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Physico-chemical Properties of Soil Affected by Different Sources of Nutrients

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Abstract: The effect of different sources of nutrients on physico-chemical soil properties in sorghum sudan grass hybrid–oat cropping system was observed from *Kharif* 2017 to *Rabi* 2018-19. The soil pH remained on the acidic spectrum with application of FYM @10 t ha^{-1}+ *Azotobacter* + PSB and 100 per cent of recommended fertilizer. Bulk density was not significantly influenced by FYM and biofertilizers and fertilizers application. An increase in soil organic carbon, biomass carbon and available NPK was observed with the application of FYM @10 t ha^{-1}+*Azotobacter* + PSB and 100 per cent recommended fertilizer over the initial status. Combined application of FYM @10 t ha^{-1}and *Azotobacter* + PSB while remaining at par with FYM @10 t ha^{-1}registered significantly higher available NPK content of soil than *Azotobacter* + PSB. Application of 100 per cent of recommended fertilizer had significantly higher available NPK content than control *i.e.* no fertilizer.

Keywords: FYM and biofertilizers, Fertilizer levels, Sorghum sudan grass hybrid-oat

Forages are the mainstay of livestock and the quality fodder is prerequisite for success of livestock industry which largely depends on the supply of sufficient quantity of nutritious green forages. Country faces a vast deficit of 35.6 per cent of green fodder, 10.9 per cent of dry fodder and 44 per cent of concentrates (Anonymous 2013). Sorghum sudan grass is becoming very popular among the farmers due to low levels of HCN (prussic acid) compared to sorghum. Moreover, it is highly suitable under predominantly rainfed conditions of Himachal Pradesh. Oat is the most important cereal forage crop growing during winter season under irrigated and rainfed conditions. Both these forage crops are quick growing, better palatability, succulent, and nutritious having luxuriant growth. Use of high analysis fertilizers in imbalance and indiscriminate manner had developed many problems of soil organic matter, increase in soil salinity, sodicity, soil pollutants and hazards of pests and diseases (Chakraborti and Singh 2004). The higher doses of inorganic fertilizers are applied in order to meet out the fodder demand which is uneconomical for fodder production and continuous use of high amount of chemical fertilizers had deleterious effect leading to decline in productivity due to limitation of one or more micronutrients. Judicious use of nutrients in forages may improve the yield and quality of fodder and optimize its production cost (Gupta et al 2005). The cost of chemical fertilizers is very high, it becomes imperative to substitute chemical fertilizers by some other available sources of organic manures *viz.* farm yard manure and bio-fertilizers in an integrated manner to meet the crop requirement, to maintain soil health and augment the efficiency of nutrients. Keeping these aspects in view, the present study was undertaken to study the effect of integrated use of organic manures and biofertilizers and inorganic fertilizers alone on physicochemical properties of soil.

MATERIAL AND METHODS

The field experiment was conducted during the rainy (*Kharif*) and winter (*Rabi*) seasons of 2017-18 and 2018-19 at Research Farm, Department of Agronomy, Forages and Grassland Management, CSK HPKV, Palampur, Kangra, Himachal Pradesh. The climate is mild temperate with annual rainfall of 1500-2500 mm per annum and average of 2000 mm. The crop sequence received total annual rainfall of 2463.7 mm in 2017-18 and 2668.8 mm in 2018-19 during the crop growth period. Soil samples from 0-15 cm soil depth were collected randomly from different spots and composite soil sample was prepared before the commencement of experiment and analysed for physico-chemical properties of soil. The soil of the region was silty clay loam in texture and acidic with a pH of 5.67. It was medium in organic carbon (0.67 %), available phosphorous (17.6 kg ha^{-1}) and available potassium (206 kg ha^{-1}) and low in available nitrogen (242 kg ha^{-1}).

The experiment was laid out in a factorial randomized block design with three replications. The treatments consisted of four levels of FYM and biofertilizers (control, FYM @ 10 t ha^{-1},*Azotobacter*+ PSB, O3-FYM @ 10 t ha^{-1}+*Azotobacter* + PSB) and four levels of fertilizers (control, 50% NPK 75 % NPK 100% NPK). FYM was applied at the time of land preparation as per the treatments. The seed was treated with the culture of *Azotobacter* and PSB @20g kg^{-1} seed prior to the sowing using 10 per cent sugar syrup. The crops were sown in a plot size of 3.60 × 4.50 m^2. Sorghum sudan grass (Red Rasili) and oat (Palampur-1) were sown using seed rates of 45 and 100 kg ha^{-1} with a spacing of 30 and 22.5 cm (R×R) spacing, respectively. The required quantity of seed for experimental area was worked @ 45 and 100 kg ha^{-1} for sorghum sudan grass hybrid and oat, respectively. The recommended dose of inorganic fertilizer was 90:60:30 and 120:60:40 kg N, P_2O_5, K_2O kg $ha^{-1}$for sorghum sudan grass hybrid and oat, respectively. Nitrogen, phosphorous and potassium were applied through urea, single super phosphate and muriate of potash, respectively. In both the crops, half dose of N and whole of P and K was applied at the time of sowing. The remaining $1/4^{th}$ dose was top dressed after 30-35 days of sowing of crop and remaining $1/4^{th}$ was applied after first cut. Treatment wise soil samples were taken from 0-15 cm soil depth at the end of experiment after two years and analysed for same physico-chemical properties. Soil pH was determined in the soil: water (1:2.5) by expand pH meter (Jackson 1967). Organic carbon was determined by method of Walkley and Black (1934). The available N, P and K content in soil was estimated by using standard methods.

