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Effect Of Tillage And Non-Tillage On Physical Properties Of Soybean Under Vertisol.

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ABSTRACT

The field investigation entitled "Effect of tillage and non-tillage on physical soil properties of soybean under Vertisol" was conducted during kharif at Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani with a view to find out appropriate combination of tillage practices, fertilizers and weeding practises to improve the physical properties of soybean. The experiment was laid out in factorial randomized block design with three replications comprising two levels of tillage practices (tillage, non- tillage), three levels of fertilizers (organic, inorganic, combined use) and two levels of weed management (manual weeding, herbicide spraying) thereby involving twelve treatment combinations on soybean variety Soybean: JS-335. The plot size was 5.4 m x 6 m. The crop was sown by dibbling method keeping row to row spacing 45 cm and plant to plant 5 cm, on 18th June, 2013 and recommended cultural practices were followed. The results indicated that, physical properties of soil were significantly influenced with adaption of tillage and combined use of fertilizer and recorded maximum 21.47 and 21.47 cm moisture content, 1.21 and 1.25 Mg m-3 bulk density and 2.79 and 2.58 cm hr-1 hydraulic conductivity, of soil respectively during growing period of soybean.

It is concluded that tillage in combination either with organics and manual weeding or combined use of fertilizer and herbicidal application these combinations were found better in obtaining improved physical properties of soybean will be sustaining the fertility of soil in Vertisol. Tillage operation was found significant importance in Vertisol.

Key Words: *Vertisol, Tillage, Bulk density, hydraulic conductivity.*

INTRODUCTION

Soil physical environment decides the magnitude of successful management of soil resource in rainfed farming system. Good tilth is a prerequisite for high crop productivity. Tillage operations (harrowing, ploughing and chiseling) reduce compatibility of soil, improve aeration and create better environment for soil microorganisms. Tillage plays an important role in controlling weeds and managing crop residues, but the primary purpose of tillage is to change the soil structure. Soil structure is changed to create conditions favoring germination of seeds, emergence of seedlings and growth of cultivated plants.

It is well recognized over since man first cultivated crops that tillage operations are beneficial to crop production. However, since ages, few changes have been made in the basic principles of tillage. Improved tillage practices have been compared and evaluated in terms of crop yield without paying any attention to study what changes are induced in soil physical condition required for a particular crop. No tillage or minimum tillage cannot achieve its objectives under all conditions, therefore, it is necessary to first define the requirement of crop root system in details, before any conclusion can be drawn. There is no secret that soil edaphic factors, namely soil temperature, bulk density and porosity of soil and soil moisture govern to a large extent the emergence of the range of variation required in each factor for crop is well known, it should not be difficult to provide the desired soil environment to the growing plant to harvest best crop at minimum cost.

No-till cultivation systems leave fields unturned and allow crop stubble to remain on the soil surface from harvest to sowing. The stubble protects the soil surface, and experimental studies have confirmed that no-till farming markedly reduces erosion, nitrogen runoff and particulate phosphorus runoff (see e.g. *Soileau et al*. 1994, *Stonehouse* 1997, *Puustinen et al*. 2005). Financial analyses of no-till have suggested that it also produces economic benefits to farms, in the form of an overall reduction in input costs (see e.g. *Clark et al*. 1994, *Stonehouse* 1997). These findings have prompted interest in no-till as a cultivation technology that would benefit both farmers and the environment. However, no-till has also been linked to undesirable environmental effects, in particular increased loading of dissolved reactive phosphorus (see e.g. *Holland* 2004, *Puustinen et al*. 2005) and leaching of herbicides due to increased herbicide application (see e.g. *Holland* 2004). From an environmental policy perspective, it is important to assess the overall environmental and economic impacts of no till. Previous empirical research on the performance of no-till is largely limited to field experiments, with completely homogenous production conditions apart from the no-till treatment effect, and to econometric analyses studying the factors influencing the adoption of no till and other conservation tillage practices (sees e.g. *Knowler and Bradshaw*, 2007, for a review). There exists little empirical evidence on the economic impact of adoption on individual farmers. *Kurkalova et al*. (2006) provide an exception; they estimate the effect of no-till on farm profits and quantify the adoption premium associated with uncertainty based on observed behavior.

MATERIAL AND METHODS

The details of experimental material used, and methods adopted during the present study are described in details.

Experimental details

The experiment comprised of twelve treatments of two tillage practices combined with different types of fertilizer resources and weed management, so as to evaluate the effect of different management practices on soil properties of soybean under Vertisol.

STATISTICAL ANALYSIS

The result was analyzed statistically as per method given in "Statistical Method for Agriculture Worker" by *Panse and Sukhatme* (1985). Appropriate standard errors were worked out. The critical difference at 5% level is given wherever necessary.

