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AN Deshmukh
Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India

AR Deshmukh
Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India

MD Sarode
Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India

NM Konde
Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India

Corresponding Author:
AN Deshmukh
Department of Soil Science and Agricultural Chemistry, Post Graduate Institute, Dr. PDKV, Akola, Maharashtra, India

Influence of BBF and Soil amendments carbon pools and yield of soybean in Purna valley of Vidarbha region

AN Deshmukh, AR Deshmukh, MD Sarode and NM Konde

Abstract
A field experiment was undertaken in the six farmer's fields of Purna valley with soybean crop during Kharif, 2015-16 in randomized block design, replicated six times, with four treatments comprised of only BBF, BBF + FYM @ 5 t ha^{-1}, BBF + gypsum @ 2.5 t ha^{-1} and BBF + FYM @ 2.5 t ha^{-1} + gypsum @ 1.25 t ha^{-1} combined. The use of farm yard manuare and gypsum in broad bed furrow system recorded improvement in physical and chemical and biological properties as well as carbon pools resulting into enhancement in soil parameters. The use of gypsum showed relatively more improvement in exchangeable cations except sodium. The use of organic manure was found beneficial as that of gypsum in physical properties of soils in addition to gradual chemical amelioration. Although considerable improvement in chemical properties has been found under the application of FYM. The FYM was also found useful and superior to gypsum in improving the carbon pools of soil. When gypsum was applied along with FYM, its role in enhancement of organic carbon was noticeable. Similarly application of farm yard manure has shown significant improvement in carbon status of soil. The highest Oxidizable carbon was recorded under BBF with gypsum treatment T_4 (131.83 mg kg^{-1}) at 0-15 depth of soil as well as (116.40 mg kg^{-1}) 15-30 cm depth of soil. The highest water soluble carbon was also recorded under combined use of FYM, gypsum and BBF treatment T_4 (33.02 mg kg^{-1}) at 0-15 depth of soil as well as (30.68 mg kg^{-1}) 15-30 cm depth of soil. Based on the results, it has been observed that application of farm yard manure @ 5 t ha^{-1}+ Gypsum @ 1.25 t ha^{-1}followed by FYM @ 2.5 t ha^{-1} has given remarkable results in respect of all carbon fractions. The highest soybean yield (14.03 q ha^{-1}) was obtained with the combined application of gypsum + FYM on BBF. Similarly considerable amount of yield was noticed in other treatments.

Keywords: BBF (broad bed furrow), Gypsum, Farm yard manure, Amendments.

Introduction
Soil is the most basic natural resource and the primary substrate for growing crops. It is also non-renewable over the human time scale. The land resource is gradually diminishing at a global scale. Soils, being most dynamic are able to supply nutrients, buffer acid and base reactions, destroy and absorb pathogens, detoxify and attenuate inorganic compounds and have the capacity for self-restoration through soil formation. However, soil formation is a slow process, and a substantial amount of soil can form only over a geologic timescale. Soil misuses and extremes of condition can upset these self-regulating attributes and cause a soil to regress from a higher to a lower type of usefulness and/or drastically diminish its productivity (Lal *et al.,* 1989) [14].

Out of 329 million hectares of total geographical area in our country, the arid and semi-arid zones occupy more than one-third of the area (127.4 m ha). The salt affected soils occurring in these zones occupy 12 m ha area spread over in 15 states of the country. These salt affected soils comprise of 4.12 m ha of alkali soil, 3.26 m ha of saline soil and 4.62 m ha of saline alkali soils. Among these salt affected soils, alkali soils are found to be highly problematic for crop production because of very poor physical and chemical environment particularly in irrigated areas. Sodicity problem in irrigated agriculture is becoming more and more serious because of faulty methods of irrigation, intensive cultivation of high water requirement crops, use of poor quality water, lack of adequate knowledge about soils and poor management practices. The amelioration of these alkali soils is not only expensive but also time consuming and laborious. (Gupta *et al.,* 1995).

The Purna valley spreads on both sides of Purna river, affecting about 892 villages, covering an area about 4692 sq. km. Purna river initiates from southern slopes of Govilgad hills of Satpuda range which is the principal drain joining to Tapi river. The major tributaries are Pedhi, Sarapi, Shahanur, Katepurna, Uma, Morna, Man, Mas, Nirguna, Nalganga and Dnyanganga. The soils are formed from basaltic alluvium and are characterized by high clay content (50-70 %), alkaline in reaction, calcareous with slow permeability possess to soil degradation. Salinity of ground water is historical phenomenon in Purna tract.

In Purna valley have sodicity problem in the sub soil. The pH is in the range of 8.1 to 9.4, exchangeable sodium ranges from 4 - 21 per cent and electrical conductivity from 0.3 to 5.2 d Sm^{-1}. The well water in Purna valley is also alkaline. The farmers of the valley face problems like water stagnation in rainy season, poor drainage, deterioration of soil structure, moisture stress and soil erosion. For management of problematic soils in this valley several integrated reclamation technologies have been recommended.

