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RESEARCH ARTICLE

Weed management effect on density, growth parameters and yield of cowpea

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ABSTRACT

Cowpea suffers badly due to weed invasion which cause wide range of yield reduction. Therefore, an experiment was planned to determine the effect of different pre- and post-emergence herbicides, stale seedbed techniques and hand weeding in cowpea (*Vigna unguiculata* L.) during summer season of 2019 and 2020. The average yield losses due to crop-weed competition in cowpea was estimated by 71.32%. The relative density of monocot, dicot and sedges observed in weedy plot were 55.1, 34.3 and 10.6 no./m^2, respectively. Plant height, branches/plant, pods/plant and seeds/pod were significantly higher under application of pendimethalin 30 EC 750 g/ha *fb* HW at 30 DAS, being at par with weed free (HW at 20 and 40 DAS) and pendimethalin 30 EC 750 g/ha *fb* imazethapyr 10 SL 60 g/ha at 30 DAS. This subsequently produced higher seed (1.37 t/ha) and stover yield (2.07 t/ha) and net return (₹ 65799/ha) of cowpea. Considering the labour shortage conditions and econiomics, pendimethalin 30 EC 750 g/ha PE *fb* imazethapyr 10 SL 60 g/ha at 30 DAS (₹ 64627/ha) was endorsed for weed management to produce comparable cowpea yield with highest B: C ratio (3.17).

Keywords: Cowpea, Imazethapyr, Pendimethalin, Sate Seedbed, Weed Indices

INTRODUCTION

Cowpea (*Vigna unguiculata*) is an important legume grown extensively under tropical and sub-tropical areas of the world and used as grain and vegetables. The pods are highly nutritive and good source of digestible protein, dietary fiber and vitamin A and C. In spite of the great economic prospective of cowpea as both domestic and commercial crop, a number of constraints *i.e.* insect, pests, diseases and weeds limit its production, impaired quality and crop yield. The growth of cowpea severely affected by weed competition, leads to significant yield losses. The initial slow development and wider spacing necessitate weed control in an earlier period of cowpea (Kandasamy 1999, Sinchana 2020). The critical period of crop weed competition (CWC) in cowpea was 20 to 40 days after sowing (DAS), which clearly points out the need of weed control during the first month of crop growth which would help to prevent an unacceptable yield loss. The season-long competition resulted in 53 to 76% yield reduction in cowpea (Gupta *et al*., 2016). Cowpea competes poorly with weeds in the growing stage having yield loss of 12 to 82% (Li *et al.* 2004, Tripathi and Singh 2001). The effects of weeds on crop yield depends on the duration of the interference and the time of the weed- crop system at which the interaction takes place (Knezevic *et al.* 2003). Delaying weed removal up to 14 DAE was not found good because it could reduce cowpea yield by 4 to 15% (Adigun *et al.*, 2014). Season-long weed competition resulted in 59% yield reduction in vegetable cowpea (Sinchana 2020) and, 56.7% seed yield reduction (Teli *et al.* 2020).

Considering different social, economic and environmental factors, choice of weed management needs to be applicable to crops as per requirements of the situation by including preventive and curative methods of weed management. At least two weeding are needed for cultivating cowpea (Mekonnen *et al.* 2017), and it was estimated that, for each weeding, at least 7 to 10 days work is required per hectare. Besides, manual hand weeding is labourious, intensive, tedious and does not ensure weed removal at critical stage of crop-weed competition (Patel *et al.* 2017). Hence, nowadays herbicidal weed control gains upper hand (Patel *et al.* 2023), which could replace approximately 10 labours/ha required for weed control (Gianessi and Reigner 2007). Chemical weed control seems to be cheaper and effective and generally adopted by growers except in area where the labour is cheap and easily available during peak period of farm operations. Under this situation, an integrated weed management (IWM) practice involving both chemical and other methods with agronomic manipulation may be an efficient tool. Keeping these facts in view, field study was planned with an objective to study the effect of weed management for cowpea crop.

