DEVELOPMENT OF NEMATODE RESISTANCE MAIZE VARIETIES BY DIALLEL MATING IN OWERRI, RAIN-FOREST AGRO-ECOLOGY OF NIGERIA

[1]Onyishi, G.C., [1]Agu, C.M., [1]Duru, H and [2]Chukwu, S.C[2]

[1]Department of Crop Science and Technology, Federal University of Technology, Owerri, Imo State, Nigeria
[2]Ebonyi State University, Abakaliki, Ebonyi State, Nigeria
Corresponding email: gonyishi@yahoo.com, Phone: 08037417658

Abstract
The study was conducted in 2014 and 2015 cropping season at the Centre for agricultural research and extension (CARE) of Federal University of Technology, Owerri (FUTO) located at latitude 05^0 27" N and longitude 07^0 O2" E within the rain forest agro-ecology of Nigeria; to assess the tolerance level of maize accessions to natural field infection of root not nematode (*Meloidogyne incognita*), and develop F1 progeny from Diallel mating of superior lines for subsequent evaluation for nematode resistance. A randomized complete block design (RCBD) was used with three replications. The results of the experiment show significant variation at (p = 0.05) on number of days to maturity, leaf area, plant height, and nematode count. Based on nematode count and severity level, accessions, Amiacha, Iduma, Isiochi, Nwaba White Nkalagu, Egbuonwa, Mkpanmkpa, and Nwaba white Nwadakpo were tolerant to root – knot nematode. Four accessions, Iduma, Amiacha, Isiochi, and Nwaba White Nkalagu exhibited the best values of the nematode tolerance component and were selected and used in full diallel mating to produce 16. F1 hybrid. Correlation studies show that nematode count is positively and significantly correlated with days to 50% tasseling (r =0.464**) and plant height (r = 0.387**) but negatively correlated with days to maturity.

Key Words: Maize, Nematode, Diallel mating, Resistance and accessions

Introduction

Maize (*Zea mays L)* is ranked the second most important food crop after cassava in Africa (FAOSTAT, 2009). In Nigeria, it contribute a lot to the economy of the country, as it is rich source of food, fodder, feed and also provide raw materials for the industry. Its importance has grown from being a food crop to a cash crop with its production now being market driven. Despite its importance in Nigeria, the yield is still very low compared to what is obtainable in Europe and united State. The low yield in Nigeria could be attributed to poor management practices, pest and diseases including plant parasitic nematodes. Agu (2006) reported a total crop failure in soils heavily infested with root - gall nematode (*Meolidogyne Spp*). Ayodele *et al*. (2011) also observed a sharp decline in the yield benefit of hybrid vigor among nematode susceptible maize hybrids compared to nematode resistant hybrids. The use of resistant crop variety appears to be the most dependable management strategy for a lasting solution to nematode menace. The use of host plant resistance as a nematode control option is environmental friendly and cost effective, provided that resistance gene is readily available.

Many procedures have been used by plant breeders in an attempt to increase maize yields and quality. The diallel cross/ mating schemes have been extensively used in breeding programs for the evaluation of the genetic potential of population or genotype for crop improvement. Chukwu *et al*. (2016) reported that diallel crosses present the best strategy for determining the general and specific combining ability between putative parents. The use of diallel mating in breeding program will produce promising progenies from which superior lines could originate. The effect of general combining ability (GCA) and specific combining ability (SCA) is important indicator of potential value for inbred lines in hybrid

combination. The objectives of the study were to assess the tolerance level of maize accessions to natural field infection of root knot nematode (*Meloidogyne incognita*), identify promising accessions and develop F1 progeny from Diallel mating of superior lines for subsequent evaluation for nematode resistance.

Materials and Methods

The study was conducted at the center for agricultural research and extension (CARE), Federal University of Technology, Owerri (FUTO), located at latitude 05^0 27"N and longitude 07^0 02"E at an elevation of 55 meters above sea level. Owerri lies in the tropical rainforest region of south eastern Nigeria and has a minimum and maximum annual temperature of 20^0C and 32^0C respectively, with mean annual rainfall of 2,500mm and relative humidity of 85 – 89% (Nwosu and Adeniyi, 1980). The Maize accessions were sourced from different locations of south eastern Nigeria. The screening experiment for tolerance level of the accessions was carried out from April 2014 and was arranged in a randomized complete block design in three replications. The genetic integrity of each accession was maintained by self-pollination.

