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FEATHER MEAL AS A POTENTIAL SOURCE OF ORGANIC NITROGEN FERTILIZER

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ABSTRACT

Laboratory and greenhouse experiments were carried out to study the mineralization rate of nitrogen from feather meal and its effect on growth and chemical composition of spinach plant on sandy and clay soil. The release of inorganic N from feather meal incubated with clayey and sandy soil was monitored as a function of time.

During the first week of incubation considerable amount of NH_4-N was recorded, however small amount of nitrate was noticed. The amount of NH_4-N released from feather meal was higher with time up to 14 days of incubation in both sandy and clay soils. With respect to the effect of feather meal on growth and plant composition of spinach plant. It was revealed that feather meal applied at the rates of 0.2 % and 0.4 % had a predominant effect on dry matter production of the spinach plant rather than the other treatments for both sandy and clay soils. Application of feather meal gradually increased the total nitrogen content in the plant tissues.

Feather meal at the rate of 0.2 % gave the highest value of N recovery for both types of soil as compared with other treatments. Also, result revealed that total inorganic N in spinach plant increased in control as compared with feather meal treatments in both soils. Potassium and phosphorus content and uptake increased with application of feather meal. Feather meal increased residual total N and NH_4-N content in soil while decreased NO_3-N accumulation for both two soils.

INTRODUCTION

Organic Farming system is based completely on the decomposition of organic materials. For commercial crop production the farmers can not depend on organic amendment as the main source of available nitrogen and need materials that release nitrogen at a greater rate for pre planting or top fertilization (Ciavatta *et al.*, 1990).

In organic farming, where the use of chemicals is prohibited, poultry and dairy manures having a high N content serve as a nitrogen fertilizer. Supplementary N side dressing is needed in organic cropping systems when the release of available N from soils and composted manures applied annually is in adequate to meet crop requirements. Such conditions prevail in soil which have recently been converted to organic farming or in high N demanding crops (Doran *et al.*, 1987, Liebhardt *et al.*, 1989 and Lockeretz *et al.*, 1981).

Feather meal is a by-product of the poultry processing industry which contains 10-15 % nitrogen as non soluble keratin and can be promising as organic fertilizer. Hadas and Larissa Kautsky (1994).

Feather meal contains 75-85 % protein and about 2-13 % crude fat, and it is considered to some what a poor source of protein for animal nutrition

because of its slow degree of digestion. However, in the soil, prolonged decomposition of protein rich materials such as feather meal may be advantageous for improving nutrient status particularly nitrogen in addition to effectiveness of soil microflora for its decomposition (Bielorai *et al.*, 1982). To improve yield stability; various keratin sources such as feather mail, hair, skin and horn meal as well as some plant proteins, were incorporated into composts as slow release fertilizers. Hydrolyzed feather meal and extruded maize protein at rate of 1 % increased yield by 6 kg/m² compared with the untreated control (Overstijns and Backstacle 1988 and Gagnon and Berrouard, 1994).

The objective of this study was to determine the rate of nitrogen mineralized from feather meal treated soil and its effect on the growth and chemical composition of Spinach plant.

MATERIALS AND METHODS

Laboratory experiment :

Sandy and clay soils were used for this study. Three hundred grams of 2 mm sieved air dried soil were treated with feather meal at the rate of 0.5 % and placed in wide mouth 400 ml plastic containers. Treatments were replicated and kept under controlled conditions, moisture content was maintained at 60 % of water holding capacity through the incubation periods. Samples were taken at intervals of 1,3,7,10,14,21,28,42,56 and 70 days. Determination of NH_4-N and NO_3-N followed as described by Black (1982).

Pot experiment :

A pot experiment was carried out in the greenhouse at National Research Centre. Sandy and clay soils were selected for this study. The sandy soil was characteristics as follows :
pH 7.8, EC 0.13 $ds.m^{-1}$, $CaCO_3$ 3.5 %, organic matter content 0.23 % clay content 3.2 %, silt content 4.7 % and sand 92.1 %. The clay soil had the following characteristics, pH 8.25 EC 0.49 $ds.m^{-1}$ organic matter 0.82 % clay content 50.9 % silt content 33.2 % sand, 15.9 %. Feather meal used in this experiment was Homogeneous powder containing 98 % dry matter (dried at 65°C). Feather meal contains about 8.84 % as a total nitrogen and a soulable nitrogen was about 605 mg/kg Feather meal. Pots were filled with 8 kg of air dried soil. Feather meal was applied at rates of 0.1, 0.2, 0.4 and 0.8 %, mixed with soil. Phosphorus and potassium were applied at rate of 50 and 40 mg P and K/kg soil as superphosphate and potassium sulphate, respectively, for control soil in both sandy and clay soil the nitrogen fertilizers at rate of 90 mg/kg were used as a recommended rates in order to compar between the feather meal treated soil and control soil.

