CROP RESIDUE BURNING: CONSEQUENCES ON SOIL MICROBES

J K THAKUR[1]*, SUNIL PRAJAPATI[2], ASIT MANDAL[1], M C MANNA[1], J SOMASUNDARAM[1]

[1]ICAR -Indian Institute of Soil Science, Bhopal, Madhya Pradesh
[2]Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh
*Corresponding author, E-mail: jkthakuriiss@gmail.co.in

Soil is the habitat for numerous organisms (flora and fauna) and each of those organisms have specific ecological significance. A handful of soil sustains billions of life carrying out thousands of simultaneous biochemical reactions making soil living. In fact, only living soils can sustain various ecological functions and abundance of soil microbes is vital for availing services form soil. Presence of organic matter in the soil acts as the source of carbon or food for soil micro-organism. In turn, these microbes maintain the soil condition congenial for sustainable crop production.

In India, approximately 620 million tonnes of crop residues are produced annually from various foods, fibre, millet, pulses, oil seeds and cash crops of which 30 percent contributed by rice and wheat. Out of the 16 percent of total crop residue being burnt, 62 percent is of rice and wheat (singh et al 2019). Though a small portion of these residues find alternative uses in rural areas viz. cattle feeding, soil mulching, thatching for rural homes and fuel for domestic use, a large portion of the residues is burnt in the field primarily to clean the field for sowing of the succeeding crop. Burning crop residue not only destroy the nutrient contained in it but also has environmental and health concerns.

WHY DO INDIAN FARMERS PREFER TO BURN CROP RESIDUE IN THE FIELD?

Indian farmers set fire in harvested farm fields to remove the crop stubble/residues as it is the most cost effective way of clearing the field for the next crop. Replacement of manual harvesting practices to mechanical (combined harvester) harvesting due to shortage of labour is one of the major reasons for increased crop residue burning in the country.

Figure 1: View of residue burning in the harvested paddy, sugarcane and wheat fields

Contrary to manual harvesting practices where harvest is being taken outside the field for processing combined harvesting machines do not remove crop residue from field.

In addition, shrinking livestock population, long time requirement for composting of crop residue, and unavailability of economically viable alternative solutions to manage crop residue compel farmers to burn the residues in the field itself. Further, very little gap between the harvest of *kharif* crop and sowing of *rabi* crop also force farmers to burn the harvested field for smooth tillage operations and sowing.

CROP RESIDUE BURNING AND SOIL BIOLOGICAL CONCERNS

Crop residues are a good source of plant nutrients and are important components for the stability of the agricultural ecosystem. Loss of carbon from soil will result in reduced microbial activity, affect soil nutrient cycling potential, soil detoxifying capacity and other soil function in long term. About 25% of N and P, 50% of S and 75% of K uptake by cereal crops are retained in crop residues, making them viable nutrient sources (Gupta et al., 2004). About 90% of N and S and 15-20% of P and K contained in rice residue are lost during burning. Burning of 23 million tonnes of rice residues in NW India leads to a loss of about 9.2 million tonnes of C equivalent (CO_2-equivalent of about 34 million tonnes) per year and a loss of about 1.4×10^5 t of N (equivalent to Rs 200 crores) annually (NAAS, 2017).

Burning of crop residue may increase the mineralization for short-term which result in improvement in nutrient available for the plant growth transiently besides killing the pest and diseases associated with the stubbles and straw of preceding crops. However, immediately after burning of crop residue the surface soil temperature increases to such an extent which kills most of the mesophilic organism that actively participate in nutrient transformation in the upper layer of soil. Though the effect is temporary, as the microbes regenerate after a few days, repeated burning incidence in field however may permanently diminishes the microbial population. Bacterial and fungal populations are decreased immediately and substantially in the top 2.5 cm of the soil because of residue burning. Long-term burning reduces total N and C and potentially mineralized N in the 0-15 cm soil layer.

MANAGEMENT OPTIONS FOR CROP RESIDUES

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. Depending upon local condition, crop residue can be managed *ex situ* or *in situ*.

Ex-situ Management

In *ex-situ* management, crop residue can be converted to valuable products like

- *Producer gas* through gasification process
- *Biochar* through a thermo-chemical conversion process called pyrolysis in anoxic environment. Biochar is a carbon rich porous material and can be used as soil amendment.
- *Compost* through simple aerobic or anaerobic composting process. The composting time can be also reduced by manipulating physico-chemical condition as well as through incorporation of effective microbial inoculums.
- Bedding materials for cattle, fuel briquette, and also can be used as cattle feed with nutrient enrichment.

In-Situ Management

Widely accepted methods for the *in-situ* management of crop residues include

Conservation agriculture (CA): In CA, seeds are sown in fields with standing crop stubbles through specially designed machineries like no-till drill, strip till drill, happy seeder etc with minimum or zero soil disturbances. The residues retained in the field act as permanent organic soil cover and protect soil from erosion and conserve soil moisture. In addition, reduced use of fossil fuels and fertilizers in CA leads to the reduction in CO_2 emissions, improved soil carbon levels that in turn results carbon sequestration.

In situ decomposition: In *in situ decomposition* crop residue can be incorporated in to the field along with the application of microbial inoculants and necessary nutrients, keeping adequate moisture for decomposition of the residue in the field. This method helps in improving the soil health through enrichment of soil with carbon and other nutrients besides activating soil microbes. However, additional resources such as water, nutrients and bioinoculum are required for promoting decomposition of crop residue under in situ decomposition.

CONCLUSION

Burning of crop residue not only affects the soil health by killing various life forms in soil but also affects human health adversely through polluting the environmental resources. Occasional burning of straw, stubble, and grass may be economical for residue management but these practices have short-term benefits. The adverse effects of residue burning on soil biota and thus on soil health will continue for long-term and that eventually affects sustainable crop production. The increased soil temperature at the time of residue burning not only kills the soil microbes but also depletes soil organic carbon level which is vital for keeping soil living. In short, adopting suitable location specific technology is necessary to ensure proper residue management without harming the various life forms on earth. Also, encouraging and incentivizing the farming community for enriching the soil with carbon will help in discouraging practice of crop residue burning.

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