EFFECT OF TILLAGE AND WEED MANAGEMENT PRACTICES ON PHYSICO-CHEMICAL PROPERTIES OF SOIL AND YIELD OF SOYBEAN IN INCEPTISOLS

ABSTRACT

An investigation was carried during the year 2018-19 to study the" Effect of tillage and weed management practices on physico-chemical properties of soil and yield of soybean in Inceptisols" at Research Farm of All India Coordinated Research Project (AICRP) on Weed Management, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The study has focused the integrated effect of tillage and weed management practices on physico chemical properties of soil, yield of soybean and availability of nutrients. Five weed control practices were superimposed in four strips of different tillage practices in strip plot with three replications. The tillage operations consist of conventional tillage, reduced tillage, minimum tillage and zero tillage, however weed management practices includes application of pre emergence weedicide (diclosulam), post emergence weedicides (propaquizafop + imazethapyr.), integration of pre emergence and post emergence weedicide, hand weeding and weedy check. The soils of experimental plot was alkaline in reaction and low to medium in organic carbon. The available nitrogen and phosphorus was low and potassium was high to very high. Based on the observations noted, the bulk density of soil was significantly influenced due to tillage and weed management practices. The highest bulk density was noted with zero tillage (1.46 Mg m^{-3}) followed by reduced tillage (1.45 Mg m^{-3}). The highest MWD (0.75 mm) was enumerated with minimum tillage and hand weeding management practice (0.75 mm). While, the interaction of tillage and weed management practices showed non-significant results in respect of soil physical properties. The highest available of nitrogen (207.33 kg ha^{-1}), phosphorus (20.07 kg ha^{-1}) and potassium (346.1 kg ha^{-1}) were recorded with minimum tillage and with hand weeding practice.

Keywords: ***Soybean, Inceptisols, Tillage, Weed management practices***

INTRODUCTION

Soybean (Glycine max. L.) is known as sojabean, soybean, Chinese pea and Manchurian bean which belongs to family Leguminaceae. Soybean was cultivated in China from 3000 BC. It is miracle crop has witnessed phenomenal growth in production. Processing and trade of soybean in last few years in India has revolutionized the rural economy and improved socio-economic status of farmers. Soybean cultivation has placed India on the world map in recent past. Soybean has not only gained the vital importance in Indian Agriculture, but also plays a decisive role in oil economy of India.

The soybean is commonly occurring crop. The area under soybean cultivation in India in 2018 was 23.15 million ha, having production of 42.25 million metric tons and yield is 1.83 $MTha^{-1}$. While in Maharashtra the area under cultivation of soybean was 34.48 Lakh ha and production was 29.00 Lakh MT. The soybean production of India in 2018-19 was 11 $MTha^{-1}$ (SOPA-2018) Soybean being a very important rainy season crop, suffers severally due to infestation of several weeds resulting in yield losses upto 77 per cent depending on the weeds species, their density & period of weed-crop completion (Tiwari & Kurchania,1990). If weed are not controlled during the first 30 days after sowing, the critical period of weed- crop competitions reduces the yield of soybean drop up to 31 to 84 percent depending upon the type & intensity of weed infestation (Kachroo et al., 2003).

Tillage has direct and indirect impacts on water, soil and air quality. One expects to find a diversity of tillage equipment, practices and systems, reflecting the variety of agro ecosystems and the degrees of mechanization and industrialization. Even within one tillage system, there can be numerous technical options available to farmers. The tillage experiments are site specific and yield results are often non-repeatable even under the same soil conditions. While tillage changes soil characteristics, the effects are usually not of the magnitude to significantly affect emergence and early plant growth in experimental plots. Most experiments on effects of different tillage systems shown non-significant results or inconsistent data from year to year. Therefore, the repeated tillage experiments under black-cotton soil conditions would lead to draw a definite conclusion, similarly very little work has been carried out on integration of tillage and use of weedicide on soil properties and yield of soybean. Moreover, the practical feasibility of the tillage practice would also play a major role when it comes to disseminate the technology to farmer's field. Hence, the outcome of present investigation will certainly be beneficial to the researchers and stakeholders of this region and its repetition may provide the solution on sustainable basis

Therefore considering the intensity of weeds under different tillage operation its competition with major crops and ultimate influence on soil properties and yield of soybean, the present investigation was defined. The major intention of framing this experiment was to find out the effect of various weedicides on soil. With this view the present investigation was conducted at research farm of Agronomy, All India Coordinated research project (AICRP) on Weed, Dr. PDKV, Akola during the year 2018-19.