five seeds of Spinach (*Spinucia oleracea* L.) /pot were used as test plant seeds were sown and harvested after 60 days from plantation thinning. Fresh and dry weight were recorded and prepared for analysis. Total N, in plant and soil were determined according to the methods described by Bramner and Mulvaney (1982). Ammonium and nitrate nitrogen were

determined according to Cottenie *et al.* (1982). Phosphorus and potassium were determined using a spectrophotometer and a Flame photometer as described by Cottenie *et al.* (1982).

RESULTS AND DISCUSSION

Incubation experiment :

Data in Figure (1) indicate that two processes of N transformation are at hand, the first process is largely related to the mineralization of the organic-N into mineral N. Thus the rate of NH_4 release increases gradually from the beginning of the incubation period up to 14 days of incubation. This does not exclude the occurrence of the second process which is nitrified of NH_4 to NO_3 in a rather slow rate. The following period which started after 14 days characterized by a steady decrease in NH_4 and a parallel steady increase in nitrate indicating that the process of nitrification reached its maximum up to the end of the incubation period. The two different soils used in this experiment showed the same trend of feather meal transformation, however, with different magnitude. The mineralization rate of feather meal in sandy soil did not exceed 5 mg day^{-1} in the first two weeks whereas it reached 8 mg day^{-1} in clay soil in the same period also, the nitrification rate in both soils had the same trend. However, the second and third phases of the experiment indicated a rather quick nitrification rate in clay soil than in sand soil. Nitrate build up in clay soil reached 77.7 mg N/kg corresponding to only 52.7 mg N/kg in sand soil. These results indicate that feather meal can create a considerable amounts of NH_4 which can be nitrified gradually particularly in clay soil then sandy soil which empathize the assumption of using feather meal as a slow release fertilizer for nitrogen.

The nitrate-N concentration changed slightly with time of incubation. Data also show that NO_3-N content increased in clay soil as compared with sandy soil. This increase may be due to higher microbial activity in clay soil than in sandy soil. The first considerable amount of nitrate were obtained after one day in clay soil while after 10 days of incubation was occurred in sandy soil.

Biological experiment :

Effect of feather meal on fresh and dry matter production :

Data in Table (1) show that fresh and dry weight of spinach plant tended to increase in both soils under study as a result of applying feather meal with different rates as compared with the control. This result is confirmed by Russo (1993) and Gagnon and Berrouards (1994). They reported that hydrolysed feather meal and extruded maize protein at rate of 1 % increased yields by 6 kg/m^2 compared with the untreated control. It was observed that fresh and dry matter for spinach plants grown in the clay soil treated with feather meal with different rates were higher when compared with the sandy soil.

