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Effect of different tillage practices and weed management on weed dynamics, productivity and quality of soybean [*Glycine max* (L.) merrill]

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Abstract
A field experiment was conducted during *Kharif* 2007 and 2008 at Udaipur to study the effect of three tillage practices (conventional, zero and rotavator) and seven weed control treatments (weedy check, pendimethalin, imazethapyr, quizalofop-ethyl, chlorimuron-ethyl, *in-situ* mulching and two hand weedings. The trial, therefore, assessed the bio-efficacy of herbicides in soybean under different tillage practices. Results revealed that rotavator tillage recorded minimum total weed density and total weed dry matters. Two hand weeding and imazethapyr recorded minimum total weed density and total weed dry weight. Conventional tillage recorded highest yield attributes, grain yield,oil and protein yield, as compare to rotavator and zero tillage. Two hand weedings recorded highest yield attributes, grain yield, oil and protein yield, however the B:C ratio was observed maximum in rotavator and Imazethpyr.

Keywords: Herbicides, Tillages, Weeds, imazethapyr, Soybean

Introduction
Soybean is an important crop, containing 20% oil and 40% protein as it is both a pulse and oil seed crop. It is a potential crop for changing the economical position of farmer's of India. In India it is cultivated in 8.53 m ha area with the annual production of 9.43 m tonnes. Weed infestation is one of the major problems in soybean cultivation which causing substantial loss in yield (33-55%) depending on the weed flora and density (Kewat *et al.*, 2000). Alterning tillage practices changes weed population dynamics, including weed seed distribution and abundance in the soil seed bank affects the efficacy of control practices.
Mannual weeding is the best option for weed control, but it is costly, time consuming and difficult due to rains. Timely unavailability of adequate laboures also possesses serious problem. Hence, the present investigation was undertaken to find out the effect of tillage and weed management on weed dynamics and productivity of soybean.

Material method
Experimental Site and Soil Condition
A field experiments was conducted during *Kharif* 2007 and 2008 at Instructional Farm, Rajasthan College of Agriculture, Udaipur. The soil of the experimental fields was clay loam in texture having pH 7.9, organic carbon 0.72%, medium in available N (263.15) low in P 18.99 and high in K 299.23 kg ha^{-1}.
The experiment was laid out in a split plot design with three replication. Main plot treatment were three tillage practices *viz.*, conventional, zero and rotavator and sub plots treatments were seven weed control treatments i.e. pendimethalin (1000 g ha^{-1}), PE, quizalofop-ethyl (50 g ha^{-1}), POE, imazathapyr (100 g ha^{-1}), POE chlromuron-ethyl (9 g ha^{-1}), POE, i*n-situ* mulching 30 DAS and two hand weedings 20 and 40 DAS. Crop was direct seeded without tillage, rotavator seeded and conventionaly planted after soil was tilled. Sowing of soybean cultivar JS 335 was done July, 2007 and 2008 by drilling 80 kg seeds ha^{-1} with a uniform dose of 20 kg N and 40 kg P_2O_5 kg ha^{-1}. Observation in density and dry weight of weeds were recorded at 20, 30, 45 DAS and at harvest and on yield attributes and yield were recorded at harvest.

Dominant weeds Species

The predominant weed flora included of crop during growing season in weedy check plots were *Cynodon dactylon, Echinochloa crusgalli, Cyperus rotendus, Commelina benghalensis, Amaranthus viridis, Trianthema partulacastrum* and *Digera arvensis* etc.

Effects on Weeds

Weed densities, both grassy and broadleaf were slightly lower under rotavator tillage followed by the zero and conventional tillage. The dry weight of both grassy and broadleaf weeds were recorded significantly minimum under rotavator tillage followed by the zero and conventional tillage.

All the weed control treatment significantly reduced weed density and weed dry matter 45 DAS and at harvest during both the year of investigation. Two hand weeding and imazethatyr were statistically superior in reducing weed density, dry matter of grassy as well as broadleaf weeds at harvest over rest of the weed control treatments and weedy check. Two hand weeding was significantly superior in reducing nitrogen and phosphorus depletion by grassy and broadleaf weeds at harvest. Similar results were reported by Dhakar *et al.* (2010).

Yield attributes

All the yield attributes was influenced significantly by tillage system.These parameters highest in conventional method followed by the rotavator and Zero tillage. Among weed control treatments, Two hand weedings registered significantly higher number of pods plant^{-1}and seed pod^{-1} followed by imazethapyr (100 g ha^{-1}) over weedy check.

Grain yield

Conventional tillage registered significantly higher grain yield over rotavator and zero tillage (Table 2). Bisan *et al.* (2006) and Gopinath *et al.* (2007) also observed similar results. All the weed control treatments gave significantly higher seed yield compared to weedy check. Two had weedings produced significantly higher grain yield compared to other weed control treatments and weedy check. Good grain yield in two hand weedings may be probably due to better weed management resulting in improvement in all growth and sink parameters which contributed higher seed yield owing to favourable condition in absorbing soil moisture content, nutrients and sufficient sunlight penetration during the crop period (Table 2). The result are in the agreement with those of Vyas *et al.* (2013) and Dhakar *et al.* (2010).

