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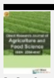

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Yield of Maize (*Zea mays*) Under Different Species of Mycorrhiza *(Arbuscular mycorrhizal)* Fungi Inoculation

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ABSTRACT

A trial on the effect of different species Arbuscular Mycorrhizal Fungi on the yield of Maize (Zea mays) was evaluated at the Teaching and Research Farm of Imo state University Owerri Imo State in the 2023 cropping season. The experimental design used was the randomized complete block design (RCBD) with six (6) treatments: Glomus intaradices, Glomus mossae, Acaulospora scrobiculata, Glomus etunicatum, Rhizophagus irregularis and Control (No specie), each replicated three (3) times. Pre planting physico-chemical properties of the soils were determined to know the soil status before planting and inoculation was done just before planting. Data collected includes the number of pods per plant, number of seeds per pod, 100-Seed Weight and grain yield. The result indicated significant differences (p≤0.05) among the treatments on all the parameters measured. Plots inoculated with the Mycorrhizal species all performed more than the control. The best yield performance of 5.12 tons/ha was recorded from the plots inoculated with Rhizophagus irregularis followed by Glomus etunicatum (4.96ton/ha) and Acualospora scrobiculata (4.68ton/ha). Among the 5 species of Mycorrhiza fungi used in the study, Rhizophagus irregularis, Glomus etunicatum and Acualospora scrobiculata are recommended for the growing maize in the study area.

Keywords: *Mycorrhizal species, Inoculation, Maize yield*

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INTRODUCTION

The use of inorganic or chemical fertilizers has become popular practice in crop production because it causes rapid increased in the crop yield, but its persistent use destroys soil reaction and impedes the activities of soil micro-organisms, by making the soil acidic and toxic in the long run (Chibuike, 2013). Recent advancement in the field of agronomy shows that the use of biofertilizers are creating some level of interest, this is because these fertilizers are environment friendly and have tremendously increased crop production(Gupta and Cummings, 2007). Biofertilizers are cultures of certain beneficial soil microbes that are added to the soil or seed to improve soil productivity. This they do by using microorganisms which establishes valuable symbiotic relationships with the plants (Preston-Mafham *et. al.* 2002). Biofertlizers has been an alternative to both organic and inorganic fertilizers (Preston-Mafham *et al.,* 2002). Mycorrhiza, also known as Arbuscular Mycorrhizal Fungi (AMF), is a type of biofertlizer, it forms a symbiotic association between a green plant and a fungus (Gupta and Cummings, 2007). In this symbiotic relationship, the plant produces and supplies organic molecules, such as sugars, through the process of photosynthesis to the fungus, and the fungus supplies to the plant water and mineral nutrients, such as phosphorus, taken from the soil (Chibuike, 2013). Maize (*Zea mays*) is usually grown domestically or commercially, whether for grain or silage, has a high demand for nutrients, especially nitrogen (N), phosphorus (P) and potassium (K) (Birch *et al.,* 2008). According to Steffen and Saldanha (2020), maize crops in symbiosis with mycorrhizae showed greater tolerance to heat stress and that the use of penergectic (an activator used in plants to enhance growth) in the maize crops enabled a significant increase in the mycorrhization percentage, and has proved to be efficient in improving the conditions of maintenance and productivity of plants under stress conditions. Huang *et al.* (2020) found that three months of AMF inoculations indicated that root mycorrhizal colonization achieved from 47.0% to 76.4% increased maize growth performance, dependent on AMF species. The symbiosis between arbuscular mycorrhizal fungi and plants has been studied for many decades. In the recent days a lot of species of mycorrhiza has been developed at the International Institute of Tropical Agriculture (IITA), Ibadan Nigeria to enhance the yield of crops. Therefore, there is a great need to investigate the effect of different species of mycorrhiza on the yield of Maize in South Eastern Nigeria.

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farm of Imo State University Owerri, in Owerri North Local Government Area of Imo State. The area lies between latitude $5^0$18' N and $5^0$34'N and longitude $6^0$56' E and $7^0$15' E with altitude 91 above sea level. The environmental conditions are characterized by a mean maximum temperature of 32.1^{0}C with relative humidity ranging from 70-85%, average annual rainfall of 2500mm (NIMET, 2008).