These soils are mainly derived from the basaltic alluvium and have clay texture with smectitic clay mineralogy. They have high swell-shrink potential, slow permeability with very low hydraulic conductivity and poor drainage conditions. Taxonomically these salt affected soils are classified as Sodic Haplusterts and Sodic Calciusterts (Padole *et al*., 1998) [21]

Increasing salinity and sodicity affects soil carbon dynamics, with soil carbon level dependent on a balance between inputs and losses, since inputs are largely related to biomass production with soil conditions affecting microbial activity. Increasing salinity and sodicity levels can potentially alter carbon stocks and fluxes in the landscape. This processcan lead to a decline in vegetation, plant biomass production and decrease in a soil productive capacity. The Purna valley is the unique tract of Vertisols in Vidarbha region (Maharashtra state) of India having combination of three fold problems, the native salinity, poor drainability and poor quality of ground water. These soils of are developed on basaltic alluvium under arid and semi-arid conditions have clay mineralogy. The salts have varying degree of deterioration i.e. salinity or sodicity and salinity-sodicity (Anonymous, 2010). These soils are having high swell-shrink potential, slow permeability with very low hydraulic conductivity and poor drainage conditions. Taxonomically these salt affected soils are classified as SodicHaplusterts and SodicCalciusterts (Padole *et al*., 1998) [21]. These soils affect the plant growth and development, causing yield loss in many crop species (Qadir *et al*., 2007) [27]. The major reasons for this low productivity of crops grown on these soils are the salt toxicity and poor soil properties (Gao *et al*., 2008) [7]. Efficient treatment strategies to reduce the salt toxicity of soils are combined application of inorganic, for instance gypsum, and organic amendments, like farm manure improves their effectiveness for increasing soil properties (Ullahand Bhatti 2007; Ipsita and Singh, 2014; Verma *et al*., 2015) [21] in turn increase the crop yields. Hussain *et al*., 2001 reported the Physical properties like bulk density, hydraulic conductivity and mean weight diameter were significantly improved when FYM (10 t ha-1) was applied in combination with chemical amendments resulting enhanced rice and wheat yields in salt affected soils.

Material and Methods

The experiment was conducted on six farmer's field with soybean crop in Ramagad located at Daryapur tehsil of Amravati district of Vidarbha region of Maharashtra during kharif, 2015-16. The design of experiment was randomized block design (RBD), replicated six times, where each farmer was treated as one replication with four treatments comprised of only BBF, BBF + FYM @ 5 t ha^{-1}, BBF + gypsum @ 2.5 t ha^{-1} and BBF + FYM @ 2.5 t ha^{-1} + gypsum @ 1.25 t ha^{-1} combined. Characteristics of the soils are comprised of clayey montmorillonitic, deep with soil order Vertisols. The initial physical and chemical properties of the experimental soils were analyzed and presented in table 1. Soil samples were collected before sowing and after harvest of soybean and analyzed for the soil bulk density, hydraulic conductivity and mean weight diameter. Soil bulk density was determined by clod coating technique as described by Blake and Hartge (1986) [4]. Hydraulic conductivity of soil was determined by constant head method as described by Klute and Dirksen (1986) [12]. Mean weight diameter of soil was determined by Yoder's apparatus method as per Kempen and Rosenau (1986) [11]. Similarly Seed yield and straw yield of soybean were also recorded during the field experimentation. The data on different parameters were tabulated and analyzed statistically by the methods described by Panse and Sukhatme (1971) [22].

Table 1: Initial physical and chemical properties of soil

S. No	Parameter	SITE I	SITE II	SITE III	SITE IV	SITE V	SITE VI
1	pH (1:2.5)	8.33	8.35	8.31	8.37	8.39	8.37
2	Ec (dSm^{-1})	0.19	0.21	0.20	0.23	0.21	0.20
3	OC (gkg^{-1})	4.1	4.3	4.4	4.7	4.4	4.6
4	Inorganic Carbon (g kg^{-1})	6.5	6.4	6.6	8.1	8.2	8.1
5	Total carbon (g kg^{-1})	10.6	10.7	11	12.8	12.6	12.7
6	B D (Mgm^{-3})	1.86	1.80	1.84	1.92	1.78	1.9
7	HC ($cmhr^{-1}$)	0.49	0.53	0.50	0.47	0.56	0.49
8	MWD (mm)	0.62	0.66	0.64	0.58	0.68	0.60
10	CEC (cmol(p^+)kg^{-1})	49.67	50.98	49.87	47.27	52.10	49.14
11	ESP	13.72	12.20	13.52	14.61	11.72	14.68

Result and Discussion

Influence of BBF and soil amendments on carbon pools of soil.

During the course of investigation the carbon status of soil was focused. Influence of BBF and soil amendments at different depth on carbon fractions of soils in Purna valley were studied and results are discussed as below.