MATERIALS AND METHODS

The field experiment was conducted at Research Farm of AICRP-Weed Management, Department of Agronomy, Dr. PDKV, Akola during *kharif* 2018-19. Akola is situated in subtropical zone and located at the latitude of 22^0 42' North and longitude of 77^0 02' East, at the altitude of 307.42 m above mean sea level (MSL). The experiment was conducted with nine treatments and three replications laid out in a strip plot design.

The Pre-emergence herbicide i.e., Diclosulam was sprayed throughout the field at the rate of 0.030 kg a.i./ha PE. The Post-emergence herbicide i.e., Propaquizafop + Imazethapyr was applied in the field according to the subplot treatments at the rate of 0.125 kg a.i./ha POE at 20 DAS. The selected plots of the field with different treatments of weed control were treated with weed free (2H at 15 & 30 DAS + 1HW at 20 DAS) and weed check (un-weeded).

The initial soil samples (0-20 cm) were collected from each plot in all the three replications. The treatment wise soil samples were also collected at harvest. Nearly 2.0 kg of representative soil sample from each plot of all the representative treatment were collected for laboratory studies. Soil clods were collected from the plot for determination bulk density. The analysis of physical and chemical properties of collected samples were carried out using standard procedures (Black 1965; Jackson 1967) and the test of significance to the experimental data was carried out as per procedure described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Effect of tillage and weed management practices on physical properties of soil

The effect of tillage and weedicide management on bulk density and MWD was studied and placed in Table 1 and graphically presented in Fig. 1. The results indicates that the bulk density (1.44 Mg m^{-3}) under conventional tillage and adoption of hand weeding (1.43 Mg m^{-3}) supported to minimize the bulk density, but it has not influenced significantly. This might be because of higher porosity and greater aeration in the soil. Similar findings were observed by Osunbitan *et. al*., (2005) who stated that zero tillage has recorded highest bulk density than other tillage practices. The results are also in conformity with the findings of Grant *et. al*., (1993). While, the MWD was numerically higher under minimum tillage and hand weeding, but the results were non-significant. Similar results were achieved by Mohnaty *et al*., (2003) reported that the tillage practices contributed in changing the mean weight diameter of the soil. The mean weight diameter was registered higher under minimum tillage. It was significantly lowered in weedy check treatment and the highest in WM2 i.e., application of post emergence weedicide propaquizafop + imazethapyr.

Effect of tillage and weed management practices on chemical properties of soil

The data pertaining to chemical properties influenced due to integration of tillage and weed management practices is presented in Table 2 and depicted in Fig. 2 and 3. The pH was higher in minimum tillage (7.64) followed by zero tillage. While the lowest (7.61) pH was registered with conventional tillage. The similar results were observed by the Kahlon *et al.*, (2014) they have noted the highest pH with conventional tillage followed by no tillage and roto tillage. Similarly, the electrical conductivity was assessed and was noted highest (0.33 dSm^{-1}) with minimum tillage. The lowest (0.27 dSm^{-1}) electrical conductivity was registered where conventional tillage was adopted. Similarly, reduced tillage (1 harrowing + 1 rototill) also contributed to minimize the electrical conductivity upto 0.29 dSm^{-1}. The results were confirmed by Kahlon and Singh (2014). Equivalent results were obtained by Gholami *et al.*, (2014). The properties like pH and electrical conductivity have not shown significant results, but the values of the same were numerically enhanced under conventional tillage and hand weeding.