Quality Parameter

Conventional tillage registered significantly higher oil and protein yield over rotavator and zero tillage. All the weed control treatments gave significantly higher oil and protein yield compared to weedy check. Two had weedings produced significantly higher oil and protein yield compared to other weed control treatments and weedy check. Maximum oil and protein yield in two hand weedings may be probably due to better weed management resulting in improvement in seed yield.

Economic returns

Conventional tillage gave higher gross and net returns compared to rotavator tillage. However, low cultivation cost recorded under rotavator tillage due to absence of preparatory tillage. It, therefore, recorded higher benefit cost ratio (2.38) compared to conventional tillage. Among weed control treatments two had weedings recorded maximum returns (21946 ha^{-1}). Imazethapyr at 100 g ha^{-1} was the next best remunerative treatment with highest B C ratio (2.50).

Conclusion

Based on the two years results of experimentation, it is found that the different tillage practices and weed management practices in Soybean significantly affect the yield attributes, Seed yield, Oil and protein yield, net return, B:C ratio, weed density and weed dry matter. In different tillage methods, conventional tillage is significantly superior as compared to other methods with regards to above parameters.In case of weed managements practices, two hand weeding followed by the Imazethapyr at 100 g ha^{-1} are superior than other methods.

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Table 1: Effect of tillage and weed control systems on weed density and weed dry matter in soybean

Treatments	Weed density m^{-2}at harvest			Weed dry matter (gm^{-2}) at harvest		
	Grassy	Broadleaf	Total	Grassy	Broadleaf	Total
Tillage						
Conventional	5.91 (34.42)	8.03 (63.91)	10.32 (105.93)	70.73	150.52	237.34
Zero	6.40 (40.47)	7.34 (53.33)	10.16 (102.75)	82.15	126.09	227.23
Rotavator	5.85 (33.70)	7.42 (54.54)	9.82 (95.96)	69.35	128.77	214.48
S.Em. ±	0.11	0.11	0.23	1.75	2.83	4.55
C.D. (P=0.05)	0.37	0.37	0.76	5.72	9.25	14.88
Weed control	5.39 (28.58)	6.82 (46.12)	9.17 (83.62)	56.69	103.77	179.36
Pendimethalin (1000 g ha^{-1}), PE	5.40 (28.69)	5.39 (28.54)	5.04 (66.93)	56.96	62.58	140.12
Imazethapyr (100 g ha^{-1}), POE	5.40 (21.58)	8.81 (77.20)	10.37 (107.00)	42.00	184.82	244.25
Quizalofop (50 g ha^{-1}), POE	4.70 (31.76)	5.02 (24.78)	8.19 (66.51)	63.18	54.67	138.99
Chlorimuron (9 g ha^{-1}), POE	4.51 (19.82)	3.97 (15.26)	6.31 (39.26)	39.73	34.81	83.41
Insitu mulching 30 DAS	1.90 (3.11)	3.13 (9.29)	3.79 (13.86)	6.37	21.43	30.90
Two HW 20 and 40 DAS	10.96 (119.82)	14.15 (199.65)	18.28 (333.64)	253.60	483.79	767.42
Weedy check	0.10	0.12	0.18	1.59	2.81	3.92
S.Em. ±	0.29	0.34	0.52	4.48	7.92	11.03
C.D. (P=0.05)						

Figures in parentheses are original values. * Transformed values (√x+0.5).

Table 2: Effect of tillage and weed control treatment on yield attributes, yield and economics in soybean

Treatments	pods plant^{-1}	seed pod^{-1}	seed yield (kg ha^{-1})	Oil yield (kg ha^{-1})	Protein yield (kg ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
Tillage							
Conventional	47.47	2.23	1975.18	410.91	824.16	21945.62	1.78
Zero	31.72	1.93	1383.07	280.98	550.79	15879.56	1.93
Rotavator	36.63	2.14	1723.69	354.08	701.87	20984.97	2.38
S.Em. ±	1.94	0.06	41.54	8.60	16.07	693.78	0.08
C.D. (P=0.05)	6.32	0.21	135.69	28.08	52.48	2266.13	0.26
Weed control							
Pendimethalin (1000 g ha^{-1}), PE	35.29	2.13	1701.04	348.34		20148.09	2.15
Imazethapyr (100 g ha^{-1}), POE	45.84	2.22	1885.60	387.31	689.59	23231.66	2.50
Quizalofop (50 g ha^{-1}), POE	31.54	1.92	1598.16	324.33	769.59	18431.44	1.99
Chlorimuron (9 g ha^{-1}), POE	40.07	2.11	1655.91	341.02	647.87	20426.22	2.46
Insitu mulching 30 DAS	40.71	2.25	1883.04	391.02	675.12	21990.42	2.08
Two HW 20 and 40 DAS	55.01	2.27	2130.61	445.98	771.75	23242.07	1.73
Weedy check	21.79	1.78	1003.48	202.60	898.04	9753.74	1.31
S.Em. ±	2.51	0.08	58.23	11.16	393.97	960.77	0.10
C.D. (P=0.05)	7.06	0.23	163.84	31.41	22.40	2703.46	0.29

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