Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.3, No.13, 2013

Dry Matter Accumulation In Maize As Influenced By Row Arrangement, Nitrogen And Phosphorus Levels In Maize (Zea Mays L)/ Castor *(Ricinus Commumis* L.*)* Mixture

Arunah U.L*; E.B. Amans; M. Mahmud; A. Ahmed; G. L. Luka; A. S. Isah; B.A. Babaji; E.C Odion

Department of Agronomy, Ahmadu Bello University, Zaria

*****Email address: luckii20002000@yahoo.co.uk

Abstract

Field experiment was conducted at the Institute for Agricultural Research farm Samaru, Zaria in the Northern Guinea Savanna zone of Nigeria during the 2007, 2008 and 2009 rainy seasons to evaluate the effect of row arrangements, nitrogen and phosphorus levels on maize dry matter accumulation. The treatments consisted of factorial combinations of three alternate row arrangements of maize: castor in 1:1, 1:2 and 2:1, four levels of nitrogen (0, 40, 80 and 120 kg N ha^{-1}) and three levels of phosphorus (13, 26 and 39 kg P ha^{-1}), laid out in a split plot design and replicated three times. Nitrogen and phosphorus fertilizer were assigned to the main plots while row arrangements were assigned to the sub-plots. The result showed that row arrangement significantly increased plant height and LAI only at 10 WAS in 2007and 2008. Where 1:2 recorded higher measured parameters than the other patterns. Increase in nitrogen up to 120 kg N ha^{-1} resulted in significantly taller plants and higher LAI in 2007 and at 10 WAS in 2009. TDM was also observed to increase throughout the years of study except at 10 WAS. The response was observed up to 120 kg N ha^{-1} for most of the parameters. Application of phosphorus significantly increased plant height only in 2009, LAI in 2007 and 2009, and TDM at 6 WAS in 2007 only. These parameters showed no response beyond applied 26 kg P ha^{-1}. Based on the finding of this study, maize can be intercropped with castor with 1:2 planting pattern with application of 80 kg N ha $^{-1}$ plus 26 kg P ha $^{-1}$.

Key words; nitrogen, phosphorus, leaf area index, total dry matter

Introduction

Row intercropping involves growing of two or more crops in well defined rows, thus maximizing the interaction between the crops (Palaniappan and Sivaraman, 2006). The potential for improved mixed cropping in increasing world food supply can be justified with the low risk involve, increase food diet, reduced weeds, low level of insect and pest infestation. There is paucity of information on maize and castor mixture in this ecological zone of Nigeria. Maize is grown in mixture with cereals, legumes, tubers and oil seed crops, thus increasing its expanse of cultivation and acceptability among farmers. Commercial production of castor started about fifty years ago in India and USA for producing cosmetics, sporting equipment, plastics, dyes, paints and lubricants. But in Nigeria it is used in demarcating farms and fence for houses or boundaries. However, being crop with good economic potential, its cultivation as a cash crop will help increase the income of poor resource farmers. The problem of producing these crops in mixture might be basically shading effect from the castor plant due to its broad leaf nature. Thus this might reduce the light interception from the maize leaf, leading to reduce dry matter production and accumulation. But if a good plating pattern is adopted, it helps reduce this problem and thus the advantage of having both food and industrial material for the farmer.

The major cause of low yields in savanna soils is the low nitrogen and phosphorus as well as inappropriate use of fertilizer. The problem is further compounded by soil erosion, severe leaching of nutrients and rapid decomposition of organic matter induced by heavy rainfall, high temperature and relative humidity, (Steiner, 1982). Maize and castor requires nitrogen and phosphorus for good vegetative growth and root development for maximum dry mater accumulation. A lot of work has been carried out on fertilizer requirement of maize while little is known about the fertility requirement for castor. For the mixture of the two crops very little is known in Nigeria as it is not a common practice. This poses a serious challenge of a need to avoid the possibility of either under or over application of these nutrients to these crops in mixture. The study was thus carried out to investigate the most appropriate planting pattern, optimum nitrogen and phosphorus levels for dry matter production in maize.

