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Dipali P Mahalle
MSc Scholar, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Anita B Chorey
Associate Professor, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Satish T Dangore
Assistant Professor, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Nilima K Darekar
Ph.D. Scholar, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Corresponding Author:
Dipali P Mahalle
MSc Scholar, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Productivity dynamics of soybean as influenced by various conservation tillage practices

Dipali P Mahalle, Anita B Chorey, Satish T Dangore and Nilima K Darekar

Abstract
A field experiment entitled **"**productivity dynamics of soybean as influenced by various conservation tillage practices**"** was conducted at Research Farm of Agro-ecology and Environment Centre, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* season of 2020-21. The results revealed that significantly higher growth attributes at harvest such as plant height, number of branches, root length, dry matter weight plant^{-1} while number of functional leaves, leaf area plant^{-1}, number of root nodules were recorded highest at 60 DAS with treatment farmer's practice (T_5). In respect to yield and economics, the highest seed yield, straw yield and B:C ratio were found with treatment farmer's practice (T_5).

Keywords: Conservation, tillage, practices, growth parameters, mulch, zero, yield

Introduction
Soybean [*Glycine max* (L.) Merill] is an oilseed crop grown widely in many parts of India. It is an excellent health food and contain about 40 per cent protein and 20 per cent oil. Besides protein and oil, soybean contains 20.9% carbohydrate, 60% polyunsaturated fatty acid, 52.3% linoleic acid, vitamins like A, B, C, D, E, K, phosphorus, iron, calcium and all other essential amino acid. The oil is useful for producing both edible and non-edible products as it contains better chemical compositor fatty acid component. As non-edible crude oils, it required for making cosmetics enamels, links, paints and oil clothes, glycerine, resins etc.
Tillage is a mechanical manipulation of soil, therefore it is essential to select a tillage practices that sustain the soil physical properties required for successful growth of agricultural crops. Tillage systems affect soil physical properties differently, because of their varied tillage intensities. Many farmers perform tillage operations without being aware of the effect of these operations on soil physical properties and crop responses (Ozpinar and Isik, 2004) [5]. Conventional soil management practices resulted in degradation of the fertile soil with low organic matter content and a fragile physical structure, which in turn led to low crop yield, low water and fertilizer use efficiency. Therefore, scientists and policy makers put emphasis on conservation tillage systems. Conservation tillage promotes soil aggregation by reducing aggregate disruption and the contact between soil microorganisms and organic matter, and by macro aggregate formation through increasing fungal growth and hyphae (Zachmann *et al*., 1987; Beare *et al*., 1994; Jat *et al*., 2009) [8, 1, 3]. Crop residue on the soil surface can drastically reduce wind and water erosion, and reduce air and water pollution. Improved soil productivity may occur from increased soil organic matter. Hence there is a need to move towards conservation tillage practices, therefore this experiment is undertaken to study the effect of conservation tillage practices on soybean growth and yield.

Methodology
The present experiment was conducted on the Research Farm of Agro-ecology and Environment Centre, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during *kharif* season of 2020. Rainfall measured during the course of study was 600 mm in a 46 rainy days. The experimental plot soil characterized as silty clay loam in texture and slightly alkaline in reaction (pH 7.8). The soil was low in available nitrogen, medium in available phosphorous, high in available potash content and high in organic carbon content.
The experiment was laid out in randomized block design with five tillage treatments replicated four times. The tillage treatments constituted of, T_1 - Reduced Tillage: 2 Harrowing + 1

Hoeing, T_2 - Minimum tillage: 1 Harrowing + 1 Hoeing, T_3 - Zero Tillage: Sowing without cultivation and weed control by Herbicide, T_4 -Zero Tillage + Mulch: Sowing without cultivation and weed control by Herbicide and mulching with gliricidia (*Gliricidia sepium*), T_5 - Farmer's practice : 1 Ploughing + 2 Harrowing + 1 Hoeing. The net plot size was 6.3 × 4.5 m^2. Sowing of soybean (var. JS-335) was undertaken during 6th July, 2020. The normal spacing was kept row to row distance of 45 cm and plant to plant distance of 5 cm. Crop was fertilized as per RDF (30:75:30 NPK kg ha^{-1}).

Results

Effect on growth parameters of soybean

The data pertaining to Table 1. showed that all the growth parameters *viz.*, plant height, number of branches $plant^{-1}$, root length $plant^{-1}$, dry matter weight $plant^{-1}$ were recorded highest at harvest and number of functional leaves $plant^{-1}$, leaf area $plant^{-1}$, number of root nodules $plant^{-1}$ were recorded highest at 60 DAS with treatment farmer's practice (1 Ploughing + 2 Harrowing + 1 Hoeing). This might be due to optimum moisture conservation in soil and adequate nutrient availability to the crop during crop growth, relatively loose soil, good soil aeration and favourable soil moisture condition for better growth of root nodules which led to the improvement in all growth parameters of soybean with treatment farmer's practice. Similar results also reported by Parlawar *et al*. (2017) [6].

