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Effect of herbicides on weed control efficiency and Yield Response of *Kharif* Cowpea (*Vigna unguiculata* L.) in sandy loam soils of Punjab

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ABSTRACT

A field experiment using a randomized block design, eight weed management treatments, and three replications was carried out in the *kharif* of 2022 at the Division of Agriculture, Lovely Professional University, Phagwara, Punjab, India. To determine the economics and effectiveness of weed control measures for managing weeds in cowpea [*Vigna unguiculata* (L.). The weed control techniques had a big impact on the weed restrictions.With pre-emergence application (PE) of pendimethalin 0.70 kg/ha combined with hand weeding, the weed density and biomass and greater weed control efficiency were consistently inferior at different stages of crop growth. This confirmed that pre-emergence herbicide application could effectively regulate the weeds emerging early in the season, and the actual controlling of weeds by it led to higher yield and B: C ratio.

***Key words**: Weeds, Weed control efficiency, Seed yield, weed Biomass, Economics.*

Introduction

The cowpea, or (*Vigna unguiculata* L.), is cultivated all over the world as a cover crop, fodder, and vegetable (for leafy greens, green pods, fresh shelled green peas, and shelled dried peas). It's commonly referred to as lobia, it is one of the essential *Kharif* pulses planted in India for grain, fodder, and green manure applications. Because it has a high amount of protein (19–26%; average: 22.5%), carbs (63.3%), minerals, and vitamins, cowpea is also known as plant meat Andargie (2011). Cowpea can contribute significantly to the feed for cattle and can also provide to the soil with readily available nitrogen.The majority of the world's arid and semi-arid ecologies are native to this dual-purpose, appealing crop. Small plots of cowpea are planted all throughout the nation as food and fodder. It is a crop with strong roots and good drought tolerance. Cowpea is now a multi-purpose crop that may be cultivated in diverse agro-ecological zones of the world as a single crop, intercrop, catch crop, relay crop, shield grain, green manure crops, etc. in sequential or monocropping. Weeding causes the crop to suffer greatly during the *Kharif* season, which leads to a significant drop in agricultural production. The development of weeds after this time produced a considerable drop in yields, according to Hanumanthappa *et al.* (2012). The critical period of weed competition in cowpea was thought to be 20–30 days following sowing therefore, it is important to plan for weed management while crops are in their active growing phase. Although hand weeding is a tried-and-true and successful method of weed control, it is very expensive and labor-intensive. This research was designed to find a viable and economical weed management technique to prevent weeds throughout the crucial crop competition time.

Climatic Conditions during the Cropping Season

One of India's coldest states, Punjab experiences daily highs of 30 degrees Celsius. Some periods of the calendar year are warm to extremely hot, with average highs of above 25 °C and sporadic highs of over 39 °C. Comparing the four herbicides to the manual weeding and weedy check treatments allowed researchers to measure the effectiveness and cost-effectiveness of the herbicides in the cowpea plant (s). One pre-emergence herbicide, i.e., Pendimethalin; three post-emergence herbicides, namely Pendimethalin, Imazethapyr, *fb* Quizalofop-ethyl, Metolachlor, and Quizalofop-ethyl) was evaluated, where "unwedded" treatments were considered as check. Therefore, treatments were: T_1 = Pendimethalin PE (1.0 kg ha^{-1}), T_2 = Pendimethalin PE (700 g ha^{-1}) + 1 hand weeding, T_3 = Imazethapyr (50 g ha^{-1}), T_4 = Quizalofop-ethyl (30 g ha^{-1}), T_5 = Metolachlor (1.0 kg ha^{-1}), T_6 = Quizalofop-ethyl (70 g ha^{-1}), T_7 = Hand weeding (manual weeded twice at 15 & 30 DAS) and T_8 = Weedy check. A comparable experimental field was used for the *Kharif* Cowpea experiment, which was set up using an RBD design with three replications right after the spring corn harvest.

Result of herbicides on Weeds

The ontogeny and morphology of the weed flora found in the experimental plots were used to identify and categories them. Five weed species were found in Cowpea in *kharif* 2022, of these two were grasses (*Commelina benghalensis* (L.), (*Cynodon dactylon* (L.) Pers) one was sedge (*Cyperus rotundus* (L.) and two were broadleaf weeds. (*Boerhaviaerecta* (L.) and *Parthenium hysterophorus I* (L.)) Yadav *et al* (2010).

