



Studies on the Effect of Composted Poultry Litter on Seed Germination and Biochemical Changes of *Capsicum annum* and Sustainable Agriculture

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Abstract – One of the major problems of agricultural soils in India is the low organic matter content. Poultry development in the recent past has shown very fast development. This tremendous increase of poultry industry results in substantial amounts of poultry litter, which can efficiently use in solving the present agronomic problems thus leading to sustainable agriculture. The application of poultry litter on land has been a long used disposal method that benefits soil and plant. The environmental problem associated with raw poultry litter application could be mitigated by stabilizing its nutrient and organic matter contents by composting before application to agricultural soils. Composted poultry litter is being applied on agricultural fields as an amendment to provide nutrients and also enhance the organic matter content and improve the physico-chemical properties of the cultivated soils. In the present study, quantitative changes in physical, chemical and microbial properties of composted poultry litter were studied in order to understand the composting process and evaluate the suitability of composted poultry litter as a soil amendment to *Capsicum annum* plant. *Capsicum annum* sps was planted and monitored for growth performance and yield. The effect of land application of composted poultry litter on the seed germination and the bio chemical properties of *Capsicum annum* plants were being evaluated in this case study.

Keywords – Agriculture, *Capsicum* sps, Composted Poultry Litter, Seed Germination, Soil Fertility.

I. INTRODUCTION

Over use of synthetic fertilizers has resulted in grave environmental concerns in many industrial countries while in developing countries they are neither available nor affordable. Economic and environmental issues associated with intensive use of chemical fertilizers have thus generated an interest in alternative management systems. Poultry litter, a combination of accumulated chicken manure, feathers and bedding materials, is a potential feedstock for bio energy and other value-added applications [2]. Poultry wastes contain higher concentrations of Nitrogen (N), Calcium (Ca), and Phosphorus (P) than wastes from other farm animals [30]. Organic mulches made with manures that are rich in nutrients may release significant quantities of nutrients if they are not managed properly [1]. Disposal of poultry litter (PL) is one of the major concerns of poultry farmers in congested cities, who have resorted to burning to reduce the volume available for disposal.

Composting may provide a beneficial alternative method for handling poultry litter due to immobilization of nutrients and a reduction in litter volume. Compost is easier to handle, store, transport and apply than non-

composted organic residues [14]. Studies have shown that the composting process immobilizes N in the litter and produces humus, a source of organic materials and slow release-nutrients [18]. The slow release of nutrients from composted poultry litter (CPL) may lessen adverse environmental effects from leaching of N in run-off from farmlands [3]. N mineralization rates for poultry litter provide the basis for field application rates, but do not guarantee that the amount applied to the soil is fully utilized by the crop. Laboratory and field work has indicated that P may become increasingly available to plants grown in composted poultry litter amended soil [19]. Plant analysis is necessary to document that soil nutrient estimates correlate with nutrient uptake by plants [16].

Poultry litter (manure plus bedding materials) can improve soil tilth, reduce soil compaction, and add organic matter and nutrients to increase soil fertility and productivity [6]. Poultry litter can be applied either as fresh or composted manure [7], [10]. The return of manure to the land completes a natural recycling process. However manure is also known to be a potential source of pollution to the environment [22], [15], [11], [21], [4]. The excessive land application leads to the buildup of soil nutrient levels, especially phosphorus (P) and increases the potential for surface and groundwater pollution through runoff and leaching. Manure management is the critical factor that affects the value of this fertilizer resource [23], [25].

By the year 2010, India is expected to produce 260 million layers (77,700 million eggs) and 3500 million broilers (5.9 million tones). Per capita consumption of meat will be around 3.5 to 4.5 kg and eggs will be around 65 and it is expected to contribute ₹ 60,000 crore. No agriculture sector is growing as fast as the Indian poultry, making it the most dynamic rapidly emerging sector of livestock economy. Indian agriculture contributes 28 per cent to the GDP of which 17% is contributed by poultry. Poultry is the only industry where modern technology co-exists with the traditional poultry keeping because poultry technology is appropriate, adaptable, accessible, available and affordable both for the rich and the poor. As per the last 17th livestock census, the state of Andhra Pradesh ranks first in poultry population (21.0% of the country). Poultry development in the recent past has shown very fast development and at present in A.P. the total population of poultry is 193 millions and from these birds the litter is estimated at 17.70 lakh tons per year. This tremendous increase of poultry industry results in substantial amounts of poultry litter, which can efficiently use in solving the present agronomic problems thus leading to sustainable agriculture.

