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Original Research Article

Effect of organics and inorganics on soil properties - A step towards nutrient management in Vertisols of Malwa Region

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A B S T R A C T

An experiment was conducted at AICRPDA farm Indore, in *kharif* season 2017-18, in which 3 replications and 9 treatments were taken with soybean crop. After experiment it was revealed that good soil physical properties maintained by the application of organics. Treatment 6 which is applied with 6 tonnes FYM + N20P13 gave the better soil physical and chemical properties. In T6 status of Available N, P, K and S after harvest found increased, pH found increased, BD found decreased, WHC and Porosity found increased. Result shows that applying organics alone and in combination with inorganics improves the nutrient status in soil also improves its physical condition.

Keywords

Organics and inorganics on soil properties, *Kharif* season

Introduction

Soil fertility refers to the ability of a soil to sustain agricultural plant growth, i.e. to provide plant habitat and result in sustained and consistent yields of high quality. A fertile soil has the properties like ability to supply essential plant nutrients and water in adequate amounts and proportions for plant growth and reproduction and absence of toxic substances which may inhibit plant growth. Sufficient soil depth for adequate root growth and water retention, Good internal drainage, allowing sufficient aeration for optimal root growth (although some plants, such as rice, tolerate water logging), Topsoil with sufficient soil organic matter for healthy soil structure and soil moisture retention, Soil pH in the range 5.5 to 7.0 (suitable for most plants but some prefer or tolerate more acid or alkaline conditions), Adequate concentrations of essential plant nutrients in plant-available forms, Presence of a range of microorganisms that support plant growth. Inorganic fertilizers are generally less expensive and have higher concentrations of nutrients than organic fertilizers. Also, since nitrogen, phosphorus and potassium generally must be in the inorganic forms to be taken up by plants, inorganic fertilizers are generally immediately bio-available to plants without modification. However, some have criticized the use of inorganic fertilizers, claiming that the water-soluble nitrogen doesn't provide for the long-term needs of the plant and creates water pollution. Slow-release fertilizers may reduce leaching loss of nutrients and may make the nutrients that they provide available over a longer period of time.

Soil fertility is a complex process that involves the constant cycling of nutrients between organic and inorganic forms. As plant material and animal wastes are decomposed by micro-organisms, they release inorganic nutrients to the soil solution, a process referred to as mineralization. Those nutrients may then undergo further transformations which may be aided or enabled by soil micro-organisms. Like plants, many micro-organisms require or preferentially use inorganic forms of nitrogen, phosphorus or potassium and will compete with plants for these nutrients, tying up the nutrients in microbial biomass, a process often called immobilization.

The balance between immobilization and mineralization processes depends on the balance and availability of major nutrients and organic carbon to soil microorganisms. Natural processes such as lightning strikes may fix atmospheric nitrogen by converting it to (NO_2). Denitrification may occur under anaerobic conditions (flooding) in the presence of denitrifying bacteria. Nutrient cations, including potassium and many micronutrients, are held in relatively strong bonds with the negatively charged portions of the soil in a process known as cation exchange.

Materials and Methods

A long term studies on the impact of organic, integrated and chemical nutrient management practices on soybean production at AICRPDA, Indore, during 2017-18. From sowing to harvesting 16 Standard Meteorological weeks were recorded. 34.7^0 C was the heighest maximum temperature, 27.36^0 C was highest minimum temperature, 636.50 mm were the total rainfall recorded during the SMW.