RESULTS AND DISCUSSION

Soil pH was not influenced significantly by FYM and biofertilizers and fertilizer levels (Table 1) and remained in the acidic spectrum. The bulk density was also not significantly influenced by FYM and biofertilizers and fertilizer levels. The increase in soil organic carbon and soil biomass carbon content was observed in all the treatments over the initial status. Application of FYM @10 t ha^{-1}+ *Azotobacter* + PSB and FYM @10 t ha^{-1} were at par with each other but was significantly better than rest of the treatments in terms of organic carbon. The effect of 50, 75 and 100 per cent recommended fertilizer was same giving significantly higher organic carbon content than no fertilizer *i.e.* control. FYM as organic manure might resulted in organic carbon build up in soil and created favourable condition for microbial growth and carbon build up, hence ultimate improvement in soil organic carbon and microbial biomass carbon in all treatments involving FYM application. Chandrakala (2008) also observed improvement in soil organic carbon with addition of FYM after the completion of crop season. Marked variations were observed in the amount of soil biomass carbon at the end of two years. The combined application of FYM @10 t $ha^{-1}$and *Azotobacter* + PSB improved the soil biomass carbon as compared to applied alone either FYM @10 t ha^{-1}or *Azotobacter* + PSB and no FYM and biofertilizers. The effect of 75 and 100 per cent recommended fertilizer also showed significantly higher biomass carbon than control. Higher biomass carbon with FYM @10 t ha^{-1} + *Azotobacter* + PSB and higher levels of fertilizer may be due to better plant growth and better root proliferation. The better root space in the rhizosphere provides more space for growth and development of microbes which ultimately resulted in more biomass carbon (Kumar 2010).

Available NPK status of soil at the expiry of experiment showed improvement in the status of soil over the initial

Table 1. Effect of different treatments on physico-chemical properties of soil

Treatments	Soil pH	Bulk density (Mg m^{-3})	Organic carbon (%)	Soil biomass carbon (µg g^{-1} soil)	Nitrogen (kg ha^{-1})	Phosphorous (kg ha^{-1})	Potassium (kg ha^{-1})
FYM and biofertilizers							
Control	5.68	1.32	0.67	74.96	235	15.9	199
FYM @10 t ha^{-1}	5.64	1.30	0.74	83.37	244	17.1	205
Azotobacter + PSB	5.63	1.30	0.70	81.66	239	16.9	200
FYM @10 t ha^{-1}+ *Azotobacter* + PSB	5.69	1.29	0.75	87.91	248	18.0	208
CD (p=0.05)	-	NS	0.03	3.69	8.17	0.91	7.03
Fertilizer levels							
Control	5.68	1.31	0.68	74.10	232	15.8	198
50 % RDF	5.67	1.30	0.71	81.86	240	16.2	202
75% RDF	5.66	1.31	0.73	85.04	244	17.6	204
100 % RDF	5.64	1.29	0.74	86.91	250	18.4	209
CD (p=0.05)	-	NS	0.03	3.69	8.17	0.91	7.03
Initial status	5.67	1.31	0.66	70.66	242	17.6	206

RDF- Recommended dose of fertilizer

values. Significantly higher available nitrogen, phosphorous and potassium was noted under application of FYM @10 t ha^{-1} + *Azotobacter* + PSB registering significant increase over *Azotobacter* + PSB and control but at par with the alone application of FYM @10 t ha^{-1}. Application of fertilizer also had significant effect on available nitrogen, phosphorous and potassium content of soil at the end of experiment. Application of 100 per cent recommended fertilizer had higher available nitrogen than no fertilizer *i.e.* control and 50 per cent of recommended fertilizer. However, the effect of 75 and 100 per cent of recommended fertilizer remaining at par with each other resulted in significantly higher available phosphorous than rest of the fertilizer levels. Available potassium was also influenced significantly by different fertilizer levels and the effect of 50, 75 and 100 per cent recommended fertilizer was same resulted in statistically similar available potassium content in post harvest soil. The release of nitrogen, phosphorus and potassium into the soil from the mineralization of FYM during the later stages of crop also resulted in higher values after the completion of experiment. The organic acids produced during the mineralization of the added FYM solublized the insoluble form of nutrients to the soluble form making it available to the crop as well as enhancing the available NPK content after the harvest of the crop. *Azotobacter* might have improved the N content of soil by fixing the biological-N, which takes in the rhizosphere of the plants. However, PSB might be beneficial in solubilizing the applied as well as native phosphorous, which consequently increased the available phosphorous status of soil (Sharma and Verma 2005). Similarly, the treatment with highest amount of NPK to the soil through fertilizer showed highest available NPK content in soil. Significantly lowest available NPK content was in control treatment in which no FYM and biofertilizers or no fertilizers were added. Since no NPK was added in control treatment and whatever quantity of these nutrients was removed from the soil through its uptake by crop was from the reserves present in the soil which resulted in significantly lowest available NPK after the harvest of crop. Many earlier workers reported that net soil available nitrogen, phosphorous and potassium was higher with the application of FYM + biofertilizers and 100 per cent recommended fertilizer, respectively (Barthwal et al 2013, Jat et al 2014, Kumar and Chaplot 2015, Deva 2015, Singh et al 2015).

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CONCLUSION

The application of FYM @10 t ha^{-1} + *Azotobacter* + PSB and 100 per cent of recommended fertilizers holds promise to improve the soil organic carbon, biomass carbon and NPK content in soil at the end of experiment after two years. Application of FYM @ 10 t ha^{-1} + *Azotobacter* + PSB and recommended NPK application had favourable effect on soil available N, P and K over initial status.

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