Three seeds of each of the nineteen maize accessions were planted per hole at a plant spacing of 0.75m x 0.25m. After seed emergence, the seedlings were thinned down to one plant per stand given a theoretical plant population of 53,333 plants per hectare. A split application of basal fertilizer was done at two weeks after planting and during tasseling using NPK 15:15:15 at the rate of 400kg ha-1. The plots were weeded manually before each fertilizer application. Data on some growth, parameters and nematode population ratio were taken. The nematode populations were scored according to Agu and Ogbuji (1996) in which 0.00 – No infection (No gall present), 1.00 – 3.00 = Rare infection (gall present), 4.00 – 10.00 = light infection (gall present), 11.00 – 30.00 = moderate infection (gall present), 30 – above = Severe infection (gall present).

The data were subjected to analysis of variance using Gen Stat Release 10.3 De (pc/windows 7) 10 April, 2006. Difference between means were separated using Fisher's least significant difference (F – LSD) as described by Obi (2002). Four maize accessions, Nwaba white Nkalagu, Amiacha, Iduma, and Isiochi showed relative tolerant to nematode attack and were selected for diallel mating. The four inbred lines were used in designing a full diallel mating experiment in 2015 in which parents and reciprocals were involved along with the F1 generation resulting in 16 F1 hybrids.

Results and Discussion

Significant variation was observed in number of days to plant emergence, number of days to 50% tasseling, no of days to maturity, leaf area, and plant height (Table 1). The result in table 2 shows significant difference in the nematode counts of the maize accessions. Based on severity level of the nematode attack, accessions, Egbuonwa, Mkpanmkpa, Nwadalukpo, Amiacha, Iduma, Isiochi, and Uwaba white Nkalagu were found to be tolerant to the Root knot nematode (*Meliodogyne incognita*) with severity level of 0.00. Oka Akiti and Oka Awka show rare level of severity (1.00 – 3.00), while Agba-White, Oka-Bende, Oka-Igala were light in severity. The rest of the maize accessions recorded moderate level.

Correlation coefficient among the traits is presented in table 3. The result shows high significant positive correlation between nematode counts and number of days to 50% tasseling (r = 0.464**) and plant height at tasseling (r = 0.387**), but significant negative correlation with days to physiological maturity (r = 0.296*) which indicates that taller plants have more nematodes than shorter plants but the nematodes count decreases as the plant matures, while plants that tasseled early recorded least

nematodes. High significant negative correlation were found between plant height and days to 50% emergence (r = - 0.286**) days to 50% silking (r = - 0.366**) and days to physiological maturity (r = - 0.730**) while positive correlation were found between days to physiological maturity and days to 50% emergence (r = 0.326*). Number of days to silking and tasseling were positively correlated (r = 0.688**).

The variability of most of the traits in the accessions could be attributed to their genetic makeup and higher adaptation to the prevailing environment. The differences in plant emergence and percentage emergence and could be as a result of the variability in the degree of viability or photosynthetic ability and nutrient absorption rate responses to the soil fertility components. Similar result was reported by Miti *et al*. (2010) who indicate that selection of better performance of maize varieties could be based on its inherent ability to tolerate the prevailing biotic factors within the period of growth and development. The result is also in line with Bleve – Zacheo *et al* (1998) who reported that penetration of susceptible and resistant plants varies depending on the host. He observed that in some cases, penetration by virulent nematodes into resistant reacts is lower than into susceptible roots

Table 4 shows the crosses performed to develop the 16 F1 maize hybrids from diallel mating of the four inbred lines with the best values of nematodes tolerant component. The F1 hybrids will subsequently be evaluated fear nematodes resistance.

Conclusion

The study was carried out in 2014 and 2015 in the process of developing nematode resistant maize varieties through diallel mating in Owerri, rain forest agro- ecology of Nigeria. Variability in degree of root knot nematode (*M incognita*) tolerance and growth of nineteen maize accessions were observed. Four maize accessions – Amiacha, Iduma, Isiochi and Nwaba white Nkalagu, exhibited the best values of the nematode tolerance component and were selected and used in full diallel mating to produced sixteen F1 hybrids. The developed F1 hybrids are recommended for subsequent evaluation for nematode resistance under nematode infested condition.