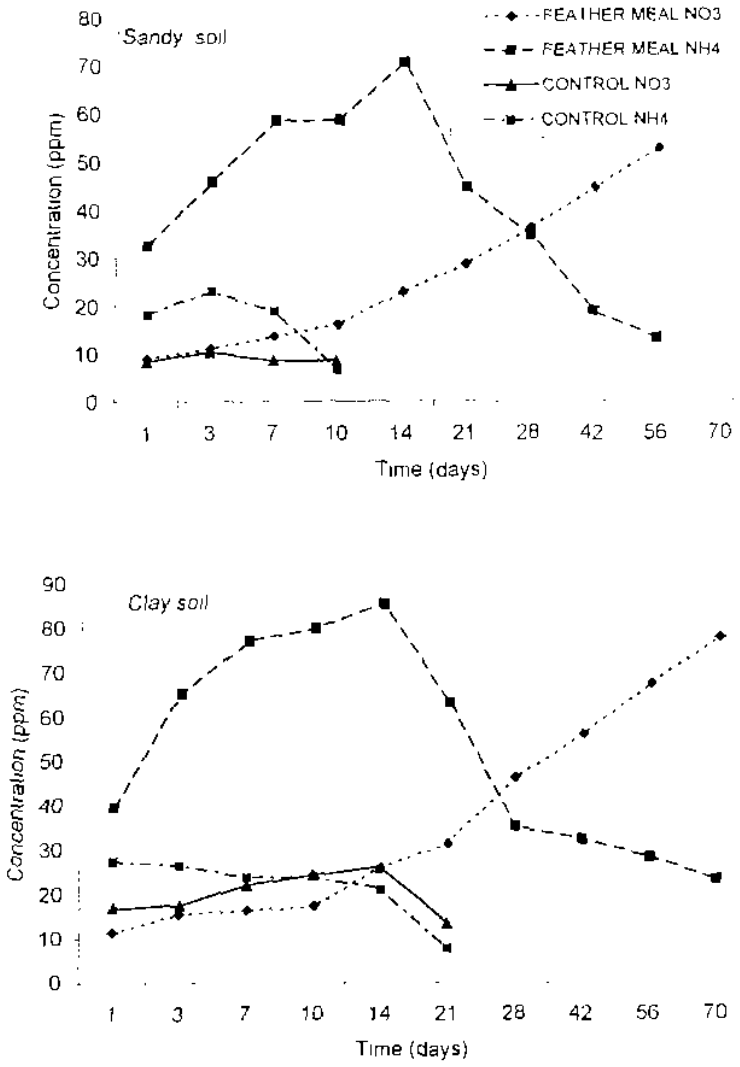

Fig (1): NH_4-N. NO_3-N released out from incubation as affected by feather meal.

In the same time data show that applying feather meal at rate 0.2 % and 0.4 % were more effective in producing fresh and dry matter than the other rates for both sandy and clay soil.

Results show also that the high rate of feather meal cause a reduction in both the fresh and dry matter. This phenomena may explained either by low solubility or by low digestibility of the feather meal. These process can not supply nutrient elements for plant growth. Aviva *et al.* (1994). They reported under suboptimal field conditions the rate of mineralization might be smaller. The slow release of inorganic nitrogen was attributed in part to retension of N by the microbial population (immobilization) that developed while decomposing of feather meal and its decay products which depending on the amount of available carbon in the soil and nitrogen which may vary among soils.

Table (1) : Effect of applied feather meal rates on fresh and dry weight of spinach plant.

Treatments	Sandy soil		Clay soil	
	F.w. g/pot	D.w. g/pot	F.w. g/pot	D.w. g/pot
Control	8.00	1.2	13.99	1 61
Feather meal 0.1 %	17.61	2.21	23.49	2.64
0.2 %	23.01	2.67	51.19	4.65
0.4 %	26.01	2.86	56.97	5.49
0.8 %	15.61	2.15	34.78	3.41

Data showed that application of feather meal stimulate the fresh weight of spinach plant. At a rate of 1 % the fresh weight of the spinach plant was increased by about 120 % and 250 % relative to control for both sandy and clay soil. Results also cleared that increasing rate of application gradually increase the fresh weight except at high rate particularly for sandy soil. Similar trends were observed in case of dry weight of the spinach plant.

Effect of feather meal on N content, uptake and easy extractable N in spinach plant :

The concentration and uptake of nitrogen in spinach plants grown in sandy and clay soil treated with different rates of feather meal are recorded in Table (2). Data indicate that all treatments tended to increase nitrogen concentration and uptake as compared with the control. It is of interest to mention that N concentration in spinach plant with respect to type of soil and rate of feather meal was very clear.

Taking the nitrogen uptake into consideration, data in the same table show that N uptake increased in the clay soil than sandy soil. This increase seems to be due to the increase in dry matter formation. Application of feather meal at rate of 4 % gave the highest value of N recovery for both sandy and clay soil (76.47 and 226.09 mg/pot) respectively.

Results observed that application of feather meal in clay soil resulted in an increased the concentration of N-the highest N concentration 5.56 %

was observed in clay soil particularly at high rate of feather meal (8.00 %). However, about 4.3 % of nitrogen was recorded for sandy soil at the same rate (8.0 % of feather meal).

Table (2) : Nitrogen content (%), uptake (mg/pot) and N recovery (mg/pot) in spinach plant as affected by feather meal.

Treatments	Sandy soil			Clay soil		
	%	mg/pot	N recovery mg/pot	%	mg/pot	N recovery mg/pot
Control	3.78	45.36	-	4.03	64.88	-
Feather meal 0.1 %	3.77	83.31	37.95	4.66	123.02	58.14
0.2 %	4.22	112.67	67.31	4.74	220.41	155 53
0.4 %	4.26	121.83	76.47	5.30	290.97	226.09
0.8 %	4.29	92.23	46.87	5.56	189.59	124.71

It was observed that application of feather meal for both sandy and clay soils gradually increased the NH_4 and NO_3 in spinach plant. Results noticed that at 1 % feather meal an increased of NH_4 in the spinach plant was about 20 % and gradually increased by increasing the feather meal. Data in Fig. (2) show that application of feather meal were more effective for increasing the control of both NH_4 and NO_3 in spinach plant as compared with sandy soil.