The organic carbon and calcium carbonate were also assessed. Minimum tillage and hand weeding practices have noted the highest organic carbon (5.28 & 5.44 g kg^{-1} respectively) as compared to other tillage practices. The calcium carbonate percentage was reduced to 10.77 % under conventional tillage. The lower values of calcium carbonate noticed under conventional tillage must be due to leaching and adsorbed carbonates on clay particles , formation of humic acids and also due to enhanced aeration in the soil rhizosphere. The results were confirmed by the study of Kahlon *et al.*, (2014) who stated that the conventional tillage has lowest soil organic carbon.

Effect of tillage and weed management practices on available nutrients under soybean

Soil available nutrients

The data pertaining to available nutrients influenced due to integration of tillage and weed management practices is placed in Table 3 and depicted in Fig. 4 and 5 .The available soil nutrients were influenced and mostly observed higher in zero tillage and minimum tillage. However, the soil nutrients were less in conventional tillage. Among weed management practices the nutrients were commonly more in weed free (hand weeding) and weedy check (un-weeded) treatment as compared to other management practices.

In respect of residual soil fertility, available nitrogen, phosphorus and potassium was influenced significantly with minimum tillage. The highest available nitrogen (207.37 kg ha^{-1}), Phosphorus (20.7 kg ha^{-1}) observed with minimum tillage. The Corresponding observations were also noticed by Khakural *et al.,* (1992) and Kahlon and Singh (2014) revealed that the conventional tillage recorded the lowest soil available nitrogen and phosphorus. Similarly, Dick (1983) reported that there was greater amount of nitrogen under no tilled and Potassium (348.17 kg ha^{-1}) were registered with minimum tillage, The soil available potassium and sulphur was showing similar decreasing trend as minimum tillage > zero tillage >reduced tillage>conventional tillage.

While, the weed management practices have also influenced the availability of available NPK significantly. The appreciable enhancement in available NPK were noted where hand weeding was followed. The similar observations were noted by Jha *et al*., (2012) they observed that among different herbicides, the highest available potassium in soil was noted with imazethapyr 10% SL @ 100 g a.i. ha^{-1}. Weedy check recorded the least and weed free resulted in the highest values of available potassium in the soil.

Yield of Soybean

The data in respect of grain and straw yield of soybean as influenced by tillage and weed management practices is placed in table 4. The grain (22.96 q ha-1) and straw yield (27.54 q ha-1) was noticed significantly higher in conventional tillage (T1) followed by reduced tillage (T2). The lowest (17.30 q ha-1) grain yield was observed in zero tillage (T4) among all tillage practices. The conventional tillage have 24.6 % more grain yield than zero tillage. While, in respect of straw yield, the 27.54 q ha-1 was recorded to be the highest straw yield under conventional tillage where ploughing and harrowing was allowed every year and which was followed by reduced tillage. The 20.76 q ha-1 was the lowest straw yield and was registered under the zero tillage (T4). The straw yield was 32.65 % greater under conventional tillage than in zero tillage. Kahlon et al., (2014) concluded that lower straw yield was observed under conventional tillage. The similar results were obtained by Webber et al., (1986) who observed that conventionally tilled soybean had a greater yield potential due to greater vegetative growth but with less than adequate

Under weed management practices the grain and straw yield was superior in weed free treatment where hand weeding was operated and found the lowest in weedy check treatment. The highest (24.74 q ha-1) grain yield and straw yield (30.10 q ha-1) was noticed in weed free treatment. It was followed by WM3 where preemergence and postemergence was applied. In weedy check (WM5) treatment the lowest grain yield (13.65 q ha-1) and straw yield (16.15 q ha-1) was measured. The Kumar et al., (2018) observed that the post emergence tank mix combination of propaquizafop + imazethapyr helps in improving growth and yield of soybean.