Organic carbon

The organic carbon has greater significance in concern to degraded soil. Because of low permeability and higher rate of oxidation, the organic carbon has major limitations for its increase. The present study has generated the findings on organic carbon which is presented in Table 2 and depicted in Fig 1 and Fig 2.

Table 2: Influence of BBF and soil amendments on organic carbon.

T. No.	Treatments	Organic carbon (gkg^{-1})	
		0-15 cm	15-30cm
T_1	BBF	5.74	5.24
T_2	BBF+ FYM@5 tha^{-1}	5.97	5.44
T_3	BBF+ Gypsum @2.5tha^{-1}	5.79	5.27
T_4	BBF+ FYM @ 2.5 tha^{-1} + Gypsum @1.25 tha^{-1}	6.02	5.48
SE(m) ±		0.07	0.03
CD at 5 %		0.22	0.11
Initial status		5.58	4.98

The organic carbon varied from 5.74 to 6.02 g kg^{-1} in 0-15 cm layer of soil and 5.24 to 5.46 g kg^{-1} in 15-30 cm layer of soil under soybean. The highest organic carbon was obtained in treatment T_4, where farm yard manure and gypsum was amalgamated (6.02 g kg^{-1}) followed by treatment T_2 where only farm yard manure was used(5.97 g kg^{-1}) in 0-15 cm soil layer. While in 15-30 cm layer of soil, treatment $T_4$where FYM +gypsum was used showed remarkable increase in organic carbon (5.48 g kg^{-1}) followed by treatment T_2 where 5 t ha^{-1}farm yard manure was applied(5.44 g kg^{-1}). Among the various treatments integrated used gypsum and FYM showed numerically highest organic carbon in both 0-15 and 15-30 cm layer of soil. Similar observations were also reported by Singh *et al*. (2006) [5].

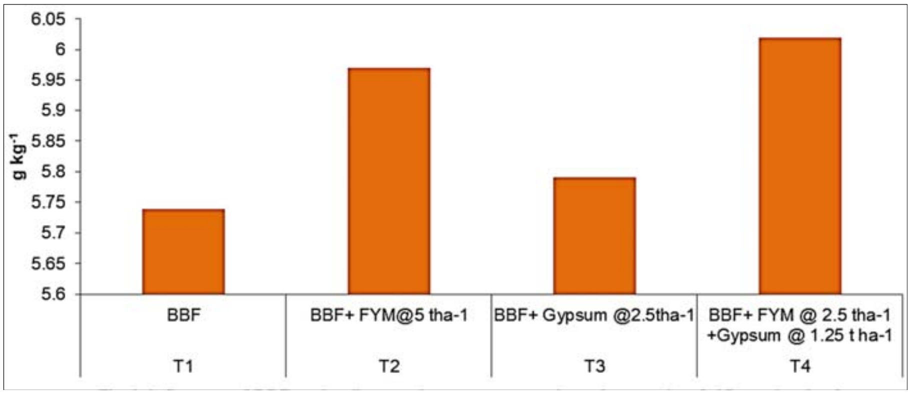

Fig 1: Influence of BBF and soil amendments on organic carbon under 0-15 cm depth of soil

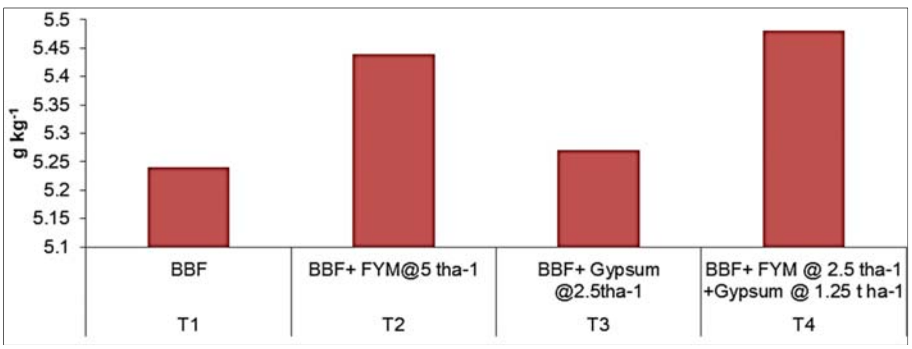

Fig 2: Influence of BBF and soil amendments on organic carbon under 15-30 cm depth of soil

The lowest organic carbon was recorded under treatment $T_1$where only BBF was practiced 5.74 g kg^{-1}in 0-15 cm layer of soil. While in 15-30 cm of soil layer it was recorded up to 5.24 g kg^{-1}. Addition of farm yard manure decomposed rapidly upon incorporation into soil under the experimental conditions characterized by high temperature and alternate aerobic and anaerobic condition which hasten decomposition**.** Vance *et al.* (1987) reported that an increase in organic carbon was observed under bed planting system than conventional in well drained (0.35 to 0.44%) than poorly drained soils (0.33 to 0.45%).

