www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(4): 1026-1028

www.thepharmajournal.com
Received: 07-01-2022
Accepted: 10-02-2022

Manu Rani
Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India

Rajni Yadav
Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India

Vikas Kumar
Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India

Anil Kumar
Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India

Dharam Pal
Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India

Sunil Kumar
Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India

Corresponding Author:
Manu Rani
Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India

Enhancing carbon sequestration in soil under various agricultural systems to mitigate the negative effects of climate change

Manu Rani, Rajni Yadav, Vikas Kumar, Anil Kumar, Dharam Pal and Sunil Kumar

Abstract
Carbon dioxide (CO_2) concentrations in the atmosphere and other greenhouse gases (GHGs) may increase radiative forcing and alter the Earth's mean temperature and precipitation. Because of this considerable impact on adiative forcing, there is a rising focus on creating ways to balance anthropogenic CO_2 enrichment rates in the atmosphere. As a result, CO_2 sequestration from the atmosphere or from point sources is the emphasis. There is a lot of interest in stabilizing the atmospheric abundance of CO_2 and other GHGs to reduce the hazards of global warming. Legumes/pulses are appropriate crops for two parts of conservation agriculture: soil cover and rotation, whether as a growing crop or as residues. SOC, POC, MBC concentrations, total SOC stocks, and their sequestration rate improved when prescribed doses of N–P–K were applied to rice and wheat, either through inorganic fertilization or through inorganic fertilizer N–P–K with 50% of nitrogen substituted by FYM or crop waste or green manure. They are, nonetheless, an important complement because having more technical solutions available will make combating climate change easier. Furthermore, a combination of technologies provides lower related costs and more realistic solutions, with the technologies chosen based on local conditions.

Keywords: Carbon dioxide, climate change, global warming, carbon sequestration

Introduction
Carbon dioxide (CO_2) concentrations in the atmosphere (from 280 parts per million in the pre-industrial era to 390 parts per million in 2010, a 39 percent increase) and other greenhouse gases (GHGs) such as nitrous oxide (N_2O) and methane (CH_4) may increase radiative forcing and alter the Earth's mean temperature and precipitation (IPCC, 2007) [5]. Because of this significant impact on adiative forcing, there is a growing focus on developing solutions to reduce atmospheric CO_2 enrichment rates by offsetting anthropogenic emissions.
As a result, the focus is on CO_2 sequestration from the atmosphere or from point sources. Combustion of fossil fuels, cement making, deforestation and biomass burning, and land-use modification, such as draining of peat lands, soil tillage, and animal husbandry, are all examples of anthropogenic sources. To limit the risks of global warming, there is a great interest in stabilizing the atmospheric abundance of CO_2 and other GHGs.
Carbon is a crucial component of many chemical reactions on the planet, as well as a fundamental building block of life. Carbon is exchanged and cycled between the earth's ocean, atmosphere, biosphere, and geosphere in the form of carbon dioxide (CO_2). CO_2 levels in the atmosphere have risen from 280 parts per million in 1850 to 390 parts per million in 2015. (CRIDA, 2013). CO_2 concentrations have been steadily rising over time as a result of anthropogenic activities, which are the primary driver of global warming. To minimize the negative effects of global warming, it is critical to cut CO_2 emissions through reducing global energy use, producing low-carbon or zero-carbon fuels, and sequestering CO_2 through natural processes.
The content of soil organic carbon (SOC) is a crucial measure of soil quality and production. As a result, raising SOC concentration in the root zone is required to restore the quality of deteriorated soils. The following are the most common causes of soil deterioration and a decrease in agronomic productivity:

1. Top-oil erosion and the SOC stock linked with sediments soil fertility reduction
2. Use of moldboard and disc ploughs for intensive deep and inversion tillage, resulting in:
    a. Rapid decomposition of crop wastes exacerbated by high temperatures

b. Disruption of stable soil aggregates, exacerbating the oxidation of contained SOC
c. Loss of microbial diversity and disruption of soil micro flora and fauna habitat

Adverse impact of climate change on Agriculture

In agriculture, the effect of higher temperature on any given crop will be determined by the crop's optimal temperature for growth and reproduction. Warming may improve the types of crops that are traditionally cultivated in some locations, or farmers may be able to switch to crops that are now grown in warmer areas. Conversely, if the higher temperature exceeds the ideal temperature for a crop, yields will suffer.

Crop yields may be affected by increased CO_2 levels. Plant development may be aided by increased CO_2 levels, according to some laboratory research. Other factors, like as shifting temperatures, ozone, and water and fertilizer shortages may, however, mitigate these potential yield gains. For example, if a crop's ideal temperature is exceeded, or if enough water and nutrients are not available, yield increases may be reduced or reversed. Reduced protein and nitrogen content in alfalfa and soybean plants has been linked to increased CO_2, resulting in a loss of quality. The ability of pasture and rangeland to support grazing cattle can be harmed by poor grain and forage quality.

Drought management could be difficult in locations where rising summer temperatures lead soils to dry up. While additional irrigation may be possible in certain areas, water resources may be reduced in others, leaving less water available for irrigation when more is required.