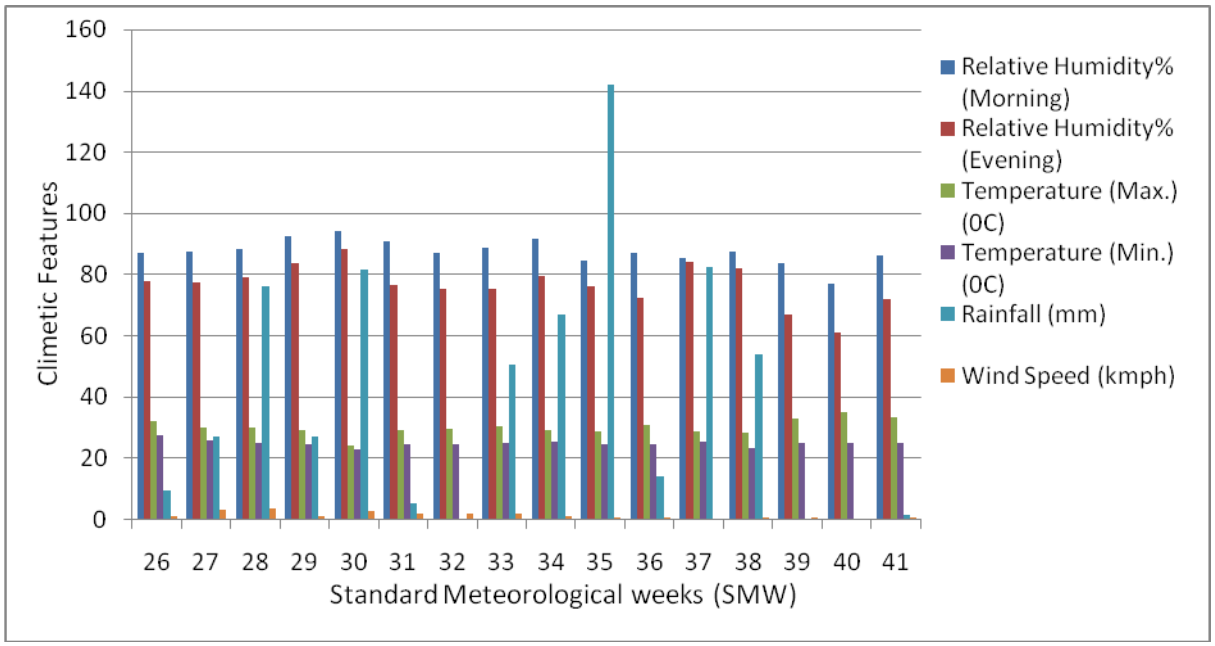
Results and Discussion

Different nutrient management practices had significant effect on soil properties:

Physical Properties: Different nutrient management practices had significant effect on soil physical properties BD, Porosity, WHC. Due to inorganics BD increases, Porosity and WHC decreases but due to application of organics alone and in integration with inorganics Soil Physical properties improves means BD decreases and WHC and Porosity increases.
Table A and B shows the effects of organics and inorganics on soil physical properties. Table A shows the physical properties of experimented soil before the sowing of soybean crop.

After the experiment it is concluded that organic fertilizers had positive effect on soil physical properties, because after harvesting results shows reduction in Bulk Density in those plots which were applied with organics and opposite of them the BD of inorganic plots found increased. Similarly organics has positive effect on Porosity and WHC of soil, organics increases both of them and due to inorganics both decreases. The best result were found from treatment T6 - FYM 6 tha^{-1}+T2, it results in lowest BD (1.15 Mg m^{-3} before sowing and 1.14 Mg m^{-3} after harvesting), Highest (52.40% before sowing and52.60% after harvesting) Porosity and WHC (43.67% before sowing and44.33% after harvesting).

Chemical Properties: In present investigation effect of different treatments of organics and inorganics and there integration on chemical properties EC, pH, Organic Carbon, Available Nitrogen, Phosphorus, Potassium and Sulphur are determined. Result before sowing and after harvesting of crop is shown in following Table C and D.



