



Conservation tillage and weed management practices effect on weeds, yield and profitability of cowpea (*Vigna unguiculata*)

D S SASODE¹, EKTA JOSHI², DINESH JINGER³, RAJNI SINGH SASODE⁴, VARSHA GUPTA⁵ and Y K SINGH⁶

Rajmata Vijayaraje Scindia Krishi Vishva Vidyalaya, Gwalior, Madhya Pradesh 474 002, India

Received: 24 April 2019; Accepted: 03 July 2019

ABSTRACT

An experiment was conducted from 2014–2018 to find out the effect of conservation tillage and weed management methods on weed flora, growth and yield of cowpea (*Vigna unguiculata* (L.) Walp. cv. RC 101) under pearl millet-mustard-cowpea cropping system. The results showed that amongst tillage treatments, zero tillage with residue application during both *kharif* and *rabi* season and only during *rabi* for four years significantly increased the grain yield by 49 and 18%, gross returns by 43 and 14% and reduced the total weed biomass by 48 and 32%, respectively with higher weed control efficiency compared to zero tillage without residue application. Among different weed flora, zero tillage with residue application during both *kharif* and *rabi* season and only during *rabi* reduced the narrow-leaved weeds population by 40 and 19%, broad-leaved weeds by 23 and 8%, respectively. All the tillage conditions had not significantly controlled sedges. On the other hand, among different weed management practices, the pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha with one hand weeding at 20–25 DAS resulted in the significant reduction of total weed biomass, highest grain yield, weed control efficiency and gross returns. The integrated weed management approach reduced the narrow-leaved weeds by 49%, broad-leaved weeds by 52% and sedges by 59% compared to herbicides application alone. However, the interaction effect of tillage practices and weed management approach was not significant except for the total weed biomass at harvest.

Key words: Conservation tillage, Cowpea, Productivity, Weed flora, Weed management

Among pulse crops, cowpea [*Vigna unguiculata* (L.) Walp.] is the most versatile crop, as it performs better than other crops in the fragile and harsh ecosystems. Beside inadequate weed control, poor soil management strategies had also been identified as a major contributory factor for yield gap in cowpea. It is regarded as smoother crop, however, in the rainy season, weeds act as major deterrent by overpowering the crop in initial stage of growth. Based on the location, soil type, varieties and agronomic management the reduction in the yield due to weeds in cowpea is in the range of 12.7–60.0% (Gupta *et al.* 2016). These all factors in bulk have a variable impact on weed flora and the dynamics of composite weed culture of cowpea under mix or intercropping systems in diverse agro-climatic conditions. Though, the conventional methods, like hand weeding and herbicide application are well proven effective method of weed control but are uneconomical due to higher cost of labour and hazardous effects of the herbicides to

the environment (Cheema *et al.* 2003). Similarly, the pre-emergence applications alone are not sufficient to curtail repeated flushes of weeds during rainy season, which also necessitates a post-emergence application after pre-emergence one (Silva *et al.* 2003).

The type of tillage system sometime depends on the availability of labour services and input cost implications. Zero tillage can reduce input costs and labour and conserve the soil (Busari *et al.* 2015). The soil, however, suffers from compaction when not tilled which can negatively affect plant growth. When tilled with residue incorporation in soil, crops are benefitted from the improved looseness, oxygen supplies and water intake. Cochran *et al.* (1982) however, reported reduction in crop yield due to no-tillage. Some other workers (Gupta and Gupta 1986) showed no-tillage to be useful in increasing crop yields with crop residues. However, there is no documented information on how cowpea responds to different tillage practices in India. Therefore, this study was aimed at developing suitable and sustainable soil management strategy and location specific and cost effective weed management method for cowpea in the Gird region of Madhya Pradesh.

MATERIALS AND METHODS

Field trials were conducted on sandy clay loam soil

¹Senior Scientist (dsingh.jnkvv@rediffmail.com), ^{2,4,5}Scientist(joshi.ekta86@gmail.com, rnikumujain@gmail.com, drvarshagupta11@gmail.com), ⁶FEO (yrmt79@rediffmail.com), RVSKVV, Gwalior, Madhya Pradesh; ³Scientist (dineshjinger28@gmail.com), ICAR, IIS and WC, Research Center, Vasad, Anand, Gujarat.

