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RESEARCH ARTICLE

EFFECTS OF DIFFERENT CHICKEN MANURE RATES OF ON EARLY GROWTH OF FIG *(Ficus Carica)*

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ABSTRACT

Fertilizing by using chicken manure as an organic amendment is a complementary to improve chemical fertilizer efficiency. This study was conducted in Glasshouse & Nursery Complex of IIUM with the objectives of evaluating different rates of chicken manure application on soil properties, leaf nutrients and the growth response of fig trees for early growth effects. The soils were amended with 0%, 10%, 20%, 30% and 50% of chicken manure on three months old saplings of cultivar BTM6 in five replications were used to observe the effects. The experiment was observed for three months. The nutrient content in T1 and treated soil showed a significant difference at $p < 0.05$. The T5 had the highest content of nutrients compared to other treatments. However, the leaf nutrient contents did not show any significant difference among all treatments. Survivability of the trees were 100% with T2 showed a superlative growth response with the high number of branches, leaves and fruits thus provide high yield production as compared to other treatments ($p<0.05$). The results clarified that application of chicken manure improved soil properties and promote growth response of fig trees in tropical environment.

KEYWORDS

Chicken manure, soil properties, leaf nutrients, growth response, fig.

1. INTRODUCTION

Applications of chemical fertilizers and organic compost have both good and adverse effects on plant growth and the soil [1]. Chemical fertilizers are inexpensive, contain high nutrients, and are readily available to be taken up by plants. However, excess usage of it results several problems, such as nutrient loss, surface water and groundwater contamination, soil acidification or basification, reductions in useful microbial communities, and increased sensitivity to harmful insects [2]. In a way, compost are some examples of organic soil amendment that can replace and improve the usage of chemical fertilizer as it also can supply macro and micro-nutrients besides it helps to improve the physical and chemical conditions of the soil which later leads to an efficient uptake of nutrients by the crops [3].

Compost is defined as a stable aerobically decomposed organic matter, which came from a managed decomposed process. It had gone through a process called aerobic decomposition done by microorganism which transformed the organic materials into series of complex organic substances. A few types of compost derived material had been used widely such as woody and herbaceous green waste, crop residues, bio-solids, animal manures and also food scraps. This feedstock vary substantially in chemical composition, particle size and also its decompositions rates . Among this, chicken manure also has been found to be rich in nutrients such as nitrogen (N), phosphorus (P), calcium (Ca), potassium (K) and magnesium (Mg) [4]. Poultry manure had significantly improve the soil physical properties, enhanced the nutrient uptake and the growth and yield [5].

Poultry manure incorporated into the soil planted with tomato, produced a higher soil organic matter and improved its macro and micro-nutrients content in of soil and leaf, its growth and yield [6]. Addition of chicken manure showed positive effects in enhancing soil fertility, as it significantly increased the N, P and exchangeable bases in the soil planted with spinach [7].

Fig is a common species found in the Mediterranean Basin, however it is able to adapt at rather marginal conditions [8]. Recently, common fig has been cultivated in Malaysia and managed to adapt the local weather and environmental condition. It can be cultivated in tropical and sub-tropical regions as it needs a warm and dry temperature to grown. Fig tree has benn reported to be rich in minerals, vitamins, and low in calories through its fruit and leaves [9]. It also has numerous phenolic compounds that able to act as an antioxidant and favorable to human health [10]. Application of organic amendments is believed to improve the soil physical and chemical properties. Proper use of manure and compost is essential for plant production and environmental perspective. Low applying rates might lead to nutrients deficiency and low yields. Meanwhile, excessive application rate can lead to nitrate leaching, phosphorus runoff and extreme vegetative growth of some crops [3]. In Malaysia, there is still limited study done on how the application of organic compost on fig tree effects its development and the soil properties. Therefore, this study was carried out to observe the effects of different rate of chicken manure as organic amendment in improving the soil health and the growth of fig trees.

2.MATERIALS AND METHODS

2.1 Study Site

Pot experiment was carried out at the Glasshouse and Nursery Complex, International Islamic University Malaysia, Kuantan Campus, Pahang (3°51'08.3"N, 103°18'42.0"E) during early June until late August 2016. The mean temperature was about 28°C with relative humidity 85.4% and mean daily rainfall amount of 138.3mm.

2.2 Soil Preparation

Kuantan series topsoil (oxidic, isohyperthermic, brown, Tipik Akrolemoks) were collected at area of Department of Physics, Kulliyyah of Science, IIUM (3°51'04.9"N 103°18'32.0"E). The soil was sieved to remove any remaining roots and large rocks. Processed dried chicken manure powder was used for this observations (Aviafic Basal).

