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EFFECT OF ROW ARRANGEMENT, NITROGEN AND PHOSPHORUS LEVELS ON CASTOR TOTAL DRY MATTER ACCUMULATION IN MAIZE (ZEA MAYS L)/ CASTOR *(RICINUS COMMUMIS* L.*)* MIXTURE

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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 effect of row arrangements, nitrogen and phosphorus levels on castor 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 shows that row arrangement of 1:2 maize: castor recorded higher height, LAI and TDM than to other pattern. Application of nitrogen from 0 to 40 kg N ha^{-1} increase plant height, LAI and TDM, beyond this level response was not significant in most of the parameters measured. Plant height, LAI and TDM was observed to increase up to applied 26 kg P ha^{-1}. Based on the finding of this study, castor can be intercropped with maize at 1:2 maize: castor ratio with application of 40 kg N ha^{-1} plus 26 kg P ha^{-1}.

KEY WORDS: castor, nitrogen, row arrangement, phosphorus, total dry matter.

INTRODUCTION

Mixed cropping involve growing of more than one crop in mixture in a piece of land where by the crops spend part or whole of their growth period together. It ensures better utilization of land, suppresses weeds, reduces labour requirement and improving the quality of product (Ossom, 2010). There is paucity of information on maize and castor mixture in this ecological zone of Nigeria. Maize is grown in mixture with other cereals, legumes, tubers and oil seed crops, thus increasing its expanse of cultivation and acceptability among farmers. Castor is used in demarcating and fencing farms in Nigeria. But this is a crop that has commercial importance in industries for production of hundreds of products ranging from cosmetics to sporting equipment, plastics, dyes, paints and lubricants. Shading effect from the tall maize plant might pose a serious challenge producing these crops in mixture. Thus this might reduce the light interception received by the castor leaf, leading to reduced dry matter production and accumulation. Adopting appropriate plating pattern will help in growing these crops in mixture and thus improve livelihood of the farmers.

Savanna soils have been characterized with low nitrogen and phosphorus which is attributed to 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 dry mater accumulation. There is no information on the fertility requirement of these crops because is not 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 row arrangement, optimum nitrogen and phosphorus levels for dry matter production in castor.

MATERIALS & 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 basal. 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 was adopted for maize and castor respectively. Data were collected on plant height, leaf area index and total dry matter. These were analysed statistically in accordance with Snedecor and Cochran (1967). The means were compared using Duncan Multiple Range Test (Duncan 1995).

RESULTS & DISCUSSION

The soil physico-chemical properties of the experimental site during the 2007 to 2009 rainy seasons are presented in Table 1.

TABLE 1: The physico-chemical properties of soil in the experiment site at Samaru in 2007, 2008 and 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^{-1})						
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

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 and high temperatures. Effect of row arrangement, nitrogen and phosphorus application on castor plant height, leaf area index and total dry matter during 2007, 2008 and 2009 rainy seasons are shown in Table 2. Plant height was significantly increased by row arrangement only at 10 and 6 WAS in 2007 and 2009, LAI at 10 WAS and TDM at 6 WAS in 2007 and 2008 respectively. Where 1:2 arrangements resulted in significantly taller plant than the 1:1 arrangement but was at par with 2:1only at 6 WAS in 2009. Row arrangement of 1:2 resulted in higher LAI than the other row arrangements that were statistically at par. Row arrangement of 1:2 resulted in heavier TDM only than 2:1 arrangement. The taller castor plants observed in 1:2 arrangements might be attributed to better land coverage of the castor plant, due to their leaf architecture and branching ability, thus resulted in taller plant. This might also be attributed to higher competition at this level resulting to taller plants. The better land coverage of the castor plant might have helped in more light interception that resulted in higher LAI, thus increased rate of assimilate production translated to the TDM. Dhimmar, (2009) observed higher LAI when castor was sown in mixture. Nitrogen application significantly increased plant height, LAI and TDM in the years except at 6 WAS in 2008 on plant height. Application of nitrogen from 0 to 40 kg N ha^{-1} gave taller plant in all the years. Further Increase up to 80 kg N ha^{-1} recorded taller plant only in 2007. Plant height was significantly increased only at 10 WAS in 2009 with applied 120 kg N ha^{-1}. Application of 120 kg N ha^{-1} resulted in higher LAI in the years than when no nitrogen was applied. This level was however, observed to be at par with other applied nitrogen levels except at 6 WAS in 2007, 2008 and 2009 where it recorded higher LAI to application of 40 kg N ha^{-1}. This level also resulted in higher LAI when compared to applied 80 kg N ha^{-1} at 6 WAS in 2007. The TDM was increased with the application of nitrogen from 0 to 40 kg N ha^{-1} in all the years. Increasing the nitrogen Level up to 80 kg N ha^{-1}, resulted in heavier TDM at 6 WAS in 2007, and 2008. Beyond this level TDM was not increased in all the years. This can be attributed to the major role nitrogen plays a in plant biochemistry, as an essential constituent of chlorophyll in assimilate production used in plant growth, as the soil nitrogen level was observed to be low (Table 1). This might have enhanced the taller plant observed with application of nitrogen. This might have resulted to longer and broader leaf of the fertilized crops compared to the control which might have resulted in better light interception and land coverage. The increase in light intercepted with applied nitrogen could have increase the amount of assimilate production that was translated to TDM produced. Similar findings were reported by Abubakar *et al*. (2010).