In Visakhapatnam, small holder vegetable production is a fast expanding enterprise due to the increasing demand from the rapidly increasing urban populations. Vegetable crops fetch attractive prices at local markets and generate income throughout the year. Vegetables provide household nutritional security since they are rich in vitamins, minerals and roughage which constitute the essentials of a balanced diet. Poor fertility is one of the major biophysical constraints to increasing vegetable productivity. The use of Poultry litter as a source of fertilizer would mitigate the problem of poultry litter disposal. Land application of manure has centered mostly on the efficient management of nitrogen and phosphorus. The literature on the evaluation of short-term application of composted poultry litter as a source of nutrients in soil is scanty. Therefore, use of composted poultry litter as manure will result in reduced levels of environmental pollution and brings about sustainable agricultural development.

II. METHODOLOGY

A. Study area

The pot experiments were carried out at Surya Farms, Thagarapuvalasa in Gudivada Village, Vizianagaram Dist, Andhra Pradesh, India during July 2008 to July 2009. Poultry litter was collected from progressive poultry farm in Boyapalem, Visakhapatnam. The test soil was collected from Surya Farm. Analysis of physico chemical characteristics of garden soil was carried out as per standard procedures. Litter was obtained from a poultry farm in Boyapalem consisting of 2000m² concrete floored houses with a stocking density of 20 fowls /m² at the start of each 60-day production cycle; the floor is covered with 5kg/m² of rice hull. It was highly efficient moisture absorbent and constitutes an important source of carbon in poultry litter used as fertilizer [24]. The area is characterized by a bimodal rainfall distribution. The major rainy season starts from end of May - July and the minor season starts from September - November. There is a short dry period in August. The mean annual precipitation is about 1500 mm while mean monthly temperatures range from 24 - 28 °C. Generally, relative humidity is high in the mornings being about 90 % at 06 hours and falling to between 60 and 70 % in the afternoon (15 hours).

B. Sampling

At the end of each production cycle after removal of the birds, the litter was removed with a loading shovel and piled under cover and the floors were washed and disinfected. Specifically ten samples each of 200g were obtained from random points in each pile, at depths of 50-100 cm. These ten samples were then pooled. The final collected composite samples of 2 kg fresh litter is collected.

C. Composting

The poultry litter collected from the poultry farm was composted in a prototype composter (cement vessel). This vessel was constructed with a volume of 250 l. Then it was filled with 120 ± 1 Kg of poultry litter. During composting period, stirring of litter was carried out successively at weekly intervals. Care was taken to retain moisture. After

60 days of composting, the composting material was collected and then transformed in to experimental pots.

D. Plantation

The composted poultry manure was mixed with soil and applied to the pots at different ratios. The composted poultry manure was amended with soil at four rates, 75% (3:1 soil and litter), 25% (1:3 soil and litter), 50% (1:1 soil and litter), 100% litter (control PL), 100% soil (control soil) and soil with of commercial fertilizer (CF) (Table.1).

Table 1: Pattern of arrangement of test pots of Capsicum sps

Pot code	Treatment	Materials used for pot
C _{CS}	Control	10 Kg. of garden soil
C ₃₁	3:1	7.5 Kg. of garden soil and 2.5 Kg. of composted poultry litter.
C ₁₁	1:1	5 Kg. of garden soil and 5 Kg. of Composted poultry litter.
C ₁₃	1:3	2.5 Kg. of garden soil and 7.5 Kg. of Composted poultry litter.
C _{CL}	Poultry litter	10 Kg. of Composted poultry litter.
C _{CF}	Soil with CF*	10 Kg. of garden soil and 1g. of commercial fertilizer

Respective controls were also maintained to compare the results for each treatment. All the pots were labeled with code. The 6 pots of 3 sets were allotted for *Capsicum* species. For irrigation, an equal amount of water was given to each pot at the same time when the mixtures in the pots dried (everyday). 40 days were elapsed as growing period under the controlled conditions. During this period any additional compost were not applied, but endosulfan [5] were given as pesticide.

E. Seed Germination

The rate of germination of seeds and the growth in each pot was observed every day and percentage of seed germination was recorded daily at pre fixed time and the speed of germination was calculated by the following formula [28].

% of Speed Germination Index (% SGI)

$$= 4(7 \times 1G + 6 \times 2G + 5 \times 3G + 4 \times 4g + 3 \times 5G + 2 \times 6G + 1 \times 7G)$$

Where 1G to 7G = seeds germinated on 1st day to 7th day.