CONCLUSIONS

On the basis of present study, it can be concluded that, the adoption of minimum tillage and hand weeding have registered notable changes in respect of physico-chemical soil properties and residual soil fertility. Therefore, the integration of minimum tillage and hand weeding have found beneficial for maintaining physico -chemical properties of soil , yield and residual fertility under soybean in Inceptisols

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Table 1. Effect of tillage and weed management practices on bulk density and mean weight diameter under soybean

Treatment	Bulk density	Mean weight diameter
	Mg m^{-3}	mm
a) Tillage practices		
T1 (Conventional tillage)	1.44	0.73
T2 (Reduced tillage)	1.45	0.70
T3 (Minimum tillage)	1.43	0.75
T4 (Zero tillage)	1.46	0.71
SE (m)±	0.01	0.02
CD @ 5%	NS	NS
b) Weed management practices		
WM1 (Preemergence weedicide)	1.44	0.71
WM2 (Postemergence weedicide)	1.45	0.73
WM3 (Preemergence & Postemergence)	1.43	0.71
WM4 (Weed free)	1.45	0.75
WM5 (Weedy check)	1.46	0.70
SE (m)±	0.01	0.03
CD @ 5%	NS	NS
Interaction of tillage and weed management (a X b)		
SE (m)±	0.02	0.06
CD @ 5%	NS	NS

Table 2. Effect of tillage and weed management practices on chemical properties of soils under soybean

Treatment	pH	Electrical conductivity	Organic Carbon	Calcium Carbonate
		dSm^{-1}	$g\ kg^{-1}$	Percent
a) Tillage practices				
T1 (Conventional tillage)	7.61	0.27	4.63	10.77
T2 (Reduced tillage)	7.62	0.29	5.14	11.73
T3 (Minimum tillage)	7.64	0.33	5.28	12.07
T4 (Zero tillage)	7.63	0.30	5.25	12.05
SE (m)±	0.04	0.01	0.15	0.08
CD @ 5%	NS	NS	NS	NS
b) Weed management practices				
WM1 (Preemergence weedicide)	7.64	0.30	4.84	11.69
WM2 (Postemergence weedicide)	7.65	0.29	5.01	11.49
WM3 (Preemergence & Postemergence)	7.64	0.31	4.81	11.75
WM4 (Weed free)	7.60	0.29	5.44	11.75
WM5 (Weedy check)	7.59	0.30	5.27	11.59
SE (m)±	0.05	0.01	0.15	0.12
CD @ 5%	NS	NS	NS	NS
Interaction of tillage and weed management (a X b)				
SE (m)±	0.11	0.03	0.31	0.24
CD @ 5%	NS	NS	NS	NS

Table 3. Effect of tillage and weed management practices on available nutrients under Soybean

Treatment	Nitrogen	Phosphorus	Potassium	Sulphur
	Kgha^{-1}			ppm
a) Tillage practices				
T1 (Conventional tillage)	193.30	16.92	332.17	8.96
T2 (Reduced tillage)	201.98	18.47	341.71	9.97
T3 (Minimum tillage)	207.33	20.07	346.17	10.95
T4 (Zero tillage)	205.76	19.89	342.52	10.73
SE (m)±	1.61	0.20	2.36	0.29
CD @ 5%	5.58	0.67	8.15	1.00
b) Weed management practices				
WM1 (Preemergence weedicide)	199.37	17.72	336.05	9.78
WM2 (Postemergence weedicide)	204.67	18.97	340.39	10.16
WM3 (Preemergence & Postemergence)	198.14	17.77	337.19	9.85
WM4 (Weed free)	205.29	20.03	345.53	10.71
WM5 (Weedy check)	202.99	19.71	344.07	10.28
SE (m)±	1.89	0.36	1.70	0.28
CD @ 5%	5.44	1.03	5.11	NS
Interaction of tillage and weed management (a X b)				
SE (m)±	3.77	0.72	10.23	0.55
CD @ 5%	10.87	2.07	NS	1.59

Table .4 Effect of tillage and weed management practices on yield of Soybean

Treatment	Yield (q ha-1)	
	Grain	Straw
a)Tillage practices		
T1 (Conventional tillage)	22.96	27.54
T2 (Reduced tillage)	20.67	25.06
T3 (Minimum tillage)	19.52	23.75
T4 (Zero tillage)	17.30	20.76
SE (m)±	0.12	0.21
CD @ 5%	0.43	0.73
b) Weed management practices		
WM1 (Preemergence weedicide)	17.84	21.36
WM2 (Postemergence weedicide)	20.66	24.43
WM3 (Preemergence & Postemergence)	23.67	29.34
WM4 (Weed free)	24.74	30.10
WM5 (Weedy check)	13.65	16.15
SE (m)±	0.47	0.71
CD @ 5%	1.35	2.06
Interaction of tillage and weed management (a X b)		
SE (m)±	0.94	1.43
CD @ 5%	NS	NS