Land Preparation/Experimental Design/Treatments

The field was cleared, prepared manually into eighteen beds measuring 2m x 2m which represent the plot size. The treatments were arranged in a randomized complete block design (RCBD) with six (6) treatment which are the varieties replicated three (3) times, namely *Glomus intaradices, Glomus mossae, Acaulospora scrobiculata, Glomus etunicatum, Rhizophagus irregularis and* Control. The inoculum (mycorrhiza) species and maize Oba Supper 6 (Hybrid) maize seeds were obtained from the biotechnology unit of the International Institute of the Tropical Agriculture (IITA), Ibadan in Nigeria. The inoculation was done in the field just before planting using the Slurry method outlined by (Lamptey *et al.* (2014). Using Accolab electronic weighing balance, 50g of each the species of mycorrhiza fungi, added to the maize seeds in their respective bowls well labelled with the names of species. The inoculated seeds were put in a container covered with cloth to protect it from direct sunlight. Two seeds were planted per hole at a depth of 4 cm and planting distance of 50cm by 50cm. Weeding was done manually by hand using a hoe at 3 and 6 WAS.

Soil sampling

Soil samples were randomly collected from 0-20cm at different locations within experimental field using a soil auger, a composite soil sample was used to determine the initial soil properties of the field. The soil pH was measured in a 1:2.5 soil: 0.1 M KCl suspensions (Mclean, 1982).Organic carbon was determined using wet oxidation method of Walkley and Black (1934) as modified by Nelson and Sommers (1982). Total nitrogen was determined by semi-microkjedahl digestion method using sulphuric acid and $CuSO_4$ and Na_2SO_4 catalyst mixture (Bremner and Mulvaney, 1982). The quantity of available Phosphorus was gotten by the Bray II method (Bray and Kurtz, 1945). Cation Exchange was determined by titration with standard 0.1N NaOH solution, (Thomas, 1982). Exchangeable Base sodium (Na) and potassium (K) were determined from ammonium acetate leachate using auto electric flame photometer. Calcium (Ca) and magnesium (Mg) was determined using the complex titration method, while Exchange Acidity (EA) was determined by titration method using 1.0 NaCl extract (Mclean, 1982).

Data collection on plant parameters

Number of pods per plant, number of seeds per pod, 100-seed weight and grain yield were determined at harvest.

Data analysis

Data collected were analyzed using analysis of variance (ANOVA) and significant treatment means were separated using least significant difference. (F-LSD) and all inference made at 5% level of probability levels according to Obi (2002).

RESULTS AND DISCUSSION

Soil properties

Pre-planting physico-chemical properties of the soil

The pH measured in water was 5.2 and the value of 10.60 cmol/kg was recorded for cation exchange capacity (Table 1). The analysis also indicated that the exchangeable sodium, potassium, calcium and magnesium were; 0.11 cmol/kg, 0.17 cmol/kg, 3.37 cmol/kg and 2.40 cmol/kg, respectively. In addition, the exchangeable acidity and available phosphorous in the studied soil had values as 1.10 cmol/kg and 4.31 mg/kg, respectively (Table 1). The soils were sandy loam with 12% clay, 20% silt and 68% sand contents. The bulk density was 1.39 mg/m^3, soil porosity 47.57%, saturated hydraulic conductivity 0.36 cm/h and particle size 2.56 mg/m^3. Soil organic carbon concentration recorded 6.47 g/kg, whereas the total soil nitrogen was 1.35 g/kg.

RESULTS

Effect of AMF on the yield parameters

The number of cob per plant differed significantly ($P<0.05$)

Table 1: Initial physical and chemical properties of the studied soil (0-20cm) depth.

Soil properties	Value
Clay (%)	12
Silt (%)	20
Sand (%)	68
Textural class	Sandy loam
Bulk density (mg/m^3)	1.39
Porosity (%)	47.57
Saturated hydraulic conductivity (cm/h**)**	0.36
Particle size (mg/m^3)	2.56
pH (H_2O)	5.2
Organic Carbon	6.47
Total nitrogen (gkg^{-1})	1.35
Exchangeable bases	0.11
Sodium (Na^+) (cmol/kg)	0.17
Potassium (K^+) (cmol/kg)	3.37
Calcium (Ca^{2+}) (cmol/kg)	2.40
Magnesium (Mg^{2+}) (cmol/kg)	10.10
Cation exchange capacity (%)	14.6
Exchangeable acidity (cmol/kg)	1.10
Available phosphorous (mg/kg)	4.31

Table 2: Effect of AMF on the yield parameters.