No of seeds = 50

Germinatoin % = Number of seeds germinated /number of seeds sown × 100

Germination Index (GI) was determined by the method in [27], [27] using the expression.

Germination Index GI = %G. La / Lc.

Table 2: Percentage of Seed Germination, Speed Germination Index and Germination Index in Experimental pots Soil Amended with different Composted Poultry Litter combinations.

Sample Code	Seed Germination (%)	Speed of Germination index (SGI)	Germination index (GI)
C _{CS}	74	536	-
C ₃₁	80	676	74.84
C ₁₁	54	332	49.18
C ₁₃	32	138	29.14
C _{CL}	16	72	14.96
C _{CF}	74	568	67.40

F. Bio-chemical analysis

Following the 10th day 20th day and 40th day, the 4 types of plants were taken for the Biochemical analysis. The following bio-chemical parameters of plants were analyzed [9], [12].

1. Total Chlorophyll content of leaf
2. Protein content of leaf
3. Total Nitrogen content of leaf
4. Carbohydrate content of leaf
5. Bio mass of plant
6. Growth parameters (Morphometrical):

In order to assess the effects of amendments and cropping systems on plant growth, plant weight and plant height at harvest was measured at the intervals (10th, 20th and 40th day,) of cultivation.

G. Statistical analysis

Data on parameters like SOC, N, P and K of test soils and leaf Chlorophyll content, leaf Total Nitrogen in the test plants) for different time periods were subjected to analysis of variance (ANOVA) using the Minitab 14 statistical package (Minitab, 2007). Means were separated using the Least Significant Difference (LSD) method at 5 % level of probability.

III. RESULTS AND DISCUSSION

The present investigation has been carried out to assess the effect of composted poultry litter on germination and bio chemical changes of *Capsicum* sps.

A. Germination studies

The effect of different soil amendments of composted poultry litter on germination and bio chemical changes of *Capsicum* sps. The *Capsicum* sps cultivated experimental pots showed that, the control (3C_{CS}) 76% and that of poultry litter amended treatment (3C₃₁) 82% seed germination on 7th day of setup (Fig-1). Similar findings were reported by carrying studies on *Fenugreek*, *Amaranthus*, sps grown in different ratios of dairy effluent amendments [13]. The *Capsicum* sps cultivated experimental pots, the control treatment (3C_{CS}) showed 578%, the poultry litter amended treatment (3C₃₁) showed 692% and that of the soil with CF treatment (3C_{CF}) showed the 620% of speed germination (Table 2). These similar findings were reported by carrying studies on *Spinach*, *Fenugreek*, *Amaranthus* and *Mustard* sps grown in different ratios of poultry litter amendments [13]. These results were also in accordance with those results as in [20]. Which conducted studies on germination and biochemical changes Of Ground nut seedlings with Hg.

Seed germination Index (SGI) values of the growth in experimental pots were given in Table-1.2. *Capsicum* sps cultivated in experimental pots, the composted poultry litter treatment (1C₃₁) showed highest (74.84) germination index value and that of lowest germination index value i.e., 12.75 in the sole poultry litter (1C_{CL}) treatment [27]. The change in germination index (GI) was dependent on the physico-chemical properties of soil and poultry litter amendment shown in Table 2.

The plants cultivated in untreated control (without poultry litter, only soil) showed some slight deficiencies of Nitrogen, Protein, Chlorophyll, and Carbohydrate during the intervals of cultivation period and these plants had lower concentrations of several minerals in comparison with plants grown in composted poultry litter amended soil. Application of composted poultry litter (animal manures) as soil amendment, improves the organic manure and plant nutrient concentrations, which lead to increase in plant growth. A positive correlation existed between organic matter and total soil N [8]. In our experiment, manure application ratio had a significant effect on soil organic matter and soil nutrients. According to present study results, application of poultry manure supplied adequate N and minerals for the plants during the course of this experiment. As soil organic matter increased by the application of manures, soil nutrient retention capacity increased. Thus, these results confirm the hypothesize that application of composted poultry litter improves soil nutrient retention and provides the required nutrients to the vegetable plants than commercial fertilizer under conditions of this experiment. Plants grown in composted poultry litter manures did not show any visual symptoms of nutrient delicacy or yield reduction. Plant nutrients from composted poultry litter amended soil showed more Nitrogen (N), Magnesium (Mg), and Calcium (Ca), and thus they had significantly higher yield against control plants during the cultivation period.

