**Mycorrhizal Colonization Rate of Some Crops Grown in Kano, Nigeria**

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**ABSTRACT**

**This research looked into the fungal richness of some crops grown in Kano, with objectives that included colonization level of the fungi and soil parameters. All data were analyzed using descriptive and inferential statistics using SPSS software. All the crops show significant levels of colonization with Groundnut having the highest colonization (37%) at the pre-flowering stage and the least colonization was observed at the flowering stage of Millet (12.6%) followed by the flowering stage of Groundnut (21.2%). Soil physicochemical properties were more favourable for Cowpea and foliar concentration higher for Groundnut plant. The correlation between root length colonization percentage and soil parameters was calculated by Spearman’s rank correlation coefficient r, and correlation was moderate with temperature and pH (-0.396 and 0.301 respectively), and low with other parameters.**

**Keywords: Fungi, Root length, Soil parameter**

**INTRODUCTION**

Within the last 20 to 30 years, there has been a growing awareness that most vascular plants could not grow and reproduce successfully without the assistance provided by networks of fungi in the soil. This association between plant and fungus is called mycorrhiza (plural: mycorrhizae). In most instances, the relationship is mutualistic or symbiotic (Okon and Solomon 2014). The plant provides sugars and carbohydrates to the fungus and in return the fungus uses its branched, thread-like hyphae (mycelium) to gather water, minerals, and nutrients for the plant (Okon and Solomon 2014). Mycorrhizal fungi greatly expand the reach of the plant’s root systems and are especially important in helping them gather non-mobile nutrients such as phosphorus. These fungi have also been found to serve a protective role for their associated plants; they can reduce plant uptake of heavy metals and salts that may be present in the soil (Lee *et al*. 2006). Many also help protect plants from certain diseases and insects (Lee *et al*. 2006). Scientists believe that it was mycorrhizal fungi that allowed ancient vascular plants to populate the land. Of the current plant families, 95% include species that either associate beneficially with or are absolutely dependent on mycorrhizal fungi for their survival (Scharnagl 2013). A number of different types of mycorrhizas exist in nature and can be identified by the hyphal structures they form. Arbuscular mycorrhizas (AM), sometimes referred to as endomycorrhizas, are formed predominantly by the fungi of the Glomeromycota (Hailemariam and Asfaw 2013).

Groundnut, Cowpea, Millet, and Sorghum, are all agricultural crops commonly grown in Kano. Although the region has produced much of these crops to the satisfaction of its human inhabitants for a long time, there is limited information on their mycorrhizal status. The aim of this work was to compare root length colonization across the crops and sites, and to test and compare soil physicochemical properties; namely; temperature, moisture content, pH, nitrogen, phosphorus, potassium and organic carbon.

**MATERIALS AND METHODS**

### Study area

Crop farm were cultivated at Bayero University Kano (BUK) Old and New Campuses located in Gwale and Ungogo Local Government Areas, respectively. Old campus was designated Site A, while New Campus was designated Site B.

**RESULTS AND DISCUSSION**

**Root length colonization**

The root length colonization is an important factor in ascertaining the richness of the soil for the growth of plants. The two sites considered in this study tend to show distinctive variability in the colonization levels of the crops. Table 1 showed the difference in colonization across the growth stages and across sites. For groundnut in Bayero University Kano Old Site, highest colonization level occurred at the Budding Stage (41.3%) which was followed by Pre-flowering Stage with 37.5% and least colonized was the Flowering Stage (21.2%). For the BUK New Site, budding stage had the highest colonization level of 36.39%, and was followed by the Flowering Stage with 33.91% and 29.70% as the least colonized as observed for the pre-flowering Stage.

For Cowpea, BUK Old Site, highest colonization level was observed at Pre-flowering Stage of the crop with 41.7% which was followed by the Budding Stage (29.6%) and the least colonized was the Flowering Stage with 28.7%. For BUK New Site however, highest colonization level was seen at the Pre-flowering Stage with 36.7%, this was followed by the Budding Stage with 33.7% and the least colonized at 29.6% which happened to be the Flowering Stage.

For Millet, highest colonization for BUK Old Site occurred at the Pre-flowering Stage with 44.6%, followed by the Flowering Stage with 29.3% and the least colonized was the Budding Stage with 26.1%. However, for the BUK New Site, highest colonization occurred at the pre-flowering stage with 44.54%, followed by the budding stage 42.83% and 12.63% was the least colonized at the Flowering Stage.