Wani *et al*. (2003) stated that crop residue additions @ 8 t $ha^{-1}yr^{-1}$ are required for long-term maintenance of organic and biomass carbon status of the Vertic Inceptisol. Any additional contribution to crop residues through leaf fall or roots by a cropping system would reduce this amount for long-term maintenance of soil organic carbon in the soil. Application of gypsum did not show significant improvement in organic carbon content. In a long term effect of green manuring and farm yard manure on fertility status in rice-wheat cropping system it was reported that application of 100% NPK + sunhemp in-situ green manuring or dhaincha in-situ green manuring or green gram in-situ green manuring significantly enhanced organic carbon content of soil (Vipin Kumar and Singh 2010) [5].

Inorganic carbon

The data in respect of inorganic carbon was presented in Table 3. and depicted in Fig 3 and Fig 4.

Table 3: Influence of BBF and soil amendments on inorganic carbon.

Tr. No.	Treatments	Inorganic carbon (g kg^{-1})	
		0-15 cm	15-30cm
T1	BBF	9.28	9.47
T2	BBF+ FYM@5 tha^{-1}	7.37	8.22
T3	BBF+ Gypsum @2.5tha^{-1}	8.12	8.62
T4	BBF+ FYM @ 2.5 tha^{-1} + Gypsum @1.25 tha^{-1}	7.78	8.45
SE(m) ±		0.17	0.09
CD at 5 %		0.51	0.29
Initial value		9.80	9.94

The Inorganic carbon content in soils increases with increase in depth of soils it was varied from 9.28 to 7.37 g kg^{-1} in 0-15 cm depth of soil. However, in 15-30 cm depth of soil it was varied from 9.47 to 8.22 g kg^{-1}. The highest reduction of inorganic carbon was occurred in treatment $T_{2,}$ where farm yard manure 5t $ha^{-1}$was added (7.72g kg^{-1}). While in treatment T_1it was slightly declined as no amendments were added (9.28g kg^{-1}) as compare to other treatment. Treatment T_2 and treatment T_4showed20.58 and18.21 %less inorganic carbon over treatment T_1.Similarly it was also noticed in 15-30 cm layer of soil where treatment T_2 FYM @ 5 t ha^{-1} showed highest decrease in inorganic carbon content (8.22g kg^{-1}) followed by treatment T_4FYM @ 2.5 t ha^{-1}+ gypsum @ 1.25 t ha^{-1}(8.45g kg^{-1}).

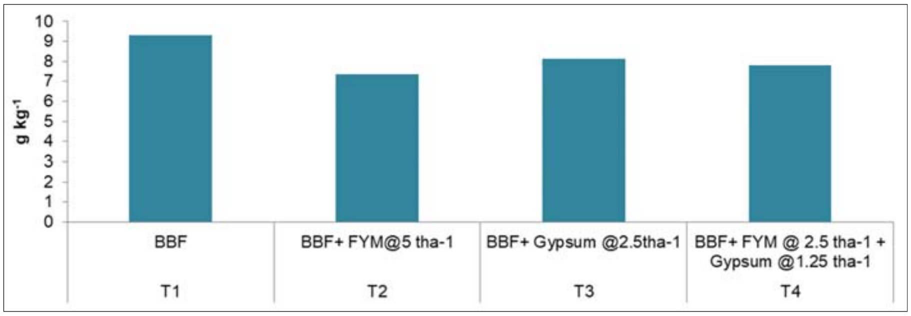

Fig 3: Influence of BBF and soil amendments on soil inorganic carbon under 0-15 cm depth of soil

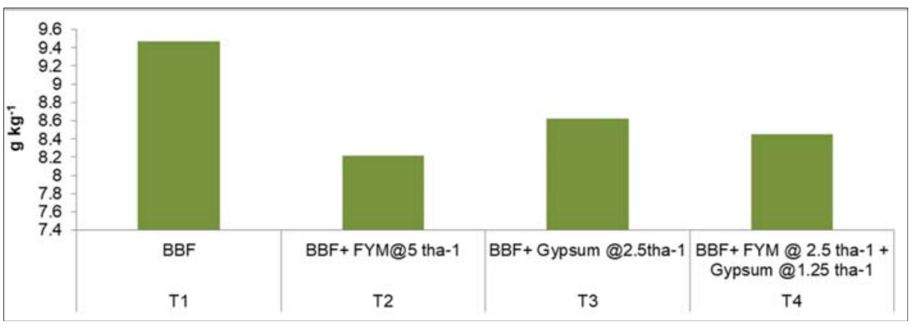

Fig 4: Influence of BBF and soil amendments on soil inorganic carbon under 15-30 cm depth of soil

The highest inorganic carbon was recorded under treatment T_1 where only BBF was practiced 9.28g kg^{-1}in 0-15 cm layer of soil while, in 15-30 cm of soil layer it was recorded up to 9.47g kg^{-1}treatment T_2 and treatment T_4 showed 13.19 % and 10.77 % less inorganic carbon over treatment T_1.