Variations in the biochemical parameters of plants grown in experimental pots of different composted poultry litter amended and commercial fertilizer treatments following with poultry litter and soil amendments were presented in Fig.1. Application of composted poultry litter (animal manures) also improved the plant nutrient status and growth yield. The various growth parameters (morphometrical properties) of vegetable plants, like root length, shoot length, root weight and shoot weight values were presented in Fig 1 & 2.

B. Morphometrical studies

The maximum values of root length and shoot length of *Capsicum* plants grown in composted poultry litter amended (3:1) treatment, for 10th, 20th & 40th days were observed as 1.6, 5.3, 7.5 and 8.9, 27.2, 39.5 cm respectively. The minimum values were found in sole poultry litter treatment (100%) 0.9, 4.5, 6.3 and 6.3, 20.5, 31.5 cm respectively for 10th, 20th & 40th days and that of control treatment of (soil without amendment) *Capsicum* showed 1.3, 5.1, 7.2 and 8.5, 25.5, 38.7 cm respectively. The results indicated that the maximum fresh weight of root and shoot weights of *Capsicum* plants grown in composted poultry litter amended (3:1) treatment were

found 0.12, 0.21, 0.39 and 0.26, 1.05, 1.95g for 10th, 20th & 40th days respectively. The minimum fresh weights of root and shoot values recorded were 0.07, 0.14, 0.29 and 0.18, 0.87, 1.68g respectively in sole poultry litter treatment and the control treatment showed 0.09, 0.17, 0.33 and 0.22, 0.95, 1.83g respectively.

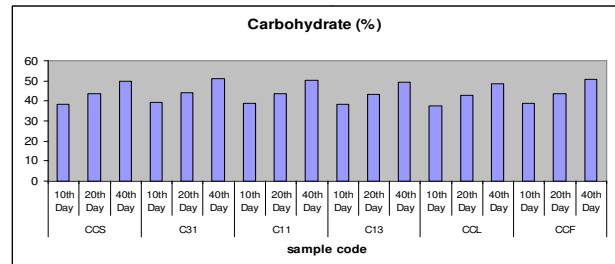
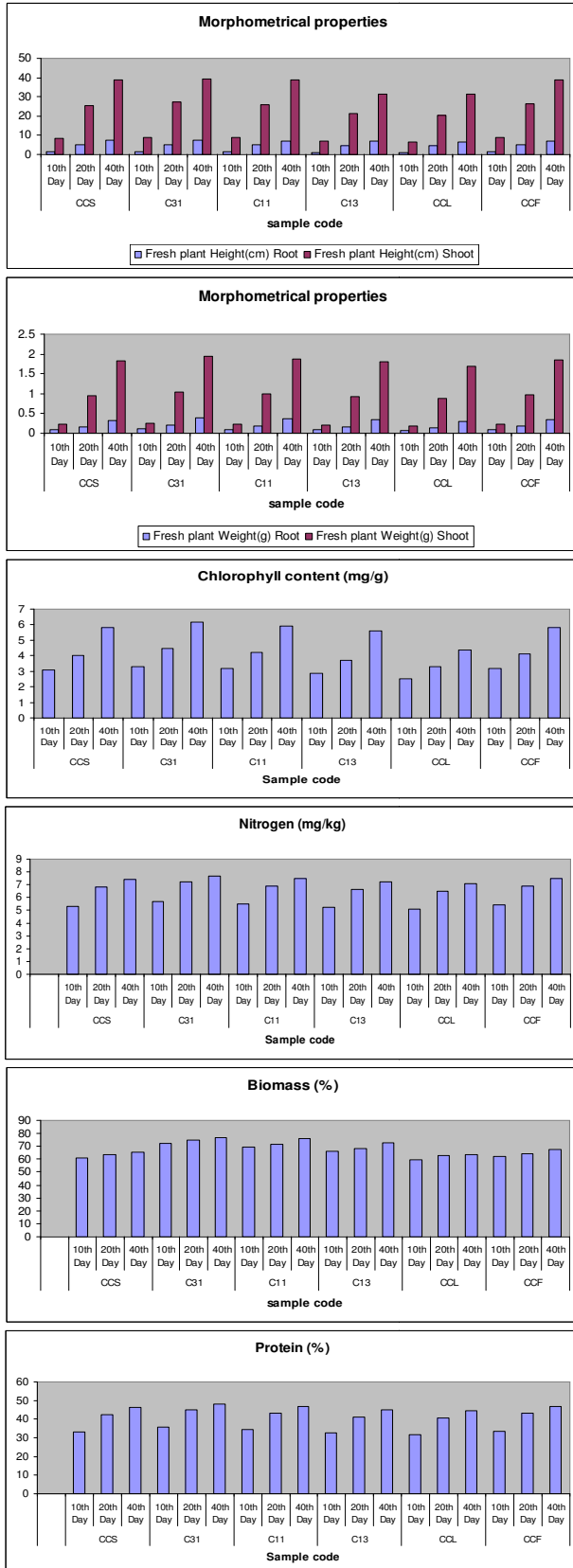