RESULT AND DISCUSSION

Effect of tillage, fertilizers and weeding practices on Physical properties of soil

Moisture content

Data on moisture content in soil are presented in below table. It was seen from the data that moisture content in soil was influenced by different treatment at all the growth stages. Moisture content of soil was sufficient at sowing stage of crop in all the treatments and further increased up to flowering stage and then dropped down at harvest stage. Tillage treatment exhibited significant response in all the stages except flowering stage. The maximum moisture content recorded in tillage practices at flowering stage (21.47 cm) while lowest moisture content was found at harvest stage (17.82 cm). Similar pattern was observed in non-tillage. Further the moisture content of soil was significantly highest with combine use of fertilizer sources except at flowering stage (21.47 cm) as compared to alone use of inorganic and organic fertilizers while lowest moisture recorded with organics (16.70 cm) as compared to

all stages of crop growth. The effect of manual weeding and herbicide application on moisture content was found non-significant. While tillage practices along with combined use of fertilizers and recorded significant influence on the moisture content in soil at all stages of soybean crop. Tillage operation helps to improve physical condition of soil by reducing bulk density which help to conserve more moisture in soil. Increased moisture content in soil as a result of incorporation of organics with tillage was also reported by *Talathi and Mehta* (1963), *Gaikwad and Khuspe* (1976) *Khiani and More* (1984). The increased moisture status as a result of better seed soil contact by direct seeding of rabbi crop without tillage was also reported by *Awasarmal et al*. (1999). *Reddy* (1997) also observed that the reduction in bulk density, improvement in moisture content, porosity, hydraulic conductivity, soil aggregations and infiltration rate was observed due to incorporation of wheat straw @5 t ha-1 followed by PMC, FYM, glyricidia over control. It also helps to reduce the volume of soil cracks.

Table 1: Effect of tillage and non-tillage on Moisture content (cm) in soil at various growth stages of soybean

Treatments	Moisture content		
	Sowing	Flowering	At harvest
Tillage practices(T)			
T1 – Tillage	18.04	21.47	17.82
T2 - Non tillage	17.27	21.05	17.16
S.E.+	0.22	0.18	0.11
C.D. at 5 %	0.64	NS	0.35
Fertilizers (F)			
F1- Organics	16.82	20.85	16.70
F2- Inorganics	17.90	21.45	17.81
F3- Combine use	18.25	21.47	17.96
S.E.+	0.27	0.22	0.14
C.D. at 5 %	0.79	NS	0.43
Weed management (W)			
W1- Manual	17.86	21.34	17.63
W2- Herbicide	17.45	21.18	17.35
S.E.+	0.22	0.18	0.11
C.D. at 5 %	NS	NS	NS

Bulk density

Data on bulk density in soil are presented in table 2 showed that the bulk density of soil was significantly decreased with adoption tillage practices over non tillage during all stages of crop growth. Initially it was lowest at the time of sowing and gradually increased during flowering and highest at harvest stage of soybean. Bulk density was ranged from 1.21-1.28 Mg m-3 during all the stages. The lowest bulk density was recorded 1.21 Mg m-3 at the time of sowing with adoption of tillage practices, while highest was noted with non-tillage 1.28 Mg m-3 at harvest stage of soybean. Fertilizer sources significantly influenced bulk density of soil during all the stages of crop. Combined use of fertilizer significantly influenced bulk density as compared to alone use of inorganic fertilizer, which was followed by organic. Bulk density was ranged from 1.21 to 1.27 Mg m-3. While non-significant effect of weed management practices was recorded on bulk density of soils. The humified fraction of soil helps to improve soil structure and tilth there by increasing aeration and aggregation which in turn reduced the bulk density of soil. The decreasing trend in soil bulk density by amending the soil with organics by tillage was also reported by *Bhushan* (1971), *Madeira et al*. (1989) and *Laddha et al*.(1998). Beneficial effect of organics in reducing bulk density was also reported by *Bellaki and Badanur* (1994), *Karle et al* (1995), *Tompe and More* (1996). Use of FYM and green manures in guar-barley-Jowargram crop rotation decreased the bulk density of collovial soils (*Havangi and Mann, 1970, Biswas et al., 1967*). Similarly, *Biswas et al.* (1971) reported that inorganic fertilizers increased the bulk density whereas the organic manures decreased it. The increase in bulk density was due to deterioration of the structure of the soil by use of nitrogenous fertilizers in maize-wheat rotation on sandy loam soils. It is also supported by the findings of *Gunai and Singh*, 1988; *Jalota and Parihar,1990; Ekwue,1990; and Bellaki and Badnur,1997.*