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MATERIALS AND METHODS

The study was conducted during the summer season of 2019 and 2020 at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari. A field vacated by maize crop was selected having the history of the presence of diversified weed flora during summer season. The soil of the experimental field was clayey in texture, low, medium and high in available nitrogen (209 kg/ha), phosphorus (40.6 kg/ha) and potassium (384 kg/ha), respectively. The experiment was laid out in a randomized complete block design with four replications and nine treatments consisted weedy check (control), weed free by hand weeding (HW) at 20 and 40 DAS, pendimethalin 30 EC 750 g/ha pre-emergence (PE), imazethapyr 10 SL 60 g/ha post-emergence (PoE) at 20 DAS, quizalofop-ethyl 5 EC 40 g/ha PoE at 20 DAS, pendimethalin *fb* HW 750 g/ha PE + HW at 30 DAS, pendimethalin *fb* imazethapyr 750 *fb* 60 g/ha PE + PoE at 30 DAS, pendimethalin *fb* quizalofop-ethyl 750 *fb* 40 g/ha PE + PoE at 30 DAS, stale seed bed (destroying of one flush of weeds through glyphosate) 1000 g/ha before sowing.

Cross-harrowing was carried out twice to prepare the soil. Cowpea variety *GC-5* was sown at a planting distance of 45 x 15cm during second week of March of both years. The crop was thinned to one seedling per stand at 15 days after germination to have a population of approximately 108 plants/plot. Irrigation was started after sowing and suspended 15 days after the dry pods were first harvested. Cowpea crop was nourished by application of 20 kg N/ha and 40 kg P/ha through urea and SSP as basal. The fertilizers were applied by hand to the bottom of the sowing furrows, both under and to the side of the seeds. The crop was sprayed with imidacloprid 3.0 ml/10 liters of water for control of aphids and flubendiamide 39.35 SC to control pod borers to keep the crop free from pest during vegetative phase as well as at reproductive period.

In stale seed beds treatment, the weed seed bank was contrived by tillage during the month of February to expose and break the nut sedges tuber chain. These was followed by irrigation to stimulate sprouting of dormant tuber and other weed seed for two weeks. thereafter applied a non-selective herbicide (*e.g.* glyphosate) and destroyed germinated weeds entirely. Required quantity of solution of herbicides, *viz.* pendimethalin, imazethapyr and quizalofop-p-ethyl was prepared as per the treatments assigned to different plots. The herbicides were applied using knapsack sprayer fitted with a flatfan nozzle by usisng volume of 450 litres water/ha (30 pump of 15 liter) for pre-emergence and 510 litres of water/ha (32 pump of 15 liter) for post-emergence herbicide. Whereas, hand weeding was carried out with the help of hand operated small spade locally called "*khurpi*" as per treatments. Herbicide and hand weeding were not done in weedy check plot.

The species and category wise weed density and dry weight was recorded using quadrate of 50 × 50 cm during both the seasons. The monocot, dicot and sedges were separately counted at 20 and 40 DAS. The weed samples collected in paper bags were sun-dried initially followed by oven drying at 65 ^{0}C for 48 hours till they attain constant weight to determine biomass in g/m^2. The data were subjected to square root transformation ($\sqrt{x+0.5}$) to normalize their distribution. However, for better understanding, original values are given in parenthesis. Weed control efficiency (WCE) and weed index (WI) were calculated based on the weed biomass and cowpea seed yield, respectively. The Experimental data related to each character was then statistically analysed as per procedure of analysis of variance and significance tested by "F" test (Gomez and Gomez 1984).

Economics was computed using the prevailing market prices for inputs and outputs *viz.* cowpea seeds (₹ 60/kg) and stover (₹ 3/kg) and manual labour (₹ 287/ day); input price pendimethalin 30 EC (₹ 410/lit.); imazethapyr 10 SL (₹ 1300/lit.); quizalofop-ethyl 5 EC (₹ 1350/lit.); glyphosate 41 SL (₹ 350/lit.); nitrogen through urea (₹ 11.6/kg); phosphorus through single super phosphate (₹ 49.4/kg), *Rhizobium* (₹ 120/lit.); imidacloprid 17.8 SL (₹ 1100/lit.) and flubendiamide 39.35 SC (₹ 18000/lit.).

RESULTS AND DISCUSSION

Floristic composition

Floristic survey **(Table 1)** reflects diversified composition of weeds and total seventeen species were identified in the experimental area. The most dominating species were *Echinochloa crus-galli* L., *Cynodon dactylon* L., *Digitaria sanguinalis* L. *Dinebra retroflexa* L. and *Commelina benghalensis* L. amongst the grasses; *Convolvulus arvensis* L., *Digera arvensis* L. and *Trianthema portulacastrum* L. from broad-leaved weeds and *Cyperus rotundus* L. was only sedge observed in weedy cheek.