Treatment details:

Sym	Treatment	Treatment detail
T1	N0P0	Control
T2	N20P13	Fertilizer N and P @ 20 and 13 kgha^{-1}
T3	N30P20	Fertilizer N and P@ 30 and 20 kgha^{-1}
T4	N40P26	Fertilizer N and P@ 40 and 26 kgha^{-1}
T5	N60P35	Fertilizer N and P @ 60 and 35 kgha^{-1}
T6	FYM 6t ha^{-1} + N20P13	FYM @ 6 t ha^{-1} in rainy season only plus fertilizer N and P @ 20 and 13 kgha^{-1}, respectively to each crop.
T7	Crop residues 5t ha^{-1} + N20P13	Crop residues of soybean @ 5t ha^{-1}
T8	FYM 6t ha^{-1}	FYM @ 6 t ha^{-1}
T9	Crop residues 5t ha^{-1}	Residues are applied to each crop after emergence of crop in between crop rows as surface mulch.

Table A. Physical properties of experimental soil before sowing

Treatments	Soil before sowing		
	BD(Mg m^{-3})	Porosity(%)	WHC(%)
T1 – Control	1.53	38.83	37.33
T2 - N20 P13	1.51	39.35	38.00
T3 - N30 P20	1.49	39.83	39.33
T4 - N40 P26	1.41	43.32	40.33
T5 - N60 P35	1.44	42.38	39.67
T6 - FYM 6 tha^{-1}+T2	1.15	52.40	43.67
T7 - Residues 5 t ha^{-1}+T2	1.16	52.31	42.67
T8 - FYM 6 t ha^{-1}	1.17	52.10	41.33
T9 - Residues 5t ha^{-1}	1.22	50.13	40.67

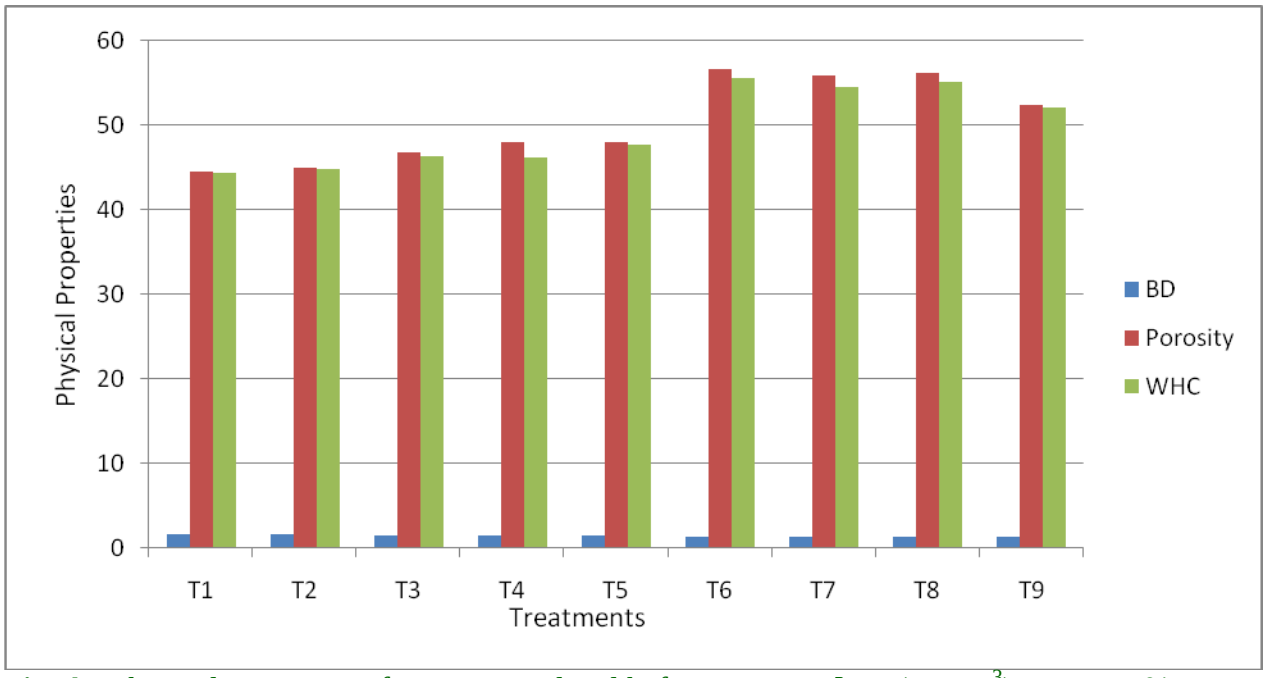


Fig. A. Physical properties of experimental soil before sowing [BD (Mg m^{-3}), Porosity %, WHC%]

