Development of fishwaste compost and its effect on quality of soil and crop

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Abstract

The main objective of this research was production of compost from fish waste generated from the seafood processing industries at Tuticorin district, Tamilnadu and examine the effect of fishwaste compost on crop and soil quality. The fish waste was acidic in pH (6.1) with EC of 3.8 dS/m. The total NPK content of fish waste is 10.17%, 0.20%, 0.74% respectively. It has an appreciable amount of organic carbon 46.22% and secondary nutrients calcium (1.86%) and magnesium (0.15%) respectively. Fish waste was composted with saw dust under the windrow method of composting and analysed. After composting, fish waste compost (FWC) was neutral in pH (7.1) with low soluble salts (EC = 0.38 dS/m). It had a considerable amount of N (1.6%), P (0.16%) and K (0.21%). A pot study conducted on blackgram comprising of different doses of fishwaste compost (0, 1, 2, 3, 4, 5 t/ha) along with recommended dose of fertilizer (RDF). Among the different treatments, application of FWC @ 4t/ha enhanced the growth and yield of black gram and improve the soil quality. From the study, it is evident that fishwaste compost can play a significant role in enhancing the soil properties and performance of blackgram invariant of dose applied.

Keywords: Fish waste compost, blackgram, nutrient content, yield

Introduction

In India, many restaurants specialize in sliced raw fish, and large amounts (approximately 2100 t/day) of fish waste are being generated every day (Kinnunen et al., 2005). These wastes are dumped in the vicinity of the seafood processing plants causing environmental pollution. The waste generated by processing fish, crab and shrimp amount to 30% to 60%, 75-85% and 40-80% respectively (Kinnunen et al., 2005). Hence, ways and means of utilizing these wastes for productive purposes need to be examined. Direct use of fish waste for land manuring has been discouraged primarily due to the obnoxious odour of putrefied fish. But fish manure contains NPK and micronutrients for plant growth. (Chand et al., 2006) observed an enhanced rhizome yield of 28.6 t/ha in turmeric when applying compost with fertilizer which was 21.6% higher over the control plot. Shewry and Holford, (2002) recorded higher growth and yield of cumin and blackgram with the application of compost from seafood processing unit waste. In this context, fish waste samples were collected and composted for evaluation on crop performance and soil quality.

Materials and Methods

Collection and Characterization of Fish wastes

Fish wastes were collected from the seafood processing unit, Thoothukudi District, Tamil Nadu, India which contained different portions of fish viz. head, tail, shells, intestine and fins and also dead fishes. The collected fish wastes were cleaned and washed with water to remove dirt and slick. The sample was oven dried at 60°C and powdered into fine particles using pestle and mortar. It was sieved using a sieve with 0.2 mm and stored for further analysis. The aqueous extracts (substrate/water 1:5 v/v) were used to determine the pH, electrical conductivity. After acid digestion with H2SO4 and H2O2 30%, Ca and Mg levels were determined by atomic absorption and Na and K by emission. Levels of P were analysed using colorimetry (Chapman and Pratt, 1984). The C: N ratio of the compost were measured by the method followed by (Kinnunen et al., 2005).
Moisture was determined by drying the samples in the oven at 105 °C to constant weight (Egan et al., 1997) [2]. All parameters were determined in triplicate and the data shown are mean values. The characteristics of fish waste are presented in Table 1.

Composting of Fish waste
A compost pile was created using the windrow method. To increase the C/N ratio in the composting materials, saw dust (particle size 10 – 20 mm) from the local saw mill was added. These materials were spread in a compost pile 2 m wide at the base, 1 m high and 6 m long, with a total final volume of 10 m³. To avoid nutrient washout, the pile was set on an impermeable base and sheltered above. The proportion of fishwaste, cow dung and sawdust at 1:1:2 was well mixed. The total duration of the composting process was four months. The compost pile was turned weekly during the first two months and every 15 days during the last two months. The temperature and O₂ levels were tested weekly to monitor the correct development of the process. Once the compost was considered mature, it was shifted using a 20 mm mesh screen and stored for further studies. The characteristics of fish waste compost are presented in Table 2.

Evaluation of fish waste compost on black gram
The effect of fishwaste compost on blackgram (Vigna mungo) variety KKM 1 was examined through a pot experiment during October – December 2019. The air-dried samples were used in the crop growth experiments. Each pot was filled with 15 kg of soils. The amendments such as RDF and different levels of (0, 1, 2, 3, 4, and 5 t/ha) fish waste compost was mixed well with respective pots as per treatment plan. The recommended dose of fertilisers for black gram is 25: 50: 25 O per hectare. The pots were arranged in CRD and wherever the treatment of the experiments were statistically analysed as per the procedure given by Gomez and Gomez (1984) [11]. The analysis results were subjected to CRD and wherever the treatment variations were significant the critical difference was worked out at 5% probability (P=0.05). If the treatment differences were non-significant, it was denoted as NS.

