LIFE CYCLE MODELING OF IMPACT OF APPLICATION OF SYNTHETIC FERTILIZER AMENDED WITH URBAN WASTE COMPOST

V. U. Khanapure
Department of Civil Engineering
Savitribai Phule Pune University
Pune, India
Email: vukhanpure.scoe@sinhgad.in

Prashant Kumar
Department of Civil Engineering
Savitribai Phule Pune University
Pune, India
Email: Prashant2009kr@gmail.com

Abstract— Integrated use of synthetic and urban waste compost would prove to be an excellent solution to these problems and it would also improve the soil properties. This paper is to review the importance of supplementing synthetic fertilizer with urban waste compost in view of the fact that it would improve soil properties and be eco friendly.

Keywords—Synthetic fertilizer, Urban waste compost, Life cycle assessment, Waste management)

I. INTRODUCTION

Artificial or natural substance containing elements that improve growth and crop productivity are known as fertilizers. Fertilizers enhance the natural fertility of the soil. People are perplexed to which type of fertilizers to use on their agricultural fields. This is because of the different advantages and disadvantages of organic and synthetic fertilizers. Synthetic fertilizers and organic fertilizers have different impacts on crop productivity, soil health and nutrients available to crops.

Organic fertilizers when used releases the necessary nutrients too slow to meet the crop requirements.

Research conducted by [2] showed that nitrogen fertilizer application for a long time significantly decreased soil pH, exchangeable Ca, Mg, K as well as Cation Exchange Capacity (CEC).

The purpose of this project is to explore the possibility of supplementing synthetic fertilizer with urban waste compost in view of the fact that it is cost effective and eco friendly.

II. WHY SYNTHETIC FERTILIZER ?

Synthetic fertilizers are essential for nourishing plants and microbes but may have harmful effects on the soil, especially when they are very concentrated and water-soluble. Chemical fertilizer may help soil life, and soil life helps fertilizers and their availability for plants and microbes [3].

Many micronutrients that plants regularly require for their healthy growth are not present in synthetic fertilizers. Synthetic fertilizers are generally made up of amalgamation of nitrogen, phosphorus, potassium, and sulphur.

Study by [4] revealed that more than 40% vegetable farmers in Rejang Lebong, Bengkulu, Indonesia applied pesticides 6-15 times a week. Most of them were ignorant of having protective equipment during pesticide application. As a result, clinical test confirmed that 22.5% of them had deterioration in liver or kidney function. Farmer has also become addicted to apply in-organic fertilizer higher than the recommendation from the authority.

III. WHY URBAN WASTE COMPOST ?

Large amount of wastes is produced in towns and cities which eventually causes the problem of disposal of this waste. Compost is a blend that comprises mainly of decayed organic matter and is used for conditioning land and fertilizing. Beneficial microorganisms are induced by compost and organic material. Microorganisms usually found in compost and soil convert organic nitrogen to inorganic nitrogen, this process is called mineralization. The nutrients released by these may then be taken up by plant. Composts contain an astounding range of microbes, many of which may be advantageous in scheming pathogens. Composting is an economical and effective way to treat animal manure for land application. This is because pathogens and weed seeds are destroyed and the heterogeneous solid-state organic matter is transformed to more stable humic substance by the activity of bacteria [8].

IV. SUPPLEMENTING SYNTHETIC FERTILIZER WITH URBAN WASTE COMPOST

Integrated use of synthetic and organic fertilizers leads to development of sustainable crop production. This may improve the efficiency of synthetic fertilizers and thus reduce their use. Integrated use of organic and synthetic fertilizers is able to improve crop productivity and sustain soil quality and fertility [5]. Study by [6] showed that integrated use of organic wastes and synthetic fertilizers also improve crop yield, soil pH, organic carbon and available N, P and K in sandy loam soil. Other research resulted that application of compost along with synthetic fertilizers produced highest yield and maximum return. [7] mentioned that organic manure application with chemical fertilizer could maintain soil nutrient balance, enhance nutrient availability, improve soil chemical and physical properties, increase soil organic matter, reducing fertilizer loss rate and improve soil fertility and ecosystem productivity.

V. METHODOLOGY

"Open LCA – Green Delta software" will be used to determine the potential impacts of two different scenarios.
Scenario I: Soil with synthetic fertilizer.
Scenario II: Soil amended with partial replacement of synthetic fertilizer by urban waste compost.
Methodology of work-
a) Soil quality report.
b) Estimation of soil nutrient requirement based on soil quality report.
c) Estimation of synthetic fertilizer to be added to soil to cope up with nutrient requirement.
d) Carry evaluation of urban waste compost to be used for agricultural purpose.

e) Analysis of partial replacement of synthetic fertilizer by urban waste compost.
f) Life cycling assessment modelling of:
Scenario I: Soil with synthetic fertilizer.
Scenario II: Soil amended with partial replacement of synthetic fertilizer by urban waste compost.
g) To design system model and assign input and output parameters.
h) Comparative analysis of impacts from the two LCA model.

