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Effect of Nitrogen Amendments and Incubation Periods on N, P, and K Contents of Various Manure Types

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ABSTRACT. A field trial was conducted to study the effect of N-amendments and incubation periods of N, P, and K contents of chicken, cow and sheep manures. Results revealed that manure N, P and K contents were highest in chicken manure followed by sheep and cow manures, respectively. N and P were significantly affected by N-amendments; whereas K was not affected. Highest N mineralization was obtained at 0.1 and 0.5% N, while highest P mineralization was observed at 0 and 0.1% N.

Incubation period significantly affected manure – N, P and K contents. Highest N and P contents were recorded at 0-week incubation period followed by 2, 4, 6 and 8-week periods, respectively. On the other hand, K content was highest at 8-week incubation period, followed by 6, 4, 2 and 0-week periods, respectively.

Introduction

Manure decomposition in the soil depends partly on manure type. Manure mineralization is governed by many factors, among which are manure type, incubation period, temperature, moisture and element constituents manure. Mineralization rate was found to correlate with the quantity of mineral N and the square root of time (Stanford and Smith, 1972; Stanford *et al.*, 1977; Talpaz *et al.*, 1981). Evidence for the role of N amendments on manure mineralization was also reported (Guenzi *et al.*, 1978; Kirchmann and Witter, 1989).

The objective of this study is to monitor the chemical changes in elemental contents of selected manures incubated for different periods under field conditions.

Materials and Methods

A field trial was initiated on the 8th of May 1989 in Hada Al-Sham Research Station, King Abdulaziz University, Jeddah, Saudi Arabia, with treatments arranged in $3 \times 3 \times 5$ factorial experiment. Treatments included three N-amendment levels (0.0, 0.1 and 0.5% N), three manure types (chicken, cow and sheep) and five incubation periods (0, 2, 4, 6 and 8 weeks). Treated manure were incubated in holes (60 cm diameter $\times$ 100 cm depth); sprayed with N solution and thoroughly mixed with water to allow manure equilibrium. Each of the mixed manure was then pressed to expel air and then covered by wood sheets during the incubation period. Manure samples (6 kg each) were draw at zero incubation time, and then every two weeks for a period of eight weeks. Manure samples were kept frozen in plastic bags before being prepared for laboratory analyses.

The following determinations were made: organic C by Walkley-Black method (Jackson, 1973); total N according to Bremner (1965); N content by using a Kjeltec auto 1030 analyzer (Tecator) and total P and K by the perchloric-nitric digestion method (Shelton and Harper, 1941). P content was quantified at 640 nu wavelength using a Turner spectrophotometer; while total K was measured using Corning 400 flame photometer.

Results and Discussion

The initial contents of each of the studied manure analysis prior to the addition of the N-amendments are shown in Table 1. It is evident that chicken manure had the highest elemental constituents followed by sheep and cow manure respectively in a decreasing order.

TABLE 1. Chemical composition of chicken, cow and sheep manures used for experimental treatments.

Element	Manure ($g\,Kg^{-1}$)		
	Chicken	Cow	Sheep
N	15.700	6.586	10.68
P	3.680	0.942	1.83
K	23.760	13.850	15.96
C	254.340	84.560	277.89
C : N	16.2 : 1	12.84 : 1	26.02 : 1

Nitrogen and Phosphorus

Manure N and P contents were significantly ($P = 0.01$) affected by manure type, N-amendment and incubation period. Meanwhile, the interactions of manure type with each of N-amendment levels and incubation periods were also significant (Table 2).

TABLE 2. Summary of analysis of variance for the place of manure incubation.

Variable		N	P	K
A	OSL	0.000**	0.000**	0.000**
B	OSL	0.000**	0.004**	0.302
AB	OSL	0.009**	0.020**	0.000**
C	OSL	0.000**	0.000**	0.000**
AC	OSL	0.000**	0.378	0.000**
BC	OSL	0.107	N.S.	0.062
ABC	OSL	0.107	N.S.	0.062
EMS		0.004	0.001	0.027
DF		88	88	88

*Significant at 0.05 level **Significant at 0.01 level

OSL = Observed statistical level
EMS = Error mean square
DF = Degree of freedom
A = Manure type
B = Nitrogen amendment
C = Incubation time

The average contents of N and P were significantly highest in chicken manure followed by those in sheep and cow manures, respectively (Table 3). N-amendment levels of 0.1 and 0.5 exhibited significant effects on increasing manure N-content compared with 0.0 level (Table 3). Contrarily, N-amendment levels of 0.0 and 0.1% had the highest effect on P-content compared with that of 0.5% (Table 3).

