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The effect of mycorrhizal inoculation and composted brewery waste on growth of potted tomato [*Lycopersicon esculentum*] plant

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Introduction

Tomato (*Lycopersicon esculentum* Mill) plant originated from South America in the tropics and is now widely grown throughout the world. [Hill and Waller 1998]. Brewery waste generated from brewery plants in Nigeria consist mostly spent sorghum grains along with other products including spent yeast, chemicals for cleaning vessels and other machinery. These are usually discharged into nearby streams where they pollute the environment and affect aquatic habitats.

Mycorrhiza refers to an association between plant roots and soil borne fungi that colonize the cortical tissue of plant roots during period of active growth (Smith and Read 1997). Mycorrhiza inoculation has been shown by many workers to promote growth and development of plants including tomato (Osundina and Liasu 1996) in both clean and oil contaminated soils. (Liasu et al, 2005). The tonnage of brewery waste released is becoming significantly high enough to constitute environmental hazards. However no report has been given as regard spent grains from brewing industries been used as composted farm yard manure.

Materials and method:

Collection of materials: - Samples of sorghum spent grains were collected from the Nigeria Breweries factory located at Alakia along the Ibadan Ile-Ife expressway. inoculum of arbuscular mycorrhizal (AM) fungus i.e. *Glomus mosseae* (Trappe and Gerdman) were collected from the Environmental Biology unit of the Department of Pure and Applied Biology. LAUTECH. Ogbomoso, Nigeria.

Tomato seeds (Ibadan local variety) were collected from National Institute for Horticultural Research (NIHORT), Ibadan.

Tomato planting and soil treatments:- Six week old tomato seedlings were transplanted from the nursery into pots filled with garden soil and treated as follows:- waste supplemented soil with mycorrhiza – C⁺M⁺, waste supplemented soil without mycorrhiza – C⁺M⁻, unsupplemented soil with mycorrhiza – C⁻M⁺ and unsupplemented soil without mycorrhiza - C⁻M⁻. Mycorrhiza inoculums (20 grammes) were used to inoculate soils where applicable. The plants were watered regularly. Two sets of experiment were conducted using spent sorghum grains that had been allowed to compost for six and twelve weeks as soil supplement.

Screening of spent grains for metal content and for degrading micro-organisms:- The spent grain samples were screened for biodegrading microorganisms through culturing and sub-culturing of representative waste samples followed by isolation, characterization and identification of colony forming microbes and their mineral and heavy metal content by wet digestion and estimation of Na, K, and Ca, concentrations by flame photometry and Pb, Cd, Zn, Mg content by a Perkins Elmer model atomic absorption spectrophotometer (AAS) at different wavelength (nm) for each metal.

Data Collection and Presentation:- The effects of *Glomus mosseae* and brewery waste soil supplement on (i) Seedling establishment i.e. the number of surviving seedlings expressed as percentage of total number of transplanted seedlings were determined. (ii) Seedling growth parameters:- The height, width, number of nodes of the stem and number of leaves per plant of tomato seedlings were monitored at weekly intervals starting from the first week after transplantation and recorded graphically.

Results

Effect of AM inoculation and soil supplementation on seedling survival and growth

performance:- Soil supplementation with brewery waste after six weeks of composting was lethal to tomato seedlings with inoculation with *G. mosseae* only providing 20% survival (Figure 1). However seedling survival was 100% when composting was extended to 12 weeks. Also, inoculation with *Glomus mosseae* promoted growth of tomato seedlings particularly in soils supplemented with brewery waste irrespective of the period of composting figures 1,2,3,4 and 5).

Heavy metal composition of soil and brewery waste:- The concentrations of the metals Zn, Fe, Pb, and Cd present in both the soil and brewery waste samples were well below the safe levels prescribed by the Federal Environmental Protection Agency (FEPA) of Nigeria (table1).

Mineral nutrient composition of soil and brewery waste:- The mineral metal nutrient content of soil and brewery waste samples i.e. calcium Ca, magnesium Mg, potassium K, and sodium Na were comparable (Table 2).

Bacterial isolates from brewery waste:- The bacteria species isolated from the composted brewery waste samples were *Micrococcus acidophilus* and *Streptococcus faecium* (Table 3).