Life cycle inventory analysis for production of synthetic fertilizer

Table 1: Example of life cycle inventory (LCI)* for production of 1 kg commercial fertilizers (N, P or K) mainly based on Patyk & Reinhardt (1997). Input to soil are based on Audsley et al. (1997).

	Unit	N	P	K
Electricity (German)	kWh	0.217	1.06	0.15
H2SO4	kg (product)		2.25	
H3PO4	Kg (product)		0.79	
NH3	kg (product)	0.67		
HNO3	kg (product)	1.78		
Potassium	g (resource)			12700
Phosphorus	g (resource)		4840	
CaCO3	g (resource)	550		
Crude oil	g (resource)	153	70.6	10.5
Gas oil	g (resource)	0.4	34	11.3
Natural gas	g (resource)	680	231	162
Coal	g (resource)	72	13.2	29
CO2	g (emission to air)	2351	923	553
CH4	g (emission to air)	0.24	0.04	0.002
N2O	g (emission to air)	15.1	0.03	0.05
SO2	g (emission to air)	4.0	12.6	0.13
CO	g (emission to air)	2.1	0.9	0.3
NOx	g (emission to air)	12.7	2.1	0.7
NMVOC	g (emission to air)	0.11	0.23	0.08
Particles	g (emission to air)	0.0012	0.1	0.03
HCl	g (emission to air)	0.06	0.01	0.08
NH3	g (emission to air)	6.7	0.004	0.001
Formaldehyde	g (emission to air)	0.0036	0.02	0.006
Benz(a)pyrene	g (emission to air)	0.00036	3.7×10^{-7}	1.13×10^{-7}
As	g (emission to water)		0.01	
Cd	g (emission to water)		0.01	
Cr	g (emission to water)		0.05	
Cu	g (emission to water)		0.05	
Hg	g (emission to water)		0.01	
Ni	g (emission to water)		0.04	
Pb	g (emission to water)		0.04	
Zn	g (emission to water)		0.06	
F	g (emission to water)		167	
$CO3^{2-}$	g (emission to water)		4500	
Ca	g (emission to water)		3000	
Cd	g (input to soil)	0.0007	0.1267	0.00013
Cr	g (input to soil)	0.0102	6.2	0.0033
Cu	g (input to soil)	0.0151	0.2	0.006
Hg	g (input to soil)	4×10^{-5}	0.0002	0.0001
Ni	g (input to soil)	0.0121	0.1	0.004
Pb	g (input to soil)	0.0039	0.03	0.002
Zn	g (input to soil)	0.1084	0.9	0.05

The life cycle impact assessment (LCIA), which produces estimates of environmental impacts, encompasses the creation of impact categories, the assignment of inventory data to specific impact categories (classification), and the modelling of the magnitudes of the inventory data within impact categories (characterisation). The Inventory data from table 1 is used in LCA model to predict the impact of production of 1kg commercial fertilizer on environment.
The impact categories include:
AP—Acidification potential; GWP—Global warming potential; Eut—Eutrophication; RC—Resource consumption; HT—Human toxicity; PO—Photochemical oxidants or ozone; Etx—Ecotoxicity; SO—Stratospheric ozone; and HM—Heavy metals.
Supplementing synthetic fertilizer with urban waste compost would lead to reduction of the above mentioned environmental impact categories and also improve the soil condition.

CONCLUSION

Therefore, it can be concluded that an integrated application of synthetic and urban waste compost would improve nutrient efficiency and maintain soil health.

Another important benefit in replacing a part of synthetic fertilizer with urban waste compost is the reduction of production of synthetic fertilizer. The production and transportation of synthetic fertilizer on a whole contributes to increase of abiotic depletion, global warming potential, ozone layer depletion potential, photochemical oxidation, acidification and eutrophication. This can be stated by caring out life cycle assessment of synthetic fertilizer.

On the other hand the use of urban waste compost not only solves one of today's major problem of disposal of urban waste but also provides nutrition to plants and soil. In addition to this, natural compost induces beneficial microbes in soil which help to control plant pathogens and enhances soil fertility.

Thus, the integrated use of synthetic and organic fertilizers would reduce the environmental impacts due to production of synthetic fertilizers, work out the problem of disposal of urban waste and help in improving the overall health of soil.

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