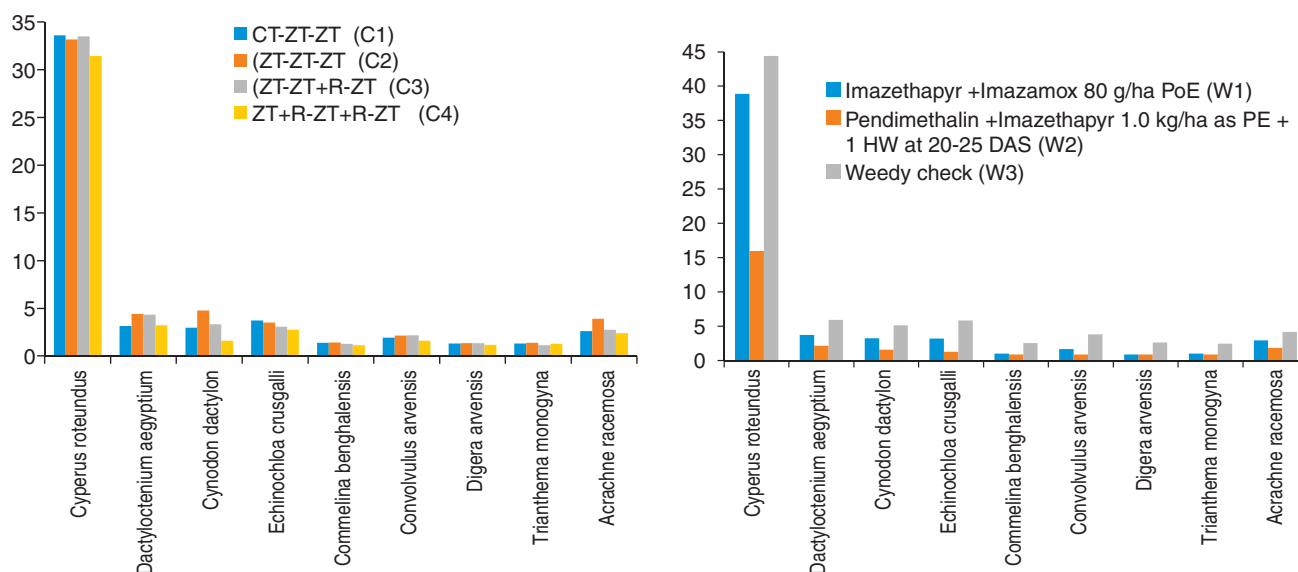


Fig 1a,b Effect of different conservation tillage and weed management practices on population of weed species/m² in cowpea under pearl millet based cropping system (pooled data).

during 2014–18 to study the impact of conservation tillage along with integrated weed control measures on weed dynamics, sustainability, productivity and profitability of cowpea in pearl millet–mustard–cowpea cropping system at the research farm of RVSKVV, Gwalior. The initial N (237 kg/ha) content of soil was low, P (19.7 kg/ha) and K (277 kg/ha) content were medium. The pH of soil was 7.4 with electrical conductivity 0.34 dS/m containing 0.51% organic carbon in the top 15 cm of soil. The experiment was laid out in a strip plot design, replicated three times, and consisted of total 12 treatments. The four treatments of tillage practices were conventional tillage in pearl millet followed by zero tillage in both mustard and cowpea (C₁); zero tillage in pearl millet, mustard and cowpea (C₂); zero tillage in both pearl millet and cowpea, zero tillage with crop residues in mustard (C₃); zero tillage with crop residues in pearl millet, mustard and cowpea (C₄) in combination with three weed control measures, viz. Imazethapyr +Imazamox 80 g/ha PoE (W₁), pendimethalin + imazethapyr 1.0 kg/ha as PE with one HW at 20–25 DAS (W₂) and one kept weedy check W₃ for comparison. The recommended dose of NPK for cowpea (20-50-20 kg/ha) were applied at the time of sowing. Cowpea variety (RC 101) was sown 25 kg/ha in rows 40 cm apart and later thinning was done to maintain plant to plant distance as 10 cm. Before sowing, the seeds were treated with the fungicides dithane M-45 @ 2 g/kg seed, bavistin @ 1 g/kg seed. Crop residues were placed as per the treatments and irrigation was applied at all the critical stages of crop growth during the experimentation. Herbicides as per the treatments were applied at recommended rates and suitable timings. Five plants in each plot were selected randomly and tagged for taking various biometric observations. Observations of weeds were recorded with the help of a quadrant 0.5 m × 0.5 m placed randomly at two spots in each plot at 40