Table 2: Effect of tillage practices, fertilizer sources and weed management on Bulk density (Mg m-3) in soil at various growth stages of soybean

Treatments	Bulk density		
	Sowing	Flowering	At harvest
Tillage practices(T)			
T1 – Tillage	1.21	1.24	1.26
T2 - Non tillage	1.23	1.25	1.28
S.E.+	0.0066	0.0066	0.0052
C.D. at 5 %	0.019	0.019	0.015
Fertilizers (F)			
F1- Organics	1.22	1.24	1.27
F2- Inorganics	1.23	1.25	1.28
F3- Combine use	1.21	1.23	1.25
S.E.+	0.0081	0.0081	0.0064
C.D. at 5 %	0.023	0.023	0.019
Weed management (W)			
W1- Manual	1.21	1.24	1.26
W2- Herbicide	1.23	1.25	1.27
S.E.+	0.0067	0.0066	0.0052
C.D. at 5 %	NS	NS	NS

Hydraulic conductivity

The data in respect of hydraulic conductivity as influenced by tillage practices, fertilizer sources and weed management practices, presented in table 3. The data showed that, hydraulic conductivity was significantly affected with adoption of different practices of tillage, sources of fertilizer and weed management. The tillage practices significantly increased the hydraulic conductivity of soil over non tillage. It was varied from 2.58 to 2.79 cm hr-1 during sowing, flowering and harvesting stages of crop. Significantly highest hydraulic conductivity 2.79 cm hr-1 recorded with adoption of tillage practices at the time of sowing, while lowest 2.58 cm hr-1 recorded with non-tillage practices at the time of harvest. The hydraulic conductivity was found to be more at sowing time, later decreased at flowering stage and dropped dawn at harvest stage with adoption of different treatments. The effect of sources of fertilizer was also significant and hydraulic conductivity ranges from 2.45 to 2.85 cm hr-1 during sowing, flowering and harvest stages of crop growth. The highest hydraulic conductivity of soil 2.85cm hr-1 was noticed with the combined use of fertilizer source at flowering stage, while lowest 2.45 cm hr-1 recorded with use of inorganic fertilizer at harvesting stage. The combined use of fertilizer sources was showed significant increase in hydraulic conductivity during all the stages of crop growth over inorganic sources which was followed by organic sources of fertilizer. Among the weed management practices, herbicide application recorded maximum 2.76 cm hr-1 hydraulic conductivity which was significantly superior over hand weeding practices. While the lowest 2.61 cm hr -1 recorded with the use of hand weeding practice. The saturated hydraulic conductivity of soil refers to readiness with saturated soil transmit water through its body and is expressed as length per unit time. Increased microbial activity with sufficient moisture in soil and presence of organic matter for prolonged period resulted in increased hydraulic conductivity of soil amended with organics as well as tillage treatment in the present investigation. The above results are also in resemblance with findings of *Jalota* and *Prihi* (1990), *Heared et al* (1988), *Swami* (2000) and *Babhulkar et al.* (1999). *Babhulkar et al*. (1999) also found significant effect of long term application of fertilizer in combination with FYM on improvement in physical properties of soil like bulk density, water holding capacity, hydraulic conductivity and water stable aggregates in soybean crop under vertisol.

Table 3: Hydraulic conductivity (cm hr-1) of soil as influenced by tillage, fertilizer sources and weed management practices in soybean.

Treatments	Hydraulic conductivity		
	Sowing	**Flowering**	**At harvest**
Tillage practices(T)			
T1 – Tillage	2.79	2.75	2.67
T2 - Non tillage	2.67	2.70	2.58
S.E.+	0.01	0.037	0.008
C.D. at 5 %	0.03	0.11	0.024
Fertilizers (F)			
F1- Organics	2.82	2.83	2.69
F2- Inorganics	2.54	2.48	2.45
F3- Combine use	2.83	2.85	2.74
S.E.+	0.012	0.046	0.010
C.D. at 5 %	0.036	0.136	0.029
Weed management (W)			
W1- Manual	2.70	2.72	2.61
W2- Herbicide	2.76	2.73	2.64
S.E.+	0.010	0.037	0.0083
C.D. at 5 %	0.030	NS	0.024