Effect of feather meal on P and K content and uptake in spinach plants :

The effect of feather meal application on the P and K concentration in spinach plant was shown in Table (3). Results observed that application of feather meal resulted in an increase in the P uptake by spinach plant for both sandy and clay soils. However, feather meal was more pronounced effect in clay soil that in sandy soil due to the differences in its physiochemical properties. The high increase in P was clear in 0.8 % feather meal rate in the clay soil (0.81 %) as compared with other treatments for both two soils under study.

Potassium concentration in spinach plant was increased with increasing feather meal in the clay soil as compared with the sandy soil. In the clay soil data indicated that higher increase in K content was noticed in 0.1 % feather meal (8.2 %) as compared with other treatments. However, the uptake of the potassium were always increased in spinach plant as affected by feather meal application as compared to the control soil. Results also noticed that application of feather meal on the uptake of potassium for both sandy and clay soil was dissimilation. Concerning P and K uptake data illustrate that the uptake was higher in the clay soil compared to the sand soil for both P and K.

The differences due to the low content of the potassium in the feather meal and also due to its difference in chemical properties of the soil It was observed that application of feather meal were gradually decreased the potassium content in the spinach plant particularly in sandy soil.

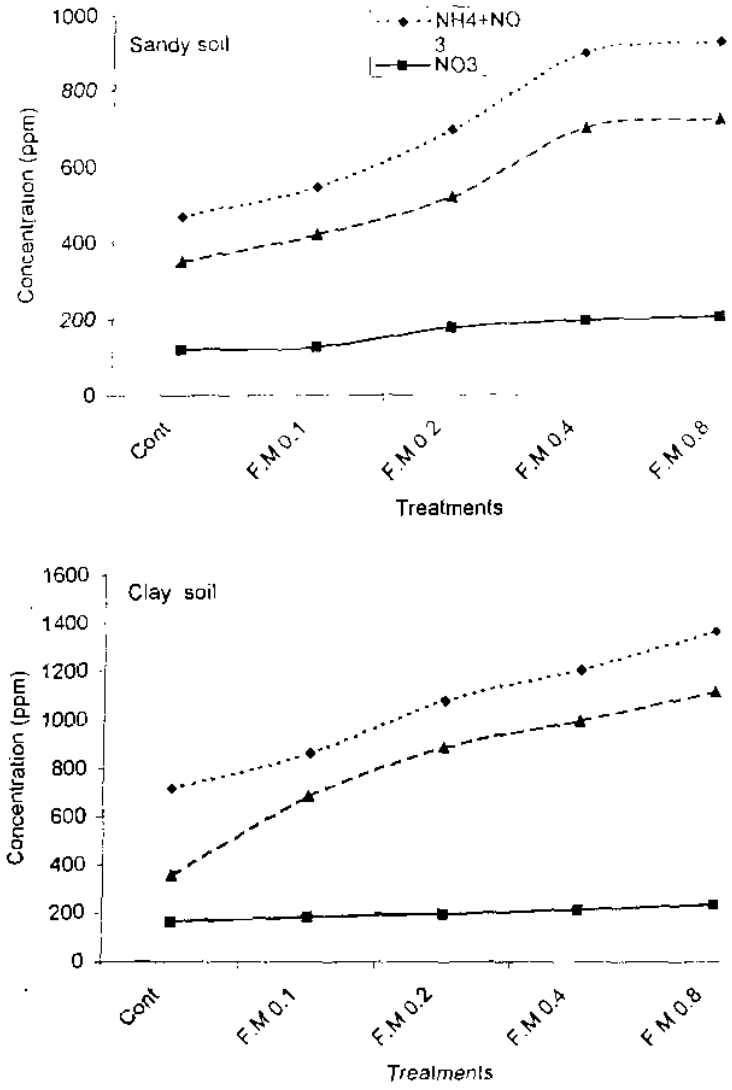

Fig.(2). Effect of feather meal on NO_3-N content in spinach plants

Table (3) : Effect of feather meal treatments on P and K content and uptake in sandy and clay soil of spinach plant.