Table 1: Growth attributes of the Maize Accessions

Maize Accessions	Days to 50% Emergence	Days to 50% Tasseling	Days to 50% Silking	Days to Maturity	Stem Girth (Cm) At 8 WAP	Leaf Area (Cm^2) At 8 WAP	Plant Height (Cm) At 8 WAP
Savannah Maize (Sama)	3	68.00	73.33	86.00	6.57	258.0	148.8
Oka Asaba (Oas)	4	66.67	70.33	85.33	4.90	366.7	161.2
Obiola Taraba (Ata)	4	68.00	71.00	88.00	6.03	223.7	149.7
Agba White (Agi)	4	67.33	71.67	84.67	6.34	252.3	160.0
Oka Akiti (Oki)	3	65.33	70.33	84.67	4.87	289.0	165.3
Egbunonwa (Ego)	4	67.33	71.67	84.67	5.97	326.0	148.2
Mkpanmkpa (MKP)	4	55.33	72.23	85.00	5.30	244.0	144.1
Nwadalu Kpo (MDO)	4	68.00	72.67	86.00	6.83	223.0	141.6
Nwadala (ALA)	3	68.67	72.33	86.00	5.45	318.0	178.9
Oka Awaka (OWA)	3	66.33	71.00	85.33	5.67	258.0	139.8
Oka Bende (OBE)	3	67.33	72.67	88.00	1.97	162.7	152.2
Oka Emekuku (OMA)	4	69.00	72.00	88.33	5.76	319.0	160.7
Oka Igala (OGA)	4	65.33	71.33	88.00	6.07	261.0	161.3
Oka Ikpe (OKE)	4	68.67	70.33	87.33	4.23	307.0	155.8
Oka Ikpo (OIP)	4	66.33	72.33	87.33	6.03	263.3	154.9
Amiacha	4	59.33	70.67	99.33	6.37	397.7	112.9
Iduma	5	58.33	71.67	97.00	5.79	360.0	100.3
Isiochi	4	54.67	64.33	101.33	6.07	320.0	122.4
Nwaba White Nkalagu	4	57.33	70.67	104.00	6.09	379.6	103.2
LSD(p=0.05)	**0.69**	**4.41**	**NS**	**7.03**	**NS**	**97.45**	**41.19**

NS = Not Significant at (p_<0.05)

Table 2: Nematode Counts and Severity Level of Nematode Attack on the Maize Accessions.

Maize Accession	Nematode Counts	Severity Level
Savannah Maize (Sama	8.25	Light
Oka Asaba (Oas)	11.50	Moderate
Abiola Taraba (Ata)	20.75	Moderate
Agba White (Agi)	9.75	Light
Oka Akiti (Oki)	0.53	Rare
Egbuonwa (Ego)	0.00	No infection
Mkpanmkpa (Mkp)	0.00	No infection
Mwadalu Kpo (Mdo)	0.00	No infection
Nwadala (Ala)	11.03	Moderate
Oka Awka (Owa)	2.25	Rare
Oka Bende (Obe)	5.00	Light
Oka Emekuku (Ome)	16.25	Moderate
Oka Igala (Oga)	9.00	Light
Oka Ike (Oke)	12.50	Moderate
Oka Ikpo (Oip)	23.25	Moderate
Amiacha	0.00	No infection
Iduma	0.00	No infection
Isiochi	0.00	No infection
Nwaba White Nkalagu	0.00	No infection
LSD (P = 0.05)	**1.11**	

Table 3: Correlation Coefficient among the growth Traits and Nematode counts of the Maize Accessions

	D-50% Emergence	Leaf of area at 8 WAP	D-50% tasseling	D-50% Silking	Days to maturity	Stem girth 8 WAP	Plant height at tasseling	Nematode counts
D-50% Emergence	-	0.355**	-0.409**	-0.168	0.326*	0.167	-0.286*	-0.006
Leaf area at 8 WAP	-	-	-0.649**	0.600**	0.23	0.241	0.063	-0.188
D-50% tasseling	-	-	-	0.688**	-0.540**	-0.197	0.260	0.464**
D-50% Silking	-	-	-	-	0.04	-0.218	-0.366**	0.120
Days to maturity	-	-	-	-	-	0.035	-0.730**	-0.296*
Stem girth 8 WAP	-	-	-	-	-	-	0.065	-0.0055
Plant height at tasseling	-	-	-	-	-	-	-	0.387**
Nematode counts	-	-	-	-	-	-	-	-

**Correlation is significant at the 0.01 level (2-tailed)

*correlation is significant at the 0.05 level (2-tailed)

Table 4: Developed F1 Maize Hybrids from Diallel Mating

Accessions	Crosses	Reciprocal	Selfing
Nwaba white nkalagu	Nwaba white Nkalagu x Amiacha	Amiacha x Nwaba White Nkalagu	Nwaba White Nkalagu x Nwaba White Nkalagu
Amiacha	Nwaba white Nkalagu x Iduma	Iduma x Nwaba White Nkalagu	Amiacha X Amiacha
Iduma	Nwaba white Nkalagu x Isiochi	Isiochi x Nwaba White Nkalagu	Iduma X Iduma
Isiochi	Amiacha x Iduma	Iduma x Amiacha	Isiochi X Isiochi
	Amiacha x Isiochi	Isiochi x Amiacha	
	Iduma x Isiochi	Isiochi x Iduma	

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