The soils are formed under arid or semi-arid climatic conditions, carbonate concentration in the soil solution remain high. In some soils inorganic carbon deposits are concentrated into layers that may be very hard and impermeable to water these layers called caliche. These are formed due to insufficient rainfall.

Significant reduction in $CaCO_3$ after 10 years due to addition of organic amendments has been reported by Bellaki *et al*. (1998) on Vertisols of Karnataka state. This might be due to organic acids released during the decomposition of organic materials which react with $CaCO_3$ in soil to release CO_2 thereby reducing $CaCO_3$ content of soil. The release of H^+ proton released from plant roots is considered as a process contributing to a decrease in pH of rhizosphere. In addition, legumes relying on symbiotic N_2 fixation shown to acidify rhizosphere (Qadir *et al*., 2007) [27]. Although considerable H^+ extrusion has been found in rhizosphere of various N_2 fixing plant species, this biological acidification mechanism in the root zone of sodic soils assist in calcite dissolution resulting in Ca^{2+} and HCO^-_3. It thus becomes apparent that the green manuring and use of crop residues is more beneficial in calcareous sodic soils in the context of soil reclamation as well as reduction in calcareousness. Soil inorganic carbon was significantly influenced due to both tillage practices and amendment application numerically lower values were recorded in (T_2) because higher rate of decomposition which produces organic acids to react with $CaCO_3$ and release CO_2 as a result of which the $CaCO_3$ content of soil is reduced. The results are in conformity with the findings of Hulugale *et al.* *(*2001).

Total carbon. (Organic carbon + Inorganic carbon)

The data in respect of inorganic carbon was presented in Table 4 and depicted in Fig 5 and Fig 6.

Table 4: Influence of BBF and soil amendments on total carbon.

Tr. No.	Treatments	Total carbon (g kg^{-1})	
		0-15 cm	15-30cm
T1	BBF	15.02	14.71
T2	BBF+ FYM@5 tha^{-1}	13.34	13.66
T3	BBF+ Gypsum @2.5tha^{-1}	13.91	13.89
T4	BBF+ FYM @ 2.5 tha^{-1} + Gypsum @1.25 tha^{-1}	13.80	13.91
SE(m) ±		0.09	0.12
CD at 5 %		0.27	0.36
Initial status		15.38	14.90

Total carbon varied from 13.34 to 15.02 g kg $^{-1}$ in 0-15 cm depth of soils as par 15-30 cm depth concern it varied from 13.66 to 14.71 gkg $^{-1}$ .Total carbon in soil increased with increase depth of soil. The highest total carbon was recorded in treatment $T_{1,}$ where only BBF was practiced (15.02 g kg^{-1}) followed by treatment T_3 where BBF+ Gypsum @2.5tha^{-1} was applied (13.91 g kg^{-1}). While in treatment T_2 where BBF+ FYM @ 5$tha^{-1}$is applied showedslightly declined in total carbon content(13.34 g kg^{-1})followed by treatment T_4 where BBF + FYM@ 2.5 t ha^{-1} + gypsum @1.25 t ha^{-1} was used (13.80 gkg^{-1}). Treatment T_2 and treatment T_4 showed 11.18 % and 8.12 % less total carbon over treatment T1.Similarly it was also noticed in 15-30 cm layer of soil where treatment T_2 FYM @ 5 t ha^{-1} showed decrease in total carbon content (13.66 g kg^{-1}) followed by treatment T_4 FYM @ 5 t ha^{-1}+ gypsum @ 1.25 t ha^{-1}(13.91 g kg $^{-1}$). In 0-15 cm layer of soil the highest total carbon recorded under treatment T_1 where only BBF was practiced 15.02 g kg^{-1}while, in the 15-30 cm of soil layer it was recorded up to 14.71 g kg^{-1}. Application of FYM showed significant reduction in $CaCO_3$ content and slight increase in organic carbon content of soils. Similar observations were also reported by Singh *et al*. (2004) [5].

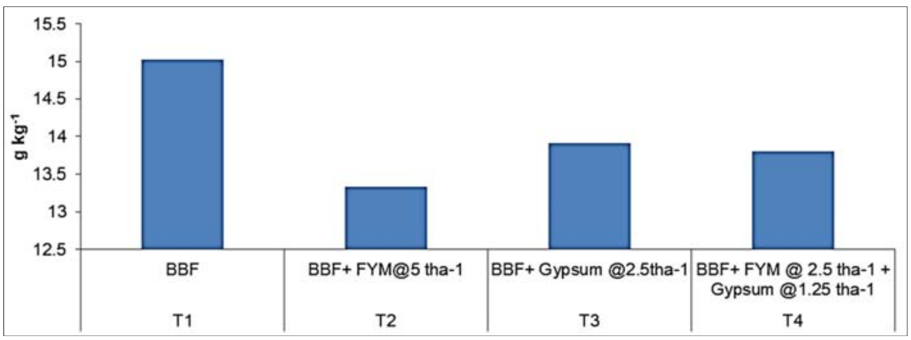

Fig 5: Influence of BBF and soil amendments on soil total carbon under 0-15 cm depth of soil