Discussion

The lethal effect of composted (six weeks) spent sorghum waste could be attributable to the fact that (i) that decomposition is still in progress and the heat of decomposition may have damaged the most of the absorptive surfaces. (ii) The organic component of the brewery waste, has some toxic organic pollutants that had not being fully detoxified i.e. completely biodegraded by the soils microbial community and probably not due to the presence of heavy metals. The better performance of the inoculated tomato seedlings in supplemented soils is due to the fact that AM fungi in the presence of organic matter not only promote growth but also speeded decomposition. with mycorrhiza and other soil micro-organism cooperating in degrading organic waste (Osundina and Liasu 1996, Garbaya 1994 Barea et al, 2005). The isolation of *Micrococcus acidophilus* and

Streptococcus faecium from the composting medium may implicate them as the probable microbial agent of decomposition.

Conclusion

Inoculation with *Glomus mosseae* promoted the establishment and growth of potted tomato seedlings in soils supplemented with composted brewery waste (i.e. spent sorghum grains) probably through enhanced decomposition and detoxification of the brewery waste supplement.

References

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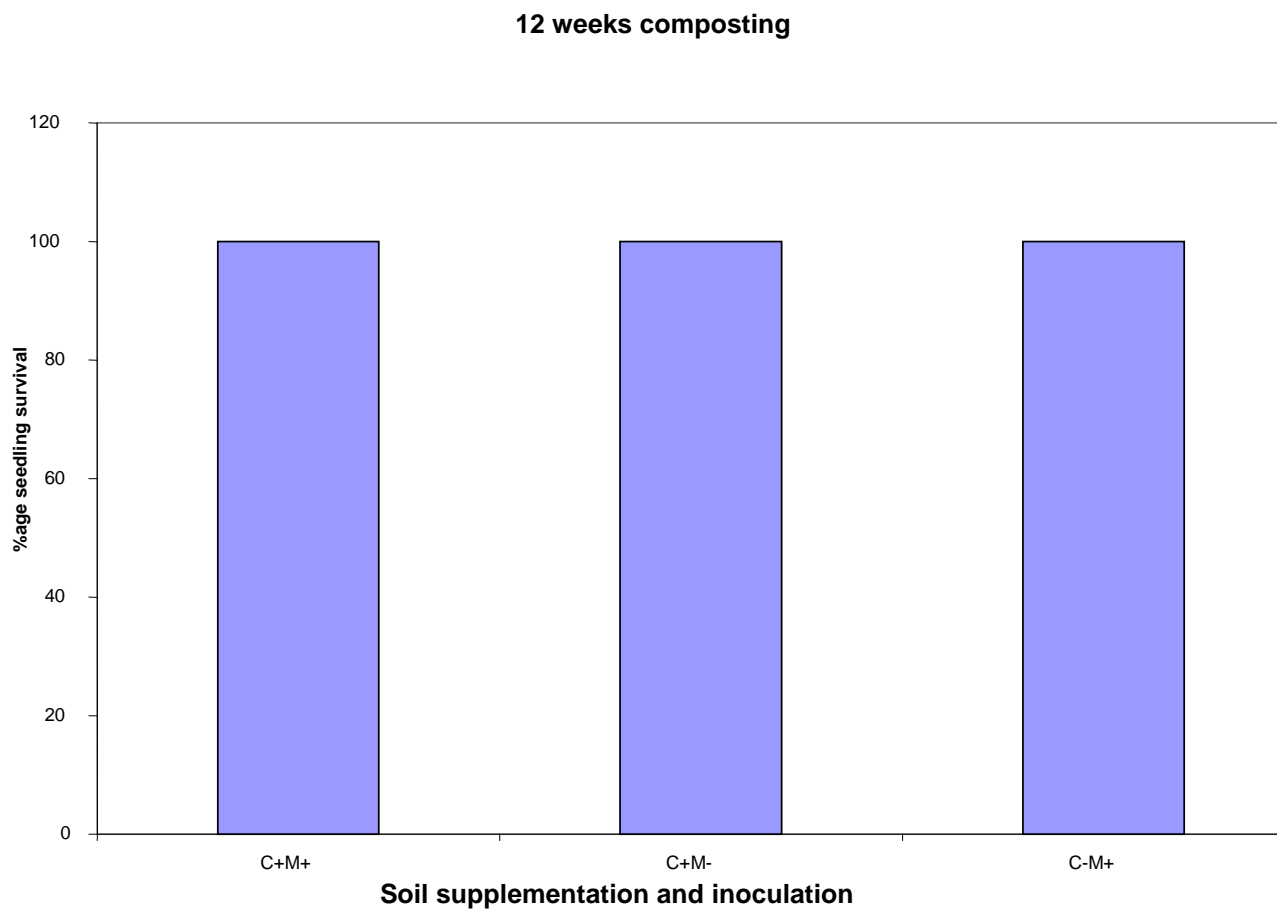
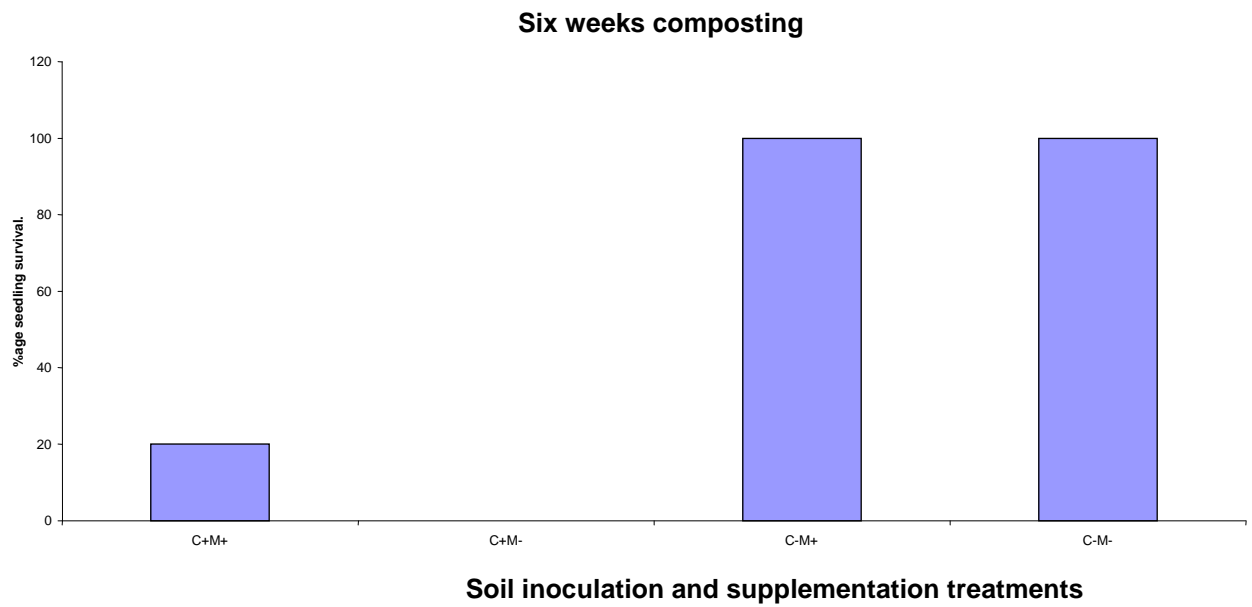


