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Spent mushroom compost – nutrient content for application to agricultural crops

Key external stakeholders:
Policy makers, Advisors, Farmers, Composters

Practical implications for stakeholders:
Spent mushroom compost (SMC) is a valuable source of major and minor nutrients as well as organic matter. Over the last decade, the composting process has changed and higher mushroom yields are now harvested from the compost compared to previously, resulting in lower phosphorus (P) levels in spent mushroom compost.

In 2011 and 2012, Teagasc analysed a number of SMC samples taken from a large random sample of commercial mushroom units. The results indicate (Table 1) that the P content is lower when compared to the previous study by Maher in 2003. The characteristics of mushroom compost and SMC have changed over time with lower levels of P due in part to lower P usage and high crop yields. These more recent analyses will help improve nutrient management planning on farms where SMC is applied to replace alternative sources of N, P and K for crop requirements.

The P content of SMC as stated in The Good Agricultural Practice (Nitrates) regulations (SI 610/2010) is higher than the average P levels in SMC currently being land spread. In practice, the producer of the compost is generally not the end user of the SMC, which is mostly utilised as a fertiliser NPK source on livestock and tillage farms. If the average P value for SMC is taken to be what is currently stated in the Nitrates regulations, then it will result in under supplying the P requirement of crops where SMC is applied as a replacement for chemical fertilisers.

Main results:
This study indicates that the N content in SMC is still similar to the previous study in 2003. The P levels have declined from 2.5 kg P/tonne in 2003 to 1.45kg P/tonne in 2012. Results also indicate that the K levels are more variable, which is in agreement with previous SMC studies.

Opportunity / Benefit:
Changes in modern composting techniques, and higher crop yields at harvest time, have resulted in lower P levels in SMC. SMC is a good source of several key nutrients and can effectively replace expensive fertilisers. The P content as determined in recent studies over the last 5 years is a more precise measure of the actual P value of SMC, which will improve its use as a replacement for artificial fertiliser in grass and tillage crops. These updated analyses of SMC will ensure that nutrient management plans deliver better nutrient advice where SMC is used to supply crop N, P and K requirements.

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1. Project background:

Spent mushroom compost (SMC) is a valuable source of major and minor nutrients and organic matter when applied to crops. Over the last decade several changes have occurred that impact on the characteristics of SMC. Firstly, less poultry manure is added to mushroom compost to reduce odour during the composting process, thereby further reducing the phosphorus (P) content in compost. Secondly, higher mushroom yields (+10%) are now harvested from mushroom compost compared to previously. Consequently, the P content of typical SMC may have decreased over time. As a result, the average P content as stated in The Good Agricultural Practice (Nitrates) regulations may over-estimate the actual P content that is present in the SMC as a fertilizer source when applied to land. In practice, the producer of the mushroom compost is generally not the end user of the SMC. If the average P values for SMC are taken as what is stated in the Nitrates Regulations, this could result in under-supplying the crops requirement for P where SMC is used to replace chemical fertilisers.

2. Questions addressed by the project:

- Has the level of P and other nutrients in SMC declined in recent years due to changes in compost ingredients and practices and higher mushroom yields?

3. The experimental studies:

Fresh spent mushroom compost samples were taken nationally from 23 randomly selected farms in 2011 and 20 farms in 2012. Sampling times (December) were the same on each occasion. Each sample consisted of 7 to 10 core samples taken at random from different shelves in each house and mixed together. The mixed bulk sample was then sub sampled and placed in a clean plastic bag and labeled. Each sample was approximately 1 kg in weight. Samples were analysed for dry matter (DM) and total content of nitrogen (N), P, potassium (K), calcium (Ca), magnesium (Mg), sulphur (S) and organic matter (OM). The data were statistically tested by analysis of variance (ANOVA), using SAS statistical software, and the results of the 2011 and 2012 surveys were compared to results from analysis of 20 SMC samples taken in 2003 (Maher, 2003).

4. Main results:

The results (mean and standard deviations) of the laboratory and statistical analysis of the samples taken in 2003, 2011 and 2012 are shown in Table 1. There were statistical differences between years in DM, N, P, K, and Ca. In the case of N, the mean content from 2011 samples was significantly lower than 2003 and 2012. There has been a significant trend of decreasing K content. However, the standard deviation of the mean is high in the case of K, indicating a high variability in the material in terms of K content.