2.3 Experimental Design

The experiment was conducted on early June 2016 with five different treatments of chicken manure (v/v) which was 0% (T1) as control, 10% (T2), 20% (T3), 30% (T4) and 50% (T5). Fig saplings of Brown Turkey Modified (BTM6) variety were propagated through hardwood cuttings. The experiment was done in Randomized Complete Block Design (RCBD) with five replications for each treatment. All pots received 10g of 15:15:15 NPK fertilizer biweekly and irrigated with automated dripping system twice per day.

2.4 Soil Analysis

Prior to planting, the physical and chemical properties of soil samples from each treatment were analyzed. The soil samples were air-dried and sieved under 2mm sieve. Soil pH was determined using soil: water ratio of 1: 2.5 and pH meter (Metler Toledo FE20, Switzerland). Particle size analysis was analyzed using Particle Size Analyzer (PSA) (Mastersizer, 2000). Total carbon was determined using a carbon analyzer (LECO CR-412, USA and the total N was determined by using Kjedahl method [11]. Extractable P, K, Ca, Mg, Fe, Cu, Zn, and Mn were determined by Mehlich III method [12]. N, P, and K were measured by auto analyser (AA) (Lachat QuikChem FIA 8000 series, USA). Ca, Mg, Fe, Cu, Zn and Mn were measured by using atomic absorption spectrometry (AAS) (Perkin Elmer 400, USA).

2.5 Leaf Nutrients Analysis

After three months of planting, the third leaf were sampled randomly from three branches each tree. The samples were oven-dried, grind and sieved under 2mm sieve. The lamina of leaf samples were selected to perform the analysis of N, P, K, Ca, Mg, Fe, Cu, Zn and Mn using wet digestion method. N, P, and K were measured by auto analyser (AA) (Lachat QuikChem FIA 8000 series, USA). Ca, Mg, Fe, Cu, Zn and Mn were measured by using atomic absorption spectrometry (AAS) (Perkin Elmer 400, USA).

2.6 Growth Response

For the growth performance observations, height of tree, stem girth, number of branches, number of leaves, number of fruits and survivability of each tree were taken biweekly until late August 2016.

2.7 Statistical Analysis

Data were subjected to analysis of variance (ANOVA), using Statistical Analysis System (SAS 9.2) to determine the treatments effect. The least significance difference (LSD) at $p < 0.05$ was used to compare the mean data of each parameter.

3. RESULTS AND DISCUSSION

3.1 Characterization of Chicken Manure Used

Table 1 showed the chemical composition of the chicken manure used in this study. The pH of the chicken manure was 7.02 and is considered as neutral. The total carbon (C) content was 22.91 and C/N ratio of the chicken manure was 16.37. The C/N ratio rate around 25% would promote rapid composting and would provide nitrogen in an immediately available form in the finished compost. The macronutrients of chicken manure contain higher K (1.54%) and total N (1.4%) compared to other macronutrients like Ca (0.84%), Mg (0.6%) and P (0.11%). For micronutrients, the chicken manure used contains more Mn (220.1 mg/kg) than Fe (146.5 mg/kg), Zn (125.7 mg/kg) and Cu (37.3 mg/kg). Poultry manure which includes chicken manure generally contains the highest proportion of total N of any animal manure source and well supplied with micronutrients [3].

Table 1: Chemical composition of chicken manure.

Properties	Unit	Amount
pH		7.02
C/N Ratio		16.37
Total C	(%)	22.91
Total N	(%)	1.4
P	(%)	0.11
K	(%)	1.54
Ca	(%)	0.84
Mg	(%)	0.60
Fe	(ppm)	146.5
Cu	(ppm)	37.3
Zn	(ppm)	125.7
Mn	(ppm)	220.1

3.2 Effects of Chicken Manure on Physico-chemical Characteristics of Soil

Soil texture showed in table 2 ranged from loam to silt loam type of soil. Loam soils contain less than 52% sand, 28% to 50% silt, and between 7% and 27% clay [13]. The addition of chicken manure was observed to change the pH of the soil. From this study, the pH increased with the increasing application rate of manure. The highest pH recorded was 7.97 at 50% application rate (T5) and the least being 5.08 for control (T1). Generally, the pH of the soil amended with chicken manure were found to be ranged from neutral to slightly alkaline [14]. Soil pH is a major determinant of which species will grow well. This was perhaps due to the availability of nutrient elements which is influenced by soil pH. In slightly acidic soil, the cation exchange site is dominated by anions such as H^+ resulting in less bases cations. However, by the addition of chicken manure, the pH was slightly increased upon microbial decarboxylation activities and the decomposition process of the organic materials [15].