Materials and methods

The experiment was conducted at the Institute for Agricultural Research farm Samaru, Zaria (11^{o}11'N 07^{o}38'E, 686m above sea level) in the Northern Guinea Savanna zone of Nigeria during the 2007, 2008 and 2009 rainy seasons. Treatments consisted of factorial combinations of three alternate row arrangements of maize: castor in 1:1, 1:2 and 2:1, four levels of nitrogen (0, 40, 80 and 120 kg N ha^{-1}) and three levels of phosphorus (13, 26 and 39 kg P ha^{-1}). The treatments were laid out in a split plot design and replicated three times. Nitrogen and phosphorus fertilizer treatments were factorially combined and assigned to the main plots while row arrangements were assigned to the sub-plots. Nitrogen fertilizer (Urea) was applied as per treatment, in two equal doses by side placement at 3 and 6 WAS after the first and second weeding respectively. The phosphorus fertilizer (in the form of SSP) in amount according to treatments was applied at sowing. The net plot size varied with row arrangement of 1:1, 2:1 and 1:2 (50:50, 33:67, and 67:33). Row spacing of 75 cm and plant spacing of 25 and 40 cm were adopted for maize and castor respectively.

Data was collected on plant height, leaf area index and total dry matter at 6 and 10 weeks after sowing (WAS). These were analysed statistically in accordance with Snedecor and Cochran (1967). The means were compared using Duncan Multiple Range Test (Duncan 1955).

Results and Discussion

The soil physico-chemical properties of the experimental site during the 2007 to 2009 rainy seasons are presented in Table 1. The analysis shows that the soil was loamy in nature from 0- 30 cm depth for the three years, except at 15- 30 cm in 2008 where it was clay loam in nature. The organic carbon, total nitrogen and available phosphorus were generally low in the three years of the study. The low level of nutrient might be due to the poor parent material of the soil, heavy rainfall experienced in the savanna, high temperatures and inadequate use of fertilizers.

The effect of row arrangement, nitrogen and phosphorus application on plant height of maize during 2007, 2008 and 2009 rainy seasons are shown in Table 2. The height of maize plant was significantly affected by row arrangement only at 10 weeks after sowing (WAS) in 2007. Where the maize plant heights were at par at the 1:1 and 1:2 maize: castor intercrop and the 2:1 produced shorter plants. The taller plants observed in the 1:1 and 1:2 could be attributed to the shading effect from the castor plant. Thus the maize plants in these planting patterns might have resulted in etiolation as a result of competition that gave them the height. Adeyemi *et al*. (2001) and Anonymous, (2002) reported similar findings.

Nitrogen application significantly increased maize plant height only in 2007 and 10 WAS in 2009. Where the application of 120 kg N ha^{-1} resulted in taller plants than when no nitrogen was applied. This rate was however, observed to be at par with other nitrogen levels except, at 10 WAS in 2007 with applied 40 kg N ha^{-1} and at 6 WAS in 2007 with applied at 40 or 80 kg N ha^{-1} where it recorded taller plants. Influence of N on the plant height indicate the major role it plays in plant biochemistry, as an essential constituent of chlorophyll increasing crops vegetative ability in terms of height. Jaliya (2004) reported similar finding of maize response to N levels.

Maize plant height was significantly increased with the application of phosphorus in 2009 only. The result showed that the application of 39 kg P ha^{-1} produced taller plants than 13 kg P ha^{-1}, but significantly comparable to 266 kg P ha^{-1}. There was no significant interactions observe between the treatments. Phoshorus plays a role in root establishment and development which might have assisted in increasing N absorption by the plant, this could have enhance maize plant height. Similar result has been recorded by research work conducted by IITA, (2007).

Table 3 shows the effect of row arrangement, nitrogen and phosphorus application on LAI of maize during 2007, 2008 and 2009 rainy seasons. Leaf area index was only significantly affected by row arrangement at 10 WAS in 2007 and 2008. The 1:2 arrangement (maize: castor) resulted in higher LAI than the other two arrangements which were at par. The higher maize LAI observed in 1:2 row arrangement could be ascribed to the taller plants obtained at this period which enhanced more leaf formation and expansion, thus increasing light interception and land area covered.

Increase in nitrogen significantly affected LAI in 2007 and only at 10 WAS in 2010. LAI was significantly increased by the application of 40 kg N ha^{-1} at 10 WAS in 2007 and 2009 than the control. The application of 120 kg N ha^{-1} was found to result in significantly higher LAI at the affected sampling periods except at 10 WAS in 2007 and 2009 where it was at par to applied 80 kg N ha $^{-1}$. The significant response on LAI could be attributed to longer and broader leaf of the fertilized crops compared to the control which might have resulted to better light interception and land coverage. Similar findings were reported by Ayuba *et al*. (2002).