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

Treatments	Plant height (cm)						Leaf area index						Total dry matter (g)					
	2007		2008		2009		2007		2008		2009		2007		2008		2009	
	6 (WAS)	10 (WAS)	6 (WAS)	10 (WAS)	6 (WAS)	10 (WAS)	6 (WAS)	10 (WAS)	6 (WAS)	10 (WAS)	6 (WAS)	10 (WAS)	6 (WAS)	10 (WAS)	6 (WAS)	10 (WAS)	6 (WAS)	10 (WAS)
Row arrangements																		
1:1	23.9	67.9b	29.4	110.9	20.1b	76.4	0.06	0.17b	1.20	2.85	0.08	0.19	24.5	83.9	31.6ab	76.9	6.9	95.1
1:2	22.2	77.8a	28.8	114.0	23.0a	77.9	0.06	0.21a	1.18	2.79	0.08	0.21	27.0	87.4	33.2a	78.2	7.0	101.0
2:1	21.3	63.3b	27.0	111.5	21.3ab	77.8	0.06	0.17b	1.09	2.71	0.09	0.19	25.0	83.2	28.8b	75.3	7.6	98.3
SE ±	0.81	1.92	1.52	3.26	0.96	2.82	0.003	0.005	0.065	0.118	0.005	0.012	0.83	2.81	1.35	1.82	0.44	1.52
N levels (kg N ha^{-1})																		
0	17.6c	45.6c	29.2	99.4b	13.9b	52.8c	0.03b	0.13b	0.79c	2.21b	0.04b	0.12b	19.4c	63.8b	20.0c	48.7c	2.6b	57.4b
40	21.2b	66.7b	28.3	116.6a	23.6a	94.8b	0.06b	0.21a	1.07b	2.84a	0.08b	0.23a	25.8b	92.7a	31.7b	83.4b	9.2a	115.6a
80	25.0a	84.7a	26.2	120.2a	23.6a	79.9b	0.06b	0.21a	1.30a	3.07a	0.10a	0.22a	29.0a	91.3a	37.4a	85.3ab	8.7a	112.8a
120	26.8a	85.7a	29.7	113.3a	25.5a	84.1a	0.08a	0.21a	1.47a	3.08a	0.10a	0.24a	29.0a	98.8a	36.7a	89.4a	8.9a	115.4a
SE ±	0.93	2.22	1.76	3.77	1.11	3.26	0.004	0.006	0.075	0.137	0.006	0.013	0.96	3.25	1.56	2.11	0.50	1.76
P levels (kg P a^{-1})																		
13	22.1	66.4	28.1	110.8	19.1b	71.8b	0.05	0.17b	1.07b	2.74	0.08	0.19	25.3	80.6b	30.2	76.4	6.2b	97.9
26	21.7	70.0	29.3	115.0	21.5a	76.5ab	0.06	0.20a	1.28a	2.83	0.09	0.19	26.1	91.1a	33.0	75.7	8.0a	98.1
39	23.7	73.0	27.7	109.9	23.9a	84.3a	0.06	0.19a	1.11ab	2.80	0.08	0.22	25.1	82.5b	30.4	78.6	7.3ab	99.0
SE ±	0.81	1.92	1.52	3.26	0.96	2.82	0.003	0.005	0.065	0.118	0.005	0.012	0.83	2.81	1.35	1.82	0.44	1.52
RXN	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
RXP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
NXP	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	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

Phosphorus application significantly affected castor plant height only in 2009, LAI at 10 and 6 WAS in 2007 and 2008, TDM at 10 and 6 WAS in 2007 and 2009 respectively. Where application of 39 kg P ha^{-1} recorded taller plant only than when 13 kg P ha^{-1} was applied. Higher LAI was obtained with applied 26 kg P ha^{-1} only than to 13 kg P ha^{-1}. Application of 26 kg P ha^{-1} resulted in heavier TDM than when 13 kg P ha^{-1} was applied at the affected measuring periods but, was at par with the application of 39 kg P ha^{-1} only at 6 WAS in 2009. The interactions between the treatments were not significant in all the years. Phosphorus plays a role in root establishment and development which might have assisted in increasing N absorption by the plant, thus might have enhanced maize plant height. The low soil phosphorus level in Table 1 might also be attributed to the response observed on maize height to P application. This might have increase plant height, more number of leaf and land coverage which might have resulted in higher light interception, increase LAI, thus improved the crop growth thus increased assimilate production that was translated to TDM produced. Naik *et al.* (1993), Hussaini (2000), Lowell *et al*. (2002), IITA, (2007) and Abubakar *et al.* (2010) have shown positive response of castor response to P fertilizer.

CONCLUSION

Based on the finding of this study, maize can be intercropped with castor at 1:2 maize: castor ratio with application of 40 kg N ha^{-1} plus 26 kg P ha^{-1}.

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