Treatment	Cob number per plant (plant^{-1})	Cob weight per plant (g)	Fresh grain weight/cob (g)	Grain number per cob	100-grain weight (g)	Grain yield per hectare (ton/ha)
Glomus intaradices	2	46.28	132.83	319.46	29.24	4.34
Glomus mossae	2	47.91	135.58	324.65	31.11	4.35
Acaulospora scrobiculata,	2	48.51	144.75	336.46	31.47	4.68
Glomus etunicatum	2	48.97	139.58	351.38	30.54	4.96
Rhizophagus irregularis	4	53.20	154.60	363.38	31.77	5.12
Control	1	41.50	119.30	310.11	27.20	2.30
LSD	0.42	1.25	8.56	11.23	NS	0.61

among the treatments and ranged from 1cobs/plant to 4cobs/plant as obtained in control and *Rhizophagus irregularis* respectively (Table 2). The fresh cob weight/plant of maize was also significantly ($p \leq 0.05$) affected by AMF treatment. Again, *Rhizophagus irregularis* produced the highest value (53.20g/plant), differing significantly ($p \leq 0.05$) from the control (41.50g/plant), but showing statistical similarities ($p \geq 0.05$) with the rest of the treatment means as shown in (Table 2). The result gotten on the number of grains and weight per cob *Rhizophagus irregularis* also gave the highest significant ($p \leq 0.05$) values while control (no innoculation) gave the least values. The trend was different on the 100-grain weight as data shows AMF had no significant differences among treatments. The grain yield per hectare differed due to treatments, *Rhizophagus irregularis* recorded a value (5.12ton/ha) significantly higher ($p \leq 0.05$) the weights of 4.35ton/ha, 4.34ton/ha and 3.30ton/ha obtained from *Glomus mossae*, *Glomus intaradices* and the control respectively, but statistically similar ($p \geq 0.05$) to 4.96ton/ha and 4.68ton/ha recorded from *Glomus etunicatum* and *Acualospora scrobiculata* respectively.

DISCUSSION

The higher values of yield and yield parameters recorded from inoculated plots over non-inoculated ones could be due to the symbiotic effect of AMF applied. When they are applied to seed, plant surfaces or soil, they colonize the rhizosphere or the interior of the plant and promote growth by increasing the supply or availability of primary nutrients to the host plant (Vassey *et. al.* 2017). Preston-Mafham *et al.* (2012) had also stated that mycorrhiza can be regarded as alternative to chemical fertilizers as they help to increase soil fertility in sustainable farming. Meanwhile, the outcome of the present study agrees with Matsuoka *et al.* (2002) who reported that AMF increased rice plant biomass and grain yield. Hassan *et al*. (2015) got similar conforming results in which mycorrhiza improved plant growth and increased yield per hectare of a large number of crops and vegetables. However, in contrast, Nagy *et al.* (2005) reported that AMP had no significant effect 100 seed weight of maize in addition to other growth parameters, but also gave a conforming report that number of grains per ear was significantly affected by AMF treatment, just as Oliveira *et. al.* (2016) observed an increase in pod number of maize as affected by AMF treatment. The result of the present study is also in conformity with Dorivar *et al.* (2009) and Kazemi *et al.* (2005) as all reported that inoculation of soybean by Rhizobial gave similar results.

Conclusion

Arbuscular Mycorrhizal Fungi (AMF) play a pivotal role in sustainable agriculture by forming a symbiotic relationship with plant roots, thereby enhancing nutrient uptake and promoting plant growth. As natural biofertilizers, AMF offer both direct and indirect benefits, including improved environmental stress tolerance, which is crucial for maintaining agricultural productivity in challenging conditions. The integration of AMF into agricultural practices represents a promising strategy for achieving long-term sustainability and resilience in crop production systems.

Recommendation

Among the 5 species of Mycorrhiza fungi used in the study, either *Rhizophagus irregularis, Glomus etunicatum* and *Acualospora scrobiculata* are recommended for the growing maize in the study area.

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