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EVALUATION OF TWO COMPOSTS FOR THE IMPROVEMENT OF CROP YIELD USING TOMATO (*LYCOPERSICON ESCULENTUM*) AS TEST CROP

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Abstract: In search of a more environmentally friendly alternative to the use of chemical fertilizers, a study was conducted to evaluate the use of compost for improved crop productivity. We compared the succession of microorganisms in the compost heaps using hot bed method of composting. They contained grass clippings, sawdust, NPK fertilizer, ashes, corn cobs, bean chaff, vegetable stalks, newspaper shreds and soil arranged in layers in a round structure. Poultry dropping was the organic nitrogen source of one heap while pig waste was used for the other heap. Samples were taken weekly and analyzed using soil dilution method for isolation of moulds on potato dextrose agar medium. The qualities of composts after eight weeks were evaluated by performance and yield of tomato crops. Eleven fungal isolates were obtained in compost containing poultry dropping and nine fungal isolates were obtained from compost containing pig manure. The predominant mycoflora of poultry dropping compost at 3 weeks of composting was *Fusarium pallidoroseum* (23.08%) while *Aspergillus fumigatus* (38.96%) dominated compost containing pig waste. Fungi isolated from the composts included cellulolytic fungi like *Chaetomium sp*. and *Phoma sp*. Soil amended with both composts improved the growth and yield of tomato crop significantly. It was concluded that compost containing poultry droppings was richer and therefore encouraged higher microbial activity than compost containing pig waste. Knowledge of the microbial succession during composting and conditions required could further be employed to enhance composting.

Key words: composting, microbial succession, soil improvement.

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Introduction

The nutrient status of soil declines as a result of crop removal, economic harvest, leaching, and erosion among others. The specific problems militating against the application of inorganic fertilizers include soil acidity, loss of organic matter and soil structural stability (Busari et al., 2009; Carvajal-Muñoz and Carmona-Garcia, 2012). Green manuring will either increase the humus content or the supply of available nitrogen but can rarely do both at the same time (Becker, 2001). The nutrient content of animal manure depends on quality of the animal diet (Seefeldt, 2013). Some animal manure is so concentrated that they must be applied sparingly because they might burn plant leaves like chemical fertilizer does. These seeming side effects of chemical fertilizer, green manure and animal manure application make composting a suitable alternative to chemical fertilizer, green manure and animal manure application.

Composting is a method of speeding up natural decomposition under controlled conditions. The present study was mainly aimed at evaluating two composts for use in the improvement of soil nutrient status and crop productivity. Fungi produce chemical substances that break down complex compounds in plant and animal materials, thereby releasing simpler compounds and nutrients, increasing soil fertility (Anastasi et al., 2005). To optimize compost quality, good understanding of fungal diversity in compost is imperative. The objectives were to compare the succession of fungi in the two composts used and to investigate the effects of the composts on physical properties of the soil as well as nutrient status, through the performance and yield of tomato crop planted in soil amended with the compost.

Material and Methods

Construction of compost heap: Hotbed or pile composting method was used. Two heaps were made with the same type and quality of materials except the animal waste contents. One heap contained poultry droppings while the other contained pig waste.

Layering of heaps or piles*:* Pile layering was started with grass clippings followed by animal waste (pig waste for heap A, poultry droppings for heap B). Ashes of newspaper shreds, chopped corn cobs, bean chaffs, vegetable stalks, sawdust and NPK fertilizer were used as another source of nitrogen. The last layer was soil which was used as compost activator. The pile was moistened by wetting each layer with about 2 litres of water (45%) after its formation. The heaps were covered with plastic sheets to prevent moisture loss.

Turning of compost heaps: The piles were sliced through with a spade and each slice was turned over. This process continued for 2 months for the composts to be ready for use.

Collection of samples from compost heaps*:* Samples of compost from both heaps were taken randomly at a depth of 15cm. A composite sample was taken from each heap and was transferred into the laboratory for analysis.

Determination of physico-chemical properties of compost*:* The physico-chemical properties determined include: pH using Kent pH metre model 7020 and organic matter content using the wet oxidation method as described by Shamshuddin et al. (1994). The hydrometer method of Gee and Or (2002) was employed in the determination of particle size, while the temperature was determined using a thermometer at the depth of about 20cm.