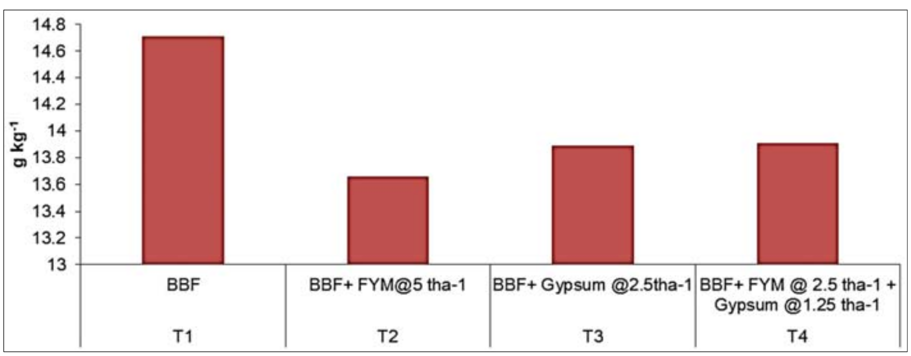

Fig 6: Influence of BBF and soil amendments on soil total carbon under 15-30 cm depth of soil

Oxidizable Carbon

The data in respect of oxidizable carbon was presented in Table 5 and depicted in Fig 7 and Fig 8.

Table 5: Influence of BBF and soil amendments on oxidizable carbon.

Tr. No.	Treatments	Oxidizable carbon (mg kg $^{-1}$)	
		0-15 cm	15-30cm
T1	BBF	107.16	94.66
T2	BBF+ FYM@5 tha^{-1}	131.12	116.16
T3	BBF+ Gypsum @2.5tha^{-1}	112.33	98.90
T4	BBF+ FYM @ 2.5 tha^{-1} + Gypsum @1.25 tha^{-1}	131.83	116.40
SE(m) ±		2.94	2.82
CD at 5 %		8.86	8.44

Labile pool of carbon is the fraction of SOC that has the most rapid turnover rates and therefore, its oxidation drives the flux of carbon dioxide from soil to atmosphere. Also, the labile carbon pool is one which is readily decomposable, easily oxidizable and susceptible to microbial attack and it sensitive to management induced changes in soil organic carbon. This pool is very important as it fuels the food web and greatly influences the nutrient cycling for maintaining the quality of soil and its productivity.
The oxidizable carbon varied from 107.16 to 131.83 mg kg^{-1} in 0-15 cm layer of soil and 94.66 to 116.16 mg kg^{-1} in 15-30 cm layer of soil under soybean. The highest oxidizable carbon was obtained in treatment $T_4$where farm yard manure and gypsum was amalgamated (131.83 mg kg^{-1}) followed by treatment T_2 where only farm yard manure is used (131.12 mg kg^{-1}) in 0-15 cm soil layer. While in 15-30 cm layer of soil, T_4 where FYM + gypsum used was most superior in increasing oxidizable carbon (116.40 mg kg^{-1}) followed by treatment T_2farm yard manure (116.16 mg kg^{-1}). Among the various treatments integrated used gypsum and FYM showed numerically highest oxidizable carbon in both 0-15 and 15-30 cm layer of soil.
The lowest oxidizable carbon was recorded under treatment T_1 where only BBF was practiced 107.16mg kg^{-1} in 0-15 cm layer of soil while, in 15-30 cm of soil layer it was recorded up to 94.66mg kg^{-1}. Similar results were also reported by Lakaria *et al*. (2012) [15] who studied soil organic pools under different land use system in vertisols of central India, based on his findings the application of 6 t FYM ha^{-1} recorded highest POC than unfertilized and fertilized plots.

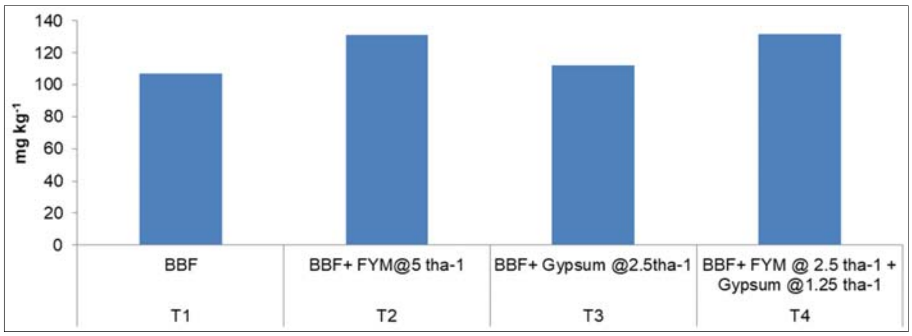

Fig 7: Influence of BBF and soil amendments on oxidizable carbon under 0-15 cm depth of soil