Relative density

The highest relative density 15.67% was recorded by *Cynodon dactylon* L. among grasses; 9.14% relative density for *Convolvulus arvensis* L. among the BLWs. The relative density of grasses, BLW's and sedges were given in **Figure 1**. Similar results were reported by Tripathi and Singh (2001).

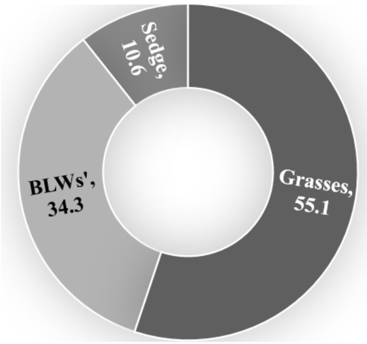

Figure 1. Relative density of weeds

Weed density

Application of pendimethalin as pre-emergence significantly reduced the density of monocot and dicot weeds at 20 DAS **(Table 1)**, while significantly the lowest density of sedges was noted under stale seedbed. Further at 40 DAS, significantly least number of monocot weeds was recorded under application of pendimethalin 30 EC 750 g/ha PE *fb* quizalofop-ethyl 5 EC 40 g/ha at 30 DAS and found statistically at par with treatments pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS, pendimethalin 30 EC 750 g/ha *fb* imazethapyr 10 SL 60 g/ha at 30 DAS and quizalofop-ethyl 5 EC 40 g/ha at 20 DAS. On account of dicots, significantly least number were recorded under application of pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS, which was at par with pendimethalin 30 EC 750 g/ha PE *fb* imazethapyr 10 SL 60 g/ha DAS. Application of pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS found to be effective against the sedges to reduce the density of sedges at lowest. Contrary to this, significantly the highest density of monocots, dicots and sedges under weedy check during both years of experimentation.

Weed dry weight

At 40 DAS **(Table 2)**, lowest weed dry weight was recorded under application of pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS. However, it was at par with pendimethalin 30 EC 750 g/ha PE *fb* imazethapyr 10 SL 60 g/ha at 30 DAS. The lowest dry weight of weeds was registered with pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS. Pre-emergence application of pendimethalin checked the germination of weed seed and controlled the weed establishment of annual broad-leaf weeds and grasses, whereas, HW at 30 DAS messed out the later emerged including sedges resulted lower dry weight of weeds. This trend was also in conformity of result repotted by Parmar *et al.* (2022).

At harvest, significantly the lowest dry weight of weeds was observed under HW at 20 and 40 DAS, followed by pendimethalin 30 EC 750 g/ha *fb* HW at 30 DAS or imazethapyr 10 SL 60 g/ha at 30 DAS. Lower dry weight of weeds in HW at 20 and 40 DAS was due to removal of first flush by hand weeding at 20 DAS and subsequent hand weeding done at 40 DAS controlled the second flush of weeds that emerged at later stages of crop growth and thus provided considerable weed free environment to the crop during the growing season. Further, significantly the highest weed dry weight was recorded with weedy check at 40 DAS and at harvest because weeds were freely allowed to grow in plot

Table 1. Weed flora observed in experimental field (mean of two years)

SN	Botanical name	English name	Local name	Family	Habitat	Density (no./m^2)	Relative (%)
[A]	Monocot weed						
1.	*Echinochloa crusgalli* L.	Sama grass	Banti	*Gramineae*	A,G,K	41	7.6
2.	*Cynodon dactylon* L.	Bermuda grass	Dharo	*Gramineae*	P,G,K	84	15.7
3.	*Digitaria sanguinalis* L.	Crabgrass	Arotaro	*Gramineae*	A,G,K	32	6.0
4.	*Commelina benghalensis* L.	Day flower	Shemul	*Commelinaceae*	A/P,H	61	11.4
5.	*Brachiaria spp*. L.	Para grass	Bharbhi	*Gramineae*	A,G,K	12	2.2
6.	*Sorghum halepense* L.	Johnson grass	Baru	*Gramineae*	P,G,K	17	3.2
7.	*Dinebra retroflexa* L.	Viper Grass	Panzer	*Gramineae*	A/P,G	48	9.0
				Total monocot weeds (A)		295	55.1
[B]	Dicot weed						
1.	*Amaranthus viridis* L.	Pigweed	Tandljo	*Amaranthaceae*	A,H,K	18	3.4
2.	*Convovulus arvensis* L.	Field bindweed	Chandan vel	*Convolvulaceae*	P,H	49	9.1
3.	*Digera arvensis* L.	Digera	Kanjaro	*Amaranthaceae*	A,H,K	32	6.0
4.	*Physalis minima* L.	Ground cherry	Popti	*Solanaceae*	A,H,K	7	1.3
5.	*Alternanthera sessilis* L.	Alligator weed	Khakhi weed	*Amaranthaceae*	A/P,H,K	15	2.8
6.	*Euphorbia hirta* L.	Garden spurge	Dudheli	*Euphorbiaceae*	A,H,K	24	4.5
7.	*Trianthema portulacastrum* L.	Carpet weed	Satodo	*Aizoaceae*	A,H,K	28	5.2
8.	*Abelmoschus esculentus* L.	White wild musk mellow	Jangli bhindi	*Malvaceae*	P,S,K,GL	8	1.5
9.	*Vernonia cinerea* L.	Little iron weed	Fulakia	*Compositeae*	A,H,K	3	0.6
				Total dicot weeds (B)		184	34.3
[C]	Sedge						
1.	*Cyperus rotundus* L.	Nut sedge	Chidho	*Cyperaceae*	P,K	57	10.6

