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Burning of Crop Residues: How does it Affect Soil Health

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Introduction

India is the second largest agro - based economy with year round crop cultivation. A large amount of agricultural waste is generated every year, including crop residues. According to the Indian Ministry of New and Renewable Energy (MNRE), India generates on an average 500 Million tonnes of crop residue per year. Crop residue contains the remains of leaves, stems, awns and remaining small grains after harvesting the cereal crops. Combined harvesters used for harvesting the crop do not remove complete plants and large amount of standing stubble remains in the field. Due to lack of proper disposal practices, approximately 92 metric tonnes of crop waste are burned every year in India (Bhuvaneshwari *et al.* 2019). Farmers opt for burning the residue because it is a n easy and quick way to manage the large amount of crop residue and prepare the field for the next crop well in time.

Crop residue burning has become a major environmental problem causing health issues as well as contributing to global warming. The burning of crop residues generates numerous problems to the environment and human health. Emission of greenhouse gases leading to global warming, release of particulate matter and smog into the atmosphere that cause respiratory problems, loss of biodiversity of agricultural lands and the deterioration of soil health are the major detrimental effects of crop residue burning. Burning of crop residues greatly affects the soil health. There is a slow and steady reduction in soil health that eventually results in reduced productivity that cannot be overcome with increased additions of mineral fertilizers. Following are the harmful effects of crop residue burning on soil health:

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1. Physical properties:

Burning of crop residue declines the organic matter content of the soil which in turn deteriorates soil physical health. Crop residue retention plays an important role in protecting soil aggregates from raindrop impact (Turmel et al. 2014). Due to poor organic matter content, soil aggregates are broken down and soil structure gets destroyed. Retention of crop residue on the soil surface provides physical protection to the soil against wind and water. However, when crop residues are burnt, soil get exposed and becomes sensitive to wind and water erosion. Bare soil is directly exposed to harmful solar radiations which results in increased soil temperature, creating unfavourable conditions for plants and other soil organisms. Furthermore, there is rapid loss of moisture from the soil which can increase the risk of crop failure in areas facing water scarcity.

2. Chemical properties:

Burning of stubble can potentially result in changes in chemical properties of soil and disrupts nutrient cycles. Due to burning of crop residues, there is continuous loss of organic carbon from soil which can potentially deteriorate soil health and productivity in long-terms basis (Chan and Heena 2015). Due to decreased organic matter content, soil pH also rises towards alkalinity and reduces level of N and C in the top 0-15 cm soil profile. Poor organic matter content results in reduced cation exchange capacity, which is an important indicator of soil fertility. Crop residue is an important and cheap source of organic carbon and nutrient elements, however, when these burnt are lost.

It is estimated that when one tonne of paddy straw is burnt, it accounts for loss of approximate 5.5 kg nitrogen, 2.3 kg phosphorus, 25 kg potash, 1.2 kg sulphur, all secondary nutrients, 50 to 70 percent of various essential micro nutrients, as well as organic carbon (Anonymous 2014). On the other hand, if the crop residue is retained or incorporated in the soil itself, it gets enriched with organic matter and nutrients particularly with organic carbon and nitrogen.

3. Biological properties:

Burning of crop residue may increase the mineralization in short-term which result in increased nutrient available for the plants besides killing the pest and diseases associated with the stubbles and straw of preceding crops (Thakur et al. 2019). However, the heat generated from burning of crop residues raises the soil temperature causing the death of beneficial soil

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organisms. The heat from burning paddy straw penetrates 1 centimetre into the soil, elevating the temperature to 33.8 to 42.2 degree Celsius. This kills the bacterial and fungal populations critical for a fertile soil. Wheat straw burning can kill about 50 per cent of bacterial population in up to 2.5 cm of soil depth (Hesammi *et al.* 2014).

There is also considerable reduction in amount and activity of soil enzymes involved in nutrient cycling. Frequent residue burning leads to complete loss of microbial population, which is important for maintaining soil health. As a result, soil health depletes rapidly eventually leading to reduced productivity that cannot be overcome no matter how much mineral fertilizers are added. Burning of crop residue causes damage to many beneficial organisms present in the upper layer of the soil. Due to the loss of 'friendly' pests, the wrath of 'enemy' pests can increase and as a result, crops might become more prone to diseases and infestation.

What can be done?

Considering the adverse effects of crop residues burning on soil health, there is an urgent need to encourage the farmers to put it for beneficial uses instead of burning it. Some of the suggestions for sustainable management of crop residues are:

1. Crop residue can be corporation of into the soil through adoption of conservation agriculture practices to prevent soil erosion from wind & water and to augment the soil moisture content.
2. Farmers can also manage crop residues effectively by employing agricultural machines like happy seeder (for sowing of crop in standing stubble), rotavator (for land preparation and incorporation of crop stubble in the soil), zero till seed drill (for land preparations directly sowing of seeds in the previous crop stubble) etc.
3. Crop residue can be used for cultivation of mushroom particularly species like Agaricus bisporus (white button mushroom) and Volvriella Volvacea (straw mushroom).
4. Crop residues, instead of burning, can be converted into beneficial products such as biogas, biochar, bio-enriched compost or used as bedding material for cattle.
5. Training should be organised for farmers for creating awareness about effects of crop residue burning, adoption of conservation agriculture practices and resource conservation technology through all ongoing State/Centre Sector Schemes.

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6. Awareness should be created of about various measures to prevent crop residue burning through mass media, print media, etc. just before the harvesting seasons.

Conclusion

Burning of crop residue is a very controversial issue. It not only pollutes the environment and creates severe health issues in human being, but also deteriorates soil health. Reduced soil organic matter, poor aggregation, reduced water and nutrient holding capacity, damage to soil bio-diversity, susceptibility to erosion are some of the many adversities arising due to the burning of crop residue. Although, several measures have been taken up by Government to eradicate this serious problem of crop residue burning, still it remains a burning issue. This indicates that there is still much needed to be done to tackle this issue. The management strategy of crop residue should be principally based on the local situation. It is highly important to create awareness among the farming community to understand the importance of organic carbon and emerging environmental concerns due to crop residue burning