DAS. Statistical analysis of the data was carried out using analysis of variance technique as applicable to split plot design (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Weed flora: The major weed flora in the experimental plots were *Dactyloctenium aegyptium*, *Cynodon dactylon*, *Echinochloa crus-galli*, *Acrachne racemosa*, *Commelina benghalensis*, *Convolvulus arvensis*, *Digera arvensis*, *Trianthema monogyna* and *Cyperus rotundus*.

Effect on weeds: The zero tillage with or without residue application resulted in significant reduction of total weed biomass at harvest compared to conventional tillage practice. Within zero tillage, with residue application during *rabi* only and both *kharif* and *rabi* for four years significantly reduced the total weed biomass by 32 and 48%, respectively with higher weed control efficiency (76.5 and 83.3%) compared to zero tillage without residue application. Similarly, the population of all narrow-leaved weeds except *Dactyloctenium aegyptium*, broad-leaved weeds except *Commelina benghalensis* and *Trianthema monogyna* significantly reduced but the population of *Cyperus rotundus* was not reduced under zero tillage with residue application compared to zero and conventional tillage without residue application. Among different weed flora, zero tillage with residue application during both *kharif* and *rabi* season and only during *rabi* reduced the narrow-leaved weeds population by 40 and 19% and broad-leaved weeds by 23 and 8%, respectively. The tillage treatments did not differ in their effect on sedges. The results showed that the population of narrow-leaved weeds continued to be less under no-till with residue application during both *kharif* and *rabi* (Fig 1a). Therefore, conservation agriculture, especially zero-till system with residue application, can contribute to decrease narrow-leaved weeds in cowpea

(Stanzen *et al.* 2017).

The conventional tillage during *kharif* followed by zero tillage without residue during *rabi* and *zaid* resulted in better control of all narrow, broad-leaved weeds and sedges compared to zero tillage without residue application during all the three seasons in a year. Soil tillage enhanced the emergence of weeds, the dominant species in the region of the study due to more favourable conditions for weed germination created by the tillage operations (Mirsky *et al.* 2010 and Calado *et al.* 2013). The total weed population, dry weight of narrow and broad-leaved weeds, sedges and total dry weight of weeds was not influenced significantly under all tillage practices but zero tillage with residue application resulted in the lowest population and dry weight of weeds compared to other tillage treatments. In the entire experiment, residue treatments had lowest population of narrow and broad-leaved weeds than without residue under zero tillage system. This indicated possible smothering effect of residues on weeds.

All the weed control treatments proved effective in minimizing the population and dry weight of weeds over weedy check (Table 1). Total weed population and weed biomass at harvest was significantly lowest with the pre-emergence application of pendimethalin + imazethapyr 1.0 kg/ha with one hand weeding at 20–25 DAS while the lowest total weed population/m² and weed biomass at harvest was under weedy check. Application of pendimethalin + imazethapyr 1.0 kg/ha with one hand weeding at 20–25 DAS reduced the total weed biomass by 60%, narrow-leaved weeds by 49%, broad-leaved weeds by 52% and sedges by 59% compared to Imazethapyr + Imazamox

80 g/ha PoE application. Among different weed flora, application of pendimethalin + imazethapyr 1.0 kg/ha with one hand weeding at 20–25 DAS had significantly reduced the population of all narrow-leaved weeds and sedges but it had not significantly reduced the broad-leaved weeds population except *Convolvulus arvensis* and was at par with PoE application of Imazethapyr + Imazamox 80 g/ha (Fig 1b). Broad and narrow-leaved weed control efficiency of treatments varied between 69.6–87.5% (Table 1). Application of pendimethalin + imazethapyr 1.0 kg/ha with one hand weeding at 20–25 DAS resulted in higher value of weed control efficiency followed by Imazethapyr + Imazamox 80 g/ha PoE application (Table 1). Similar results were also reported by Dubey *et al.* (2012) and Sasode *et al.* (2017).