Phosphorus application significantly affected LAI only in 2007 and 2009. LAI increased significantly with the application of 13 to 26 kg P ha $^{-1}$ but beyond that comparable increases responses were observed at all the affected periods except at 10 WAS in 2009. At this periods higher LAI was recorded only with the application of 39 kg P ha $^{-1}$ than the control. Significant interactions were observed between nitrogen and phosphorus at 10 WAS in 2007 and 2009. The increase in maize plant height might have increased number of leaves formed, leaf length and width thus increasing land area covered, thus the reason for the significant increase in LAI. The low soil P level in Table 1 might also be attributed to the response observed on maize growth characters to P application. Research work conducted by Naik *et al*. (1993) and Hussaini (2000) have shown positive response of maize to P fertilizer.

The interactions between nitrogen and phosphorus in 2007 and 2009 are presented in Table 4. In 2007 application of 80 N $^{+}$ 39 P (kg ha $^{-1}$) resulted in higher LAI when compared with the N control at 13 kg P ha $^{-1}$. Applied 80 N $^{+}$ 13 P (kg ha $^{-1}$) increased LAI than when no N was applied with at 13 kg P ha $^{-1}$ in 2009. The significant response of maize LAI on applied nitrogen and phosphorus signifies the importance of nitrogen and phosphorus for growth and development which lead to higher photosynthetic activities. The phosphorus might have helped in root development that assisted the rate of nitrogen absorption. At zero N, LAI responded to the highest P levels which show that this element is very important for maize growth. At other Nitrogen levels P response was not beyond application of 26 kg P ha $^{-1}$, which could be due to synergic and compensation between the elements, this was further confirmed at the highest N level where no response was recorded. Similar significant response between nitrogen and phosphorus were reported by, Baba (2002), and Inyang, (2006).

The effect of row arrangement, nitrogen and phosphorus application on maize total dry matter (TDM) during 2007, 2008 and 2009 rainy seasons are shown in Table 5. Row arrangement of maize: castor had no significant effect on TDM in the three years of the trial. However, application of N was observed to significantly affect maize TDM throughout the years of study except, at 10 WAS in 2008. Application of 120 kg N ha $^{-1}$ resulted in increase in TDM than when nitrogen was not applied but, it was at par with other nitrogen levels except at 6 WAS in 2007and 2009. At the affected periods the application of 120 kg N ha $^{-1}$ recorded higher TDM than applied 40 and 80 kg N ha $^{-1}$. The significant response on LAI could have resulted to taller plants, higher growth, more assimilate formation for dry matter production than the control. Similar finding were reported by Sharifai, *et al.* (2008).
Significant response to application of phosphorus on TDM was recorded only at 6 WAS in 2007. Where applied 26 kg P ha $^{-1}$ produced the highest TDM than to the other levels which were a similar. There was no significant influence on TDM by the interacting factors.

Conclusion

Based on the finding of this study, maize can be intercropped with castor at 1:2 row arrangement with application of 80 kg N ha $^{-1}$ plus 26 kg P ha $^{-1}$.

References

Adeyemi, A.A.; T.A.T. Wahua and A.O. Ayeni (2001). Effect of Cropping Patterns and NPK (15-15:15) Fertilizer Application on N, P, and K Uptake of Componet Crops In: cassava/ maize/ /Melon Intercrop. Industrial Crops and Products Volume 31, (1) January 2010, Pages 185-19

Anonymous (2002). A hand book for innovative maize-legume intercropping. SACRED Africa, Bungoma, Kenya, May 2002. In Agrobrief number 4 Intercropping of Annual food crops. Martine Van Wolfswinkel, 20 pp

Ayuba, M; M.A. Nadeem; M.S. Sharar; N. Mhamoud (2002). Response of maize (*Zea mays* L.) fodder to different levels of nitrogen and phosphorus. *Asia Journal of Plant Science* (A): 352- 254.

Baba I.S.C. (2002). Effect of plant density and rate of NPK fertilizer on the performance of popcorn (*Zea mays* L.). Unpublished B.Agric Poject, submitted to Department of Agronomy, Ahmadu Bello University, Zaria.48pp

Duncan, D. B (1955). Multiple Range and Multiple "F" test *Biometrics* 11: 1-42.

Hussaini M.A.; S.G. Ado; H. Mani (2002). Influenced of nitrogen management and planting date on the performance of pop corn in the Northern Guinea Savanna of Nigeria. *Journal of the Science of Agriculture, food Technology and the Environment* volume 2 No. 1. Eboyin state University, Abakaliki pp 24- 30.