Isolation of fungal isolates from composts: This was done via the serial dilution technique. The 10^{-3} dilutions were plated on potato dextrose agar (PDA) with 1% streptomycin to inhibit bacteria growth. The plates were incubated at 37°C for 3–5 days. Fungi were counted and expressed as number per gram of sample.

Identification of fungal isolates: General colony and microscopic morphology of fungi were used in identifying fungi. Colony morphology used includes: color of spores, nature of mycelia, presence of pigment and elevation of mycelia. Using lactophenol cotton blue staining, the microscopic identifications of fungal isolates were carried out by mounting fungal isolates on microscope slides. Microscopic characteristics were noted and used as guidelines for identification. These microscopic characters include shape, type of sexual and asexual spores, presence or absence of cross walls in the hyphae, presence of chlamydospores, sporagiospores, etc.

Evaluations of the two different compost types for improving soil fertility: Tomato (*Lycopersicon esculentum*) plant was used for each of the compost types. The three pots were allotted to each treatment. Treatments are used as outlined below.

Table 1. Treatment combinations used for the study.

S/No.	*Treatments	Compost: soil ratios
1.	Compost A:Soil	2:1
2.	Compost B:Soil	2:1
3.	Compost A:Soil	1:2
4.	Compost B:Soil	1:2
5.	Soil Only	0:3

*Compost A - contains pig manure; Compost B - contains poultry droppings.

Planting of tomato: Tomato seeds were planted in the different pots directly and were later thinned down to 3 seedlings per pot.

Growth and yield evaluations*:* The parameters considered include: number of leaves, height of plants, number of flowers and number of fruits.

Statistical analysis: The frequency of occurrences of varying fungal isolates was estimated. Data collected on growth and yield of tomato crops were subjected to analysis of variance.

Results and Discussion

The total fungal counts in compost heaps over a period of four weeks are shown in Table 1. Higher fungal colony forming units were recorded in compost heap B (containing poultry droppings) than in compost A (containing pig manure) at 4 weeks. This could be attributed to higher nitrogen content of poultry droppings. According to Seefeldt (2013), poultry droppings have higher nitrogen and phosphorus concentration than pig manure.

Table 2. Total fungal counts in compost heaps over a period of four weeks.

Week	Compost A (containing pig manure)	Compost B (containing poultry manure)
1.	$20x10^4$	$23x10^4$
2.	$23x10^4$	$25x10^4$
3.	$24x10^4$	$36x10^4$
4.	$24x10^4$	$38x10^4$

The frequency of occurrences of fungi in composts A and B for a period of four weeks is reported in Figures 1 and 2 respectively. Nine fungal isolates were encountered in compost A while 11 isolates were encountered in compost B. This could be due to higher organic matter content of compost B as shown in Table 3. The quantity of organic matter is a major determinant factor of fungal population (Swer et al., 2011). This is also in line with the report of Hoorman and Islam (2010) . *Aspergillus fumigatus* had the highest frequency of occurrence in compost A successively for 4 weeks; *Fusarium pallidoroseum* had the highest frequency of occurrence in compost B for 3 successive weeks while *A. fumigatus* had the highest frequency in the 4^{th} week. Two third (66.7%) of the isolates recorded in compost A and 6/11 (54.5%) of compost B are *Aspergillus species*, and this could be because many of *Aspergillus sp.* are known to produce cellulolytic enzymes which aid decomposition. The presence of *Chaetomium sp.* in compost A at the 4^{th} week could be linked with its highly cellulolytic characteristics. *Phoma sp.*, *F. solani, A. terreus* and *Chaetomium piluliferum* were peculiar to compost A. *M. hiemalis*, *F. pallidoroseum*, *Verticillium sp.*, *Oosporum sp.*, *Cladosporium sp.* and *M. plumbeus* were peculiar to compost B. *Verticillium sp.* was encountered in the 2^{nd} week of decomposting of compost B. However, it is significant to note that this organism which is a potential pathogen of many crops was wiped off by the 4^{th} week.