A-annual, P-perennial, G-grass, K-kharif, S-sedges, H-herb throughout the crop growth period, ultimately population and dry weight of weeds increased progressively under this treatment with successive growth stages.

Weed control efficiency and weed index

Highest weed control efficiency (70.71%) was recorded under weed free through HW at 20 and 40 DAS, closely followed by pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS (65.9%) and pendimethalin 30 EC 750 g/ha PE *fb* imazethapyr 10 SL 60 g/ha at 30 DAS (63.3%). Two initial flushes of weeds through HW removal at 20 and 40 DAS reduced the weed growth more effectively during most of the crop growth period. Further, results indicated that application of pre-emergent pendimethalin 30 EC in addition to post-emergence imazethapyr 10 SL eventually provided weed free and congenial environment as the consequence of enhanced weed control efficiency of cowpea crop. On the other hand, inhibition of germination and growth of weeds following pre-emergence application of pendimethalin 30 EC might have reduced the weed growth through arresting different metabolic activities and thus causing mortality of weeds and HW done at 30 DAS controlled the second flush of weeds efficiently. These seem to be the most spectacular reason of accumulating lesser dry weight of weeds and consequently higher weed control efficiencies. Efficacy of different herbicidal application has been recounted by Mekonnen *et al.* (2016), Kumar and Singh (2017) and Parmar *et al.* (2022).

Weedy check treatment recorded maximum weed index as it allowed weeds to establish freely and caused 71.32% seed yield loss in cowpea followed by stale seedbed (60.09%), while pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS emerged out as best treatment with reference to weed index followed by weed free (HW at 20 and 40 DAS) and pendimethalin 30 EC 750 g/ha PE *fb* imazethapyr 10 SL 60 g/ha at 30 DAS (3.69%). The herbicide + hand weeding or sequential application of herbicides were found to be more effective in respect of reducing weed index addition with answer the labour shortage and reducing the drudgery of hand weeding. This may be attributed to better control of weeds under these treatments which provided comparatively stress-free environment to the crop. Their findings were in close proximity of that reported by Chattha *et al.* (2007).

Growth parameter and yield attributes

Significantly, the higher plant height and number of branches/plant at harvest was found under pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS treatment, being at par with weed free (HW at 20 and 40 DAS) and pendimethalin 30 EC 750 g/ha PE *fb* imazethapyr 10 SL 60 g/ha at 30 DAS. It might be due to aforesaid treatments' direct impact on reduction in density and periodical weed dry matter accumulation that caused reduction in crop–weed competition to the considerable extent. The lower values of plant height were recorded in weedy check, which might be due to severe crop-weed competition for resources, which made the plant inefficient to take up sufficient moisture and nutrients, consequently reducing the photosynthate production hence adversely affecting the crop growth (Mekonnen and Dessie 2017).

Weed-crop competition may pull down cowpea yield by suppressing one or more yield attributes. The yield attributes *viz.*, pods/plant and seeds/pod increased significantly by all weed management treatments compared to weedy check. Significantly higher number of pods/plant and number of seeds/pods were recorded with application of pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS, being at par with weed free (HW at 20 and 40 DAS) and pendimethalin 30 EC 750 g/ha PE *fb* imazethapyr 10 SL 60 g/ha at 30 DAS (**Table 4**).