IITA (2007). Multiple Croppping. IITA Research guide 60 http//www.iitaresearch. org/ details/ trn_mat/irg60 html

Inyang, S.J. (2006). Effect of NPK fertilizer and plant density on the performance of quality protein maize (*Zea maize* L.) at Samaru, Nigeria. Unpublished M.Sc. Thesis, submitted to Postgraduate School, Ahmadu Bello University, Zaria.20-64pp

Jaliya M. M. (2004). Effect of Sowing Date and NPK Fertilizer on Growth and Yield of Quality Protein Maize (Zea mays L.) in Northern Guinea Savanna of Nigeria. Unpublished M,sc Thesis submitted to Postgraduate School, A.B.U Zaria, Nigeria. 75- 77.

Naik, K.G.A; G.R. Manure; M.K Badiger (1993). Yield of castor by fertilizing with P, S and B. *Journal of the Indian Society of Soil Science* 41(4) 686-688 cited from Field crop abstract 1994 47(10) pp859.

Palaniappan, S.P and K. Sivaraman (2006). Cropping systems in the tropics; Principles and Management. New Age Internaional (P) Ltd, publisher. 3rd Ed. Pp 7- 63.

Sharifai, A.I; M. Mahamud; M.A. Mahadi; H.N. Kura; A. Namakka (2008). Effect of different levels of NPK compound fertilizer on growth parameters of extra early maize (*Zea mays* L.) varieties. *Journal of Agricultural Research and Policies* 3 (2): 65-69.

Snedecor, G.W and W.G Cochran (1967) statistical methods 10th ed. Iowa state university press. Ames, Iowa U.S.A 456 pp

Steiner, K.G. (1982). Intercroppingin tropical small holder agriculture with reference to West Africa. German agency for Technical Co-operation (GTZ) D. 6236. Eschhorn, Germany.*Agronomy Journal* 9pp.

Table1: The physico-chemical properties of soil in the experiment site at Samaru in 2007, 2008and 2009 rainy seasons

Physical composition (%)	**2007**		**2008**		**2009**	
	0- 15	**15-30**	**0-15**	**15-30**	**0-15**	**15-30**
Sand	480	440	380	280	480	480
Silt	420	480	400	300	400	360
Clay	100	80	220	420	120	160
Textural class	Loam	Loam	Loam	Clay loam	Loam	Loam
Chemical composition						
pH in water	6.29	5.00	6.20	4.90	5.90	5.60
pH in 0.01 ml $CaCl_2$	4.85	4.00	4.50	3.90	5.20	5.10
Organic carbon (%)	0.76	0.66	0.84	0.56	0.52	0.48
Total Nitrogen (%)	0.13	0.13	0.18	0.15	0.14	0.10
Available phosphorus (ppm)	12.60	14.07	13.80	15.10	12.25	5.25
Exchangeable bases (Cmol kg $^{-l}$)						
Ca	3.74	2.21	4.17	8.33	1.00	0.80
Mg	0.77	0.55	1.42	2.64	0.60	0.69
K	0.20	0.30	0.33	0.35	0.23	0.15
Na	0.19	0.25	0.30	0.35	1.20	1.60
CEC	5.69	12.21	7.60	14.80	5.30	5.80

Table 2: Effect of row arrangement, levels of nitrogen and phosphorus on plant height (cm) of maize during rainy season of 2007, 2008 and 2009

Treatments	**2007 (WAS)**		**2008 (WAS)**		**2009 (WAS)**	
	6	**10**	**6**	**10**	**6**	**10**
Row arrangements						
1:1	67.4	140.1a	99.8	176.6	79.9	156.1
1:2	67.9	140.0a	104.7	177.6	77.4	156.3
2:1	66.2	130.0b	103.7	172.7	76.6	156.8
SE ±	1.7	2.6	3.4	2.6	2.1	2.8
N levels (kg N ha^{-1})						
0	52.9c	119.8c	100.3	173.6	73.1	141.6b
40	67.3b	135.5b	102.3	175.5	80.3	160.3a
80	68.5b	143.4ab	101.5	173.3	80.1	164.1a
120	80.9a	147.5a	106.8	180.9	78.3	159.6a
SE ±	2.0	3.0	3.9	3.1	2.4	3.2
P levels (kg P ha^{-1})						
13	67.5	134.0	104.3	173.9	71.7b	150.0b
26	65.6	136.1	103.1	176.4	80.7a	159.6a
39	64.5	139.8	100.8	176.6	81.4a	159.6a
SE ±	1.7	2.6	3.4	2.6	2.1	2.8
RXN	NS	NS	NS	NS	NS	NS
RXP	NS	NS	NS	NS	NS	NS
NXP	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in a column are not significantly different at P = 0.05 using DMRT NS= Not significantly different at P = 0.05

