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Evaluation of Glomusfacultative's Mitigating Effects on Tomato Growth and Fruit Yield in Alternariasolani Infected Soil

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ABSTRACT
Effect of different concentrations (0 g, 50 g and 70 g) of **Glomus facultative**on the growth and fruit yield of tomato grown on **Alternariasolani Infected Soil.** Soil sample and infected tomato plants were collected from A. solani infected field for pathogen enumeration and isolation. Seedlings of two varieties of tomato; UC-82B and Roma-VF were transplanted to the field at 75 cm × 45 cm three weeks after sowing in the nursery. Three levels (0 / control, 50 and 70 g) of soil containing G. facultative crude inoculum / spores concentrations were applied at transplanting respectively. Agronomical data were taken on growth parameters as well as disease incidence and severity of the plants at four, eight and twelve weeks after transplanting (WAT). Data collected were subjected to analysis of variance (ANOVA) and significant means were separated with Fisher's LSD ($P < 0.05$). Experimental results showed that fifty and seventy grams of G. facultative inoculum were found effective in the control of A. solani. However, seventy grams of G. facultative crude inoculum / spores was found to be the best in the control of A. solanicontributed to reduced disease incidence and severity at week eight, which gave rise to increased general plant growth and development and resulted to high yield of tomato fruit in both varieties (UC-82B and Roma-VF).
Keywords: Tomato, Glomus facultative, Alternariasolani.

I. INTRODUCTION

Tomato (Lycopersiconlycopersicum) is one of the most important fruit vegetable crops cultivated in the temperate and tropical regions of the world, consumed in various forms such as raw fruit, canned, paste e.t.c. (Aditi et al., 2011; Aremuet al., 2016). It was originated from Andean region of Colombia, Chile, Peru, and Bolivia (Peralta and Spooner, 2007). Tomatoes are members of the family Solanaceae (Linnaeus, 1753). The cultivated species are Solanumlycopersicum, and Solanumpimpinellifolium as the closest wild relative to domesticated ones with a divergence of only 0.6 percent nucleotide base pairs (Genome et al., 2012). Knowledge obtained from studies conducted on tomato can be easily applied which makes tomato important research material. Because of these facts, tomato serves as a model organism for the family Solanaceae and, specifically, for fleshy-fruited plants.

Despite management practices adopted by farmers, tomato is affected by numerous diseases among is Alternariasolanicauses early blight disease. It is a fungus disease that affects tomatoes. It is a damaging and widely dispersed pathogen that can be found in various areas of the plant in mild to severe forms (Kamble, 2006). Symptoms on affected plants started with yellowing and browning of the lower leaves, progressing upwards under high humidity conditions. Under severe infection, lesions enlarged and coalesced causing blighting of the leaves, followed by wilting and leaving the fruit exposed to sunburn which eventually caused serious damage and resulted in critical yield losses, quality, quantities and profit of tomato fruit (Akhtar et al., 2004).

On the other hands, plants and fungi coexisted in a symbiotic relationship known as 'mycorrhiza'. Millions of years ago, plants utilized sun energy to grow and fungi specialized in extracting nutrients from the soil (Karandashovet al., 2004). Mycorrhizae are highly evolved, mutualistic relationships between soil fungi and plant roots. The fungus offers nutrients (particularly phosphorus) to the host plant, while the plant nourishes the fungus with carbohydrates and lipids. Glomus facultative, one of the arbuscular mycorrhiza fungi (endomycorrhiza) species. It has a golden yellowish tint, indicating a symbiotic relationship between the plant's root and the soil fungus. It enhances the amount of nutrients available to plants by increasing the amount of soil that is accessible to them. The fungus colonizes a host plant's roots, either intracellularly or extracellularly, which is a crucial aspect of soil life. The fungus works as an extra root to the existing plant roots in this way.The mycelia of the mycorrhizal fungus access immobile phosphate ions, and other minerals and make them available to the plants they colonize in a basic pH medium (Salami and Osonubi, 2003). In exchange for photosynthetic products, they offer mineral fertilizers and water to the host plant (Smith and Read, 2008). The arbuscular mycorrhiza fungi mycelium that arises from the root system can get nutrients from soil volumes that roots can't reach (Smith et al., 2000). From the research, it was observed that arbuscular mycorrhiza (Glomus facultative) increases plant nutrient supply by acquiring nutrient forms that plants would not normally have access to (Salami et al., 2008).