Bulk density directly measure the soil compactness. It can be changed through management practices. It affect the crop growth significantly by affecting soil moisture conservation, rooting characteristics, infiltration rate etc. The bulk density was measured before sowing i.e. after giving tillage treatments and at harvest. The data regarding the impact of tillage on bulk density are presented in table 3. Lower bulk density with treatment farmer's practice (1 Ploughing + 2 Harrowing + 1 Hoeing) may be due to, as the soil manipulation increases, reduction in bulk density was observed that causes increase in soil porosity and soil moisture content. Therefore, it can be inferred from the data that tillage practices reduced the bulk density to a remarkable extent, as the soil become porous helps to conserve the soil moisture. Bulk density also has impact on moisture availability. lower bulk density and formation of plough layer in conventional tillage results into more moisture availability to crop. Similar results also reported by Gangawar *et al.* (2004) [2].

Effect on yield of soybean

The data pertaining to Table 2. showed that significantly highest seed yield, straw yield and B:C ratio were obtained with treatment farmer's practice (1 Ploughing + 2 Harrowing + 1 Hoeing). It is obvious that, where all growth parameters, yield attributes, soil physical status and soil moisture content were improved, the seed yield and straw yield were also increase. In treatment farmer's practice soil compaction is less which resulted into greater availability of soil moisture, which ultimately resulted into greater seed and straw yield with treatment famer's practice (1 Ploughing + 2 Harrowing + 1 Hoeing). Major problem associated with zero tillage was weed competition. Weeds that remain in the crop from three to eight weeks after soybean emergence have the greatest potential to reduce soybean yield. While inter-cultivation practices i.e. hoeing and hand weeding reduced the weed growth to an extent which reduces the crop weed competition resulted into greater availability of nutrients to plant, which ultimately reflected into greater seed and straw yield in treatment farmer's practice. Similar results also reported by Monsefi *et al.* (2014) [4].

Table 1: Growth parameters as influenced by different treatments

Treatment	Plant height $plant^{-1}$ (cm)	Number of branches $plant^{-1}$	Number of functional leaves	Leaf area $plant^{-1}$ (dm^2)	Root nodules $plant^{-1}$	Root length (cm)	Dry matter accumulation $plant^{-1}$ (g)
T_1: Reduced tillage	43.96	9.87	27.91	24.16	51.75	18.70	27.79
T_2: Minimum tillage	41.60	9.32	26.64	22.65	49.50	17.56	24.74
T_3: Zero tillage	37.29	8.31	23.45	15.99	43.00	16.30	20.22
T_4: Zero tillage + mulch	38.44	8.87	24.72	18.90	46.00	16.76	22.01
T_5: Farmer's practice	45.24	10.93	29.44	28.51	54.25	20.49	29.63
SE (m) ±	1.72	0.54	1.17	1.16	1.91	0.726	0.91
CD (P=0.05)	5.27	1.66	3.59	3.56	5.88	2.227	2.81
GM	41.30	9.46	26.43	22.04	48.90	17.96	24.87

Table 2: Seed yield (kg ha^{-1}), straw yield (kg ha^{-1}) and economics as influenced by different treatments

Treatment	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	B : C ratio
T_1: Reduced tillage	1339	2316	2.48
T_2: Minimum tillage	1275	2205	2.46
T_3: Zero tillage	1127	2028	2.40
T_4: Zero tillage + mulch	1174	2113	2.43
T_5: Farmer's practice	1535	2640	2.63
SE (m) ±	49.77	90.52	-
CD (P=0.05)	152.71	277.27	-
GM	1288.50	2235.25	2.48

Table 3: Bulk Density (Mg m^{-3}) as influenced by different treatments

Treatments	Bulk Density (Mg m^{-3})	
	Before Sowing	At Harvest
T_1 – Reduced Tillage	1.29	1.31
T_2 – Minimum Tillage	1.30	1.32
T_3 – Zero Tillage	1.33	1.34
T_4 – Zero Tillage + mulch	1.32	1.33
T_5 – Farmer's practice	1.28	1.30
GM	1.30	1.32

Conclusion

From the result following can be concluded that, the conservation tillage practices influenced the soil physical properties though the treatment farmer's practice (T_5) in which 1 Ploughing + 2 Harrowing + 1 Hoeing was carried out recorded higher growth parameters and yield than other conservation tillage practices. While treatment zero tillage + mulch (T_4) showed significant improvement in bulk density over zero tillage. Many evidences are there which proved that conservation tillage practices promotes better crop growth, higher crop yield as well as good soil health, as this is a first year of experiment, conservation tillage did not perform satisfactorily. It require further long term experiments to better characterize the effect of conservation tillage practices on soybean growth and yield.

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