Similarly, for Sorghum BUK Old Site, 45.6% for the Pre-flowering Stage was the highest colonized followed by the Flowering Stage with 29.9% and 24.5% for the Budding Stage was the least colonized for this site. For BUK New Site, 41% was the highest colonized for Pre-flowering Stage. This was followed by the Budding Stage with 36% and 23% was the least colonized for the Flowering Stage.

**Table 1.** Root length (50cm) colonization across plants and sites (Values in Parentheses are Percentages).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Plant | Site | Root Length Colonized (mm) | | |
| **Pre-flowering** | **Flowering** | **Budding** |
| Groundnut | A | 10.48±4.32d (37.5) | 5.92±4.49d (21.2) | 11.52±3.06c (41.3) |
| B | 11.0±3.55bc (29.7) | 12.56±2.66b (33.91) | 13.48±5.49c (36.39) |
| Cowpea | A | 18.00±1.26a (41.7) | 12.40±3.43b (28.7) | 12.76±4.49b (29.6) |
| B | 16.00±2.63b (36.7) | 12.92±4.02a (29.6) | 14.72±3.27a (33.7) |
| Millet | A | 16.04±2.54b (44.6) | 10.52±4.60c (29.3) | 9.40±3.63bc (26.1) |
| B | 8.32±3.92d (42.8) | 2.36±2.50d (12.6) | 8.00±4.49d (42.8) |
| Sorghum | A | 16.00±1.68b (45.6) | 10.48±5.02c (29.9) | 8.60±4.13d (24.5) |
| B | 13.88±4.25c (41) | 7.76±4.81bc (23) | 12.16±4.87b (36) |

**Key**: A= BUK Old Site, B= BUK New Site.   
Values are Mean ± SD. Means in the same column followed by different superscript letters are significantly different at *p* < 0.05 level of probability

The result of the study showed that all the plants grown on the two sites (A and B) had extensive colonization by Arbuscular mycorrhizal fungi at a time when plant growth was maximal and nutrient demand was high prior to flowering. However, it was observed that groundnut plant grown at site A and B had highest colonization by AMF at the budding phase of the plant growth. *Arachis hypogea* has thick roots with few branches which according to Baylis (1975) have greater dependence on mycorrhizal association. Isobe and Tsuboki (1998), have found higher AMF colonization in leguminous than in graminaceous crops. Thus as a legume, *A. hypogea* probably favoured mycorrhizal colonization to assist the symbioses with Rhizobium (Okon and Solomon 2014).

The AM fungal structure in the root system of the selected crops varied. Mycorrhizal structures were found in all parts of the roots. Some root parts recorded arbuscules, oval and spherical shaped vesicles were also found in this study, which was supported by Khanam *et al*. (2003, 2004).

The result of the present study showed that the pre-flowering growth phases of the selected plants had highest mycorrhizal abundance than the flowering and budding phase. This variation might be due to the differences in the structure of root system and Phosphorus uptake and also might be due to genetic variations. This result was consistent with previous findings that mycorrhizal plant community has high levels of colonization by AMF during the critical pre-flowering growth phase (Dodd *et al.* 2002; Ludwig-Müller 2010). In addition, Pringle and Bever (2008) asserted that legume plants tend to be more mycorrhizal than other plants especially during the pre-flowering stage of the plant after AM fungal inoculation. This is evident from the result of the present study where the pre-flowering phase of cowpea plants grown in site A (Table 1) had the highest mycorrhizal abundance of 18±1.26 (41.7%). Similarly, the differences in colonization and response to AMF-mediated enhancement between the leguminous (groundnut and cowpea) and cereal-grain (millet and sorghum) plants at this sites suggest that AMF may similarly promote diversity at the sites by altering the competitive balance between the more abundant legumes and cereal-grain plants.

### CONCLUSIONS

It is apparent that mycorrhizal fungi are essential components of both agricultural and native vegetation communities. Arbuscular mycorrhizal knowledge will significantly improve the survival environment of rhizosphere fungi in improving the quality of the soil and the growth of plants. The result finding concludes that there were significant associations between soil properties and root colonization. There was no conflict of interest from the findings of this research.