Crops can be harmed by more extreme temperatures and precipitation. Floods and droughts, in particular, can destroy crops and lower output. High overnight temperatures, for example, impacted maize yields across the Corn Belt in 2010 and 2012, and premature budding caused $220 million in Michigan cherry losses in 2012.

While increased CO_2 encourages plant growth, it also lowers the nutritional value of most food crops. Most plant species, including wheat, soybeans, and rice, have lower protein and critical mineral concentrations when atmospheric carbon dioxide levels rise. This direct effect of rising CO2 on crop nutritional value poses a possible health risk to humans. Growing pesticide use, as a result of increased insect pressures and pesticide efficacy declines, poses a concern to human health.

Warmer temperatures, wetter climates, and higher CO2 levels favor the growth of many weeds, pests, and fungi. Weed and pest ranges and distributions are anticipated to expand as a result of climate change. This could result in new challenges for farmers' crops that were previously unaffected by these pests.

Soil carbon sequestration:

SOC levels in soils reflect the long-term balance of organic carbon imports and losses. This long-term balance was upset by intense soil cultivation, and more and more of the C in the soil's organic matter was exposed to oxidative reactions. Crop cultivation affects C stored in soil and released into the atmosphere as CO_2. Crop cultivation takes up around 20% of the earth's surface area, so it has a significant impact on C stored in soil and released into the atmosphere as CO_2. As more and more of the carbon in the soil was oxidized in the United States, the SOC dropped dramatically. Because it had become more available to live soil organisms that not only continuously respire the C back to the atmosphere as CO_2, but also release the nutrients in the SOM, the SOC fell until a new balance was achieved.

Cultivation is thus a method of "mining" soil nutrients to make them more readily available for plant uptake, but it also exposes them to losses into the environment. If the amount of carbon entering the soil exceeds the amount lost to the atmosphere, and oxidative processes are slowed by management measures such as keeping more crop residues on or near the soil surface, these processes can be reversed, and the SOC can be enhanced. This type of shift can be caused by the employment of less-intensive tillage practices (such as conservation tillage rather than plough ploughing) and a soil environment that slows residue breakdown rates.

In the atmosphere, the continuous increase in the concentration of carbon dioxide (CO_2) and other GHGs mainly due to anthropogenic sources is believed to be responsible for climatic changes and related consequences occurring across the globe (IPCC, 2001). As a result of this circumstance, there is a growing interest in creating measures to reduce GHG emissions into the atmosphere. Only 3.8 Gt C/year remains from the roughly 8.7 Gt C per year spewed into the atmosphere by anthropogenic sources. The 4.9 Gt C per year discrepancies is thought to be sequestered in terrestrial bodies (oceans, forests, soils, etc.) and is referred to as the "missing sink" (Battle *et al*. 2000) [1]. This understanding has sparked interest in the terrestrial sector's (particularly soil) ability to sequester carbon in long-term existing pools, lowering the quantity of carbon in the atmosphere (Post *et al*. 2000) [7].

Farming systems and their capacity to sequester carbon:

In comparison to fertilizer application alone, long-term use of organic materials coupled with fertilizers considerably enhanced soil organic carbon (SOC). Furthermore, greater levels of SOC with long-term application of manures and fertilizers could be attributable to additional C inputs from crop residues returning to soils. Antil *et al*. (2011) observed similar results in a pearl millet-wheat cropping system with long-term FYM use. The effect of manures on SOC decreased with soil depths, similar to bulk density (Kumar *et al*., 2012) [4].

Total organic C and N (TN) concentrations in bulk soil samples of unfertilized control plots lost about one-third of their original TOC and two-thirds of their initial TN concentration (Manna *et al*., 2006) [6]. The extent of the decline was reduced in the 100 percent N or N–P treatment compared to the control, whereas the 100 percent N–P–K or N–P–K plus FYM treatment either maintained or enhanced TOC and TN concentrations compared to the unfertilized (control) treatment.

The surface layer (0–15 cm) had larger concentrations of C and N pools than the deeper layers (15–30 and 30–45 cm). In the surface layer (0–15 cm), the MBC and MBN in the treatment receiving FYM with fertilizer N–P–K were roughly 48.6 to 200 percent and 32.8 to 88.8 percent higher than in the N, N–P, and N–P–K treatments, respectively, and 1.5 and 1.3 times higher than fallow soils. In the surface layer, MBC ranged from 2.8 to 6.1 percent of TOC and MBN from 1.6 to 2.7 percent of total N, but these values were considerably higher in all treatments at lower depths. On an average the water soluble C (WSC) and water-soluble N (WSN)