Effect on crop: Under all the tillage conditions, residue application had efficiently controlled weeds which resulted in significant increase in plant height, number of branches/plant, number of pods/plant, pod length, number of seeds/pod and was followed by conventional tillage practices (Table 2). Zero tillage with residue as mulch perhaps provided an advantage to crop over weeds, resulted in better resource utilization and greater suppression ability of weeds than the without residue treatments that indirectly led to better growth and yield of cowpea. Results corroborate with the results of Nath *et al.* (2016) and Singh *et al.* (2017). The zero tillage without residue application resulted in the lowest values of growth and yield attributes of cowpea and was at par with treatment where with zero tillage residue was applied during *rabi*. Zero tillage with residue application during *rabi* only and both *kharif* and *rabi* increased the

Table 1 Effect of different conservation tillage and weed management practices on total weed population and dry weight of weeds/m², weed biomass at harvest and weed control efficiency of cowpea under pearl millet based cropping system (pooled data)

Treatment	Total weed population /m ²				Dry weight of weeds /m ²			Weed biomass at harvest (kg/ha)	WCE (%)
	Narrow	Broad	Sedge	Total	Narrow	Broad	Total		
<i>Tillage</i>									
CT-ZT-ZT (C1)	6.88	2.66	33.59	34.53	18.36	1.28	19.64	6354	82.2
(ZT-ZT-ZT (C2)	8.76	2.98	33.15	34.56	15.80	1.34	17.15	4428	72.3
(ZT-ZT+R-ZT (C3)	7.11	2.75	33.47	34.50	17.36	1.51	18.87	3033	76.5
ZT+R-ZT+R-ZT (C4)	5.25	2.31	31.44	32.06	15.46	1.56	17.02	2284	83.3
SEm±	0.19	0.10	1.61	1.56	2.60	0.20	2.63	183	-
CD (P=0.05)	0.57	0.30	4.97	4.80	8.00	0.60	8.10	565	-
<i>Weed control</i>									
Imazethapyr +Imazamox 80 g/ha PoE (W1)	6.83	1.84	38.86	39.57	21.40	0.00	21.41	2619	69.6
Pendimethalin +Imazethapyr 1.0 kg/ ha as PE + 1 HW at 20-25 DAS (W2)	3.46	0.88	16.00	16.45	6.21	0.00	6.21	1039	87.5
Weedy check (W3)	11.24	5.83	44.41	46.25	22.62	4.27	26.89	8416	0.0
SEm±	0.27	0.19	0.91	0.90	1.81	0.15	1.78	318	-
CD (P=0.05)	0.79	0.54	2.62	2.60	5.22	0.43	5.12	917	-

Table 2 Effect of different conservation tillage and weed management practices on growth parameters, yield attributes, yield and economics of cowpea under pearl millet based cropping system (pooled data)

Treatment	Plant height (cm)	No. of branches/plant	No. of pods	Length of pod (cm)	No. of seeds/pod	Seed yield (kg/ha)	Stover yield (kg/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B C ratio
<i>Tillage</i>										
CT-ZT-ZT (C1)	36.24	8.11	13.08	14.78	18.32	669	3055	49622	30491	1.58
(ZT-ZT-ZT (C2)	34.74	6.49	10.97	13.50	16.98	509	3067	39189	20058	1.03
(ZT-ZT+R-ZT (C3)	35.98	7.23	12.08	14.12	17.50	600	2840	44665	25534	1.32
ZT+R-ZT+R-ZT (C4)	37.84	8.54	13.39	15.32	19.52	760	3252	55881	36750	1.91
SEm±	0.38	0.31	0.37	0.23	0.34	39	314	2623.7	2623.7	0.135
CD (P=0.05)	1.17	0.95	1.13	0.70	1.06	120	967	8084.5	8084.5	0.415
<i>Weed control</i>										
Imazethapyr + Imazamox 80 g/ha PoE (W1)	36.96	8.01	12.99	14.50	18.25	614	2895	45679	27902	1.57
Pendimethalin + Imazethapyr 1.0 kg/ha as PE + 1 HW at 20-25 DAS (W2)	37.78	8.96	14.40	15.86	19.50	843	3581	61961	41373	2.01
Weedy check (W3)	33.88	5.82	9.74	12.93	16.49	446	2684	34378	15351	0.81
SEm±	0.55	0.25	0.34	0.15	0.13	37	162	2323.4	2323.4	0.123
CD (P=0.05)	1.60	0.73	0.99	0.42	0.39	106	466	6693.0	6693.0	0.354