Mean weight diameter

Data on moisture content in soil are presented in table.4. It was seen from the data that mean weight diameter in soil was significantly influenced by different treatment at all the growth stages. No tillage treatment exhibited significant response in all the stages of sampling over tillage. The MWD was varies from o.65-0.75 mm because of tillage practices during all growth stages. The mean weight diameter recorded significantly highest in non-tillage practices and at sowing stage (0.75 mm) of crop while lowest (0.65 mm) was found at harvest stage of soybean crop. The use fertilizer sources also significantly influenced MWD and which ranges from 0.72-0.83mm. The mean weight diameter of soil was significantly highest with combined use (0.83 mm) as compared to alone use of organic or inorganic fertilizers while lowest (0.72 mm) mean weight diameter recorded with use of inorganics at harvest stage of crop growth. The increase in mean weight diameter at FYM applied plots could mainly be due to the result of basal application of FYM, which significantly improved the soil aggregation (*Prasad and Singh*, 1980; *Bhatia and Shukla*, 1982; *Selvi et al.* 2005 and *Hati et al.*, 2007). This may be ascribed to the improvement in physical condition of soil and to the increased organic carbon content which might be responsible for stabilization of aggregates and hence higher mean weight diameter with the application of FYM and inorganic fertilizers. This observation is in conformity with the findings of *Bellaki et al.* (1998), *Sharma et al.* (2007), *Rasool et al.* (2008) and *Bandyopadhyay et al.* (2010).

The added organics could supply additional fresh organic residues (water soluble and hydrolysable substrates) and carbon to the soil resulting in the production of microbial polysaccharides that increase aggregate cohesion, which could explain the progressive increase in aggregate stability to mechanical breakdown. The structure especially in black clay soils is considerably hard and many times moderate to coarse in the form of large hard clods. The continuous application of only chemical fertilizers did not show much improvement in the MWD in the long run, indicating an immense need of organics to improve such an important soil physical property which is reflected in the treatments of INM.

Table 4: Mean weight diameter (mm) of soil as influenced by tillage, fertilizer sources and weed management practices in soybean.

Treatments	Mean weight diameter		
	Sowing	Flowering	At harvest
Tillage practices(T)			
T1 – Tillage	0.69	0.68	0.65
T2 - Non tillage	0.75	0.73	0.73
S.E.+	0.008	0.007	0.008
C.D. at 5 %	0.024	0.020	0.024
Fertilizers (F)			
F1- Organics	0.81	0.78	0.76
F2- Inorganics	0.77	0.75	0.72
F3- Combine use	0.83	0.81	0.78
S.E.+	0.017	0.011	0.018
C.D. at 5 %	0.048	0.033	0.051
Weed management (W)			
W1- Manual	0.77	0.75	0.73
W2- Herbicide	0.82	0.78	0.74
S.E.+	0.009	0.007	0.008
C.D. at 5 %	0.027	0.021	NS

CONCLUSION:

Effect of tillage, fertilizers and weeding practices on physical properties of soil.

1 Moisture content

The maximum moisture content recorded in tillage practices at flowering (21.47 cm) while lowest moisture content in non-tillage at harvest stage (17.82 cm). The moisture content of soil was increased with combined use at flowering stage (21.47 cm) compared to inorganics and organics while minimum moisture recorded in organics (16.70 cm) at harvest. Manual weeding treatments help to conserve more moisture content (21.34 cm) at flowering stage, followed by sowing and harvest. In case of herbicide treatment minimum moisture content (17.35 cm) observed at harvest stage.

2 Bulk density

Bulk density was increased in non-tillage at harvest 1.28 Mg m-3 and lower bulk density in tillage at sowing 1.21 Mg m-3. The bulk density of soil was increased with inorganics 1.28 Mg m-3 at harvesting stage compared to organics and combined use and minimum bulk density recorded in combined use 1.25 Mg m-3 at harvest. Herbicide application showed significant increase in bulk density 1.27 Mg m-3 at harvest stage followed by manual weeding at all the sampling stages.

3 Hydraulic conductivity

The maximum hydraulic conductivity (2.79 cm hr-1) recorded in tillage practices at sowing, while lowest hydraulic conductivity (2.58 cm hr-1) recorded in non-tillage at harvest stage. Combined use proved better to improve hydraulic conductivity at all the stages. Significantly highest hydraulic conductivity (2.85 cm hr-1) at flowering stage followed by inorganics and organics at all the sampling stages. Herbicide spraying found highest hydraulic conductivity at sowing (2.76 cm hr-1) than manual weeding (2.70 cm hr-1).

4. Mean weight diameter

The maximum mean weight diameter (0.75 mm) recorded in no tillage practices at sowing stage while lowest mean weight diameter (0.65 mm) in tillage at harvest stage. The mean weight diameter of soil was increased with combine use at sowing stage (0.83 mm) compared to organics and inorganics while minimum mean weight diameter recorded in inorganics (0.72 mm) at harvest. Herbicide spray treatment helps to conserve more mean weight diameter (0.82 mm) at sowing stage, followed by flowering and harvest stage. In case of manual weeding minimum mean weight diameter (0.73 mm) observed at harvest stage.

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