

POULTRY MANURE TO CROPS - A REVIEW

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ABSTRACT

Animal oriented manure has a salutary effect on soil fertility besides improving the soil conditions and plant growth. Poultry manure in this regard occupies the pride of place as it is rich in nutrients than the other manures. But, much of the manure now produced under modern methods of rearing poultry contains no litter and contains 70 % moisture making the process of application difficult. At the same time, if stored to reduce the moisture content, nutrient losses occur. Hence, the immediate processing of poultry manure to prevent its nutrient loss is essential. In this context, available literature in respect of nutrient content, effect of composting, effect of application of poultry manure on soil properties, yield and quality of crops and residual effects are reviewed in this paper.

Poultry manure is rich organic manure since solid and liquid excreta are excreted together resulting in no urine loss. In fresh poultry excreta uric acid or urate is the most abundant nitrogen compound (40-70 per cent of total N) while urea and ammonium are present in small amounts (Krogdahl and Dahlsgard, 1981). Deep litter for poultry consists of groundnut shell, rice husk in a layer of 10 -15 cm. When excreta are added, the litter becomes moist but remains aerobic. Aerobic fermentation occurs with the production of heat and loss of some CO₂ and ammonia. The nutritional value of unprocessed poultry manure deteriorates rapidly. Deep litter containing more than 22 per cent moisture, when stored in open air rapidly loses its nitrogen due to high proteolytic activity (Miller, 1984). Hence, the immediate processing of poultry manure to prevent its rapid decomposition and save its nutrient properties is, thus essential.

Composting or the biological degradation of organic wastes has been investigated as a method of stabilizing poultry litter and manure prior to land application. This process of composting produces a material with

several advantages with respect to handling by reducing volume, mass of dry matter, odors, fly attraction and weed seed viability (Sweeten, 1980). Composting poultry manure under anaerobic conditions helps for greater recovery of final product and negligible loss of nutrients particularly nitrogen (Kirchmann and Witter, 1989).

Utilization of cattle dung and poultry litter has been a common practice in India since long time as manure. Farmyard manure and poultry manure can effectively be utilized in conjunction with fertilizers. Even though poultry manure contains more amount of nutrients than other manures, the research work on poultry manure is less when compared to farm yard manure which has been studied extensively, since poultry population is concentrated only in certain areas and hence the manure availability also. In this context, a review of available literatures in respect of effect of FYM and poultry manure on yield and quality of crops, nutrient availability, residual effects and composting assumes importance.

Nutrient content

Nutrient values of poultry manure vary considerably depending upon the conditions

under which it is processed. The ratio of litter to manure and the moisture content caused considerable variation among manures from different houses (Mountney, 1983). Poultry manure is used as a source of N, P and K but litter also contains Ca, Mg, S and some micronutrients (Mullins et al., 2002).

In fresh poultry excreta, uric acid or urate was the most abundant nitrogen compound (40-70 per cent of total N) while, urea and ammonium was present in small quantities (Krogdahl and Dahlsgard, 1981).

Loss of nutrients on storage

The nutritional value of unprocessed poultry manure deteriorated rapidly. Deep litter containing 22 per cent moisture, when stored in open air, rapidly lost its N due to high proteolytic activity (Muller, 1984). Hence, immediate processing of poultry manure was suggested to prevent rapid decomposition. During storage considerable nitrogen losses may occur. In litter of meat poultry, losses upto 30 per cent were found.

Limitations on the use

Mountney (1983) reported that if poultry manure is stored, nutrient losses occur and handling cost increases. The nitrogen availability is too quick that, if care is not taken, burning occurs. Upon direct addition, a plowsole layer of partially decomposed manure was formed, resulting in a perched water table and severely diminished infiltration rate (Edwards and Daniel, 1992). Fresh poultry manure is difficult to handle because of its high water content and cannot be applied to crops due to caustic effects on foliage (Mondini et al., 1996).

Loss of nutrients after application

Nitrogen in poultry litter is present in both organic and inorganic forms that are subject to volatilization, denitrification, immobilization, mineralization, leaching and plant uptake (Castellanos and Pratt, 1981).

