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Genotype x Concentration x Mycorrhiza Interactions on Early Maturing Maize under *Striga lutea* in Nigeria.

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Introduction

Maize (*Zea mays* L.), a genus of the family *Graminae* (Poaceae) is currently one of the most important cereal crops cultivated world-wide for over 5000years. It is tall, monoecious annual grass with overlapping sheath, and broad conspicuous distichous blades of distinct growth characterized by lower leaves with broad flags of about 50-100cm long and 5-10cm wide. The stems are erect with many nodes casting off flag-leaves at every node (Muler, 1974; Obi, 1991). The ear of 10-25cm in length contains 200-400 kernels which are of various colours; brackish, bluish-grey, purple, green, red, white and yellow (Edmeades *et al*., 1992). It is a major source of food to man and animals. Industrially, it is a major source of starch in production of corn syrups, herbal supplements, alcohol, beer, bio-fuel, plastics, fabrics and adhesives (Olakojo, 2004; Olawuyi *et al*., 2010). The yield losses in maize production in tropical Africa including Nigeria are threatened by a number of unfavourable biotic agents of which *Striga lutea* is included (Olakojo and Olaoye, 2003; Sata *et al*., 2003). *Striga spp* (witch weed) belong to the family Scrophulariaceae, and attach themselves to the roots of their hosts for survival using a specialized organ called haustorium, to obtain water, nutrients and assimilate from the host (Berner *et al*., 1997; Estabrook and Yoder, 1998).
Arbuscular mycorrhizal fungi (AMF) are integral component of any soil system that forms symbiotic association between a fungus and the roots of vascular plant. They facilitate the uptake of soil mineral nutrients by plants and in exchange obtain carbohydrate (Osonubi *et al*., 1991; Smith and Read, 1997; Sieverding, 1991). They also interact positively with plants in enhancing growth, yield and protection against biotic and abiotic stresses (Osonubi, 1994; Odebode *et al*., 1998; Salami *et al*., 2005; Olawuyi *et al*., 2013). The activities of biotic factors depend on genetic constitution of the cultivars and stages of growth at the time of infections. The problems of soil conservation and crop improvement practices are also constraints to maize breeding. Therefore, the early and maturing traits could be improved with AMF. Therefore, this study aimed at investigating the interactive effect of quality protein maize genotype, concentration and AMF on early maturing traits and yield components under *S. lutea* infestation.

Materials and Methods

The AMF species (*Glomus mosseae*, *G. clarum*, *G. deserticola* and *Gigaspora gigantea*) and maize genotypes (ILEI-OB, ART-98-SW4-OB, ART-98-SW5-OB and ART-98-SW6-OB) were obtained from the department of Botany, University of Ibadan and germplasm of

the Institute of Agricultural Research and Training (IAR&T) Ibadan, Nigeria respectively. The AMF is a mixture of soil and root fragments, while the viable *S. lutea* seeds were extracted and prepared according to Berner *et al*. (1997).
The field trials sited at Temidire (longitude 3^0 21'E and latitude 7^0 25'N) and Farm settlement (longitude 3^0 23'E and latitude 7^0 32'N), were striga endemic zones of Eruwa in Southwestern Nigeria. The factorial arrangement was 4x4x3 in randomized complete block design with three replications. The treatment consisted of 12.5g, 25g and 50g concentrations of AMF inoculated at the depth of 2cm from the soil surface, while the untreated plants served as control. 10.4g of striga seeds were artificially infested two weeks before planting to allow pre-conditioning, while uninfested served as control. Two maize seeds were sown, but thinned to one per stand after two weeks. Planting was done on four-row plots of 3m x 5m at spacing of 75 x 50cm. All agronomic practices were duly carried out. Data recorded on early maturing and yield related traits of maize were analyzed with analysis of variance (ANOVA) using General Linear Model, while means were separated at 5% level of probability.

Results and Discussions

The effects of the genotypes, AMF were highly significant ($p<0.01$) for all the early and maturing characters, but non-significant for number of days from sowing to 50% silking (DSK) in Temidire and Farm settlement (Tables 1 and 2). At the concentration level, number of days from sowing to emergence (DSE), number of days from sowing to primary leaflets (DSP), number of days from sowing to production of secondary leaflets (DSS) and DSK were highly significant, while the significant ($p<0.05$) effects were shown for number of days from sowing to tertiary leaflets (DST) and number of days from sowing to tasselling (DT) in Temidire (Table1). Again, the concentration effect in farm settlement was highly significant on DSE and DSS, but also significant on DST and DT, while DSP and DSK were not significant (Table 2). The interaction of AMF concentration and AMF type (AxB) produced highly significant effect on the early and maturing traits in both locations except DSK which was not significant in farm settlement. A significant interaction was observed for AMF concentration and genotype (AxD) on the early and maturing traits in Temidire, while the effect was also significant on DSS and DST in farm settlement. The interaction of AMF type and genotype (BxD) similarly produced significant effect on the early and maturing traits in Temidire compared to farm settlement which was not significant for DSE and DSK (Tables1 and 2). Of all traits, only DSE in Temidire did not show positive effect to the second order interaction of (AxBxD) in table 1, while DSS, DST and DT significantly responded positively in farm settlement (Table 2). The interaction of concentration x mycorrhiza x genotype (AxBxD) was highly significant ($p<0.01$) for plant height at 8 weeks after planting (WAP), 10WAP and yield related traits in both locations except for husk cover (Table 3). The influence of genotypic, concentration and AMF which were highly significant ($p<0.01$) for all the early and maturing characters is an indication of variation which contributed to their performances. The highly significant performance of growth, agronomic and yield related traits under striga infestation in the two locations could be attributed to the positive response of maize to the effects of the genotypes, AMF concentration, AMF types and their interactions as similarly observed by Olakojo *et al*. (2001) and Olawuyi *et al*. (2011). The first order interactions of (concentration x genotype) and (concentration x AMF) which were highly significant for all the early and maturing characters in Temidire suggests the significance of considering the adoption of sowing dates related traits and use of varied concentrations of mycorrhizal fungi in breeding for tolerant genotypes in such endemic location.