Table.B Physical properties of experimental soil after harvesting

Treatments	Soil after harvesting		
	BD(Mg m^{-3})	Porosity(%)	WHC(%)
T1 – Control	1.54	38.67	36.33
T2 - N20 P13	1.52	38.16	37.00
T3 - N30 P20	1.50	39.68	38.33
T4 - N40 P26	1.42	43.06	39.33
T5 - N60 P35	1.45	42.41	39.00
T6 - FYM 6 tha^{-1}+T2	1.14	52.60	44.33
T7 - Residues 5 t ha^{-1}+T2	1.15	52.55	43.67
T8 - FYM 6 t ha^{-1}	1.16	52.45	41.50
T9 - Residues 5t ha^{-1}	1.21	50.27	41.17

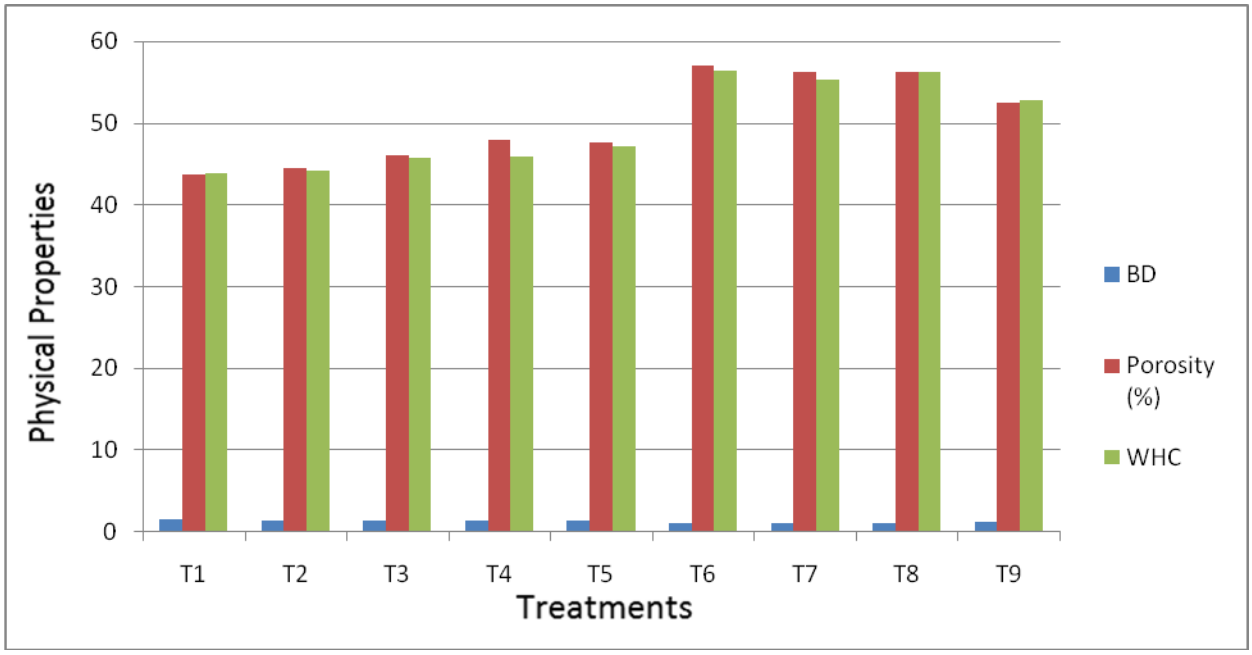


Fig.B Physical properties of experimental soil after harvesting [BD (Mg m^{-3}), Porosity %, WHC%]