Results and Discussion
The fish waste was acidic in pH (6.1) with EC of 3.8 dS/m. The total N, P, K of the fish waste was 10.17, 0.20 and 0.79% respectively (Table.1). It also had an appreciable amount of organic carbon content 46.22%. The calcium and magnesium content of fish waste were 1.86 and 0.15% respectively. Saw dust recorded the highest C:N ratio of 75:1. The total NPK content of the fish waste compost are presented in Table 2. The results revealed that the compost was neutral in pH (7.1) with low soluble salts (EC = 0.38 dS/m). It has 28% organic carbon content and an appreciable amount of N (1.6%), P (0.16%) and K (0.21%).

Table 1: Characteristics of raw materials used for composting (on dry weight basis)

| S. No. | Parameters     | Fish waste | Saw dust |
|-------|----------------|------------|----------|
| 1.    | pH (1: 5)      | 6.1±0.61   | 7.5±0.75 |
| 2.    | EC (1: 5) (dSm⁻¹) | 3.8±0.38   | 0.78±0.08 |
| 3.    | C:N Ratio      | 4.5±0.45   | 75±7.50  |
| 4.    | Organic carbon (%) | 46.2±6.2   | 31.5±3.15 |
| 5.    | Total Nitrogen (%) | 10.17±1.02 | 0.42±0.04 |
| 6.    | Total Phosphorus (%) | 0.2±0.02   | 0.06±0.01 |
| 7.    | Total Potassium (%) | 0.79±0.08  | 0.65±0.07 |
| 8.    | Total Calcium (%) | 1.86±0.19   | 0.31±0.03 |
| 9.    | Total Magnesium (%) | 0.15±0.01  | 0.29±0.03 |

Mean value ± Standard deviation

Table 2: Characteristics of final harvested fish waste compost

| S. No. | Parameters     | Fish waste compost (FWC) |
|-------|----------------|--------------------------|
| 1.    | pH (1: 5)      | 7.1±0.71                 |
| 2.    | EC (1: 5) (dSm⁻¹) | 0.38±0.04               |
| 3.    | C:N Ratio      | 17.1±2.80                |
| 4.    | Organic carbon (%) | 28±0.16                 |
| 5.    | Total Nitrogen (%) | 1.6±0.02                |
| 6.    | Total Phosphorus (%) | 0.16±0.02               |
| 7.    | Total Potassium (%) | 0.21±1.71               |

Mean value ± Standard deviation

Effect on soil properties
The soil was slightly alkaline in reaction both initial (pH-8.2) and post-harvest stage (pH-8.19). Application of FWC slightly decreased soil pH, but this effect was statistically non-significant (Table 3). The decrease in acidity is because of release of mineral acids from fertilizer (Sedberry, 1971), release of organic acids from the decomposition of FWC (Saxena et al., 2001) and excretion of organic acid such as gluconic acid by the microbes (Sunthakumari et al., 2016). The soil EC was significantly affected by various treatments imposed. The highest EC (0.27dS m⁻¹) was observed in the soil receiving RDF + FWC 5 t/ha. The control plot noticed for lowest EC (0.21 dS m⁻¹) (Table 3). The soil EC was low and safe level under all treatments imposed.

| Treatment | pH | EC (dS m⁻¹) |
|-----------|----|-------------|
| RDF + FWC 0 t/ha | 8.21 | 0.22       |
| RDF + FWC 1 t/ha | 8.21 | 0.22       |
| RDF + FWC 2 t/ha | 8.22 | 0.23       |
| RDF + FWC 3 t/ha | 8.20 | 0.24       |
| RDF + FWC 4 t/ha | 8.24 | 0.27       |
| RDF + FWC 5 t/ha | 8.20 | 0.25       |
| Mean | 8.20 | 0.23       |
| SEd | 0.27 | 0.09      |
| CD (0.05) | NS | 0.019     |

Table 3: Effect of fish waste compost (FWC) on soil reaction and electrical conductivity
The soil organic carbon content was higher (0.43%) in treatments receiving FWC 4 t/ha which was on par with treatment receiving FWC 3 t/ha at all the stages (Table 4).

Table 4: Effect of FWC on soil organic carbon status at different stages of black gram

| Treatment         | Organic carbon (%) |
|-------------------|--------------------|
|                  | Vegetative | Flowering | Harvest |
| RDF + FWC 0 t/ha | 0.41       | 0.41      | 0.41    |
| RDF + FWC 1 t/ha | 0.41       | 0.41      | 0.42    |
| RDF + FWC 2 t/ha | 0.41       | 0.41      | 0.42    |
| RDF + FWC 3 t/ha | 0.43       | 0.43      | 0.43    |
| RDF + FWC 4 t/ha | 0.43       | 0.43      | 0.43    |
| RDF + FWC 5 t/ha | 0.42       | 0.41      | 0.41    |
| Mean              | 0.42       | 0.42      | 0.42    |
| SEd               | 0.01       | 0.01      | 0.02    |
| CD (0.05)         | NS         | NS        | NS      |