The soil of T1 was found to be slightly acidic and has low content of macro- and micronutrients compared to others. Without application of chicken manure, the concentration of total N (0.15%), exchangeable P (0.001%), K (0.012%), Ca (0.21%) and Mg (0.05%) is low. However, there was a significant increase of total N, exchangeable P, K and Mg with increasing application rate of the chicken manure. The amount of total N, exchangeable P, K and Mg in T5 was highest at 0.74%, 0.094%, 0.547% and 0.13%, respectively. However, for exchangeable Ca, the addition of chicken manure significantly increased the content with the highest value found in T4 (0.36%) however dropped at T5 (0.11%). At rate of 50% chicken manure, the amount of nitrate was found to be the highest; this leads to a downward movement of the exchangeable Ca in the soils. High content of nitrate released from poultry manure able to chelate Ca cations and facilitate the leaching of Ca [16].

Amending chicken manure into the soil results in increasing micronutrients content (exchangeable Fe, Cu, Zn, Mn). This result can be explained due to the high levels of trace elements found in the chicken manure. The increase in soil Fe^{2+}, Cu^{2+}, Zn^{2+}, Mn^{2+} contents could be explained, among other factors, by the dissolution and mineralization of Fe, Cu, Zn, Mn organic forms found in the chicken manure. The increasing formation of soluble complexes results in increasing soil pH. The mechanism responsible for this increase in soil pH was due to ion exchange reactions which occur when terminal OH^- of those micronutrient hydroxyl oxides are replaced by organic anions which are decomposition products of the manure such as malate, citrate and tartrate. A finding stated that higher Cu and Zn contents in the soils with high pH, which is corresponding with the results [17]. However, the micronutrient behavior and its availability to plants can be mitigated by the measurement of soil pH. As the soil pH increases, the availability of micronutrients decreases [13].

3.3 Effects of Chicken Manure on Leaf Nutrients Content

The nutrients content of fig leaf after three months was showed in Table 3. The content of N, P and K were slightly increased with increasing rate of chicken manure. However, it did not show any significant effects compared to T1 ($p>0.05$). The concentrations of N, P and K ranged between 3.39% - 3.53%, 0.08% - 0.10% and 1.91% - 2.29%, respectively with control has the lowest value and T5 the highest. The leaf nutrient contents were similar to the control, showing that nutrients added through manuring were taken up and allocated for further growth and yield. At three months planting, fig tree was within the vegetative and reproductive growth, the remobilization of short or mid-term storage of macro- and micronutrients within the plant occurs, which might be used to buffer a transient lack of mineral uptake by roots as new sinks are emerging.

3.4 Effects of Different Rate of Organic Amendment on Plant Growth Response

The plant growth showed 100% survivability for control and all treatments (Table 4). The results showed that, there were significant effects on parameters measured due to different rates of chicken manure ($p<0.05$). The T2 showed the highest reading of plant height (94.4cm), stem girth (2.59cm) and number of leaves (151) compared to control and other treatments. The pH of T2 is suitable for growing fig. The pH influences the soil factors affecting the fig tree growth, such as the nutrient leaching and nutrient availability. For the number of branches, T2 (10) showed second highest reading after T3 (11). Similarly with number of fruits, T2 (11) showed second highest reading after T4 (11) and T5 (12). The chicken manure provides good effect on the growth of fig. This might be due to the additional nutrient amendments to the soil as chicken manure was rich in nutrients needed by the plants growth and the acidity was near neutral [18]. Similar results was also found during the study on the effects of poultry manure on fig tree, which stated that poultry manure with bio N-fertilization gained best vegetative growth, productivity and fruit quality [19]. However, applying too much manure may reduce crop quality or increase risk of plant diseases. In terms of crop yield and plant size, T2 (10%) performed well as compared to others. Though T5 (50%) and T4 (30%) have the high number of yield the plant size was reduced. From the observation, fig rust which is a common disease for fig tree were most detected in T1, T4 and T5. Hence, high concentration of manure may not be suggested to be applied as it may reduce the crop quality and high cost maintenances.

Table 2: Physico-chemical characteristics of soil samples before planting.