II. MATERIALS AND METHODS

The research was conducted at Plant Pathology Laboratory, Mycology Unit, ObafemiAwolowo University, Ile Ife and on an infected soil at waasinmi Farm settlement Ikire. In this study, Effect of different concentrations of **Glomus facultative**on the growth and fruit yield of tomato grown on **Alternariasolani Infected Soil was evaluated.** Soil sample was collected randomly across the Alternariasolani infected field at the depth of 15cm;pathogen was enumerated through the method of serial dilution and identified. Suspected pathogen was isolated from an infected plant and identified.Quantification of fifty and seventy grams of mycorrhizal spores (Glomus facultative) inoculum was done in the pathology laboratory using the wet sieving and decanting method.Two varieties of tomato; UC-82B and Roma VF seedlings were transplanted to the field of 3 m × 1.8 m bed at 75 cm × 45 cm. Three concentrations (0 g, 50 g and 70 g) of Glomus facultative inoculum were applied at transplanting. The experiment was 2 × 3 randomized complete block design (RCBD) replicated three times given a total of eighteen plots. Prior to analysis of variance (ANOVA), count data were subjected to square-root transformation. All the data collected during the experiment were subjected to ANOVA using SAS 9.1 and means of significant treatments were separated using the Fisher’s LSD at 0.05 probability levels.

III. RESULTS AND DISCUSSION

At week 4, concentration of Glomus facultative (Gf) produced only significant ($P < 0.01$) effect on plant height as shown in the table (1). At this stage, the association of G. facultative with the plant roots have not been completely established to have significant effect on other growth parameters.

The significant effect of G. facultative was recorded on plant height for UC-82B and Roma VF varieties. Glomus facultative (50 and 70 g) inoculated had influence on plant height, however, the optimum inoculated plant which produced significant effect was found on 70 g. An increase in number of G. facultative spores aided the growth (plant height) of tomato plant grown on infected soil positively when compared with 50 g and control (0 g) figure (1). This is due to the availability of essential nutrients (Nitrogen, Phosphorus, and Potassium), which allowed chlorophyll in the leaf to trap light energy from solar radiation to provide energy for photosynthesis and roots to absorb mineral nutrients from the soil, transfer and transport them to other parts of the plants, as these nutrients (NPK) appear to be the major constraint for plant growth in natural ecosystems at the beginning (Salami et al., 2005).

Table 1: Mean squares from the analysis of variance for coefficient of variation and coefficient of determination of the Growth parameters of tomato plants as influenced by Glomus facultative (Gf)at week four after transplanting (4WAT).

Source of variation	Df	Plant height (cm)	Leaf area (m^2)	No of leaf	No of branch
Rep	2	106.19	368.17	463.57	2.22
Var	1	2.32	191.07	65.92	98.46
Gf	2	167.47*	761.49	140.75	154.11
Error	34	36.77	440.55	96.19	116.59
CV (%)		14.82	32.75	16.06	8.00
R^2 (%)		69	55	55	55

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Rep: Replicate, Var: Variety, Gf: Glomus facultative, DF: Degree of Freedom, CV: Coefficient of Variation, R^2: Coefficient of Determination.
*Significant difference at P level < 0.05, **Significant difference at P < 0.01