grain yield by 18 and 49.3%, respectively compared to zero tillage without residue application but was at par with conventional tillage during *kharif* followed by zero tillage during *rabi* and *zaid*. The higher growth and yield of cowpea in zero tillage with residue application may be attributed to better aeration and adequate moisture or differences in soil structure and fertility level.

Application of pendimethalin + imazethapyr 1.0 kg/ha with one hand weeding at 20–25 DAS resulted in the significantly higher values of growth and yield parameters compared to all other treatments and was followed by Imazethapyr + Imazamox 80 g/ha PoE application. Grain yield of cowpea was significantly influenced due to different weed control treatments. Application of pendimethalin + imazethapyr 1.0 kg/ha with one hand weeding at 20–25 DAS established its superiority by recording significantly higher grain yield (Table 2) and noted the increment by 89 and 33% of seed and stover yield compared to weedy check and 37 and 24% higher seed and stover yield compared to Imazethapyr + Imazamox 80 g/ha PoE application, respectively. This increase in yield might be due to effective control of weeds in early stage, which smothered weed growth and gave higher yield attributes of cowpea and ultimately resulted to higher yields. This data was in conformity with the findings of Singh *et al.* (2015), Stanzen *et al.* (2017) and Shivran *et al.* (2017).

However, the interaction effect of tillage practices and weed management approach was not significant except for the total weed biomass at harvest. The application of

pendimethalin + imazethapyr 1.0 kg/ha with one hand weeding at 20–25 DAS resulted in the significantly lowest weed biomass at harvest and provided the maximum grain and stover yield under zero tillage with residue application (Table 3). On the other hand, zero tillage without residue application under weedy check conditions produced

Table 3 Interaction table for weed biomass, grain and stover yield of cowpea under pearl millet based cropping system (pooled data)

Treatment	Weed biomass (kg/ha)	Seed yield (kg/ha)	Stover yield (kg/ha)
C1W1	22004	3975	18172
C2W2	9481	5254	20329
C2W3	82884	2821	16489
C3W1	21677	2734	16762
C3W2	6841	4090	22935
C3W3	51189	2329	15518
C4W1	11820	3416	15662
C4W2	5918	4971	21531
C4W3	36853	2409	13926
C5W1	7351	4603	18889
C5W2	2706	5918	21160
C5W3	31057	3152	18494
SEm (±)	900.1	104.4	457.1
CD (P=0.05)	2593.0	300.7	1316.7

significantly highest weed biomass and lowest grain and stover yield of cowpea and was followed by zero tillage with residue application during *rabi* only and conventional tillage.

Economics: Among different tillage conditions, zero tillage with residue application during both *kharif* and *rabi* season and only during *rabi* increased the gross returns by 43 and 14% and B:C ratio by 85 and 28%, respectively compared to zero tillage without residue application. Similarly, it increased the gross returns and BC ratio by 13 and 21%, respectively compared to conventional tillage practice during *kharif* followed by zero tillage during *rabi* and *zaid* but was at par with the same (Table 2). Among different weed management treatments, the net monetary returns (₹ 15351/ha) and benefit cost ratio (0.81) were lowest in weedy check plots. Application of pendimethalin + imazethapyr 1.0 kg/ha with one hand weeding at 20–25 DAS recorded significantly highest net returns (₹ 27902/ha) and B:C ratio (1.57) and was followed by Imazethapyr + Imazamox 80 g/ha PoE application and increased the gross returns and B:C ratio by 36 and 28%, respectively compared to Imazethapyr + Imazamox 80 g/ha PoE application.