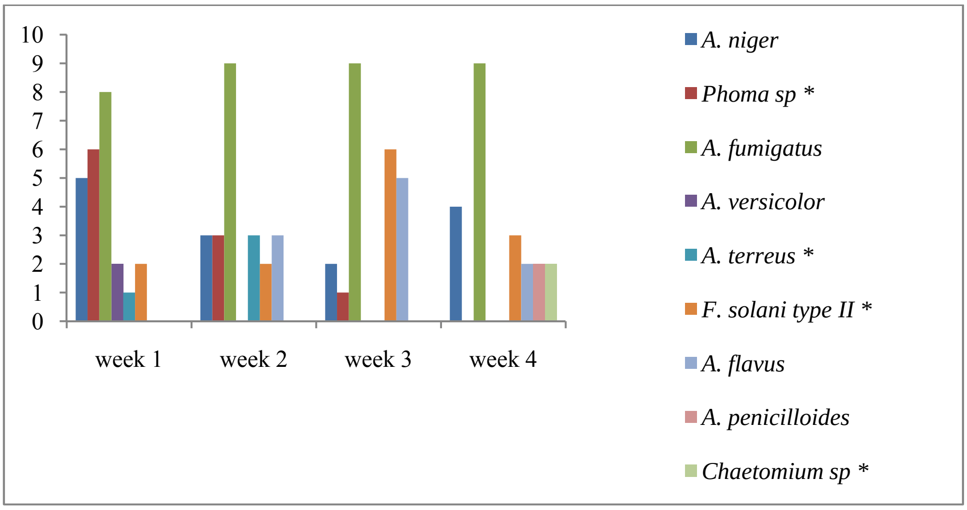

Figure 1. Succession of fungi in compost A for a period of four weeks
*Organisms peculiar to compost A.

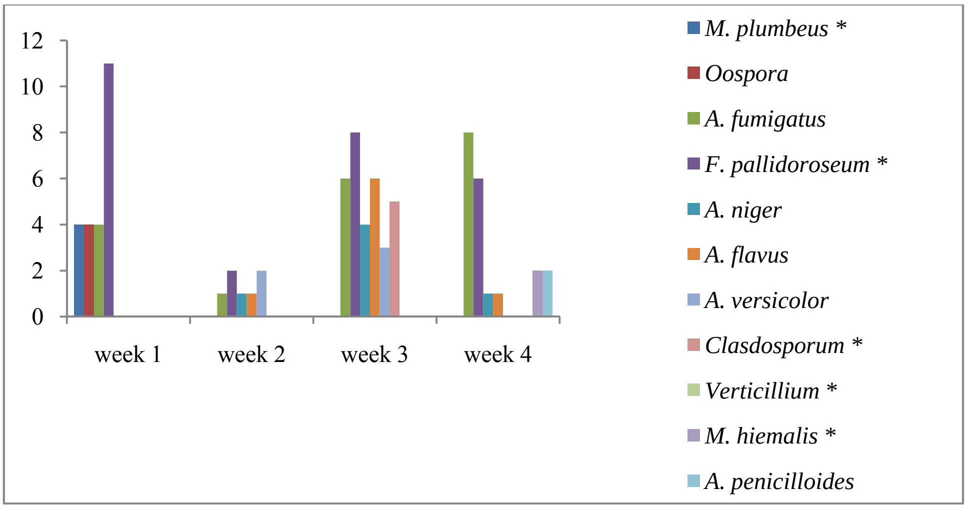

Figure 2. Succession of fungi in compost B for a period of four weeks
*Organisms peculiar to compost B.

The occurrence of *Fusarium solani* type II and *F. pallidoroseum* in composts A and B respectively over the period of study is however a bit disturbing as both organisms are potential pathogens of crops (Zhang et al., 2006). With the knowledge of their presence in these composts, the use of fungicides alongside with the compost for healthy crop production is recommended.

While evaluating the composts with regard to growth of tomato, it was observed that the germination of seed in buckets containing compost B started on the 3rd day while germination of seed in buckets containing compost A started on the 5th day just as the control. This could be attributed to the presence of *Fusarim solani* type II as this fungus has been reported to have the ability to release phytotoxins in growth medium of seeds which may delay germination (Svistova et al., 2003).

The statistical analysis of the growth parameters is shown in Table 3. It can be inferred that growth in the treatments varied. Tomato plants that received the ratio of 2:1 of compost B to soil performed better than 1:2 of compost B to soil. On the other hand the ratio of 1:2 of compost A to soil did better than ratio of 2:1. This variation in growth with compost B could be attributed to the higher organic matter content of compost B which is contained in higher proportion in the ratio of 2:1 of compost B to soil. The better growth performance of crop with the ratio of 1:2 of compost A to soil could be because the ratio of 2:1 of compost A to soil had higher population of *Fusarium* solani type II, a fungal pathogen of tomato.

Table 3. Growth of tomato plants in soils amended with varying proportions of composts.