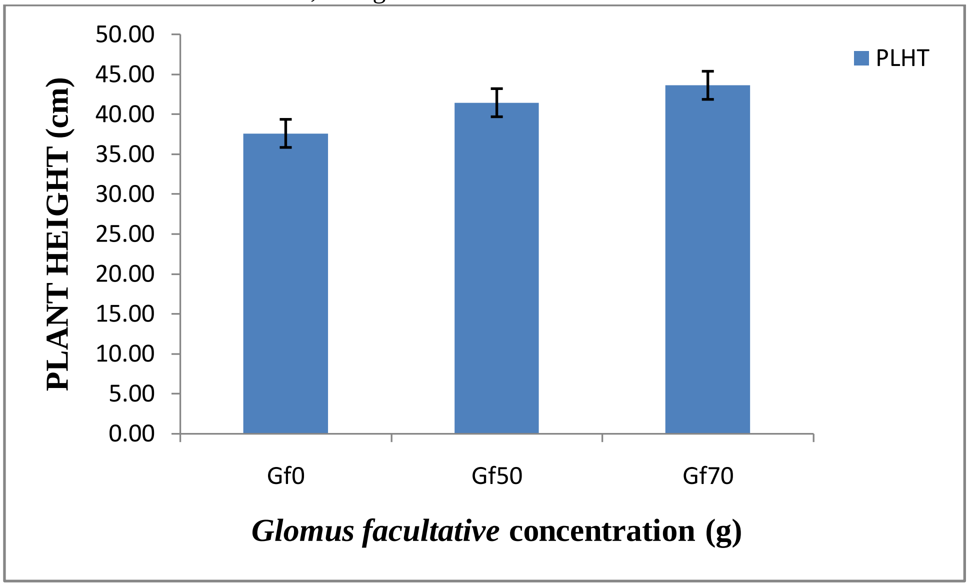

Figure 1: Effect of Glomus facultative concentration on Plant Height at Week 4.

Similarly at week 8, significant increases in growth indices were also effected by G. facultative (plant height, leaf area and number of leaves). The optimum concentration of G. facultative was found on 70 g (Figures 2, 3 and 4) which led to an increase in phosphorus intake in higher plant (Garcia-Garridoet al. 2009). The root hairs of the plant treated with G. facultative grew thicker and developed more rapidly, allowing the plant to absorb more water and mineral salts from the soil, bolstering all other defense mechanisms to withstand pathogenic attack.

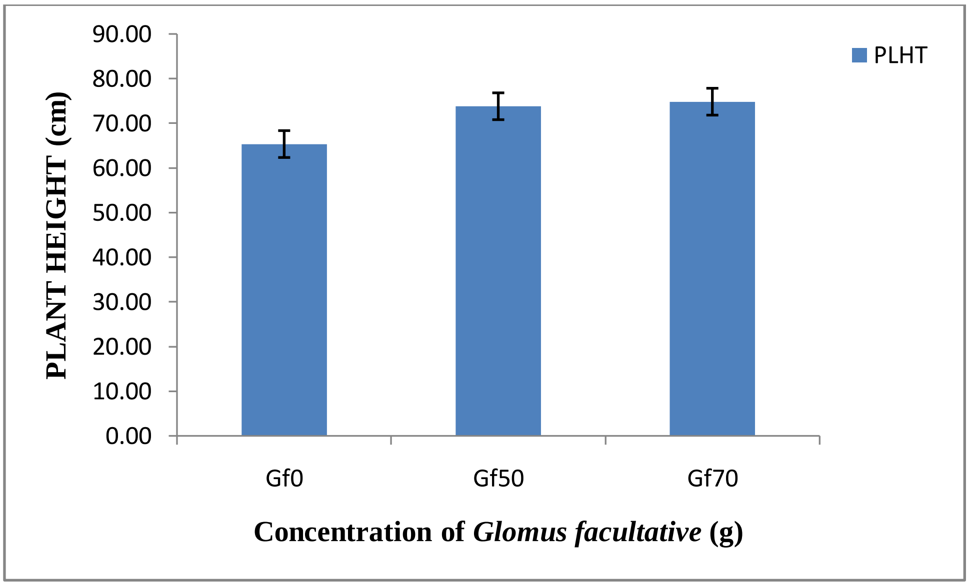

Figure 2: Effect of Glomus facultative concentration (g) on Plant Height (cm) at Week 8.

