2005). Arable and vegetable crops. Gift-Press Associates, Benin City.

Saeed, I. N, K. Abbasi, and M. Kazim (2001). Response of maize (Zea nmays) to nitrogen and phosphorus fertilization under agro-climatic condition of Rawalokot Azad Jammu and Kashmir. Pak. J. Biol. Sci. 4:53-55.