**REFERENCES**

Akamine H, Hossain MA, Ishimine Y, Yogi K, Hokama K, Iraha Y, and Aniya Y (2007). Eﬀects of application of N, P and K alone or in combination on growth, yield and curcumin content of turmeric (*Curcuma longa* l.). *Plant Production Science, 10*, 151–154.

Almagrabi OA, and Abdelmoneim TS (2012). Using of Arbuscular mycorrhizal fungi to reduce the deficiency effect of phosphorous fertilization on maize plants (Zea mays L.). *Life Science Journal* 9 (4):1648-1654.

Baylis GTS (1975). The magnoloid mycorrhiza and mycotrophy in root systems derived from it. In: Sanders, F. E., Mosse, B. and Tinker, P. B. (eds) Endomycorrhizas. Academic Press, London. 373-389.

Brundrett MC, Bougher N, Dell B, Grove T, and Malajczuk N (1996). Working with glomalean fungi. In: Working with Mycorrhizas in Forestry and Agriculture. ACIAR Press, Canberra, Australia.

Chowdhury AHMRH, Rahman GMM, Saha BK, and Chowdhury MAH (2008). Addition of some tree leaf litters in forest soil and their effect on the growth, yield and nutrient uptake by red amaranth. *Journal of Agroforestry and Environment, 2*, 1–6.

Dodd JC, Dougall TA, Clapp JP, and Jeffries P (2002). The role of arbuscular mycorrhizal fungi in plant community establishment at Samphire Hoe, Kent, UK – the reclamation platform created during the building of the Channel tunnel between France and the UK. *Biodiversity and Conservation,* 11: 39–58.

Donald IA, and Katherine PG (1999). Better crops with plant food. *Better Crops, 83*, 1–39.

Fageria NK, and Baligar VC (1997). Phosphorus Use Efficiency by Corn Genotypes. *Journal of Plant Nutrition*, 20, 1267–1277.

Hailemariam M, and Asfaw Z (2013). Arbuscular mycorrhizal association of indigenous agroforestry tree species and their infective potential with maize in the rift valley, Ethiopia. *Agroforestry System*; Volume 87, [Issue 6](https://link.springer.com/journal/10457/87/6/page/1), pp 1261–1272.

Hao X, and Papadopoulos AP (2004). Effects of calcium and magnesium on plant growth, biomass partitioning and fruit yield of winter greenhouse tomato. *Horticulture Science, 39*, 512–515.

Hossain MA, Akamine H, Nakamura I, and Tamaki M (2012). eﬀects of N, P and K on growth characteristics of redﬂower ragleaf (*Crassocephalum crepidioides*). *Science Bulletin of the Faculty of Agriculture, University of the Ryukyus, 59*, 13–18.

Hossain MA, Yamanishi M, Yara T, Chibana S, Akamine H, and Tamaki M (2011). Growth characteristics, yield and mineral content of redﬂower ragleaf (*Crassocephalum crepidioides* (Benth.) S. Moore) at diﬀerent growth stages, and in dark-red soil, red soil and gray soil in Okinawa. *Science Bulletin of the Faculty of Agriculture, University of the Ryukyus, 58*, 1–11.

Howeler RH, Sieverding E, and Saif S (1987). Practical aspects of mycorrhizal technology in some tropical crops and pastures. *Plant and Soil*, 100, 249-283.

Isobe K, and Tsuboki Y (1998). The relationship between growth promotion by arbuscular mycorrhizal fungi and root morphology and phosphorus absorption in gramineous and leguminous crops. *Japanese Journal of Crop Science*, 67, 347-352.

Khanam DARM, Solaiman M, Mridha AU, and Karim AJMS (2003). Arbuscular mycorrhizal fungi association with some agricultural crops grown in four agro-ecological zones of Bangladesh. *Bangladesh Journal of Soil Science*. 27-28: 1-12.

Khanam DARM, Solaiman M, and Mridha AU (2004). Biodiversity of arbuscular mycorrhizal fungi in agricultural crops grown under different agro ecological zones of Bangladesh. *Bulletin of Institution of Tropical Agriculture*, Kyushu University. 27: 25-33.

Lee J, Park S, and Eom A (2006). Molecular Identification of Arbuscular Mycorrhizal Fungal Spores Collected in Korea. *Mycobiology* 34(1): 7-13

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