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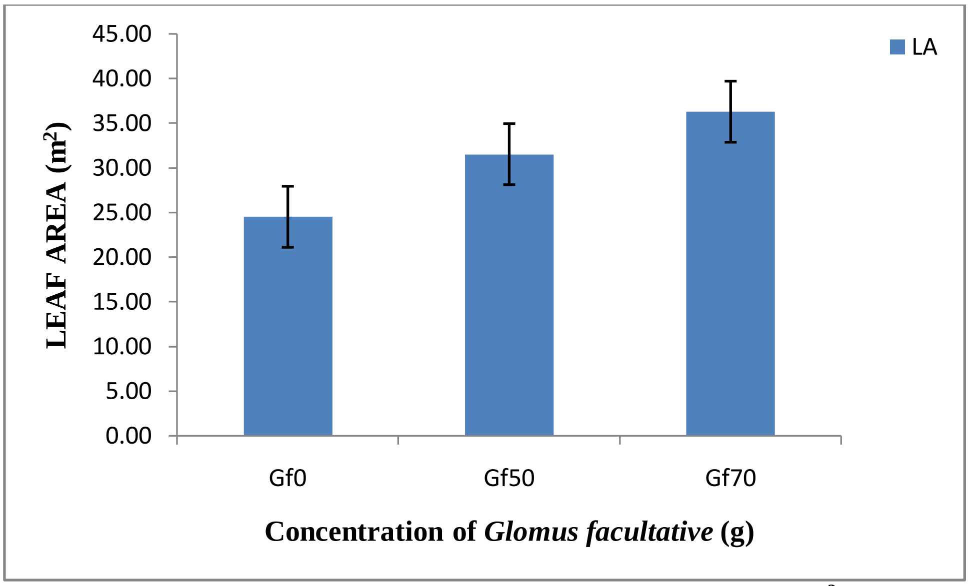

Figure 3: Effect of Glomus facultative concentration (g) on Leaf Area (m^2) at Week 8.

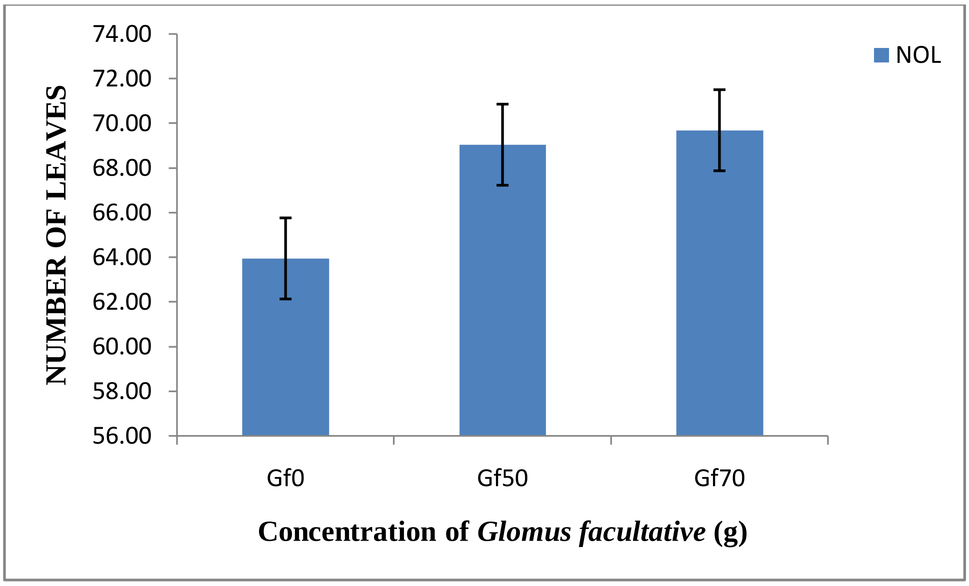

Figure 4: Effect of Glomus facultative concentration (g) on Number of Leaves at Week 8.