*Treatment	Number of leaves	Height of plants	Number of flowers	Number of fruits
A (2:1)	95.91[a]	46.50[a]	3.60[a]	3.70a
B (2:1)	360.30[b]	93.75[b]	35.30[b]	25.30[b]
C (soil) 0:3)	40.10[c]	38.25[c]	0.00[c]	0.00[c]
A (1:2)	177.31[d]	75.25[d]	11.60[d]	9.00[d]
B (1:2)	266.70[e]	77.50	24.30[e]	15.70[e]

*Compost: soil ratios.

Table 4 shows the particle size analysis of the soils amended with the two composts after planting tomato plants. The compost did not have an appreciable effect on the soil particle size. This was probably as a result of short duration of amendment before sampling. Composts are known to help in improving the structure of soil (Davis and Whiting, 2014).

Table 4. Particle size analysis of soil amended with varying composts and cropped with tomato plant.

Treated soil	% clay	% sand	% silt	Class of soil
A1	0.72	92.8	6.48	Sand
B1	0.36	94.96	4.68	Sand
A	1.08	94.96	3.96	Sand
B	0.72	93.52	5.76	Sand
C	0.72	94.96	4.32	Sand

A1 – compost A: soil 2:1, B1 – compost B: soil 2:1, A – compost A: soil1:2, B – compost B: soil 1:2 and C – compost: soil, 0:3.

Conclusion

This study has established that the fast or hot bed method is effective for decomposition of compost materials. The use of poultry droppings was found to be a better source of organic nitrogen for composting than pig manure. Soil amended with the two composts led to an improved performance and yield. A good number of molds isolated from the heaps are known to be highly cellulolytic organisms.

Compost heap A was found to contain *Fusarium solani* type II which could be phytotoxic to seeds causing a delay in germination. The application of fungicides would be desirable with the use of these for soil dressing. Further work on the physiology of the predominant fungi in the compost heaps will be necessary. These organisms could be manipulated to further enhance the rate of decomposition.

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PROCENA DVE VRSTE KOMPOSTA ZA POBOLJŠANJE PRINOSA USEVA KORIŠĆENJEM PARADAJZA (*LYCOPERSICON ESCULENTUM*) KAO OGLEDNOG USEVA

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R e z i m e

U potrazi za ekološki prihvatljivijom alternativom korišćenju hemijskih đubriva, sprovedeno je istraživanje kako bi se procenila upotreba komposta za poboljšanje produktivnosti useva. Uporedili smo sukcesiju mikroorganizama u kompostnim gomilama koristeći rasadnički metod kompostiranja. Komposti su se sastojali od trave, piljevine, NPK đubriva, pepela, oklasaka kukuruza, pasuljevine, stabljika od povrća, komadića novina i zemljišta raspoređenih u slojevima u okrugloj konstrukciji. Živinsko đubrivo je bilo izvor organskog azota jedne gomile, dok je svinjski stajnjak korišćen za drugu gomilu. Uzorci su uzimani nedeljno i analizirani su korišćenjem metode razblaživanja zemljišta radi izolacije plesni na podlozi krompir-dekstrozni agar. Kvaliteti komposta posle osam nedelja su procenjeni izgledom i prinosom useva paradajza. Jedanaest izolata gljiva su dobijeni u kompostu koji je sadržao živinsko đubrivo i devet izolata gljiva je dobijeno iz komposta koji je sadržao svinjski stajnjak. Dominantna mikoflora živinskog đubriva tri nedelje od kompostiranja je bila *Fusarium pallidoroseum* (23,08%), dok je *Aspergillus fumigatus* (38,96%) preovladavao u kompostu koji je sadržao svinjski stajnjak. Gljive izolovane iz komposta su uključivale celulolitske gljive kao što su *Chaetomium sp*. i *Phoma sp*. Na zemljištu kojem su dodata oba komposta značajno je poboljšan rast i prinos useva paradajza. Zaključeno je da je kompost, koji je sadržao živinsko đubrivo bogatiji i stoga je podstakao veću mikrobnu aktivnost nego kompost koji je sadržao svinjski stajnjak. Poznavanje mikrobne sukcesije tokom kompostiranja i uslova koji su potrebni može dalje biti iskorišćeno kako bi se poboljšalo kompostiranje.

Ključne reči: kompostiranje, mikrobna sukcesija, melioracije zemljišta.

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