TABLE 3. Average N, P, K, and their tests of significance* for field experiments.

Factors means			N	P	K
A	B	C		$g\,Kg^{-1}$	
Manure type (A)					
1			10.50 A	2.93 A	16.67 A
2			5.97 C	0.97 B	9.44 C
3			9.20 B	1.10 B	12.91 B
L.S.D.**			0.27	0.13	0.69
Nitrogen treatment (B)					
1			8.20 B	1.74 A	12.90 A
2			8.83 A	1.70 A	13.32 A
3			8.64 A	1.56 B	12.81 A
L.S.D.			0.27	0.13	0.69

TABLE 3. Contd.

Factors means			N	P	K
A	B	C		$g\,Kg^{-1}$	
Incubation period (C)					
1			12.09 A	2.08 A	8.44 E
2			9.75 B	1.83 B	9.81 D
3			8.51 C	1.52 C	12.52 C
4			7.11 D	1.50 C	15.62 B
5			5.33 E	1.41 C	18.65 A
L.S.D.			0.34	0.17	0.89

* Every two means having at least one liter in common do not differ significantly, otherwise they do.
**L.S.D. = Least Significant Difference at 0.05.

A – Manure type	B – Incubation period	C – Nitrogen amendment
1 – Chicken manure	1 – 0 weeks	1 – 0.0 % N
2 – Cow manure	2 – 2 weeks	2 – 0.1 % N
3 – Sheep manure	3 – 4 weeks	3 – 0.5 % N
	4 – 6 weeks	
	5 – 8 weeks	

The average N and P contents were significantly highest at 0-week incubation period followed by 2, 4, 6 and 8-week periods (Table 3). This reduction in N and P contents is mainly attributed to the mineralization rate of the organic materials by soil microorganisms (Meek *et al.*, 1982; Kirchmann and Witter, 1989).

Regarding the joint effects of incubation period with manure type (Fig. 1) and N-amendments (Fig. 2) there was a gradual decrease in both N and P contents of chicken, cow and sheep manures with increasing the incubation time (Fig. 1) or in their average contents under each of the N-amendments (Fig. 2). The reduction observed in the average contents of N and P with time is basically related to the mineralization process of organic matter (Miller, 1974; Stanford and Smith, 1976; Saber *et al.* 1977; Meek *et al.* 1979) and probably to the washing effect of rains occurred during the incubation period (Pratt and Laag, 1981).

Potassium

K content was significantly ($P \leq 0.01$) influenced by manure type and incubation period. On the other hand, interactions among manure types with N-amendments and incubation periods were also significant. N-amendments showed no effect on K content (Table 2). Similar to the case of N and P, the highest K content was observed in chicken manure followed by sheep and cow manures, respectively (Table 3). This behaviour was ascribed to the initial content of chicken manure (Table 1) which exhibited the highest elemental content followed by sheep and cow manures (Deschenes and Dubuc, 1979).