At week 12 after transplanting, the results revealed significant difference in crude G. facultative inoculated applied on fruit weight, fruit diameter and fruit yield for UC-82B and Roma VF varieties (Table 2). During this stage based on low coefficient of variation (CV) and high coefficient of determination (R^2) obtained from the analysis of variance (ANOVA) in the present study, the ANOVA precisely and sufficiently explained the significant effects of G. facultative alone on reduced disease incidence and severity resulted in increased fruit weight, diameter as well as fruit yield. The life activities of the pathogen (Alternariasolani) has altered which enables the plant to uptake both macro e.g. nitrogen, phosphorus, potassium, magnesium e.t.c. and trace nutrients e.g. Sulphur, manganese, iron, boron e.t.c. and water from the soil with the help of G. facultative mycelia, as well as to withstand spell period. The optimum concentration of G. facultative that led to reduced disease incidence and severity translated to increase yield on the aforementioned yield parameters was found on 70 g G. facultative. Mycorrhiza inoculation has a significant impact on yield and has the ability to increase root size and effective surface area, allowing for more efficient use of available nutrients and water (Salami and Osonubi, 2003). Arbuscular mycorrhizafungus improves plant growth and yield by enhancing photosynthesis through N and P acquisition (Salami et al., 2017).

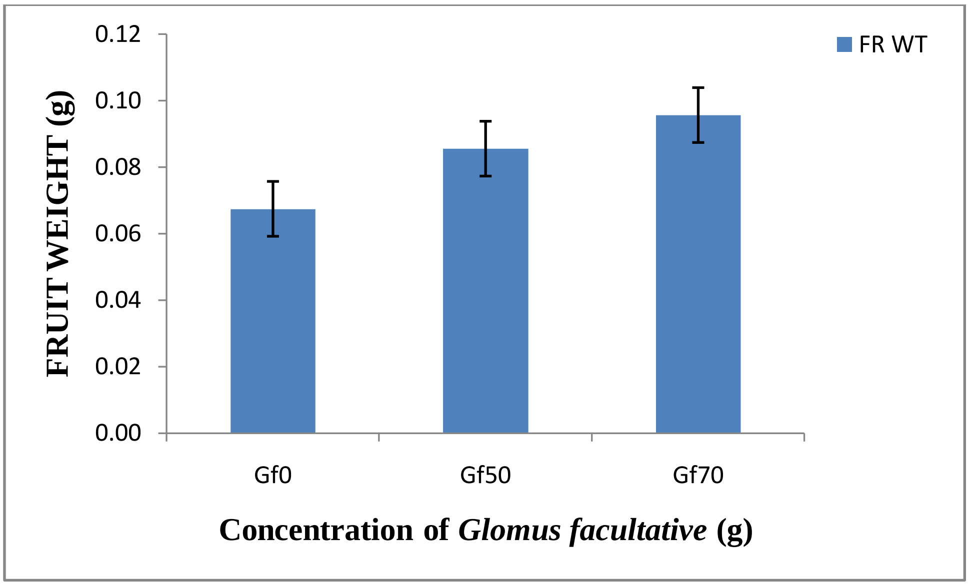

Figure 5: Effect of Glomus facultative concentration (g) on Fruit Weight at Week 12.