Conclusion

The effects of first and second order interactions were of significant importance to maize productivity in striga endemic areas. However, selection of early maturing traits and concentration of bio-inoculants should be considered in breeding for *S. lutea* tolerant genotypes in improvement of maize production.

Table 1: Interactions of Genotype x concentration on early growth and maturing characters in maize as influenced by mycorrhiza fungi under striga infestation in Temidire.

Source of variation	df	DSE	DSP	DSS	DST	DT	DSK
Replication	2	22.64	75.06	76.80	93.95	10.94	9.02
Concentration (A)	2	5.04**	13.41**	35.07**	7.41*	33.15*	22.02**
Mycorrhiza (B)	3	76.89**	76.79**	43.43**	107.92**	459.28**	334.13**
Maize Genotype (D)	3	67.92**	182.91**	230.40**	281.86**	696.37**	1271.46**
A x D	6	0.75*	0.85*	1.92**	1.85*	19.64*	8.24**
A x B	6	3.44**	23.20**	7.24**	4.06**	53.88**	12.34**
B x D	9	0.80*	0.69*	2.32**	2.58**	120.88**	49.28**
A x B x D	18	0.27^{ns}	1.10*	1.81**	3.11**	18.32**	9.49**
Standard Error	111	0.22	0.32	0.00	0.44	5.00	1.39
Total	160						

Table 2: Mean squares for early growth and maturing characters in maize under mycorrhizal and striga infestation in farm settlement

Source of variation	df	DSE	DSP	DSS	DST	DT	DSK
Replicate	2	18.82	41.11	44.38	55.52	40.26	34.71
Concentration (A)	2	19.68**	0.84^{ns}	6.99**	3.06*	23.16*	675.13^{ns}
Mycorrhiza (B)	3	25.25**	35.61**	20.25**	16.73**	79.74**	690.05^{ns}
Maize Genotype (D)	3	56.47**	123.33**	133.15**	166.56**	120.79**	104.13^{ns}
A x D	6	0.58^{ns}	0.29^{ns}	0.67**	0.87*	1.70^{ns}	455.37^{ns}
A x B	6	1.57**	4.89**	5.85**	4.81**	56.87**	585.81^{ns}
B x D	9	0.55^{ns}	2.04**	1.83**	1.14*	168.93**	670.53^{ns}
A x B x D	18	0.15^{ns}	0.42^{ns}	1.14**	0.94*	7.26*	432.73^{ns}
Standard Error	108	0.30	0.32	0.08	0.56	3.60	423.65
Total	157						

Table 3: Mean squares for growth, agronomic and yield related characters of maize under mycorrhizal fungi and striga interaction

Source of Variation	df	Plant height 8WAP	Plant height 10WAP	Number of leaves per plant	Husk cover	Plant aspect	Plant harvest	Ear aspect	Ear harvest	Grain yield	Field weight
Replicate	2	2250.56	4732.40	63.23	5.30	10.54	4.29	7.97	4.58	5.17	4558.68
Conc (A)	2	15680.28**	648.59**	8.46**	0.18^{ns}	0.38*	0.33*	3.70**	0.50*	6.17**	2309.55**
Mycorrhiza (B)	3	9211.25**	1641.08**	68.60**	8.28**	6.05**	5.21**	4.52**	5.64**	12.03**	18238.39**
Genotype {D}	3	6751.67**	14197.15**	189.68**	15.89**	31.62**	12.86**	23.89**	13.74**	15.50**	13676.63**
AxD	6	6345.28**	26.13**	1.93**	0.30*	0.54**	0.01^{ns}	0.62**	0.10^{ns}	0.06**	15.81**
AxB	6	10383.39**	196.24**	2.28**	0.63**	0.32**	0.65**	0.52**	1.14**	1.78**	147.35**
BxD	9	5968.84**	100.39 **	2.41**	0.87**	0.95**	0.43**	0.77**	0.46**	0.23**	46.16**

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