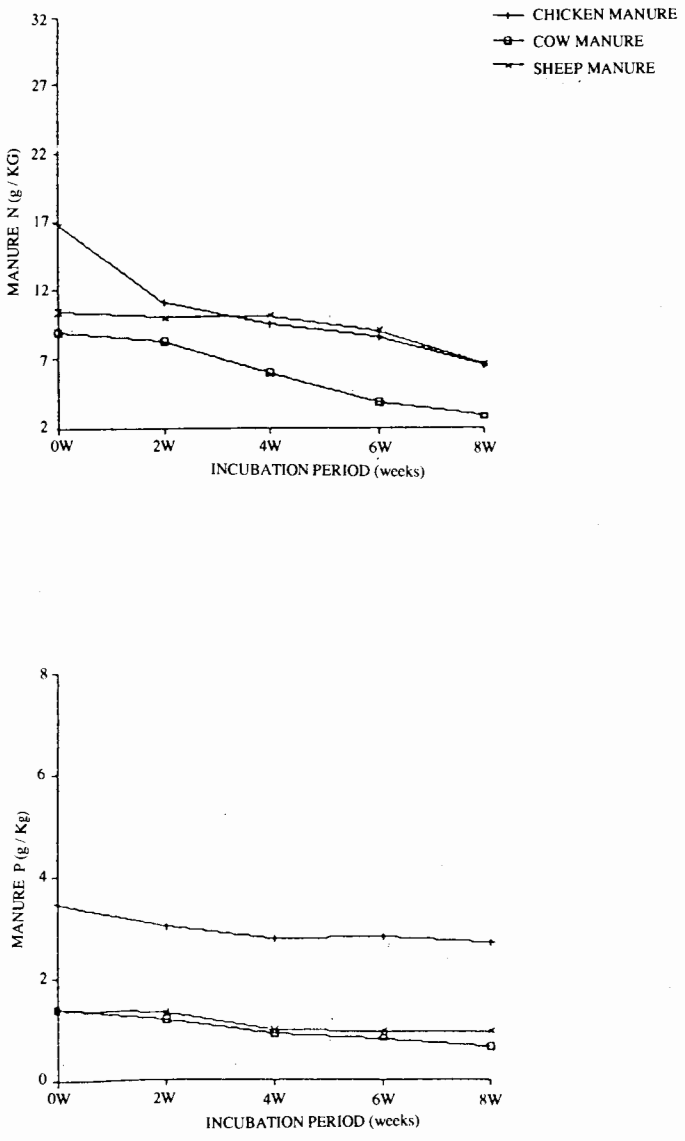

FIG. 1. Effect of incubation period on total N and P contents of three different manure types.

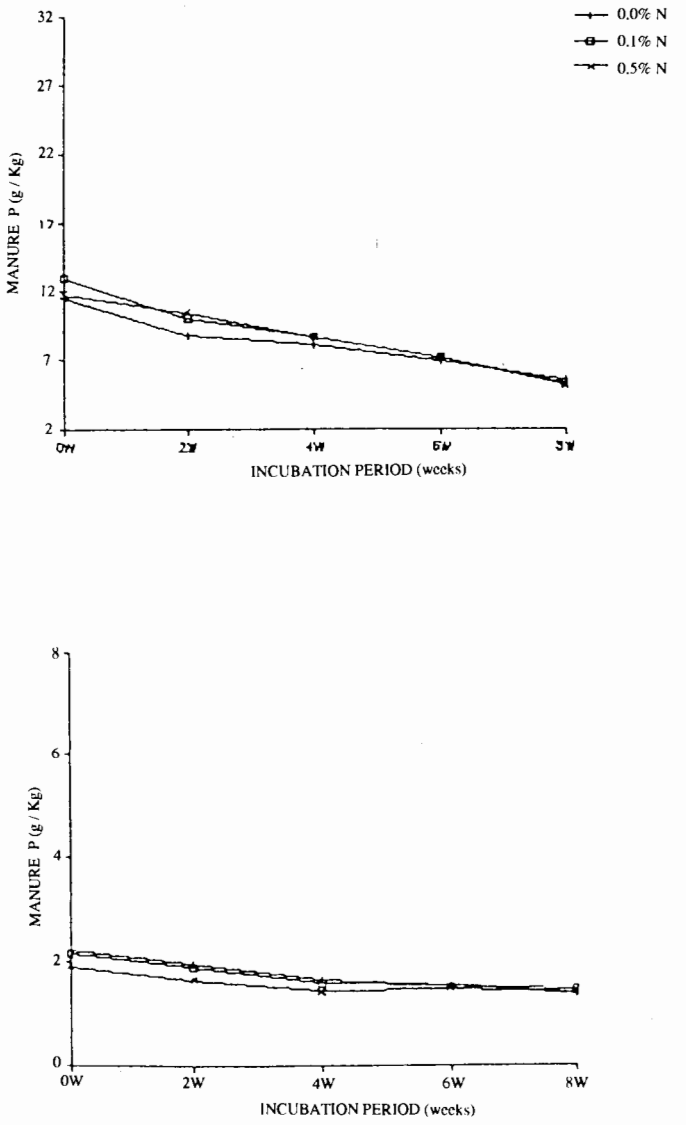

FIG. 2. Effect of incubation period on total N and P contents at three N-amendments levels.

A gradual increase in K content with the increase in incubation period was observed (Table 3). The highest K content was recorded at 8-week period followed by 6, 4, 2 and 0-weeks, respectively (Meek *et al.* 1982), (Table 3).

Joint effects of incubation period with manure type (Fig. 3) and N-amendments (Fig. 4) on K-contents indicated a gradual increase in the K contents of each of the studied manures (Fig. 3) and in their average contents under each of the N-amendments. Interactions in the first case were significant ($P \leq 0.01$) while those in the second were not.