Table 1. Laboratory analysis of mean dry matter, nutrient, and organic matter concentrations in SMC samples. (Standard deviations of the mean values are shown in parenthesis. Letters in superscript indicate years with statistically significant differences in concentration).

Year	n	DM (%)	N (kg/t fresh)	P (kg/t fresh)	K (kg/t fresh)	Ca (kg/t fresh)	Mg (kg/t fresh)	S (kg/t fresh)
2003	20	33 (2.4)^{a}	8.0 (0.92)^{a}	2.5 (0.39)^{a}	9.7 (1.68)^{a}	Not analysed		
2011	23	35 (5.3)^{b}	5.9 (1.38)^{b}	1.3 (0.30)^{b}	7.9 (3.04)^{b}	21 (6.5)^{a}	2.2 (0.64)	6.8 (1.55)
2012	20	36 (5.1)^{b}	8.6 (1.40)^{a}	1.5 (0.35)^{b}	5.4 (2.18)^{c}	13 (3.1)^{b}	1.9 (0.39)	6.3 (1.59)
Effect of Year[1]		*	***	***	***	***	NS	NS
SI 610 of 2010			8.0	2.5				
2007/2009[2]			6.9 - 7.4	1.86 - 1.98	6.6 - 8.4			

[1] Significant differences between years are indicated as: * = < 0.05; ** = < 0.01; and *** = < 0.001
[2] Results for outdoor stored SMC (up to 12 months old) from Velusami (2013)

The largest difference between years was found with P content, with the samples in 2011 and 2012 being

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1.3 and 1.5 kg/t, respectively, compared with 2.5 kg/t in 2003. This represents a significant decrease in P content of over 40% since 2003, as was expected due to changes in compost manufacture and mushroom production practices. These results indicate that the current value of P content, assumed in the Nitrates regulations, over-estimates the actual P content in SMC.

Analysis of Ca, Mg and S were not available for the 2003 samples. There was a significant difference between 2011 and 2012 in the case of Ca, but there was no significant difference in Mg or S contents.

The results of these surveys are in agreement with analysis of other samples of SMC following outdoor storage, taken between 2007 and 2009, in a study by Velusami (2013) (Table 1). In that study, the N and K contents measured were in the range of 6.9-7.4 kg/t for N, and 6.6-8.4 kg/t for K. The P content ranged from 1.9-2.0 kg/t which is intermediate between the 2003 data and the 2011/2012 data.

5. Opportunity/Benefit:

1. The nutrient content of all organic manures, including SMC, is variable. The mean P content of SMC in 2011 and 2012 is lower than the average values reported by Maher (2003) as shown in Table 1. Under the current Nitrates regulations, the P value of SMC is assumed as 2.5 kg P/t. This study indicates that the nutrient value of SMC from modern mushroom units has declined to 1.3-1.5 kg/t of P, due to modern composting and production techniques, resulting in an overall reduction in the level of P in spent mushroom compost as a consequence.
2. The lower mean P content of SMC detected in recent surveys provide a better, more accurate, estimate of the actual nutrient content of SMC and will ensure more precise fertiliser planning where SMC is used to replace artificial fertilisers in crop production.

6. Dissemination:

All Ireland Mushroom conference, Monaghan, 20th October, 2011
http://www.teagasc.ie/publications/2011/1056/index.asp
Teagasc Mushroom Newsletter, April, 2012
http://www.teagasc.ie/publications/2012/1166/Mushroom_April12.pdf

Main publications:

Maher, M.J., Magette, W.L., Smyth. S., Duggan, J., Dodd, V.A., Hennerty, M.J. and McCabe, T. (2000). Managing spent mushroom compost,Teagasc End of Project Report No. 4444.
http://www.teagasc.ie/research/reports/horticulture/4444/eopr4444.pdf
Maher, M.J (2003). The Challenge Ahead. All-Ireland Mushroom Conference& Trade Show, Hillgrove Hotal Monaghan, Thursday 16th October, 2003.
Velusami, B. (2013). Stored Spent Mushroom Compost- Measurement of Hydrogen Sulphide Emissions and Material Characteristics. PhD thesis, School of Biosystems Engineering, UCD. Dublin 4 (submitted).

Popular publications:

Making best use of spent mushroom compost, Teagasc factsheet (Teagasc T NET, 2013), Tillage Specialist Unit.

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