Figure 1:- Effect of inoculation with *G. mosseae* and soil supplementation with composted (6 and 12weeks composting) brewery waste on %age survival of transplanted tomato seedlings)

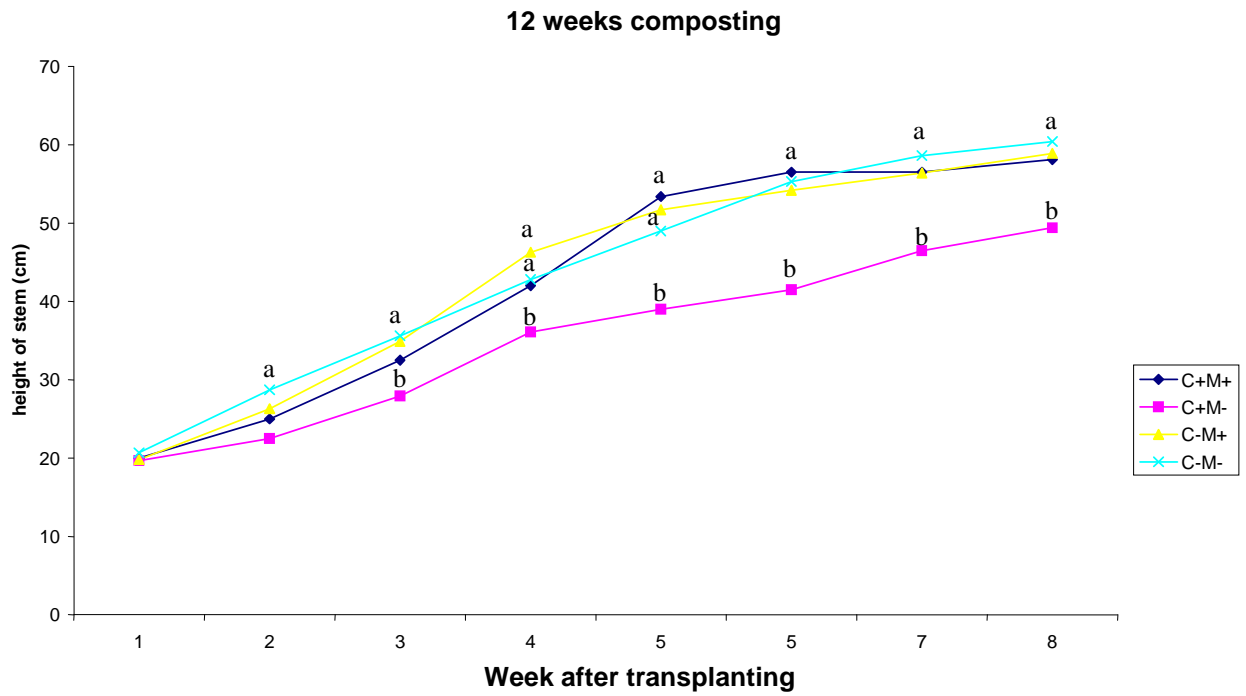
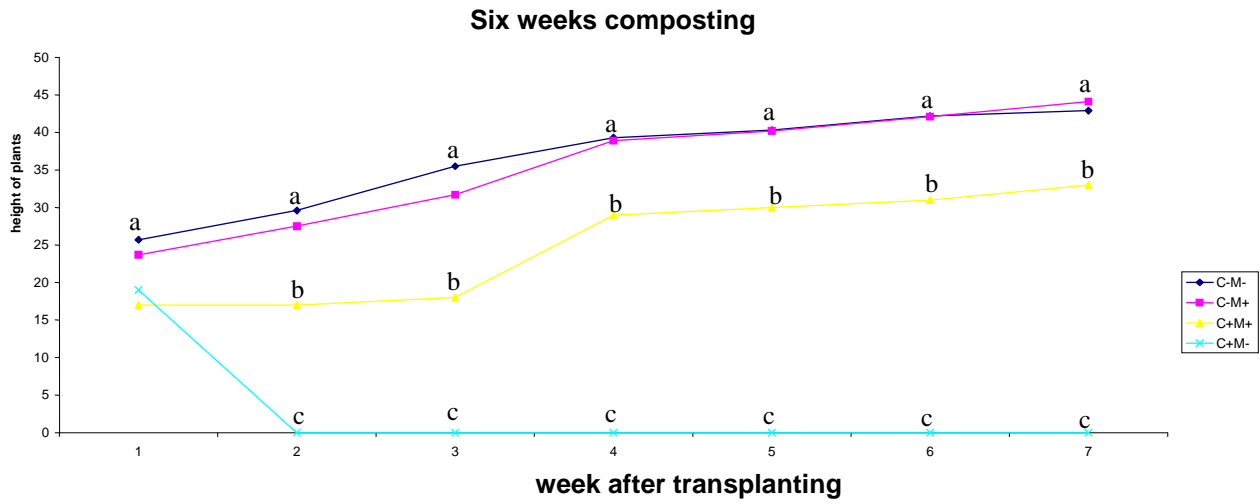


Figure 2:- Effect of inoculation with *G. mosseae* and soil supplementation with composted (6 and 12 weeks composting) brewery waste on weekly increases in height of stem of transplanted tomato seedlings.

*** Means at same week not carrying the same letters are significantly different at $P > 0.05$ according to Duncan's Multiple Range Test (DMRT)**