Seed and stover yield

Significantly, the higher seed yield (1354 and 1380 kg/ha) and stover (2047 and 2088 kg/ha) yield were recorded with application of pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS during 2019 and 2020 respectively (**Table 4)**. It was almost equal to yield obtained under the weed free *i.e.* HW at 20 and 40 DAS (seed yield – 1335 and 1360 kg/ha; stover yield – 2026 and 2067 kg/ha) and pendimethalin 30 EC 750 g/ha PE *fb* imazethapyr 10 SL 60 g/ha at 30 DAS (seed yield – 1305 and 1328 kg/ha; stover yield – 1969 and 2006 kg/ha) during 2019 and 2020, respectively. On the basis of pooled data, the magnitude of increase in seed yields was 3.49, 3.45 and 3.36 and stover yield was 253, 2.50 and 2.44 times more in pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS, 2 HW at 20 and 40 DAS and pendimethalin 30 EC 750 g/ha PE *fb* imazethapyr 10 SL 60 g/ha at 30 DAS, respectively over the weedy check.

The higher yield achieved under application of pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS might be due to application of pre-emergence herbicide and removal of weeds by hand weeding as evidenced by less number **(Table 2)** and dry weight of weeds **(Table 3)**, which resulted in less competition with plant nutrients and water, which increased the growth rate and biomass production which in turn increased the rate and supply of photosynthates to various metabolic sinks which have favoured yield. Moreover, pendimethalin herbicide found superior, because it persists in soil much longer time as half-life is greater than 42 days, even under extreme weather conditions, thus enabling longer protection for crop from weed competition, that reflected in growth and yield of cowpea. Improved yield under the weed free (HW at 20 and 40 DAS) and pendimethalin 30 EC 750 g/ha PE *fb* imazethapyr 10 SL 60 g/ha at 30 DAS was due to better control of weeds from the initial stage by periodical removal of weeds either by hand weeding or combined application of pre and/or post-emergence herbicide as evident by reduced crop-weed competition under these treatments saved a huge amount of nutrients for crop, which led to profuse growth enabled the crop to utilize more soil moisture and nutrients from deeper soil layers. These favourable effects in rhizosphere were apparent more in herbicides + HW, HW twice and pre- and post-emergence herbicides combination than application of herbicides alone because it improved the tilth by making soil more vulnerable for the plants to utilize water and air. In the presence of weeds, though the vegetative growth of the crop attained a level, but sink was not sufficient enough to accumulate the meaningful food assimilates translocation towards seed formation. Besides, the most severe crop-weed

Table 2. Weed density as influenced by weed management in cowpea (mean of two years)

Treatment	Dose	Weed density at 20 DAS (no./m^2)						Weed density at 40 DAS (no./m^2)					
	(g/ha)	Monocot		Dicot		Sedge		Monocot		Dicot		Sedge	
Weedy check (control)	-	6.23	(38.0)	4.73	(21.5)	3.60	(12.0)	6.72	(44.2)	5.36	(27.7)	4.08	(15.7)
Weed free	-	6.11	(37.0)	4.67	(21.0)	3.11	(8.8)	3.93	(14.5)	3.27	(9.8)	3.04	(8.25)
Pendimethalin	750	2.78	(6.8)	2.16	(3.8)	3.43	(10.7)	3.93	(14.5)	3.57	(11.7)	3.87	(14.0)
Imazethapyr	60	6.02	(36.0)	4.71	(21.2)	3.34	(10.2)	2.98	(8.0)	3.45	(11.0)	3.77	(13.2)
Quizalofop-ethyl	40	5.79	(33.0)	4.67	(21.0)	3.42	(10.7)	2.15	(3.8)	5.15	(25.7)	3.74	(13.0)
Pendimethalin *fb* HW	750	2.68	(6.3)	2.06	(3.3)	3.20	(9.3)	1.93	(2.8)	2.45	(5.0)	2.33	(4.5)
Pendimethalin *fb* imazethapyr	750, 60	2.72	(6.5)	2.33	(4.5)	3.16	(9.0)	1.99	(3.0)	2.49	(5.3)	3.73	(13.0)
Pendimethalin *fb* quizalofop-ethyl	750, 40	2.77	(6.8)	2.11	(3.5)	3.31	(10.0)	1.87	(2.5)	3.42	(10.8)	3.84	(13.7)
Stale seed bed (glyphosate)	1000	2.63	(6.0)	2.59	(5.8)	2.24	(4.3)	5.06	(24.7)	4.71	(21.2)	3.80	(13.5)
LSD (p=0.05)		0.87		0.49		0.42		0.42		0.46		0.37	