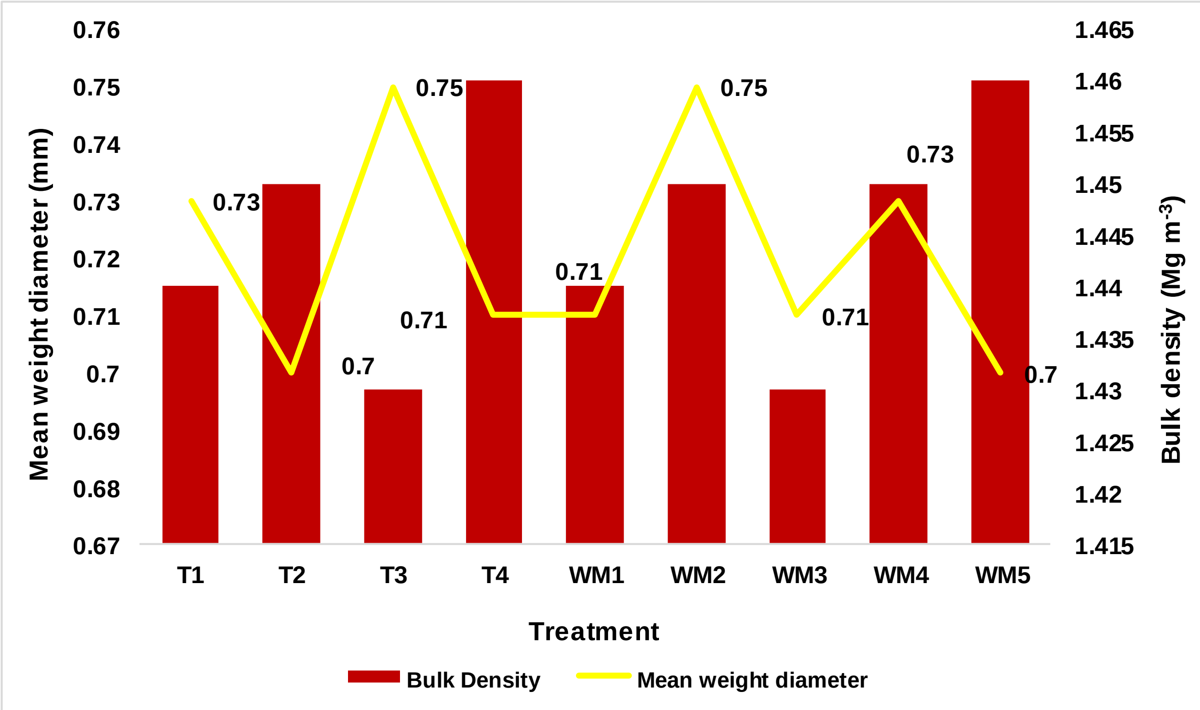

Fig 1. Effect of tillage and weed management practices on bulk density and mean weight diameter