Treatments	Sandy soil				Clay soil			
	P		K		P		K	
	%	mg/ plant	%	mg/ plant	%	mg/ plant	%	mg/ plant
Control	0.32	3.84	7.3	87.6	0.61	9.82	6.5	104.65
Feather meal 0.1 %	0.40	8.84	6.3	139.23	0.53	13.99	8.2	216.48
0.2 %	0.32	9.15	5.8	165.88	0.51	27.45	7.9	433.71
0.4 %	0.43	11.48	4.7	25.49	0.57	26.50	6.9	320.85
0.8 %	0.41	8.81	4.9	105.35	0.81	27.62	6.5	221.65

Residual ammonium, nitrate and total N in soil after harvesting :

The residual total N and the form of NH_4-N and NO_3-N content in soil after the harvest of spinach plants from the two soils under investigation are illustrated in Table (4). Data show that feather meal increased total N and NH_4-N content in soil, while decreased NO_3-N accumulation for both sandy and clay soil. The highest increase was observed in the clay soil as compared with the sandy soil.

The residual total N and extractable fractions of nitrogen (NH_4-N, NO_3-N) content in the soils after the harvest of spinach plants are illustrated in Table (4). Results observed that application of feather meal increased. The residual fraction of nitrogen as well as the extractable one. Feather meal increased the ammonium-nitrogen (NH_4-N) due to mineralization the organic nitrogen. However, NO_3-N in the soil decreased due to d nitrification process. This process was more pronounced effect in sandy soil for the clay soil. With regard to the effect of feather meal application, it is clear that 0.8 % gave higher values of residual total N for both soils (0.053 % and 0.195 % respectively).

Also, data indicated that increasing feather meal application increased total N, NH_4-N content in soil.

Table (4) : Residual ammonium, Nitrate (ppm) and total N % in the two soil after harvesting.

Treatments	Sandy soil			Clay soil		
	NH_4-N	NO_3-N	Total N	NH_4-N	NO_3-N	Total N
Control	110.03	17.36	0.025	130.76	110.10	0.115
Feather meal 0.1 %	175.20	27.40	0.035	169.66	51.65	0.139
0.2 %	180.26	19.56	0.051	169.60	91.20	0.155
0.4 %	165.50	40.77	0.043	204.66	99.73	0.186
0.8 %	180.13	59.0	0.053	236.27	145.90	0.195

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استخدام مخلفات الدواجن (ريش الطيور) كمصدر من مصادر النتروجين العضوى

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اجريت تجارب معملية وزراعية على مخلفات الدواجن (ريش الطيور) كاحد المصادر الهامة للنتروجين العضوى وذلك بصوبة المركز القومى للبحوث باستخدام نوعى ارض (رملية ، طينية) بغرض دراسة مدى امكانية استخدام مخلفات الدواجن كمخلف عضوى غنى بعنصر النتروجين وتأثير ذلك على نوعية وانتاج محصول السبانخ – حيث تشير النتائج للأتى :

- وجد ان اضافة ريش الدواجن للتربة فى تجربة التحضين ادى الى انطلاق النتروجين الغير عضوى طوال فترات التحضين كما وجد ان الامونيوم المنطلق قد زادت عن كمية النترات خلال الاسبوع الاول من التحضين وان معدل انطلاق الامونيوم وصل الى اعلى كمية له بعد ١٤ يوم من التحضين .
- ادت اضافة مخلفات الدواجن (ريش الدواجن) الى زيادة المادة الطازجة والجافة للسبانخ اذا ماقورن بالارض الغير معاملة كما ان زيادة نسبة الوزن الجاف والطازج للنباتات كانت اعلى عند معدلى الاضافة من مخلفات الدواجن (٠,٢ %، ٠,٤ %) وكذلك اوضحت التجارب ان المعدل العالى من مخلفات الدواجن ٠,٨ % ادت الى نقص فى حصول السبانخ لكل من الارض الرملية والطينية معا .
- اوضحت التجارب ان اضافة مخلفات الدواجن ادت الى زيادة تركيز فى عنصر النتروجين وكذلك معدل الامتصاص بواسطة نبات السبانخ الا ان التركيز العالى من مخلفات الدواجن ٠,٨ % ادى الى نقص النتروجين الممتص بواسطة نبات السبانخ .
- اضافة مخلفات الدواجن بمعدل ٠,١ % ادى الى زيادة كل من النترات والامونيوم فى نبات السبانخ بالمقارنة بالمعدلات الاخرى التى ادت الى نقص تركيز الامونيوم والنترات كذلك ادت اضافة مخلفات الدواجن الى زيادة امتصاص عنصرى الفوسفور والبوتاسيوم .
- اوضحت التجارب ان كمية النتروجين المتبقية والميسرة قد زادت بزيادة معدلات اضافة مخلفات الدواجن .