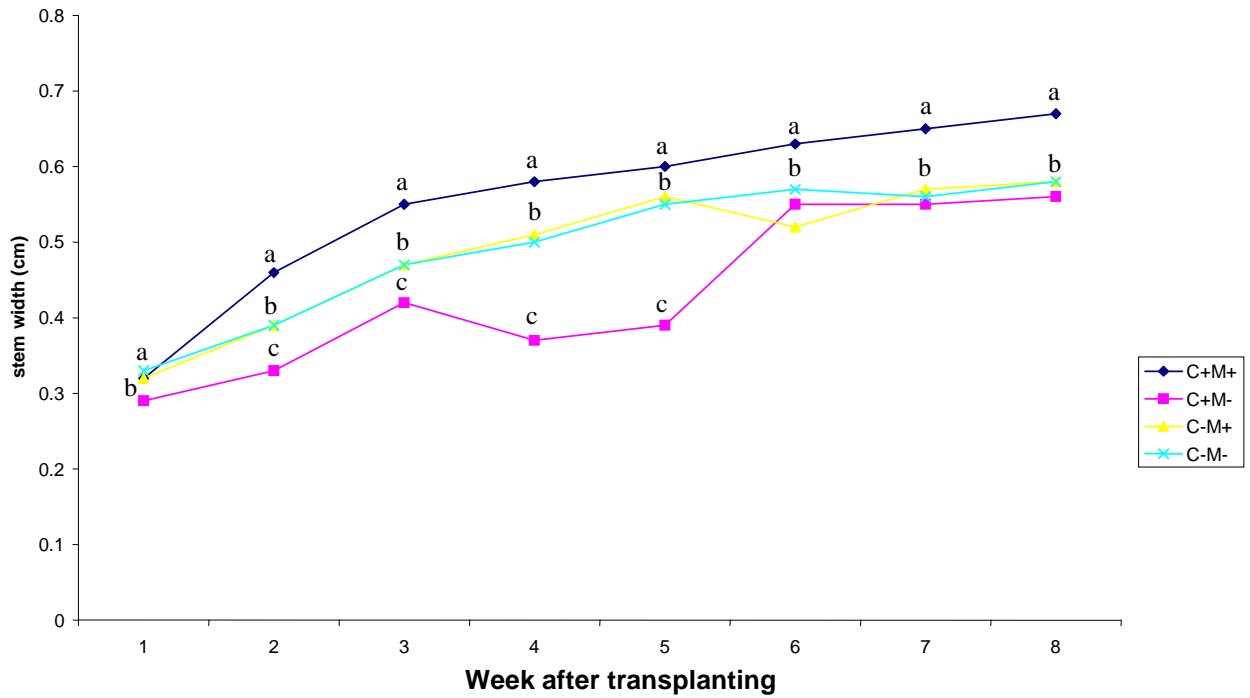
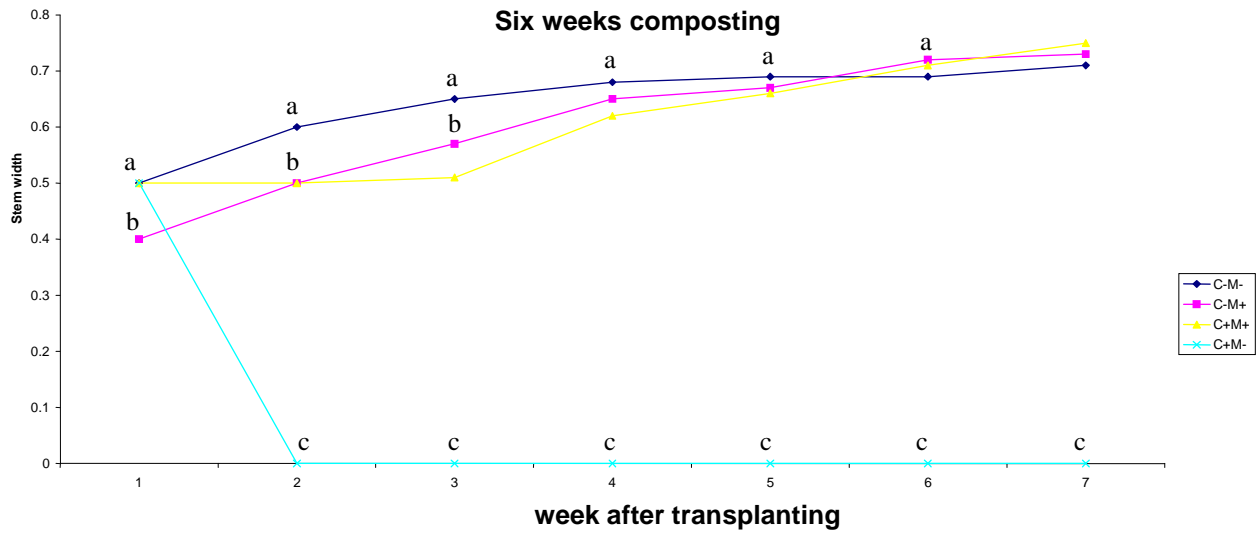


Figure 3:- Effect of inoculation with *G. mosseae* and soil supplementation with composted (6 and 12 weeks composting) brewery waste on weekly increases in stem width of transplanted tomato seedlings.