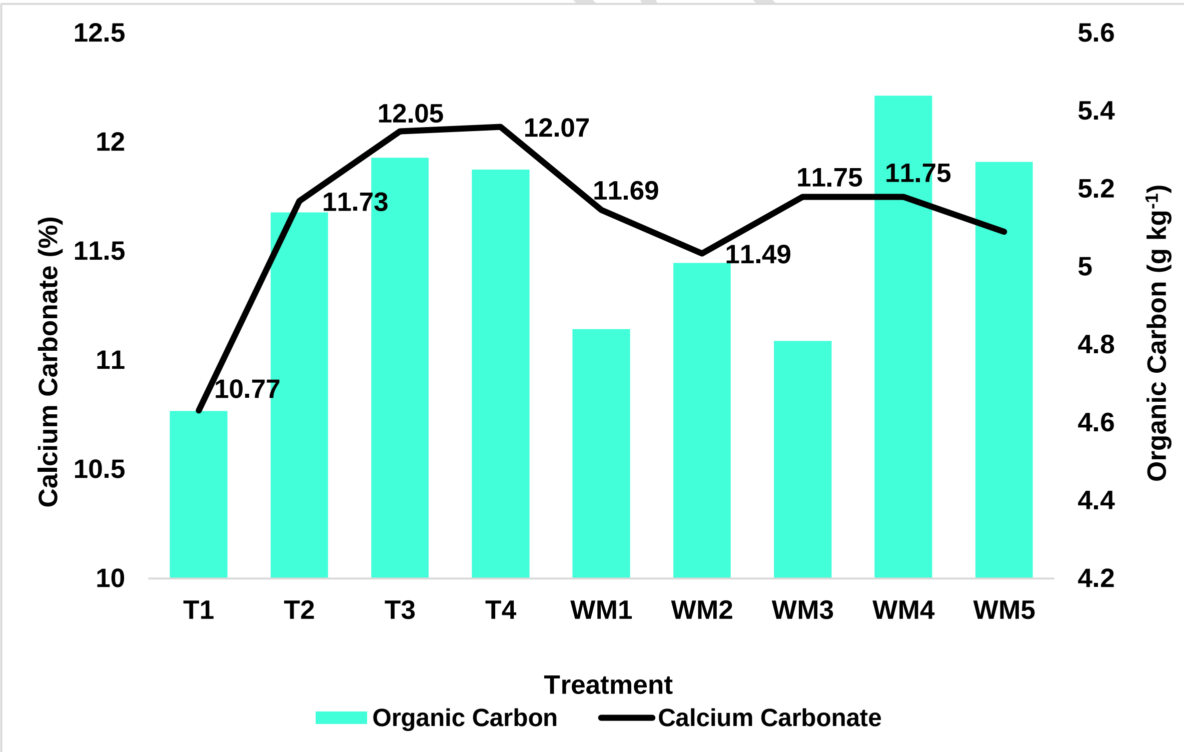

Fig 2. Effect of tillage and weed management practices on organic carbon & calcium carbonate