Ammoniacal& Nitrate Nitrogen (NH₄−N& NO₃–N)
Various levels of application of FWC marked influence on soil ammoniacal & nitrate nitrogen content. The soil NH₄–N ranged from 130 to 144, 125 to 140 and 109 to 125 kg ha⁻¹ at vegetative, flowering and harvest stages respectively. Application of FWC has influenced the NO₃–N at different growth stages of black gram. It varied from 48 to 66, 31 to 55 and 25 to 45 kg ha⁻¹ at vegetative, flowering and harvest stage respectively. Treatment receiving FWC @ 4 t/ha recorded highest value of both NH₄–N and NO₃–N at various stages of crop growth. (Table 5).

Table 5: Effect of FWC on soil NH₄−N & NO₃–N status at different stages of black gram

| Treatment         | NH₄ - N (kg ha⁻¹) | NO₃ - N (kg ha⁻¹) |
|-------------------|------------------|------------------|
|                  | Vegetative | Flowering | Harvest | Vegetative | Flowering | Harvest |
| RDF + FWC 0 t/ha | 98.00      | 95.00      | 88.00   | 45.00      | 31.00      | 28.00   |
| RDF + FWC 1 t/ha | 101.00     | 96.00      | 95.00   | 48.00      | 36.00      | 25.00   |
| RDF + FWC 2 t/ha | 105.00     | 98.00      | 96.00   | 55.00      | 38.00      | 36.00   |
| RDF + FWC 3 t/ha | 120.00     | 116.00     | 106.00  | 60.00      | 46.00      | 38.00   |
| RDF + FWC 4 t/ha | 144.00     | 140.00     | 125.00  | 64.00      | 54.00      | 45.00   |
| RDF + FWC 5 t/ha | 130.00     | 125.00     | 106.00  | 66.00      | 55.00      | 44.00   |
| Mean              | 116.00     | 112.00     | 104.00  | 56.00      | 43.00      | 36.00   |
| SEd               | 8.05       | 7.33       | 6.69    | 2.26       | 2.37       | 1.38    |
| CD (0.05)         | 15.61      | 15.14      | 12.81   | 4.66       | 4.88       | 2.84    |

Available Phosphorus (Olsen-P)
A significant difference on available P status of soil was observed due to various treatments. The mean P ranged from 15.00 to 19.79 kg ha⁻¹. The available P got increased over vegetative stages and decreased there with harvest stage of the crop. The minimum available P was documented without addition of FWC. In respect of available phosphorous in soil, phosphorous availability was increased wherever FWC was applied. (Manikandan and Subramanian, 2010)

Table 6: Effect of FWC on soil available phosphorus status at different stages of black gram

| Treatment         | Soil available P in (kg ha⁻¹) |
|-------------------|------------------------------|
|                  | Vegetative | Flowering | Harvest |
| RDF + FWC 0 t/ha | 15.55      | 11.65     | 10.40   |
| RDF + FWC 1 t/ha | 15.30      | 11.35     | 10.20   |
| RDF + FWC 2 t/ha | 15.45      | 11.53     | 10.25   |
| RDF + FWC 3 t/ha | 18.50      | 14.50     | 14.05   |
| RDF + FWC 4 t/ha | 22.50      | 19.50     | 18.10   |
| RDF + FWC 5 t/ha | 20.50      | 16.50     | 16.10   |
| Mean              | 19.79      | 16.09     | 15.00   |
| SEd               | 0.91       | 0.62      | 0.67    |
| CD (0.05)         | 1.88       | 1.27      | 1.39    |

Available Potassium (NH₄OAc-K)
Various dose of FWC significantly influenced the soil available potassium (Table 7). The soil available K ranged from 269 to 325 kg ha⁻¹ at various stages of crop growth due to the influence of different treatments. A gradual reduction in available potassium was observed as the crop growth advanced.
The soil available potassium increased at vegetative, flowering and harvest stage of black gram due to the addition of RDF along with FWC. Decreasing trend is observed in soil available K from vegetative to harvest stage, this might be due to the crop removal. The similar results are reported by (Dhar et al., 2009; Chaudhary, 2017).

**Effect on crop**

The grain yield of black gram significantly increased due to the application of FWC. The data pertaining to the grain yield (Fig. 1) revealed that grain yield obtained from various treatments ranged from 2.18 to 3.02 g/plant. With respect to various treatments, the highest grain yield of 3.02 g/plant was accounted for RDF + FWC @ 4 t/ha followed by RDF + FWC @ 5 t/ha (2.67 g plant⁻¹). The minimum yield was documented with the control (2.18 g plant⁻¹). The higher grain yield was due to carbohydrate synthesis and translocation of sugars; healthy photosynthesis of crops, phytohormone production of root associated microbes and NPK fertilization. Malewar et al., (1990) [16] and Kumar et al., (2004) [17] reported similar findings in mungbean and turmeric.

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