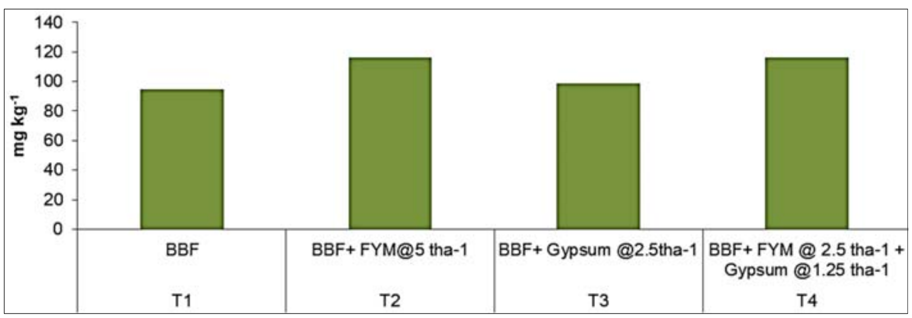

Fig 8: Influence of BBF and soil amendments on oxidizable carbon under 15-30 cm depth of soil

Water soluble carbon.

The data in respect of water soluble carbon was presented in Table 6 and depicted in Fig 9 and Fig 10.

Table 6: Influence of BBF and soil amendments on water soluble carbon.

Tr. No.	Treatments	Water soluble carbon (mg kg^{-1})	
		0-15 cm	15-30cm
T1	BBF	24.26	22.63
T2	BBF+ FYM@5 tha^{-1}	32.9	30.28
T3	BBF+ Gypsum @2.5tha^{-1}	26	24.46
T4	BBF+ FYM @ 2.5 tha^{-1} + Gypsum @1.25 tha^{-1}	33.02	30.68
SE(m) ±		0.23	0.28
CD at 5 %		0.70	0.84

The water soluble carbon varied from 24.26 to 33.02mgkg^{-1} in 0-15 cm layer of soil. The highest water soluble carbon was obtained in treatment T_4 (33.02 mg kg^{-1}) where farm yard manure and gypsum was amalgamated followed by treatment T_2 BBF+ FYM@5 tha^{-1}(32.9 mg kg^{-1}) in 0-15 cm of soil depth. However the lowest water soluble carbon was recorded under treatment $T_1$where only BBF was practiced (24.26 mgkg^{-1}).

The results from 15-30 cm layer of soil were also showed similar effect to the different treatments as showed in 0-15 cm layer of soil where water soluble carbon varied from 22.63 to 30.68mg kg^{-1}. The highest water soluble carbon was obtained in treatment T_4 (30.68 mg kg^{-1}) where farm yard manure and gypsum was amalgamated followed by treatment T_2 BBF+ FYM@5 tha^{-1}(30.28 mg kg^{-1}) in 15-30 cm of soil depth. However the lowest water soluble carbon was recorded under treatment T_1 where only BBF was practiced (22.63 mg kg^{-1}).

Based on the result obtained it can be stated that amongst all the treatments T_4 FYM 2.5 t ha^{-1} + gypsum 1.25 t ha^{-1} followed by treatment T_2 FYM @ 5 t ha^{-1} having greater significant in increasing water soluble carbon in soil. These results were also in accordance with the findings of Mishra *et al* (2008) [19], Abril (2013) [2] and Lindquist *et al*. (1999).

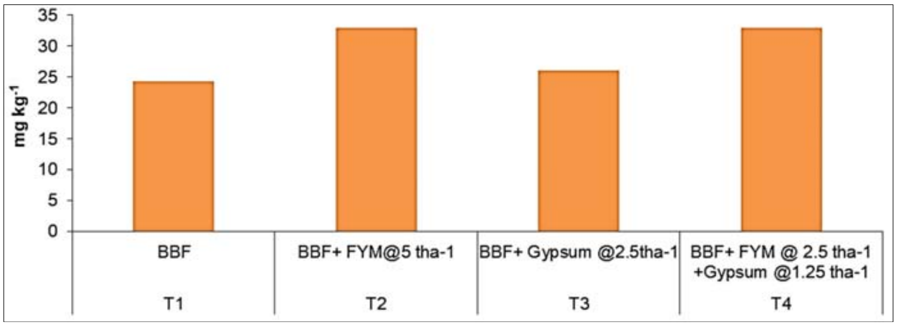

Fig 9: Influence of BBF and soil amendments on water soluble carbon under 0-15 cm depth of soil