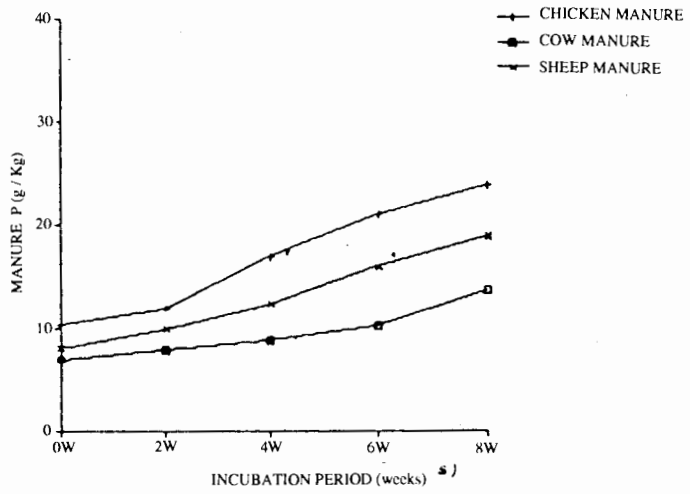

FIG. 3. Effect of incubation period on manure-K content of three different manures.

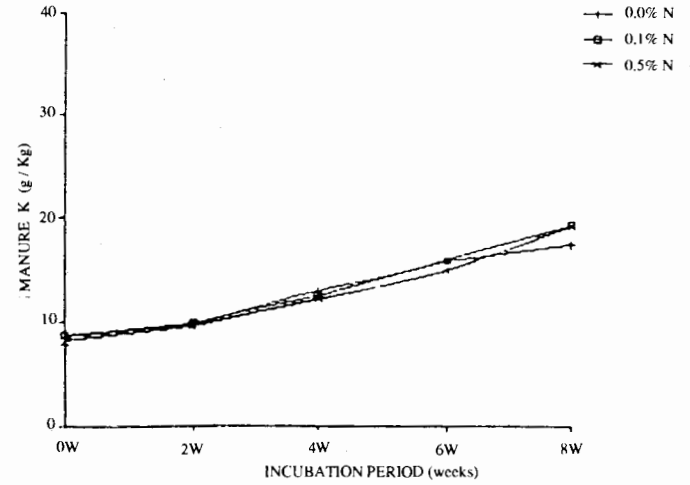

FIG. 4. Effect of incubation period on manure-K content at three N-amendments levels.

In conclusion, the elemental content of animal manure is greatly dependent upon its original constituents and the release of elements is appreciably influenced by manure incubation time as well as the addition of N-amendments.

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تأثير إضافة النيتروجين وفترات التحضين على محتوى النيتروجين والفوسفور والبوتاسيوم بالمخلفات الحيوانية

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المستخلص . أجريت هذه التجربة حقليا بهدف دراسة تأثير إضافة النيتروجين وفترات التحضين على محتوى النيتروجين (N) والفوسفور (P) والبوتاسيوم (K) بالمخلفات الحيوانية (داوجن – أبقار – أغنام) .

ولقد أظهرت النتائج أن مخلفات الدواجن تحتوي على أعلى كمية من النيتروجين (N) والفوسفور (P) والبوتاسيوم (K) ثم الأغنام فالأبقار على التوالي . كما أن إضافة معدلات مختلفة من النيتروجين أثرت تأثيرًا معنويًا على كمية النيتروجين والفوسفور في المخلفات الحيوانية ولكنها لم تؤثر على كمية البوتاسيوم وقد كانت أعلى معدنة للنيتروجين عند المعدلين ١,٠٪ و ٥,٠٪ بينما كانت أعلى معدنة للفوسفور عند المعدلين (صفر و ١,٠٪) . كذلك تأثرت كمية النيتروجين (N) والفوسفور (P) والبوتاسيوم (K) في المخلفات الحيوانية تأثيرا معنويا بفترات التحضين حيث سجلت أعلى كمية من النيتروجين (N) والفوسفور (P) في المخلفات الحيوانية عند المعاملة بدون تحضين (معاملة المقارنة) متبوعة بالمعاملات التي تم تحضينها لمدة ٢ – ٤ – ٦ – ٨ أسابيع تناقصيا على التوالي بينما سجلت أعلى كمية من البوتاسيوم (K) عند المعاملة التي حضنت فيها المخلفات لمدة ٨ أسابيع متبوعة بالمعاملات التي تم التحضين فيها لمدة ٦ – ٤ – ٢ – صفر أسبوعيا تناقصيا على التوالي .