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# Weed diversity and yield of cowpea as influenced by weed management practices

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**Abstract**
A field experiment was carried out during the summer season of 2019 on vertisol soil at Navsari Agricultural University, Navsari to study the integrated efficacy of various herbicides applied as pre and post-emergence in cowpea (*Vigna unguiculata* L.). Among the different weed management practices, application of Pendimethalin 750 g/ha (PE) *fb* HW at 30 DAS found superior while weed free (2 HW at 20 and 40 DAS) and Pendimethalin 750 g/ha (PE) *fb* Imazethapyr 60 g/ha at 30 DAS remained at par and significantly reduced the density and dry weight of weeds. Hence, it resulted in significantly higher seed yield of cowpea. On the basis of results obtained, Pendimethalin 750 g/ha (PE) *fb* HW at 30 DAS found appropriate. Moreover, in view of the increasing wages and crisis of labour at critical periods, application of Pendimethalin 750 g/ha (PE) *fb* Imazethapyr 60 g/ha at 30 DAS can be proved equally effective and remunerative weed management option for cowpea.

**Keywords:** Cowpea, weed dry weight, herbicides, weed management

## Introduction
Pulses constitute an important dietary ingredient of the oriental food due to their high protein content. The importance of pulses is much more in a country like India, where majority of the people are vegetarian. Pulses contribute 16-18 percent of total protein of Indian average diet. Besides, they play an important role in agriculture by using atmospheric nitrogen through biological nitrogen fixation, which is viable and environmentally acceptable. They occupy an important position in multiple cropping patterns. However, the pulses production in the country is quite low and has not been to keep pace with the increasing population. Stagnant production together with increase in population has led sharp decline in per capita availability of pulses from 71.0 g (1995) to 34.4 g/day as against the minimum requirement of 70 g per capita per day. Therefore, increase pulse production continues to remain a thrust area.
Cowpea (*Vigna unguiculata*) is one of the important legumes which grown extensively under tropical and sub-tropical areas of the world. The real yield limiting factor in cowpea is inadequate source and sinks, limiting quality seed production (Kumar and Sarlach, 2014) [9]. Besides these inadequate weed control had also been identified as a major contributory factor for yield gap. Cowpea competes poorly with weeds in the growing stage. This is made under irrigation where adequate moisture supply encourages the rapid growth of weeds. Yield losses caused by weeds alone in cowpea production can range from 25 to 76% depending on the cultivar and environment (Gupta *et al.*, 2016) [4]. Weeds may mechanically be managed by two hand weeding at 20 & 40 DAS. But manual hand weeding is labour intensive and tedious and does not ensure weed removal at critical stage of crop-weed competition. Even non-availability and high wages of labour during critical period warrant an effective and economical weed control practice. Nevertheless, chemical herbicides become cost-effective. Thus, it is a major challenge to maximize productivity of this important pulse crop. Under this situation, an integrated weed management (IWM) practice involving both chemical and other agronomic manipulation may be an efficient tool, as increasing crop density seems to be an alternative to shift crop weed competition in favor of crop. Hence, evolving a proper management strategy was felt to avert such yield loss due to weeds in cowpea.

## Materials and Methods
The present experiment was conducted at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during summer 2019. 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 trial was laid out in a randomized block design with nine treatments with four replication. Nine treatments comprised *viz*., Weedy check ($W_1$), Weed free (2 HW at 20 and 40 DAS: $W_2$), Pendimethalin 750 g/ha PE ( $W_3$), Imazethapyr 60 g/ha at 20 DAS ($W_4$), Quizalofop ethyl 40 g/ha at 20 DAS ($W_5$), Pendimethalin 750 g/ha (PE) *fb* 1HW at 30 DAS ($W_6$), Pendimethalin 750 g/ha (PE) *fb* Imazethapyr 60 g/ha at 30 DAS ($W_7$), Pendimethalin 750 g/ha (PE) *fb* Quizalofop ethyl 40 g/ha at 30 DAS ($W_8$) and Stale seed bed (destroy one flush of weeds)($W_9$). The herbicides were applied using knapsack sprayer fitted with flat fan nozzle by mixing in 500 litres of water/ha as per treatments. The 'GC-5' cowpea was sown manually keeping the row distance of 45cm with the seed rate of 25 kg/ha during second week of March. Entire quantity of nitrogen (20 kg/ha) and phosphorus (40 kg/ha) in the form of urea and single super phosphate, respectively were applied as basal. Weed population was recorded using 0.25 quadrate and then converted into number of weeds/$m^2$. Two representative spots in each plot were selected randomly. The monocot, dicot and sedges weeds were separately counted at 20 and 40 DAS as well as at maturity of cowpea. The data were subjected to square root transformation (x+0.5) to normalize their distribution (Gomez and Gomez 1984). After uprooting of weeds, the weeds were sun-dried completely till reached to constant weight and finally the dry weight was recorded for each treatment and expressed as g/$m^2$. Weed control efficiency and weed index were calculated by the formulae suggested by Kondap and Upadhya (1985) [8].