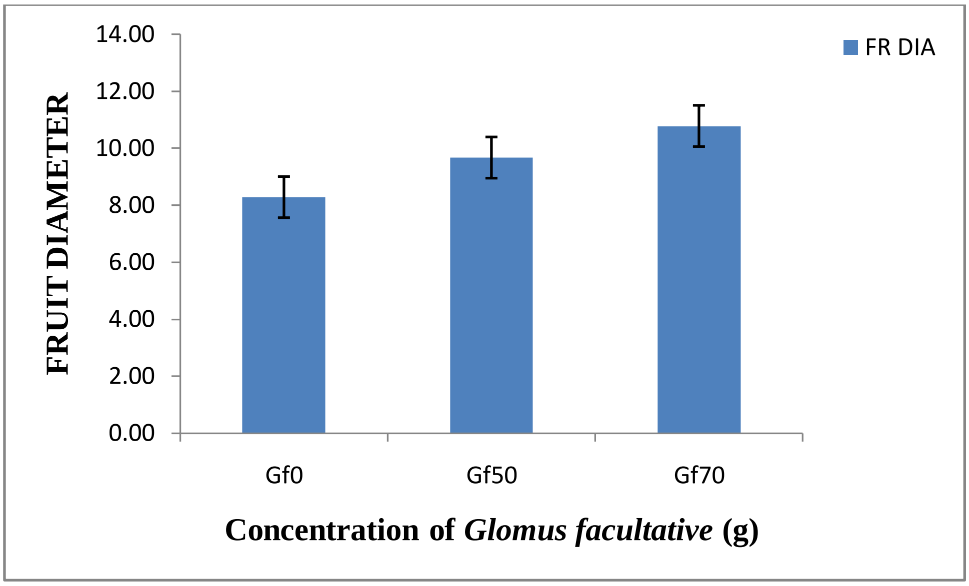

Figure 6: Effect of Glomus facultative concentration (g) on Fruit Diameter at Week 12.

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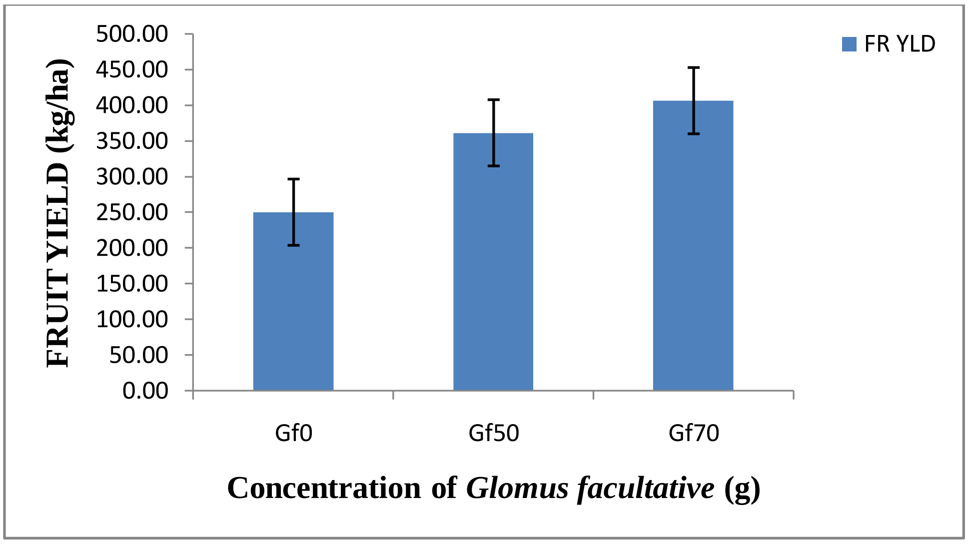

Figure 7: Effect of Glomus facultative concentration (g) on Fruit Yield (kg/ha) at Week 12.

Table 2: Mean squares from the Analysis of Variance for Coefficient of Variation and Coefficient of Determination of Fruit Yield parameters as influenced by Glomus facultative (Gf) at Week twelve (12WAT).

Source of variation	Df	FR/P	FRW/P	FR DIA	FRYLD
Rep	2	426.55	2.61×10^{-5}	9.24	473.08
Var	1	128.97	2.0×10^{-4}	0.91	3636.69
Gf	2	342.81	3.68×10^{-3}**	28.24**	66820.09**
Error	34	307.82	8.06×10^{-5}	0.61	1463.86
CV(%)		28.84	10.83	8.18	10.83
R^2(%)		44.84	76.04	80.54	76.04

Rep: Replicate, Var: Variety, Gf: Glomus facultative Degree of Freedom, FR / P; Fruit/Plant, FRW/P; Fruit Weight/ Plant, FR DIA; Fruit Diameter, FRYLD; Fruit Yield, CV: Coefficient of Variation, R^2: Coefficient of Determination.
*Significant difference at P level < 0.05, **Significant difference at P < 0.01.

IV. CONCLUSION

The approach used in this paper provides way out for the farmers in improving the growth and development of the tomato plant through the absorption of major nutrients (NPK) required by the plant and trace elements at initial stage as well as improving the yield of tomato fruit. Fifty and seventy grams of Glomus facultative inoculum applied provided support in absorbing nutrients although seventy gram of Glomus facultative applied produced high significant effect compared to fifty gram and control.

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