Gale and Gilmour (1986) as well as Chescheir et al. (1986) have suggested immobilization was responsible for reducing inorganic N shortly (1-2 weeks) following application of poultry waste. Undigested feed and the litter bedding material (Gale and Gilmour, 1986) have been identified as immobilizing agents.

Mineralisation occurs quite rapidly following application of poultry waste. Bitzer and Sims (1988) found that approximately 69 per cent of organic N in poultry litter incorporated into a sandy loam soil was mineralized in 140 days. Shortly following application, conditions generally favour volatilization of the ammonia-cal - N. Wolf et al. (1988) found that 37 per cent of the total - N in surface applied poultry manure was volatilized in 11 days. Volatilization losses may significantly reduce the amount of N available for plant uptake.

Effect of application on soil physical properties

Poultry manure application at 10 t ha⁻¹ was observed to improve the physical properties of soil (Ravikumar and Krishna-moorthy, 1975). Soil physical properties such as bulk density, water holding capacity and percent water stable aggregation were noted to be favourably influenced by poultry waste addition to soil (Weil and Kroontje, 1979). Mbagwu (1992) reported that poultry manure significantly decreased bulk density and increased total and macroporosity, infiltration capacity and available water capacity. Mullins et al., (2002) revealed that poultry litter contains a considerable amount of organic matter due to the manure and the bedding material. Litter can also have an impact on soil pH and liming due to varying amounts of calcium carbonate in poultry feed.

Effect on nutrient availability

Land applied poultry litter supplied nutrients necessary for crop growth, the most

TABLE 1. Nutrient content of deep litter poultry manure

Total N (%)	Total P ₂ O ₅ (%)	Total K ₂ O (%)	Author(s)
2.87	1.07	1.70	Mountney (1983)
3.03	2.63	1.40	Kirchmann (1985)
1.85	1.81	-	Singh <i>et al.</i> (1992)
2.05	1.95	1.20	Opara and Asiegbu (1996)
2.80	2.30	2.30	Nicholson <i>et al.</i> (1996)
1.60	1.00	1.30	Ugbaja (1996)

TABLE 2. Micronutrient content of deep litter poultry manure

Fe	Zn	Cu	Mn	Unit	Author (s)
1380	90	7.1	210	ppm	Singh <i>et al.</i> (1992)
1050	430	78	530	wgg ⁻¹	Kirchmann and Witter (1992)
842	188	55.8	268	mg kg ⁻¹	Edwards and Daniel (1922)

prevalent being nitrogen (Sims, 1987; Bitzer and Sims, 1988). Adding single super phosphate and poultry manure together to soil resulted in higher P availability. Application of poultry manure decreased the adsorption capacity and increased the soluble P and phosphorus desorption (Reddy *et al.*, 1980).

Increase in available N was noticed when poultry manure; swine manure and FYM were applied to the soil (Rayar, 1984). Sims (1987) reported that corn grain and stover removed 16 per cent of N per year from the slowly mineralized fraction of broiler litter, which left considerable part of soil N. The combination of nitrogen from different organic manures was comparable on equivalent N basis in which poultry manure proved to be a better source (Ketkar, 1993).

Ravikumar and Krishnamoorthy (1983) reported that application of poultry manure increased the available P content of the soil. More and Ghonsikar (1988) reported that the availability of P increased when super phosphate was mixed with poultry manure and applied to soil than application of super phosphate alone. Sharma and Saxena (1990) confirmed that poultry manure followed by castor cake and FYM were found to increase the P availability in soil and nutrient uptake in maize. A marked increase in the exchangeable K due to application of poultry manure upto

24th day after incubation was observed in an incubation study by Madhumita Das *et al.* (1991).

Effect on nutrient uptake

Iyengar *et al.* (1984) reported that poultry manure resulted in significantly higher build up of P concentration in leaf sample of banana five months after planting. Prasad *et al.* (1984) reported that addition of poultry manure alone or in combination with N, P, K, Zn and Fe increased the uptake of Zn and Fe by wheat and rice. More and Ghonsikar (1988) reported that the P content in wheat was significantly higher due to the application of poultry manure with super phosphate. Faiyard *et al.* (1991) recorded an increase in N, P, K, Fe, Mn and Cu contents in faba beans due to the application of poultry manure.