* Means at same week not carrying the same letters are significantly at $P > 0.05$ according to Duncan's Multiple Range Test (DMRT)

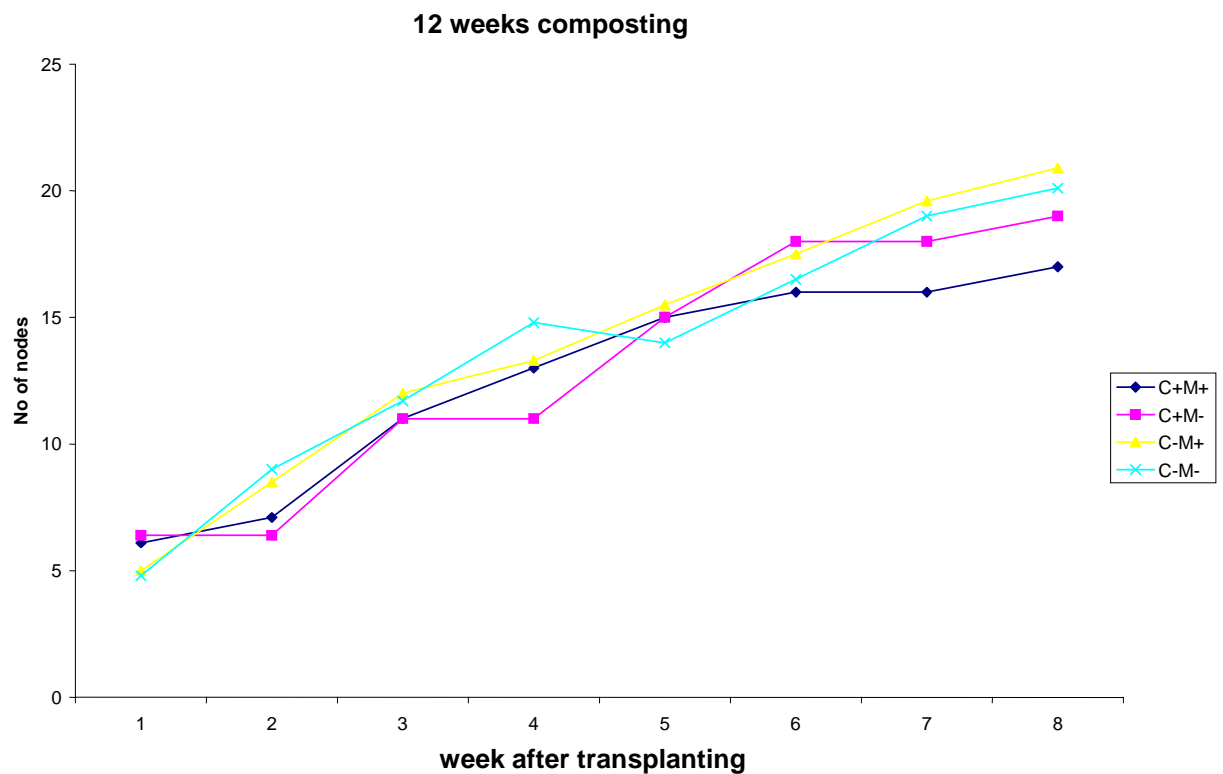
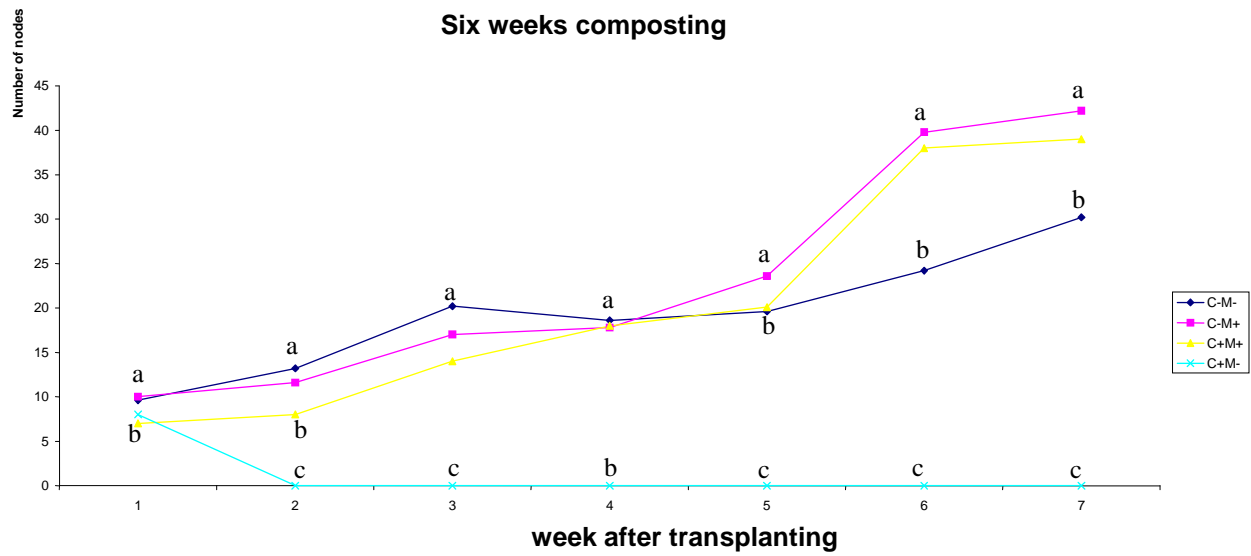