Table.C Chemical properties of experimental soil before sowing of soybean

TREATMENT	Before sowing of soybean (2017-18)						
	OC%	Kg ha^{-1}				EC dSm^{-1}	pH(2:1)
		N	P_2O_5	K_2O	S		
T1 – Control	0.27	181.00	8.08	460.67	6.91	0.43	7.49
T2 - N20 P13	0.39	243.00	11.30	541.00	7.78	0.43	7.57
T3 - N30 P20	0.46	216.33	11.35	553.00	8.69	0.42	7.55
T4 - N40 P26	0.52	210.67	11.71	559.33	10.52	0.42	7.56
T5 - N60 P35	0.58	216.33	13.84	575.33	7.23	0.44	7.58
T6 - FYM 6 tha^{-1}+T2	0.78	308.33	13.64	708.33	18.07	0.40	7.61
T7 - Residues 5 t ha^{-1}+T2	0.74	291.33	12.73	665.33	16.68	0.41	7.60
T8 - FYM 6 t ha^{-1}	0.73	287.00	12.63	641.33	15.07	0.42	7.64
T9 - Residues 5t ha^{-1}	0.62	252.00	12.43	586.67	14.07	0.41	7.66

Table.D Chemical properties of experimental soil after harvesting of soybean.

TREATMENT	After harvest of soybean (2017-18)						
	OC %	Kg ha^{-1}				EC dSm^{-1}	pH(2:1)
		N	P_2O_5	K_2O	S		
T1 – Control	0.26	180.00	8.44	459.00	6.80	0.33	7.48
T2 - N20 P13	0.38	241.00	10.86	525.33	6.13	0.30	7.56
T3 - N30 P20	0.45	215.33	11.31	542.33	7.07	0.31	7.56
T4 - N40 P26	0.51	209.33	11.37	551.67	7.75	0.33	7.55
T5 - N60 P35	0.57	215.00	14.44	573.33	7.28	0.25	7.57
T6 - FYM 6 tha^{-1}+T2	0.79	310.00	14.70	715.33	18.38	0.22	7.62
T7 - Residues 5 t ha^{-1}+T2	0.75	289.00	13.77	667.67	16.78	0.21	7.61
T8 - FYM 6 t ha^{-1}	0.74	288.33	13.63	644.33	16.07	0.21	7.65
T9 - Residues 5t ha^{-1}	0.61	253.33	12.77	607.00	17.09	0.22	7.68