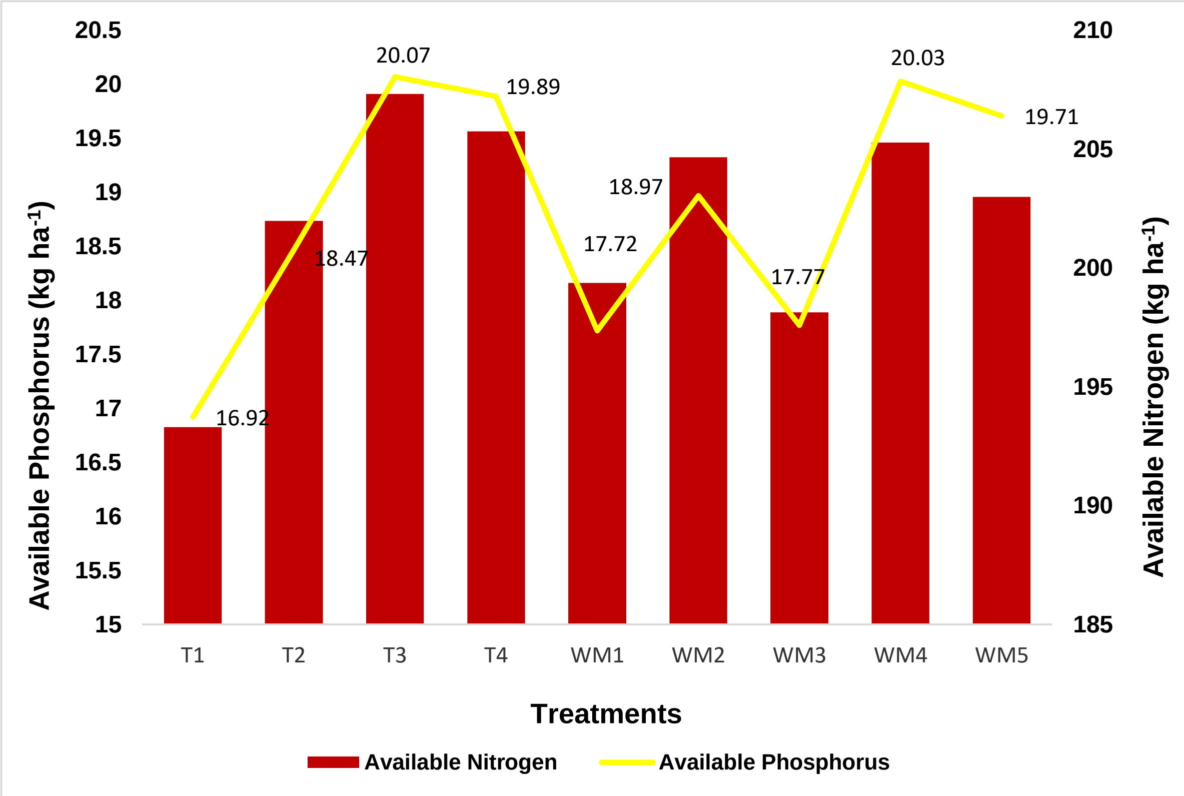

Fig 3. Effect of tillage and weed management practices on available nitrogen and phosphorus

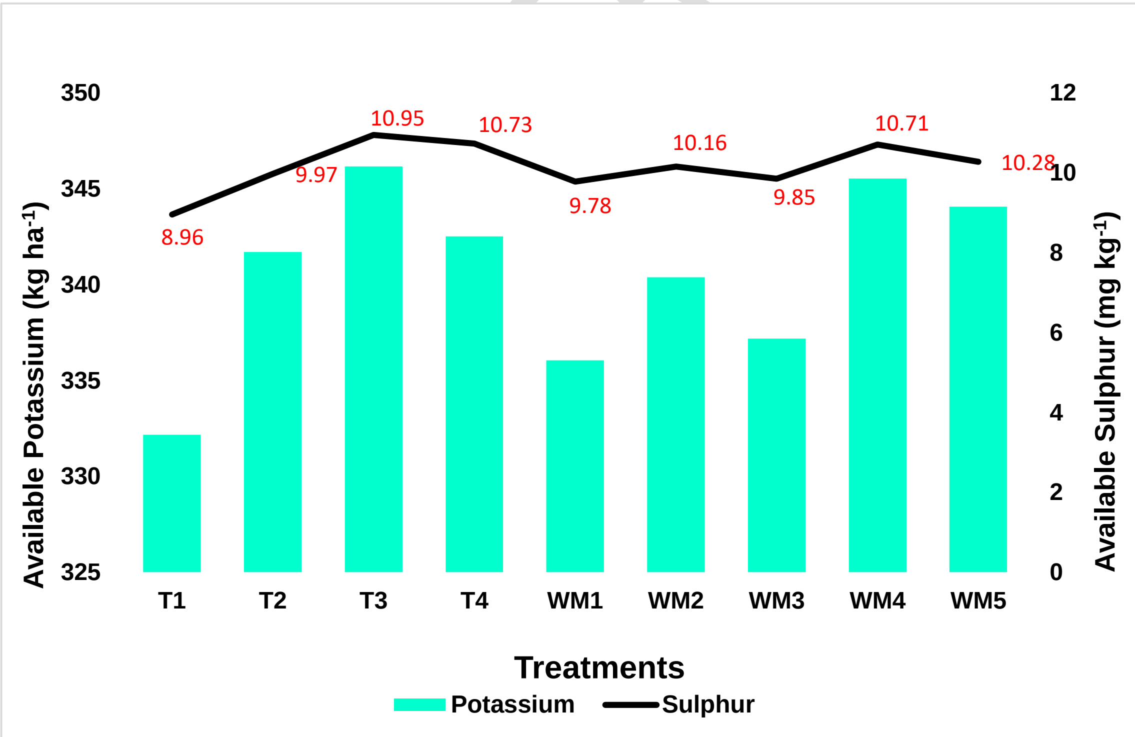

Fig 4. Effect of tillage and weed management practices on available potassium and available sulphur