Not with standing delaying weed emergence as seen by the weed density at 20 DAS, pendimethalin PE alone effectively controls weeds at later phases of crop growth. When pendimethalin and manual weeding were used together, there was a considerable decrease in weed density. Lower weed density and biomass have been observed as a result of hand weeding, other intercultural operations, and pre-

Table 1. Weed density and dried mass in cowpea at consecutive crop growing phases

Treatments	Weed density (no. m^2)			Weed biomass (g, m^2)		
	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
Pendimethalin (1.0 kg ha^{-1}) PE	*3.10(9.61)	3.50(12.32)	3.62(13.12)	0.54(0.302)	0.52(0.272)	0.77(0.607)
Pendimethalin (700 g ha^{-1})PE + 1 HW	2.84(8.11)	2.86(8.18)	2.86(8.21)	0.52(0.271)	0.56(0.315)	0.70(0.50)
Imazethapyr (50 g ha^{-1}) PoE	6.00(36.12)	5.05(25.57)	4.95(24.53)	1.05(1.11)	0.72(0.519)	0.84(0.715)
Quizalofop-ethyl (30 g ha^{-1}) PoE	5.74(33.01)	5.15(26.55)	5.07(25.75)	1.00(1.00)	0.68(0.469)	0.79(0.625)
Metolachlor (400 g ha^{-1}) PoE	4.68(23.69)	3.67(13.49)	3.44(11.88)	0.97(0.946)	0.62(0.390)	0.73(0.535)
Quizalofop-ethyl (70 g ha^{-1}) PoE	5.53(30.68)	2.97(8.83)	2.50(6.26)	0.96(0.950)	0.64(0.416)	0.64(0.429)
HW (15 & 30 DAS)	3.12(9.75)	2.92(8.54)	2.93(8.64)	0.57(0.329)	0.61(0.376)	0.78(0.624)
Weedy check	5.89(40.71)	7.57(57.38)	7.79(60.64)	1.34(1.81)	0.46(2.15)	1.82(3.32)
SEM (±)	0.08	0.11	0.14	0.05	0.05	0.08
CD (p = 0.05)	0.24	**0.32**	**0.42**	**0.16**	**0.14**	**0.24**

PoE: Post-emergence, PE: Pre-emergence; DAS: Days after sowing, HW: Hand weeding. All values are square root transformed ($\sqrt{x+0.5}$).

and post-emergent herbicide applications combined with different crop durations. This can also be attributed to the better resource utilization by cowpea as a consequence of efficient weed management by those treatments by (Kumar, 2008).

The type of weed seeds present, the weed seed bank, tillage, and other factors all affect weed density. Due to the varied timing of application of the various weed management strategies, either alone or in combination, variation in weed density at different times of the year was noted. The weedy check revealed a consistent rise in weed density, which may be attributable to the crop's ability to efficiently absorb water and nutrients.

At 20 DAS, weed density and biomass was lowest where pendimethalin 700 g/ha PE + 1 Hand weeding equivalent to pendimethalin 1.0 kg ha^{-1} PE colleagues reported making comparable findings by Yadav *et al.* (2017). At 40 DAS, suggestively lowermost value for weed thickness and biomass was documented with pendimethalin 700 g/ha PE + 1 Hand weeding tracked by hand weeding twice at 20 and 40 DAS (Table 1). Hand weeding scraped the soil's surface to control late emergent blushes while pendimethalincontrolling the early flushes of weeds for a longer period of time. As a result, the weed density was reduced. At 60 DAS, quizalofop-ethyl 70 g ha^{-1}PoE documented lowermost weed density and biomass and was on par with that of pendimethalin 1.0 kg/ha PE *fb* metolachlor 400 g ha^{-1}PoE. Which shown that weeds appearing early in the season could be successfully managed by pre-emergence herbicide application, and weeds emerging later in the season could be successfully managed by post-emergence herbicides, which was comparable to two manual weeding done 20 and 40 DAS.