accounted for 0.2 to 1.4% of TOC and 1.0 to 2.3% of TN, respectively, whereas hydrolysable carbohydrates accounted for 9.2 to 12.6% TOC at the top surface layer (0–15 cm depth). In lower depths (15–30 and 30–45 cm), both WSC and WSN followed an almost similar trend to that of surface soil.
According to Brar *et al*., 2013 [3], soil organic carbon content was lowest in the control and highest in the 100 percent NPK + FYM treatment. A 100 percent N, 100 percent NP, and 100 percent NPK application at a soil depth of 0–5 cm raised SOC content by 13.2, 17.1, and 30.0 percent, respectively, over the control. Long-term use of chemical fertilizers has had a similar favorable effect. SOC content was substantially greater in the 0–5 cm layer 100 percent NPK + FYM treatment (5.07 g kg^{-1}) than in the 100 percent NPK dosage alone. In the 5–10 cm layer, the pattern was similar.
In the surface soil layer (up to the 0–15 cm layer), the effect of balanced nutrient application (100 percent NPK) with and without organic manure (FYM) on SOC content was significant over all other treatments. Identical outcomes have also been reported. SOC content accumulated more on the surface layer due to the addition of more root biomass, root exudates, and plant biomass, and it reduced as depth increased, regardless of fertilizer treatments. Identical outcomes were also reported. The accumulation of varied amounts of root biomass, root exudates, and plant residues left in respective soil layers may explain the fluctuation in SOC content at different soil depths due to farmyard manure and fertilizer application.
Apart from the MBR + DSR-ZTW + RR-ZTMB and TPR-ZTW plots, Bhattacharya (2015) [2] found that soil plots under TPR-CTW had considerably higher mean (three-year) rice ABP than all CA plots. The mean wheat ABP statistics from all treatments, on the other hand, were very similar. Because MBR+ DSR-ZTW + RR-ZTMB plots had green gram ABP after three years, the system's total ABP was approximately 15% greater than that of DSR-ZTW plots. The above-ground yield responses of the crops and treatment types influenced the mean yearly input of organic biomass/residues to soil from all crops. Total C input from all crops after three years in the plots under MBR + DSR-ZTW + RR-ZTMB was highest and was approx.117 and 127% higher than DSR-ZTW and TPR-CTW plots, respectively.
According to Vanktesh *et al*., 2013 [8], carbon stabilization in the active pool is substantially higher than in the passive pool in the current study. For a long-term view, carbon stabilization in the passive pool is more crucial, which was found to be higher (13.1%) in the pigeon pea wheat system compared to 10.8% in the maize-wheat system. Overall, including pulses in upland maize-based system increased carbon sequestration in the soil in this study.

Conclusion

Food/pulses Because of their unique properties of short lifetime, deep rootedness, and less competition for mineral N (biological nitrogen fixation), legumes are an important component of crop diversification and serve as an important complement to cereals. As a growing crop or as residues, legumes/pulses are suitable crops for two aspects of conservation agriculture: soil cover and rotation. SOC, POC, MBC concentrations, total SOC stocks, and their sequestration rate improved when prescribed doses of N–P–K were applied to rice and wheat, either through inorganic fertilization or through inorganic fertilizer N–P–K with 50% of nitrogen substituted by FYM or crop waste or green manure.

Future prospects

It is critical to recognise that the agriculture sector's climate change countermeasures are to reduce the dangers of climate change while taking advantage of the opportunities. Policymakers, environmentalists, and the general public must all be educated on the benefits and drawbacks of this method by the research community. Carbon sequestration is not a substitute for increasing energy efficiency or the use of non-carbon energy sources. They are, nevertheless, a crucial complement because there will be less difficulty in tackling climate change if more technical solutions are available. In addition, a mix of technologies offers lower related costs and realistic solutions, with the technologies chosen based on local circumstances.

References

1. Battle M, Bender ML, Tans PP, White JWC, Ellis JT, Conway T *et al*. Global carbon sinks and their variability inferred from atmospheric O_2 and δ13C. Science. 2000;287(5462):2467-2470.
2. Bhattacharyya R, Das TK, Sudhishri S, Dudwal B, Sharma AR, Bhatia A *et al*. Conservation agriculture effects on soil organic carbon accumulation and crop productivity under a rice–wheat cropping system in the western Indo-Gangetic Plains. European Journal of Agronomy. 2015;70:11-21.
3. Brar BS, Singh K, Dheri GS. Carbon sequestration and soil carbon pools in a rice–wheat cropping system: effect of long-term use of inorganic fertilizers and organic manure. Soil and Tillage Research. 2013;128:30-36.
4. Ghosh PK, Venkatesh MS, Hazra KK, Kumar N. Long-term effect of pulses and nutrient management on soil organic carbon dynamics and sustainability on an inceptisol of indo-gangetic plains of India. Experimental agriculture. 2012;48(4):473-487.
5. IPCC. Climate Change. The Fourth Assessment Report. The Physical Science Basis. Cambridge, United Kingdom, Cambridge University Press, 2007
6. Manna MC, Swarup A, Wanjari RH, Singh YV, Ghosh PK, Singh KN *et al*. Soil organic matter in a West Bengal Inceptisol after 30 years of multiple cropping and fertilization. Soil Science Society of America Journal. 2006;70(1):121-129.
7. Post WM, Kwon KC. Soil carbon sequestration and land-use change: processes and potential. Global change biology. 2000;6(3):317-327.
8. Venkatesh MS, Hazra KK, Ghosh PK, Praharaj CS, Kumar N. Long-term effect of pulses and nutrient management on soil carbon sequestration in Indo-Gangetic plains of India. Canadian Journal of Soil Science. 2013;93(1):127-136.