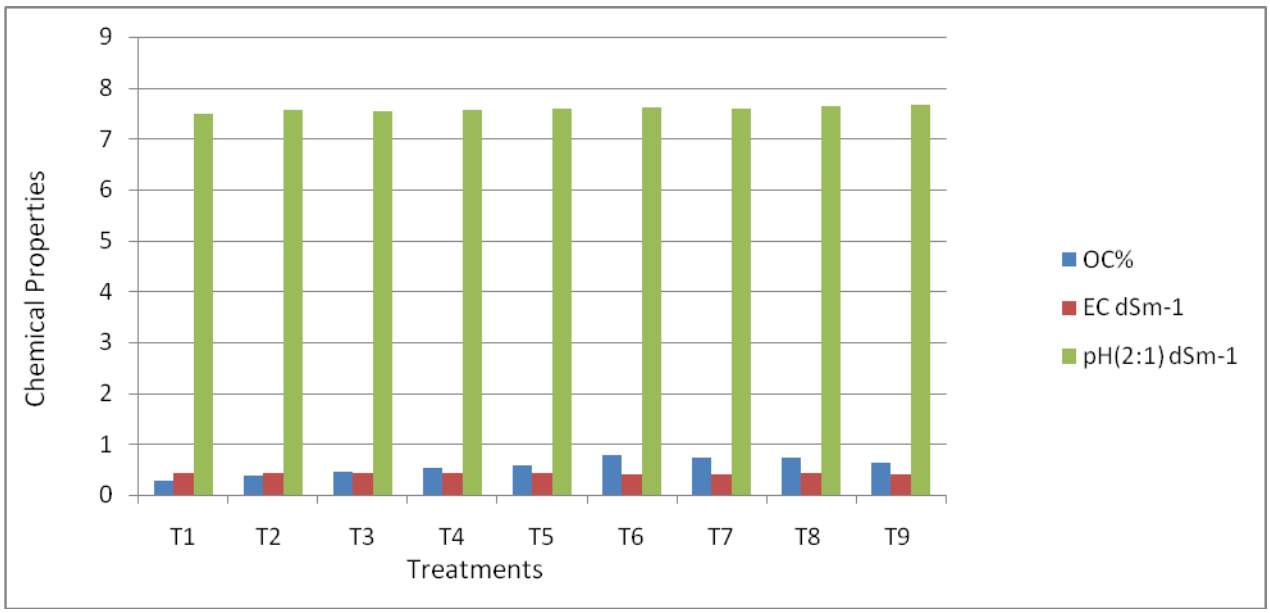


Fig.C EC, pH and OC of soil Before sowing of Soybean.

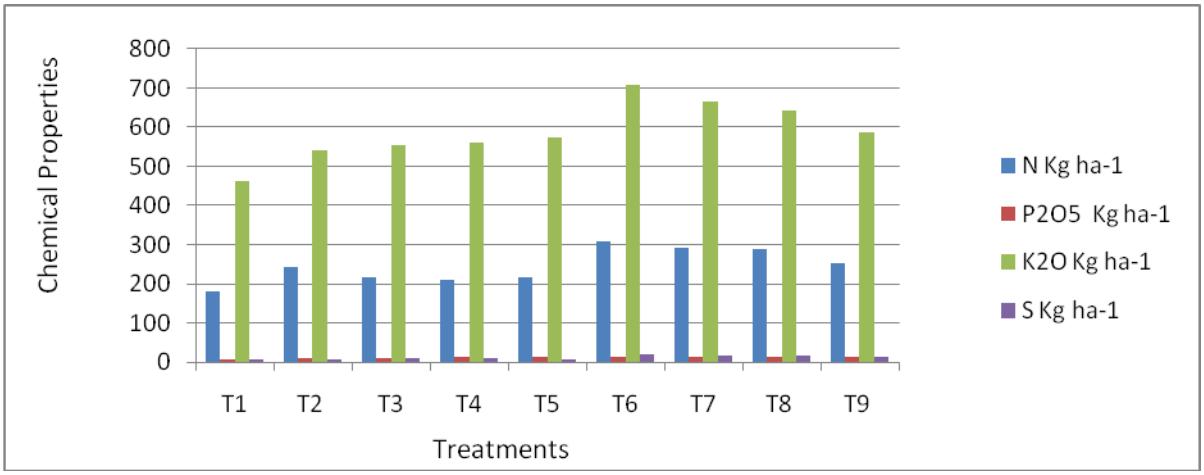


Fig.D Available N, P_2O_5, K_2O and S Before sowing of soybean.