Effect on yield of crops

Poultry manure and FYM recorded higher yields of rice and ragi when combined with inorganic fertilizers (Ravikumar and Krishnamoorthy, 1983). Maximum grain yield of rice was recorded with the application of poultry manure by Prasad *et al.* (1984). Increase in the yield of wheat due to application of poultry manure along with super phosphate was obtained by More and Ghonsikar (1988). Higher grain yields of rice by incorporation of farm wastes and green manures, with the

TABLE 3. Nutrient content of different types of Poultry manure

Particulars	Deep Litter	Broiler House	Cage Manure
C/N Ratio	9.5-11.5	9.4-11.2	5.8-7.6
Total N (%)	1.70-2.20	2.40-3.60	3.63-5.30
Total P ₂ O ₅ (%)	1.41-1.81	1.56-2.80	1.54-2.90
Total K ₂ O (%)	0.93-1.30	1.40-2.31	2.5-2.90
Fe (Ppm)	930-1380	970-1370	970-1450
Zn (Ppm)	90-308	160-315	290-460
Cu (Ppm)	24-42	27-47	80-172
Mn (Ppm)	210-380	190-350	370-590
Ca (%)	0.90-1.10	0.86-1.11	0.80-1.02
Mg (%)	0.45-0.68	0.42-0.65	0.40-0.56

highest yield by poultry manure was obtained under lowland conditions by Budhar *et al.* (1991) indicating, the superiority of poultry manure. Savithri *et al.* (1991) reported that application of coir pith based poultry litter at 6.35 t ha⁻¹ along with recommended levels of NPK registered highest yield of sorghum. Madhumita Das *et al.* (1991) recorded highest grain yield of maize by application 5t of poultry manure + 28 kg P₂O₅ ha⁻¹ as single super phosphate.

Giardini *et al.* (1992) reported an increased yield of onion bulbs due to poultry manure, which produced yields of more than 35 t ha⁻¹. They have also reported that the highest yield of tomato and marketable yield of tomato due to combined application of poultry manure and mineral fertilizers. In ferralitic soils of Nigeria, Oikeh and Asiegbu (1993) obtained highest tomato yields (10 t ha⁻¹) out of poultry and swine manures. Stuart Nakamoto *et al.* (1994) reported that application of 25 per cent recommended commercial fertilizer with 75 per cent biodegraded poultry manure slurry was superior and concluded that poultry manure has potential for supplementing or replacing commercial fertilizer in sweet corn production.

Jayanthi (1995) reported that application of recycled and composted poultry manure resulted in higher grain yield of rice. In a degraded soil in Southern Nigeria, Obi and Ebo (1995) found that average maize grain

yield was significantly improved due to 100 per cent poultry manure application and also in 50 per cent poultry manure + 50 per cent inorganic fertilizer application. Abdel-Magid *et al.* (1995) reported that grain and straw yield of wheat increased with increased rate of chicken manure in Saudi Arabia and obtained the greatest economic return by 8.25 t ha⁻¹.

In Nigeria, Ugbaja (1996) found that castor seed yields were the highest with poultry manure or swine manure applied at the rate of 10 t ha⁻¹. Opara and Asiegbu (1996) observed an increase in the fruit yield of eggplant with increased rates of poultry manure upto 15 t ha⁻¹. Akande *et al.*, (2005) reported that complementary application of rock phosphates with poultry manure increased maize grain yield by 33 and 26 %, respectively while cowpea yield was increased by 25 and 32 % in 2001 and 2002, respectively.

Residual effects

While evaluating the comparative efficacy of poultry manure with or without FYM on the residual effect of wheat grain yield, it was concluded that the residual effect was in the order of poultry manure + FYM followed by poultry manure, FYM and no manure (Gupta *et al.*, 1988).