Treatments	pH	Soil Texture	Total C (%)	C/N Ratio	Total N	Exc. P	Exc. K	Exc. Ca	Exc. Mg	Exc. Fe	Exc. Cu	Exc. Zn	Exc. Mn
							(%)				(ppm)		
T1 (Control)	5.08	Loam	1.31	8.68	0.15±0.02^{c}	0.001±0.001^{e}	0.012±0.009^{c}	0.21±0.18^{ab}	0.05±0.02^{ab}	96.39±3.00^{b}	0.69±0.39^{d}	3.45±4.23^{c}	5.66±2.85^{c}
T2 (10%)	6.74	Silt Loam	2.09	8.21	0.25±0.04^{c}	0.029±0.006^{d}	0.100±0.019^{c}	0.23±0.17^{ab}	0.02±0.02^{b}	134.77±1.96^{ab}	5.95±0.79^{c}	27.92±15.32^{b}	31.54±15.15^{bc}
T3 (15%)	7.36	Silt Loam	3.47	8.31	0.42±0.11^{b}	0.057±0.004^{c}	0.253±0.043^{b}	0.30±0.09^{ab}	0.10±0.03^{ab}	147.20±6.01^{a}	10.18±0.60^{b}	41.25±4.80^{b}	41.20±4.46^{ab}
T4 (30%)	7.47	Silt Loam	4.92	10.39	0.47±0.04^{b}	0.074±0.009^{b}	0.313±0.073^{b}	0.36±0.05^{a}	0.12±0.03^{ab}	130.40±5.86^{ab}	9.02±0.57^{b}	66.45±21.55^{a}	75.16±37.52^{a}
T5 (50%)	7.97	Loam	7.56	10.25	0.74±0.05^{a}	0.094±0.003^{a}	0.547±0.051^{a}	0.11±0.10^{b}	0.13±0.10^{a}	135.18±44.51^{ab}	13.13±2.34^{a}	65.87±1.61^{a}	70.31±1.66^{a}

*Means with different letter are significantly different at $p < 0.05$ according to LSD test.

Table 3: Nutrients content of leaf samples after three months of planting

Treatments	N	P	K	Ca	Mg	Fe	Cu	Zn	Mn
			(%)				(ppm)		
T1 (Control)	3.39±0.15^{a}	0.08±0.02^{a}	1.91±0.21^{a}	0.67±0.11^{d}	0.10±0.00^{e}	377.87±233.64^{a}	62.50±26.34^{a}	53.33±16.65^{a}	44.13±29.46^{a}
T2 (10%)	3.20±0.05^{a}	0.09±0.00^{a}	1.99±0.22^{a}	2.94±0.20^{c}	0.48±0.08^{d}	351.07±91.04^{a}	46.67±18.93^{a}	60.00±15.21^{a}	5.60±5.01^{b}
T3 (15%)	3.53±0.37^{a}	0.09±0.02^{a}	2.13±0.44^{a}	3.77±0.29^{a}	0.99±0.21^{c}	402.93±101.75^{a}	40.00±5.00^{a}	57.50±7.50^{a}	11.87±3.95^{b}
T4 (30%)	3.52±0.30^{a}	0.10±0.02^{a}	2.23±0.04^{a}	3.62±0.24^{ab}	1.41±0.07^{b}	296.67±150.44^{a}	41.67±15.88^{a}	65.83±22.68^{a}	4.00±1.44^{b}
T5 (50%)	3.53±0.18^{a}	0.08±0.01^{a}	2.29±0.44^{a}	3.38±0.22^{b}	1.98±0.12^{a}	214.00±37.52^{a}	35.83±11.81^{a}	50.83±1.44^{a}	28.27±16.72^{ab}

*Means with different letter are significantly different at $p < 0.05$ according to LSD test.

Table 4: Average plant growth response after three months of planting.

Treatment	Survivability (%)	Plant Height (cm)	Stem Girth (cm)	Number of Leaves	Number of Branches	Number of Fruits
T1 (Control)	100	69.0 ± 19.1 ^{b}	2.15 ± 0.52 ^{bc}	105 ± 44 ^{b}	5 ± 2 ^{b}	4 ± 2 ^{b}
T2 (10%)	100	94.4 ± 34.7 ^{a}	2.59 ± 0.37 ^{a}	151 ± 50 ^{a}	10 ± 3 ^{a}	11 ± 7 ^{a}
T3 (15%)	100	84.0 ± 28.0 ^{b}	1.97 ± 0.64 ^{cd}	121 ± 79 ^{a}	11 ± 7 ^{a}	8 ± 6 ^{ab}
T4 (30%)	100	79.6 ± 26.4 ^{b}	1.77 ± 0.38 ^{d}	115 ± 67 ^{a}	9 ± 5 ^{a}	11 ± 8 ^{a}
T5 (50%)	100	82.8 ± 42.9 ^{ab}	1.98 ± 0.53 ^{b}	89 ± 52 ^{b}	7 ± 3 ^{a}	12 ± 12 ^{a}

*Means with different letter are significantly different at $p < 0.05$ according to LSD test.

4. CONCLUSION

The soil nutrient contents of control and treatments show significant difference at $p < 0.05$ with T5 having the highest content of nutrients compared all treatments. However, the leaf nutrient contents for all treatments did not show any significant difference. For morphological parameters, there were significant differences between the treatments as 10% (T2) shows the superlative growth response with the high number of branches, leaves and fruits thus provide high yield production compared to other treatments. Hence, the 10% chicken manure is recommended in term of cost and agronomic values. The results clarified that application of chicken manure can improve soil properties and promote growth response.

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