Data in parentheses indicates actual value and outside parenthesis indicates ($\sqrt{x+1}$) transformed value

Table 3. Dry weight of weeds at 40 DAS and at harvest as influenced by weed management (mean of two years)

Treatment	Dose (g/ha)	Dry weight of weeds		WCE (%)	WI (%)
		At 40 DAS (g/m^2)	At harvest (kg/ha)		
Weedy check (control)	--	122.54	851.7	--	71.32
Weed free	--	38.52	249.4	70.7	1.45
Pendimethalin	750	54.40	413.0	51.5	48.60
Imazethapyr	60	44.69	409.5	51.9	42.04
Quizalofop-ethyl	40	72.78	627.3	26.3	50.70
Pendimethalin *fb* HW	750	19.85	290.4	65.9	--
Pendimethalin *fb* imazethapyr	750, 60	33.84	312.7	63.3	3.69
Pendimethalin *fb* quizalofop-ethyl	750, 40	39.14	355.7	58.2	31.89
Stale seed bed (glyphosate)	1000	112.67	690.9	18.9	60.09
LSD (p=0.05)		9.69	61.8	--	--

WCE= Weed control efficiency and WI= Weed Index

Table 4. Growth and yield of cowpea as influenced by weed management (mean of two years)

Treatment	Dose	Plant height	Branches / plant	Pods/ plant	Seeds /pod	Yield (kg/ha)						Net return	B: C ratio
						Seed			Stover				
	(g/ha)	(cm)	(No.)	(No.)	(No.)	2019	2020	Pooled	2019	2020	Pooled	(₹/ha)	
Weedy check (control)	--	58.75	13.30	6.65	7.40	404	380	392	829	802	816	8128	0.46
Weed free	--	71.75	19.00	11.25	10.95	1335	1360	1347	2026	2067	2046	62710	2.59
Pendimethalin	750	64.25	15.50	9.25	8.50	715	690	702	1602	1619	1610	27729	1.44
Imazethapyr	60	65.85	16.45	9.55	9.00	801	783	792	1711	1734	1722	33710	1.78
Quizalofop-ethyl	40	63.70	14.75	9.20	8.35	667	681	674	1484	1494	1489	25631	1.33
Pendimethalin *fb* HW	750	74.50	19.50	11.70	11.20	1354	1380	1367	2047	2088	2068	65799	2.93
Pendimethalin *fb* imazethapyr	750, 60	74.00	18.25	11.00	10.50	1305	1328	1317	1969	2006	1988	64627	3.17
Pendimethalin *fb* quizalofop-ethyl	750, 40	64.70	16.50	10.55	9.30	934	928	931	1767	1793	1780	40543	1.96
Stale seed bed (glyphosate)	1000	62.00	14.45	7.75	8.15	548	543	545	1121	1110	1115	17009	0.89
LSD (p=0.05)		8.01	2.56	1.27	1.41	137	150	99	238	251	167	--	--

competition throughout the season due to unrestricted weed growth under weedy check plots encouraged the depletion of nutrients and moisture by weeds, thus adversely affecting the crop growth. It might have also declined the translocation of photosynthates towards seed formation affecting yield attributes adversely, which reduced the yield to the lowest level. Higher crop weed competition due to poor growth and less uptake of nutrients in the weedy check was in close conformity with those reported by Chattha *et al.* (2007) and Oluwafemi and Abiodun (2016).

Economics

Amongst the treatments, pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS secured maximum net realization of ₹ 65799/ha with B: C ratio of 2.93 for cowpea crop followed by weed free treatment using HW at 20 and 40 DAS ₹ 62710 /ha and 2.59 and pendimethalin 30 EC 750 g/ha PE *fb* imazethapyr 10 SL 60 g/ha ₹ 64627 /ha and 3.17, respectively. The lowest seed and stover yields achieved under weedy check treatment was eventually reflected in the lowest net returns (₹ 8128/ha) and B: C ratio (0.46). The results were in conformity with the findings of Gupta *et al.* (2017).

Conclusion

It was inferred that application of pendimethalin 30 EC 750 g/ha (PE) *fb* HW at 30 DAS effectively managed the weeds, therefore recommended for securing higher and profitable yield of cowpea. Moreover, considering the labour scarcity and high wages, sequential application of pendimethalin 30 EC 750 g/ha (PE) *fb* imazethapyr 10 SL 60 g/ha at 30 DAS was proved more economical weed management.

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