The relative efficacy of organic manures with respect to residual effect in all soils was the highest in poultry manure followed by FYM and pig manure in Meghalaya

(Madhumita Das *et al.*, 1996). Savithri *et al.* (1991) reported that application of 6.25 t ha^{-1} poultry manure to the first crop of sorghum had significant residual effect on succeeding crop yield and that also increased the nutrient content of the soil. The postharvest soil sample analysis indicated that Sesbania, FYM, biogas slurry and poultry manure application resulted in higher amount of residual N, P and K in the soil (Budhar *et al.*, 1991).

Ibeawuchi *et al.* (2006) reported that in a degraded soil of Nigeria, poultry manure application increased the residual soil N, K, Ca, Mg, and organic matter. The high organic matter with increase in other soil chemical components is an indication that poultry manure has high potential of gradual nutrient release to the soil that can help to improve the fertility of a degraded soil thereby sustaining yield in a continuous cropping system.

Effect on quality of crops

Singh *et al.* (1970) reported that application of poultry manure to cauliflower resulted in the increase of vitamin C, protein and calcium content and a slight decrease in carbohydrate content, with the highest values at 170 g ha^{-1} . In a study to find out the effect of organic and inorganic form of N on fruit qualities of Okra, Abu Saleha (1992) observed an increase in the total carbohydrate, protein and ascorbic acid and a decrease in the crude fiber content due to the application of 10 kg N as ammonium sulphate + 50 kg N as poultry manure. Pimpini *et al.* (1992) observed the best results of processing suitability index in potato for production of both chips and sticks with 4 t ha^{-1} poultry manure. In a similar study, on sugarbeet Pimpini *et al.* (1992) reported higher total and extractable sucrose and a lesser extractable sucrose ratio at 4 t ha^{-1} of poultry manure.

Processing of poultry manure

Before field application immediate processing of poultry manure is needed to

prevent rapid decomposition and loss of nutrients (Muller, 1984). Overcash *et al.* (1983) pointed out that there were several commonly practised methods of storing poultry manure, each of which could affect the quality of the manure at the time of application.

Several researchers (McNeill *et al.*, 1980; Kroodsma, 1985) have investigated "drying" to improve the physical characteristics of the poultry manure. Although drying improves the physical characteristics of the manure while achieving acceptable N conservation, it is limited by cost and mechanical considerations (Flegal, 1988). Similar work has been conducted regarding centrifugation (Ross *et al.*, 1971), vacuum filtration (Cassel *et al.*, 1966) and electro-osmosis (Cross, 1966). The reports indicated that all these methods have proven successful, but the economic feasibility has not been conclusively established.

Composting poultry manure

The C:N ratio of poultry manure is very less, 7.9 as reported by Kirchmann and Witter (1992) and as per Nodar *et al.* (1992) the C/N ratio was 9.7 (for poultry slurry) and 6.3 as per Nicholson *et al.* (1996) for stilt house manure. Composting, or the controlled biological decomposition of organic waste, has been investigated as a method of stabilizing poultry litter and manure prior to land application. This process produced a material with several advantages with respect to handling by reducing volume, mass of dry matter, odors, fly attraction and breeding and weed seed viability (Sweeten, 1980). The heat generated during composting may also destroy pathogens (Golueke, 1977).

Conservation of nitrogen was also better under anaerobic storage conditions (Kirchmann, 1985). Kirchmann and Witter (1989) reported that low losses of N occurred under anaerobic conditions but it was higher under aerobic conditions. Composting poultry

manure and poultry carcasses, with straw as carbon source successfully decomposed the manure and carcasses and produced a stable organic material physically and chemically similar to the manure used in the composting process (Sims *et al.*, 1992).

Kirchmann and Witter (1992) reported that the C/N ratio of anaerobically decomposed poultry manure was 17.9 as against 11.7 in aerobically decomposed poultry manure. Sims

et al. (1992) found that the C/N ratio of poultry compost was 18.3.

The foregoing review revealed the importance of poultry manure, its effect on soil properties, nutrient supplying ability, yield and quality of crops and also the limitations to the use and the method of composting poultry manure before application. It can be concluded that poultry manure can be efficiently used for the crops after composting the same to save the nutrients.

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