Figure 4:- Effect of *G. mosseae* and soil supplementation with composted (6 and 12 weeks composting) brewery waste on weekly increases in no of nodes of transplanted tomato seedlings.

*** Means at same week not carrying the same letters are significantly different at $P > 0.05$ according to Duncan's Multiple Range Test (DMRT)**

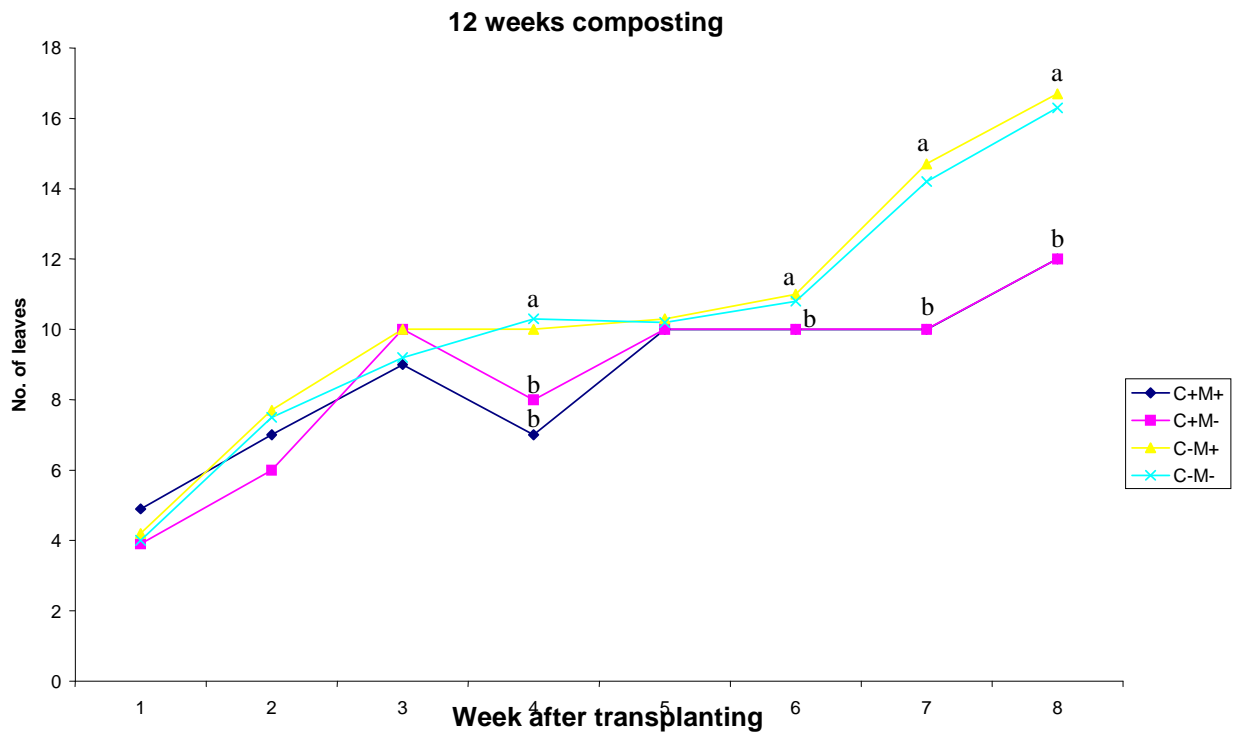
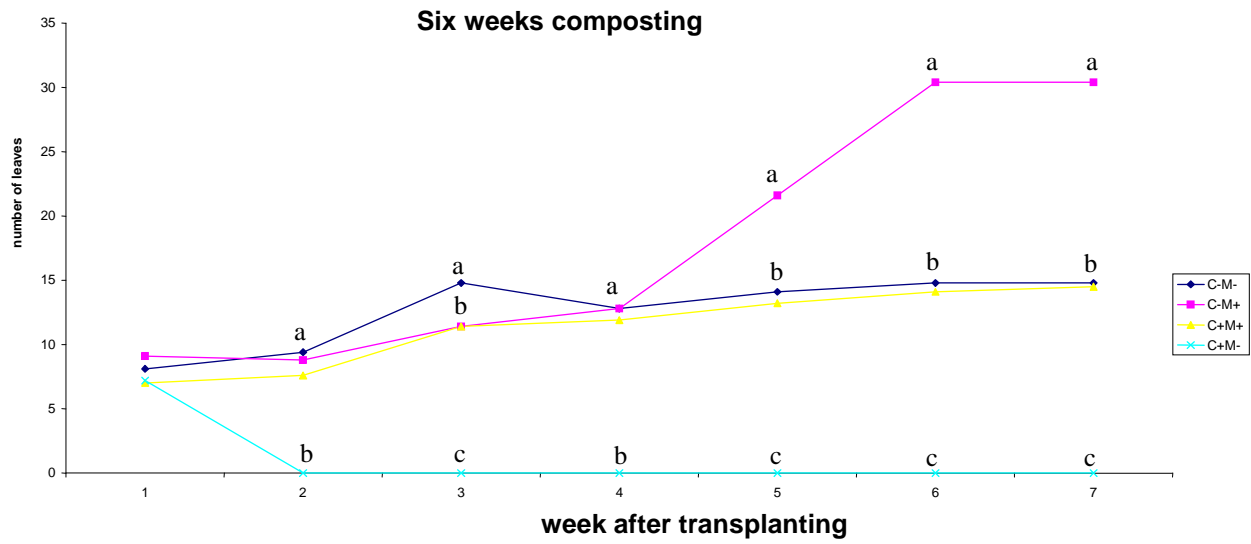