Fig1. Morphometrical and Bio-Chemical Parameters of Germinated Capsicum spp seeds in experimental pots



Fig.2. Capsicum cultivated in experimental pots on 10th, 20th & 40th day

C. Bio- chemical analysis

Out of biochemical properties of *Capsicum* plants, the minimum Biomass yield of *Capsicum* plants grown in sole poultry litter treatment was observed (viz., 59.4, 62.6 and 63.8 %) for 10th, 20th & 40th days. The maximum biomass (72.4, 74.8 and 76.5 %) was found in composted poultry litter amended (3:1) treatment and that of control treatment showed 61.2, 63.5 and 65.2 % respectively for 10th, 20th & 40th days. The minimum leaf Carbohydrate content of *Capsicum* plant was found in sole poultry litter treatment (viz., 37.5, 42.6 and 48.7 %) for 10th, 20th & 40th days respectively. The maximum leaf Carbohydrate content (39.3, 44.2, and 51.2 %) was observed in composted poultry litter amended (3:1) treatment and that of control treatment showed 38.6, 43.5 and 49.8 % respectively for 10th, 20th & 40th days.

Capsicum plants showed minimum amount of leaf Chlorophyll content in sole poultry litter treatment (viz., 2.5, 3.3, 4.4 mg/g) for 10th, 20th & 40th days respectively. The maximum amount of leaf chlorophyll content was found in composted poultry litter amended (3:1) treatment (3.3, 4.5, 6.2 mg/g) for 10th, 20th & 40th days respectively and that of control treatment showed 3.1, 4.0 and 5.8 % respectively for 10th, 20th & 40th days. The minimum leaf Nitrogen content of *Capsicum* plant was found in sole

poultry litter treatment (viz., 5.1, 6.5, 7.1 g/kg) for 10th, 20th & 40th days respectively. The maximum leaf Nitrogen content of *Capsicum* plant was observed in composted poultry litter amended (3:1) treatment (5.7, 7.2, 7.7 g/kg) for 10th, 20th & 40th days respectively and that of control treatment was showed 5.3, 6.8 & 7.4 for 10th, 20th & 40th days respectively. These results indicated that the lower Protein content of *Capsicum* plants for 10th, 20th & 40th days were observed in sole poultry litter treatment (viz., 31.87, 40.62, 44.37 mg/g) for 10th, 20th & 40th days respectively. The higher protein content (35.62, 45, 48.12 mg/g) was found in composted poultry litter amended (3:1) treatment and that of control treatment showed 33.12, 42.5 & 46.25 mg/g for 10th, 20th & 40th days respectively.

IV. CONCLUSION

Composted poultry litter manure application, particularly poultry litter soil amended treatment (3:1) improved the both leaf Nitrogen and Protein concentrations in the cultivated plants. The results showed that there was a significant change in parameters in plants, which were grown in different ratios of composted poultry litter amendments with respect to control. These results are in agreed with [17]. Similar observations were reported by [13], grown plants (leafy vegetables) irrigated with dairy effluent and in the studies on biochemical changes of ground nut seedlings with Hg [20]. In this experiment, other nutrients such as Phosphorus (P), Calcium (Ca), Magnesium (Mg) and Potassium (K) were also incremented by the Composted poultry litter than commercial fertilizer.

RECOMMENDATIONS

Since peak demand of the majority of nutrients (e.g. Nitrogen, Phosphorus, Potassium, etc.) by plants, proper timing of amendments application should be encouraged taking into consideration their peak nutrient release pattern to ensure synchrony. Considering the results of this study, it is recommended that in an area where fertility of the agricultural land is a diminishing quantum, continuous cropping could be sustained with effective nutrient management.

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