At 20 DAS, the WCE recorded with pendimethalin 700 g ha^{-1} PE+ 1 HW; pendimethalin 1.0 kg ha^{-1} PE were on equivalence with handed weeding twice at 15 and 30 DAS. At 40 DAS, pendimethalin 0.700 kg/ha PE + hand weeding has documented significantly highest WCE among all the treatments excepting weedy check. At 60 DAS, WCE was significantly higher in quizalofop-ethyl 70 g ha^{-1}PoE at par with hand weeding twice at 15 and 30 DAS which was on par with weed-free and better than all other treatments except for pendimethalin 700 g ha^{-1} PE+ 1 HW followed by metolachlor 400 g ha^{-1} PoE. At 60 DAS quizalofop-ethyl 70 g ha^{-1} PoErecorded highest assessment for WCE which was greater to all other treatments except weedy check. Similar opinion made by Mathew *et al.* (1995) and Singh and Sekhon (2013).

The weed index standards (**Table 2**) were significantly lowermost with pendimethalin 1.0 kg ha^{-1} PE *fb* metolachlor 400 g ha^{-1} hand weeding at 15 and 30 DAS excluding that with quizalofop-ethyl 30 g ha^{-1}. Low WI may be caused by the impact of weed biomass and seed output (Kumar, 2008; Idapuganti *et al.*, 2005).

Effect on crop and yield

The different herbicide combinations were successful in stopping weed growth for about 40 days, which significantly increased pod yield. Weedy check, which recorded the lowest value for pod yield, would have otherwise resulted in about 80% yield loss. By analyzing the impact of weed biomass and density on cowpea production, it can be con-

Table 2. Weed control efficiency, seed yield and weed index as predisposed by the altered weed controller treatments in cowpea

Treatments	Weed control Efficiency (%)			Seed yield (kg/ha)	Weed index	B:C Ratio
	20 DAS	40 DAS	60 DAS			
Pendimethalin (1.0 kg ha^{-1})	83.33	85.95	81.71	7.58	10.23	1.82
Pendimethalin (700 g ha^{-1}) + 1 HW	85.02	87.39	83.43	7.81	00.00	2.02
Imazethapyr (50 g ha^{-1}) PoE	38.67	75.86	78.46	6.55	41.44	1.60
Quizalofop-ethyl (30 g ha^{-1}) PoE	44.75	78.18	80.57	6.91	30.87	1.72
Metolachlor (400 g ha^{-1}) PoE	47.77	81.86	83.38	7.35	16.61	1.72
Quizalofop-ethyl (70 g ha^{-1}) PoE	26.25	80.65	87.98	6.81	37.08	1.66
HW (15 & 30 DAS)	75.62	82.51	81.20	7.22	26.51	1.53
Weedy check	-	-	-	3.84	46.30	0.63
SEM (±)	-	-	-	12.21	0.59	-
CD (p = 0.05)	-	-	-	35.68	1.78	-

PE: Pre-emergence; HW: Hand weeding, DAS: Days after sowing, PoE: Post-emergence.

cluded that decreased weed biomass and density might effectively lessen the rivalry for resources between the crop and weed, which has led to an increase in cowpea output. Highest seed yield was documented in pendimethalin 700 g ha^{-1} PE+ 1 HW (Table 2) with pendimethalin 700 g ha^{-1} PE+ hand weeding creating an environment that is conducive to crop growth, HW decreased weed growth and competition with crops from sowing to harvesting, increasing cowpea production. Effective weed control methods boost crop plant growth and development by enhancing photosynthetic activity and reducing crop weed competition, which increases cowpea seed output. (Freitas *et al.*, 2009; Mekonnen *et al.*, 2017).

Economics

Highest gross revenues and net returns were achieved with pendimethalin700 g ha^{-1} PE+ 1 hand weeding, pendimethalin 1.0 kg ha^{-1} PE (Table 2). Highest value for B: C ratio was recorded with pendimethalin 700 g ha^{-1} PE+ 1 hand weeding was on par with pendimethalin 1.0 kg ha^{-1} PE because Sasikala (2004) all observations .'s of higher gross income with lower cultivation costs are true. Instead of using a single method, the integration of weed management techniques has resulted in effective weed control according to (Yadav *et al.*, 2017).

The best and most cost-effective way of weed management in cowpea is the application of herbicides combined with hand weeding, followed by hand weeding at the most crucial stage and maintenance of weed free condition. Better weed management has been achieved at the crucial time of crop weed competition as a consequence of the integration of several weed control techniques that control weeds both in the early stages and the new weed flushes in the later stages. In the crucial phase of crop weed competition, pendimethalin PE and hand weeding could effectively keep the field weed-free, and this was reflected in the yield and yield characteristics. As a result, these tried-and-true integrated weed control techniques can be suggested for cowpea to increase yield and profit.

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