Figure 5:- Effect of *G. mosseae* and soil supplementation with composted (6 and 12 weeks composting) brewery waste on weekly increases in no of leaves of transplanted tomato seedlings.

***Means at same week not carrying the same letters are significantly different at $P>0.05$ according to Duncan's Multiple Range Test (DMRT)**

Table 1:- Analysis of soil and brewery waste (i.e. spent sorghum grains) samples for their heavy metal content in comparison with FEPA save levels.

Description	Heavy metal concentration (mg/kg)			
	Zn	Fe	Pb	Cd
Soil sample	2.60	1.60	1.10	0.90
Spent grains	1.63	1.84	0.10	0.07
Safe Levels	3.40	1.95	1.85	1.00

Abbreviation

+ mg/kg = Milligram per kilogram.

Table 2:- Initial chemical analysis of soil and brewery waste (i.e. spent sorghum grains) samples before commencement of experiment.

Description	pH	Ca	Mg	K	Na	H ⁺	O.C.	N	Av.P
		Cmol/k	Cmol/k	Cmol/k	Cmol/k	Cmol/k	%	%	mg/kg
		g	g	g	g	g			
Soil sample	5.65	0.94	1.52	0.22	0.57	0.13	1.14	0.15	4.93
Spent grains	n.d.	0.48	1.47	0.35	0.17	n.d	n.d	n.d.	n.d

Abbreviations

+ Cmol/kg - Centimole per kilogramm
 Av.P - available Phosphorus
 O.C - Organic carbon
 Mg/kg - Milligram per kilogram

Table 3 :- Biochemical analysis, characterization and identification of bacterial isolates from effluents from composted brewery (spent sorghum grains)waste.

Isolate No	Gram stain	Shape	Motility	Catalase	Oxidase	Coagulase	Urease	Indole	Methyl Red	Voge-Proskauer	Caesin hydrolysis	Gelatin hydrolysis	Citrate production	Fructose	Glucose	Lactose	Mannitol	Raffinose	Arabinose	Xylose+	
1	+	C	+	+	+	-	-	-	-	-	+	-	-	A	A	A	A	A	A	A	A
2	+	S	-	+	-	-	+	+	-	-	-	+	+	A	A	A	-	-	d	d	

Probable identification; - Isolate 1 = *Micrococcus acidophilus*

Isolate 2 = *Streptococcus faecium*

KEY

+ = positive

- = negative

C = Cocci

S = Sphere

A = Acid production

d = doubtful