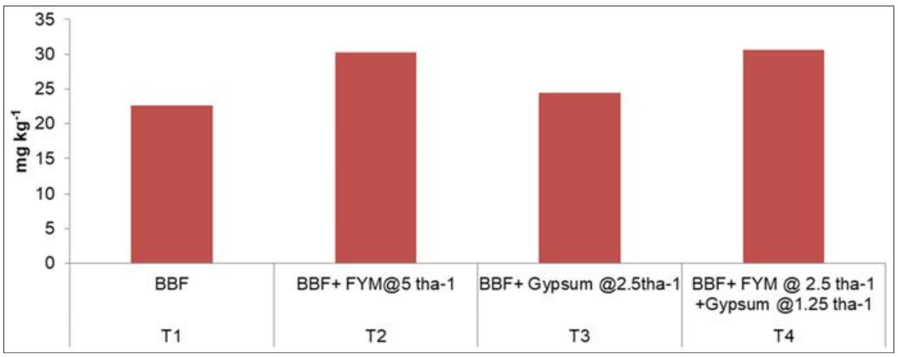

Fig 10: Influence of BBF and soil amendments on water soluble carbon under 15-30 cm depth of soil

Seed and straw yield of soybean

In respect of yield of soybean as influenced by various treatments, the highest soybean yield (18.13 q ha^{-1}) in treatment T_3 BBF+ Gypsum @ 2.5 t ha^{-1} and which was at par with T_4 –BBF+ FYM @ 2.5 t ha^{-1} + Gypsum @ 1.25 t ha^{-1} and significantly superior over rest of the treatment. The results are in conformity with the findings of Ravindar J. *et al*. (2015).Similar results have also been reported by Sagare *et al.* (2000) [28] the application of gypsum @ 50% GR in combination with FYM @ 5 t ha^{-1} enhanced the grain yield of crop.

Table 7: Influence of BBF and soil amendments on yield of soybean

Tr. No.	Treatments	Grain	Straw
		q ha^{-1}	
T1	BBF	13.42	18.93
T2	BBF+ FYM @ 5 t ha^{-1}	15.60	22.44
T3	BBF+ Gypsum @ 2.5 t ha^{-1}	18.13	27.09
T4	BBF+ FYM @ 2.5 t ha^{-1} + Gypsum @ 1.25 t ha^{-1}	17.38	25.74
SE(m) ±		0.48	0.90
CD at 5 %		1.41	2.64
C.V		6.01	7.72

This is due to significant reduction in pH, ECe and ESP at Ca^+ ion that exchange with Na^+ of clay complex leading to creation of favourable environment for microbial activity which results in improvement at soil health (Rao and Pathak, 1996)

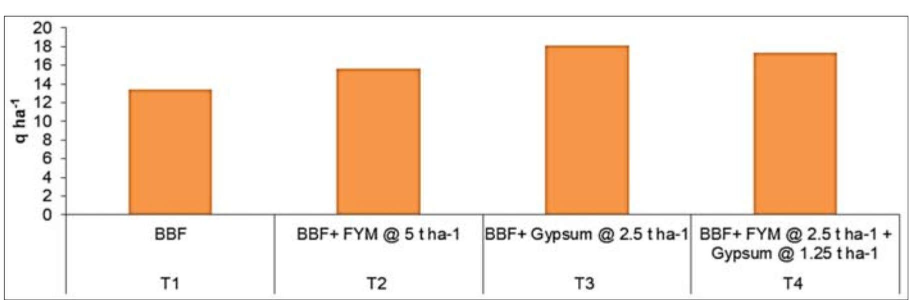

Fig 5: Influence of BBF and soil amendments on grain yield of soybean

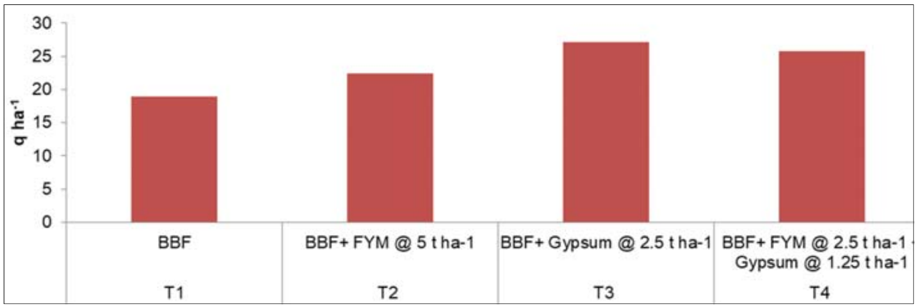

Fig 6: Influence of BBF and soil amendments on straw yield of soybean

Conclusion

- The land configuration technique along with application of farm yard manure@2.5 t ha^{-1} + gypsum @ 1.25 t $ha^{-1}$was found beneficial for improvement and enhancing various carbon pools in soil.
- The integration of BBF and soil amendments was found beneficial for better amelioration and more grain and straw yield of soybean in sodic Vertisols of Purna valley.

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