Table 3: Effect of row arrangement, levels of nitrogen and phosphorus on LAI of maize during rainy season of 2007, 2008 and 2009

Treatments	**2007 (WAS)**		**2008 (WAS)**		**2009 (WAS)**	
	6	**10**	**6**	**10**	**6**	**10**
Row arrangements						
1:1	0.83	1.64b	0.25	0.30b	1.33	2.55
1:2	0.76	1.76a	0.22	0.33a	1.46	2.60
2:1	0.76	1.57b	0.21	0.30b	1.39	2.50
SE ±	0.04	0.04	0.02	0.01	0.06	0.08
N levels (kg N ha^{-1})						
0	0.56b	1.22c	0.21	0.30	1.31	2.32c
40	0.89b	1.74b	0.22	0.30	1.43	2.45b
80	0.84b	1.84ab	0.21	0.32	1.40	2.67ab
120	0.99a	1.87a	0.24	0.31	1.42	2.75a
SE ±	0.04	0.04	0.02	0.01	0.06	0.09
P levels (kg P ha^{-1})						
13	0.74b	1.54b	0.22	0.31	1.27b	2.39b
26	0.86a	1.67a	0.22	0.31	1.43a	2.55ab
39	0.84a	1.76a	0.25	0.30	1.47a	2.72a
SE ±	0.04	0.04	0.02	0.01	0.06	0.08
RXN	NS	NS	NS	NS	NS	NS
RXP	NS	NS	NS	NS	NS	NS
NXP	NS	*	NS	NS	NS	**

Means followed by the same letter(s) in a column are not significantly different at P = 0.05 using DMRT NS= Not significantly different at P = 0.05

Table 4: Interaction between N and P level on leaf area index of maize at 10 WAS in 2007 and 2009 at Samaru

	P level (kg P ha $^{-1}$)		
N levels (kg N ha $^{-1}$)	13	26	39
		2007	
0	0.94d	1.20d	1.43c
40	1.70b	1.73ab	1.72b
80	1.68b	1.87ab	1.96a
120	1.82ab	1.89ab	1.87ab
SE ± 0.074			
		2009	
0	1.8d	2.25c	2.92ab
40	2.6bc	2.24c	2.77abc
80	2.4c	3.11a	2.70abc
120	2.6bc	2.58bc	2.49bc
SE ± 0.150			

Means having the same letters are not statistically different at P = 0.05 (DMRT)

Table 5: Effect of row arrangement, levels of nitrogen and phosphorus on TDM (g) of maize during rainy season of 2007, 2008 and 2009

Treatments	**2007 (WAS)**		**2008 (WAS)**		**2009 (WAS)**	
	6	**10**	**6**	**10**	**6**	**10**
Row arrangements						
1:1	37.3	117.1	55.8	112.9	38.7	116.6
1:2	40.0	120.1	52.0	118.5	38.9	122.2
2:1	39.4	116.4	52.7	106.9	38.7	115.4
SE ±	1.90	3.78	4.02	5.32	2.72	4.43
N levels (kg N ha $^{-1}$)						
0	31.6c	106.7b	44.7b	114.0	32.5b	104.9c
40	38.0b	116.1ab	49.6ab	105.4	35.6b	114.9b
80	41.9ab	123.3a	56.8ab	116.1	42.0a	123.6a
120	44.5a	126.0a	62.9a	115.6	45.1a	129.5a
SE ±	2.20	4.37	4.64	6.15	3.15	5.13
P levels (kg P ha $^{-1}$)						
13	35.5b	114.6	54.1	120.1	37.5	116.3
26	45.3a	124.4	53.2	111.8	40.7	122.6
39	35.4b	114.0	53.3	106.5	37.9	114.8
SE ±	1.90	3.78	4.02	5.32	2.72	4.43
RXN	NS	NS	NS	NS	NS	NS
RXP	NS	NS	NS	NS	NS	NS
NXP	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in a column are not significantly different at P = 0.05 using DMRT NS= Not significantly different at P = 0.05

Biography

Arunah U.L was given birth in Auchi town, Edo State Nigeria on 4th March 1973. I obtained B.Agric in 2000, M.Sc Agronomy in 2004 and PhD in Agronomy in 2012 all from Department of Agronomy, Ahmedu Bello University, Zaria, Kaduna, Nigeria. My area of specialization is farming systems / organic agriculture.

I became a member of the Organic Agriculture Project in Tertiary Institutions in Nigeria in 2006, member Horticultural society of Nigeria in 2010 and member of ISOFAR in 2011