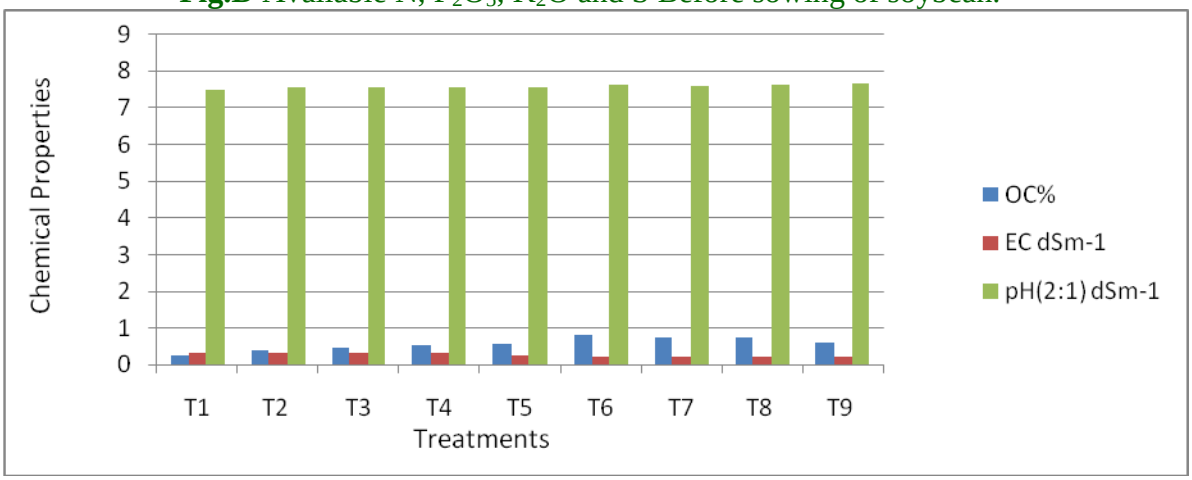


Fig.E EC, pH and OC of soil After harvesting of Soybean

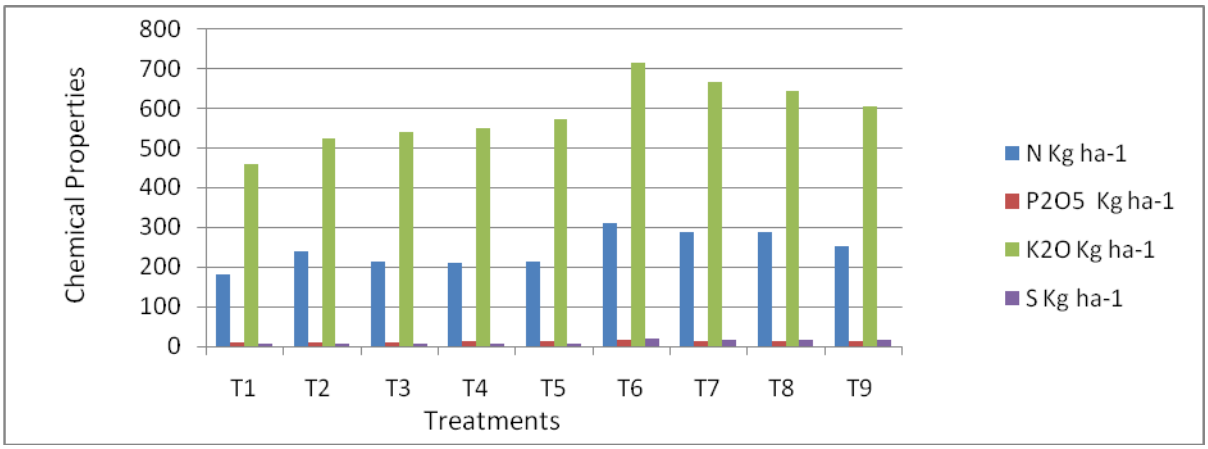


Fig.F Available N, P_2O_5, K_2O and S After harvesting of soybean

After the completion of experiment it revealed that best result found in (T6 - FYM 6 tha^{-1}+T2) OC and pH increased and EC decreased in organically applied plots. In T6 OC increased from 0.78% to 0.79%, pH increased from 7.61 to 7.62, EC decreased from 0.40 dSm^{-1} to 0.22 dSm^{-1}, Available N increased from 308 kg ha^{-1} to 310 kg ha^{-1}, Available P_2O_5 increased from 13.64 kg ha^{-1} to 14.70 kg ha^{-1},Available K_2O increased from 708 kg $ha^{-1}$to 715 kg ha^{-1} and Available S increased from 18.07 kg ha^{-1} to 18.38 kg ha^{-1}. Followed by T6, treatment T7, T8, T9 gave better results. Experiment revealed that Organics adds nutrients in soil and made it nutrient rich, healthy and sustain its life for future needs, But on the other hand continuous use of chemical fertilizers have negative effect on soil because they reduce the nutrients from soil.