Based on four years experimentation it is concluded that the population of narrow and broad-leaved weeds continues to be less under no-till with residue application during both *kharif* and *rabi*. The application of pendimethalin + imazethapyr 1.0 kg/ha with one hand weeding at 20–25 DAS resulted in the maximum control of weeds specially grassy weeds and provided the maximum grain yield, gross and net returns under zero tillage with residue application. Therefore, conservation agriculture, especially zero-till system with residue application, can contribute to decrease narrow-leaved weeds and higher productivity and profitability of cowpea in pearl millet-mustard-cowpea cropping system.

REFERENCES

- Busari M A, Kukal S S, Kaur A, Bhatt R and Dulazi A A. 2015. Conservation tillage impacts on soil, crop and the environment. *International Soil and Water Conservation Research* **3**: 119–29.
- Calado J M G, Basch G, Barros J F C and Carvalho M. 2013. Weed management in winter wheat influenced by different soil tillage systems. *African Journal of Agricultural Research* **8**: 2551–58.
- Cheema Z A, Hussain S and Khaliq A. 2003. Efficacy of sorgaab in combination with allelopathic water extracts and reduced rate of pendimethalin for weed control in mungbean. *Industrial Journal of Plant Sciences* **2**: 21–25.
- Cochran V L, Elliott L F and Papendick R I. 1982. Effect of crop residue management and tillage on water use efficiency and yield of winter wheat. *Agronomy Journal* **74**: 929–32.
- Dubey M and Gangwar S. 2012. Effect of chemical weed control of Imazethapyr in groundnut. *Plant Archives* **12**: 671–75.
- Gomez K A and Gomez A A. 1984. *Statistical Procedures for Agricultural Research*, 2nd Edn. John Wiley and Sons Inc., New York.
- Gupta J P and Gupta G K. 1986. Effect of tillage and mulching on soil environment and cowpea seedling growth under arid conditions. *Soil and Tillage Research* **7**: 233–38.
- Gupta K C, Gupta A K and Saxena R. 2016. Weed management in cowpea (*Vigna unguiculata* L. Waslp.) under rainfed conditions. *International Journal of Agricultural Sciences* **12**: 238–40.
- Mirsky S B, Gallandt E R, Mortensen D A, Curran W S and Shumway D L. 2010. Reducing the germinable weed seed bank with soil disturbance and cover crops. *Weed Research* **50**: 341–52.
- Mohanty S and Satyasai K J. 2015. Feeling the Pulse. Indian Pulses Sector. NABARD Rural Pulse.
- Nath C P, Das T K and Rana K S. 2016. Effects of herbicides and tillage practices on weeds and summer mungbean in wheat-mungbean cropping sequence. *Industrial Journal of Plant Sciences* **86**: 860–64.
- Singh R P, Verma S K, Prasad S K, Singh H and Singh S B. 2017. Effect of tillage and weed management practices on grassy weeds in wheat (*Triticum aestivum* L.). *International Journal of Science, Environment and Technology* **6**: 404–12.
- Sasode D S, Gupta V, Joshi Ekta, Arora A, Dixit J P and Panse R. 2017. Management of diverse weed flora of wheat by herbicide combinations. *Indian Journal of Weed Science* **49**: 147–150.
- Shivran O P, Singh M K and Singh N K. 2017. Weed flora dynamics and growth response of greengram (*Vigna radiata* L.) under varied agri-horti system and weed management practices. *Journal of Applied and Natural Science* **9**: 1848–53.
- Shuaib O S B. 2001. Critical period for weed competition in green gram. *Journal of Natural Applied Sciences* **5**: 11–18.
- Silva J B F, Pitombeira J B, Nunes R P and Pinho J L N. 2003. Weed control in cowpea under no till system. *Planta Daninha* **21**: 151–57.
- Singh R, Singh A P, Chaturvedi S, Rekha R and Pal J. 2015. Metribuzin + clodinafop-propargyl effects on complex weed flora in wheat and its residual effect on succeeding crop. *Indian Journal of Weed Science* **47**: 362–65.
- Stanzen L, Anil Kumar, Puniya R, Sharma Neetu, Sharma Ashu, Mahajan A and Bana R C. 2017. Effect of tillage and weed management practices on weed dynamics and productivity in maize (*Zea mays*)-wheat (*Triticum aestivum*) system. *International Journal of Current Microbiology and Applied Sciences* **6**: 1907–13.