## Results and Discussion

### Weed flora

Weedy check plot heavily invaded by *Digitaria sanguinalis* L., *Cynodon dactylon* L., *Convolvulus arvensis* L. and *Cyperus rotundus* L. The highest relative density 15.67 per cent was recorded by *Cynodon dactylon* L. among monocot weeds; while, among the dicot weeds, 9.14 per cent relative density was recorded for *Convolvulus arvensis* L. The relative density of monocot, dicot and sedges were 55.1, 34.3 and 10.6, respectively.

### Effect on weed

Amidst all the weed management treatments, Pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS (W6) registered significantly the lowest number of total weeds (12.3/$m^2$). Moreover, weedy check (W1) recorded significantly the highest count of total weeds (71.5 and 87.6/$m^2$, respectively) at 20 and 40 DAS. Different weed control treatments significantly influenced the density of different weed species (monocot, dicot, sedges and total weed population) at 40 days after sowing. Among weed management treatments, pre emergence application of Pendimethalin 30 EC 750 g/ha (PE) *fb* Imazethapyr 10 SL 60 g/ha at 30 DAS or HW at 30 DAS reduced the total population of weeds, while, Quizalofop-ethyl only effective against monocot, its effectiveness was not reflecting in total weed population. Moreover, in treatment weed free (2 HW at 20 and 40 DAS), second hand weeding was operated at 40 DAS, hence it was not contributed in reduction of total weeds at 40 DAS. The results are reinforced with the studies of Mekonnen *et al.* (2017) [11] and Gupta *et al.* (2016) [4]. Among the different treatments, Pendimethalin 750 g/ha PE *fb* HW at 30 DAS, weed free (HW at 20 and 40 DAS) and Pendimethalin 750 g/ha PE *fb* Imazethapyr 60 g/ha at 30 DAS recorded significantly lower dry weight of monocot, dicot and total weeds with higher weed control efficiency at harvest (Table 1). Such positive and significant effect of the herbicides on decline of dry matter yield is in accordance with those testified earlier by Sah *et al.* (2015) [14] and Hanumanthappa *et al*. (2012) [6]. In line with the current research result, Ahmad *et al.* (1996) [1] reported that pre-emergence application of Pendimethalin at 1.25 and 1.50 kg/ha + hand weeding were equally and even much more effective in reducing dry weight of weeds than other treatments. The better weed suppression due to herbicide mixtures may be due to effective suppression of both types of weeds. Also, the low weed density observed in herbicides treated plots could be attributed to effective weed control of the herbicides and their ability to manage weeds beyond the critical period of cowpea growth. Also, the adequate weed cover by cowpea vine led to smothering effect of the weeds judging from the low weed population and low weed dry weight, which invariably led to increase in weed smothering efficiency. They also found lower weed dry matter and higher weed control efficiency with herbicides + hand weeding than other treatments included in their experiment. Sharma *et al.* (1998) [15] also concluded that dry weight of weeds was significantly reduced in herbicide-treated plots of common bean. In common pigeon pea, effective weed control has been reported with integrated use of Pendimethalin and hand weeding (Tomar *et al.*, 2004) [18] However, lower performance of intra-group herbicides might be due to lower doses than their recommended doses, which needs to be investigated at recommended doses of individual herbicides in mixture (Yadav *et al.*, 2010) [19].

### Weed indices

Different weed management treatments exerted their remarkable effect on weed control efficiency and weed index (Table 1). Amongst various weed management treatments, highest weed control efficiency was recorded under weed free (2 HW at 20 and 40 DAS: W2), closely followed by Pendimethalin 30 EC 750 g/ha PE *fb* Imazethapyr 10 SL 60 g/ha at 30 DAS (W7) and Pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS (W6). This variation in weed control efficiency is directly associated with the amount of weed dry matter accumulated under different treatments. Efficacy of different herbicidal application has been recounted by Mekonnen *et al.* (2016) [12] and Kumar and Singh (2017) [10]. The current finding is in agreement with the investigation of Shinde *et al.* (2003) [16] who reported that integration of Pendimethalin with hand weeding 40 days after sowing is known to provide high weed control efficiency in pigeon pea. Priya *et al.* (2009) [13] also found the lowest weed dry matter and higher weed control efficiency with herbicides + hand weeding in soybean. A similar trend was also reported by Jafari *et al.* (2013) [7] in common bean, where pre-emergence herbicides application gave high weed control efficiency by reducing the weed density and dry weight significantly as compared to the weedy check. Sylvestre *et al.* (2013) [17] also reported that unweeded check showed lower weed control efficiency than the rest of pre-emergence herbicide treatments in soybean. A similar trend was also reported by Jafari *et al.* (2013) [7] in common bean, where pre-emergence herbicides gave high weed control efficiency by reducing the weed density and dry weight significantly as compared to weedy check. Weedy check resulted in maximum weed index (70.1%), followed by stale seed bed (W9: 59.5%), while

Pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS (W6) emerged out as best treatment with reference to weed index followed by weed free (2 HW at 20 and 40 DAS: W2-1.4) and Pendimethalin 30 EC 750 g/ha PE *fb* Imazethapyr 10 SL 60 g/ha at 30 DAS (W7-3.6). The followed two weed control treatments 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. Their findings are in close proximity of that reported by Chattha *et al*. (2007) [2].

**Table 1:** Weed population, dry weight of weeds and weed indices as influenced by weed management

| Treatments | Weed population at 20 DAS | | Weed population at 40 DAS | | Dry weight of weeds | | WCE (%) | WI (%) |
|---|---|---|---|---|---|---|---|---|
| | | | | | At 40 DAS (g/m$^2$) | At harvest (kg/ha) | | |
| Weedy check (control) | 8.51 | (71.5) | 9.42 | (87.6) | 122.0 | 813 | -- | 70.1 |
| Weed free (2 HW at 20 and 40 DAS) | 8.19 | (66.8) | 5.78 | (32.5) | 42.4 | 251 | 69.07 | 1.4 |
| Pendimethalin 750 g/ha (PE) | 4.72 | (21.3) | 6.42 | (40.2) | 57.1 | 412 | 49.30 | 47.2 |
| Imazethapyr 60 g/ha at 20 DAS | 8.27 | (67.4) | 5.76 | (32.2) | 48.1 | 409 | 49.72 | 40.8 |
| Quizalofop ethyl 40 g/ha at 20 DAS | 8.08 | (64.7) | 6.59 | (42.5) | 74.2 | 623 | 23.38 | 50.7 |
| Pendimethalin 750 g/ha (PE) *fb* HW at 30 DAS | 4.44 | (18.9) | 3.63 | (12.3) | 19.4 | 308 | 62.08 | -- |
| Pendimethalin 750 g/ha (PE) *fb* Imazethapyr 60 g/ha at 30 DAS | 4.58 | (20.0) | 4.72 | (21.3) | 32.4 | 286 | 64.78 | 3.6 |
| Pendimethalin 750 g/ha (PE) *fb* Quizalofop ethyl 40 g/ha at 30 DAS | 4.60 | (20.3) | 5.29 | (27.0) | 40.6 | 354 | 56.50 | 31.0 |
| Stale seed bed (Destroy one flush of weeds) | 4.09 | (16.1) | 7.77 | (59.4) | 113.7 | 663 | 18.39 | 59.5 |
| CD (p=0.05) | 0.79 | | 0.43 | | 13.0 | 81.9 | -- | -- |

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

**Economics**

Amongst the treatments, Pendimethalin 30 EC 750 g/ha PE *fb* HW at 30 DAS (W6) secured maximum net realization of ₹ 64956 /ha with B:C ratio of 2.90 in cowpea crop. However, it was followed by weed free (HW at 20 and 40 DAS: W2) (₹ 61930 /ha and 2.55) and Pendimethalin 30 EC 750 g/ha PE *fb* Imazethapyr 10 SL 60 g/ha (W7: ₹ 63850 /ha and 3.14). The higher B:C ratio achieved under superior treatments seems to be due to higher seed and stover yields and higher returns per rupee investment than poor yielding treatments. The lowest seed and stover yields achieved under weedy check treatment was eventually reflected in the lowest net returns (₹ 8887/ha) and B:C ratio (0.50). The results are reinforced with the studies of Gupta *et al.* (2017) [5].

**Summary and Conclusion**

Based on experiment, it is concluded that application of Pendimethalin 30 EC 750 g/ha (PE) *fb* HW at 30 DAS found effective for controlling the weeds and secure higher and profitable yield of cowpea under agro climatic condition of South Gujarat. In view of the increasing wages and crisis of labour at critical periods, integration of pre and post emerged herbicides is best option to manage the weeds in cowpea with profitable seed yield. Hence, Pendimethalin 30 EC 750 g/ha (PE) *fb* Imazethapyr 10 SL 60 g/ha at 30 DAS can be proved equally effective and remunerative weed management option for cowpea.

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