Good soil physical properties maintained by the application of organics. Treatment 6 which is applied with 6 tonnes FYM + N20P13 gave the better soil physical and chemical properties. In T6 status of Available N, P, K and S after harvest found increased, pH found increased, BD found decreased, WHC and Porosity found increased. Result shows that applying organics alone and in combination with inorganics improves the nutrient status in soil also improves its physical condition.

Prasad *et al.* (1983) reported that bulk density increases with application of inorganic fertilizers (50 to 150% NPK). Whereas, FYM incorporation with 100% NPK lower down the bulk density of soil as compared to 100% NPK application and control.

Maheswarappa *et al.* (1999) conducted an experiment and reported that the FYM and vermicompost application alone decreased the bulk density, improved soil porosity, organic carbon and maximum water holding capacity to a great extent whereas, under NPK alone and control there was no change in physical and chemical properties of soil.

Jha and Rattan (2007) revealed that mineralization of crop residue also supply essential nutrients. Organic matter greatly influences the availability of N, P, K and several other plant nutrients.

Singh (2007) concluded from a comparative study of INM and the farmer's practice based on changes in relative soil quality index (RSQI) and quality changes that soil quality in INM trial was increased by 12-19 units as compared to 7-9 units in farmer's practice. The soil quality in terms of CEC, pH, N, P, K, organic matter, soil structure etc. increased up to 5 percent.

Pothare *et al.* (2007) conducted a long- term fertilizer experiment started since 1988 at

Dr. P.D.K.V., Akola. There were 14 treatments replicated four times indicated that all the soil properties such as pH, EC, organic matter, total and available N, P, K and S etc. were favorably influenced with the conjunctive use of organics and inorganics. Highest values were observed in the treatment of 100% NPK + 10 t FYM ha. The influence on soil properties ultimately reflected in higher yield of sorghum and wheat and in the same treatment it is also observed that all the soil properties except pH, EC were highly significantly correlated with yield.

Thakur *et al.* (2009) conducted an experiment with soybean - wheat - maize cropping sequence initiated during 1972 at J.N.K.V.V., Jabalpur (Madhya Pradesh, India) with the aim to investigate the effect of continuous application of different agricultural inputs on the soil health and dynamics of nutrients of medium black soil (Vertisols). The study was designed with 10 treatments, namely: (T1) 50% NPK; (T2) 100% NPK; (T3) 150% NPK; (T4) 100% + HW (hand weeding); (T5) 100% NPK + Zn (ZnSO4); (T) 100% NP; (T7) 100% N; (T**8**) 100% NPK + farmyard manure (FYM); (T9) 100% NPK-S (sulphur free) and (T10) control plot. Organic carbon content in the surface soil was found to be higher as compare to the lower layers in different treatments and the highest and significantly higher values at different depths were noted in the treatment that received recommended dose of fertilizer along with FYM (T). The contents were higher in all soil layers of the treatments receiving balanced applications as compared to the treatments where imbalanced application is being practiced.

Nandapure *et al.* (2011) conducted a study to assess the long term effects of fertilizers and FYM on soil physical properties and crop productivity after19th cycle of sorghum-wheat cropping sequence in a Vertisols. The combined use of inorganic fertilizers (100% NPK) along with FYM @ 10 t/ha significantly improved the bulk density, hydraulic conductivity, available water capacity, water stable aggregates and coefficient of linear extensibility of soil and yield of crops. Total productivity (sorghum+wheat) was found to be positively correlated with these properties.

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