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Influence of Weed Management Practices on Growth Parameters and Economics of Cowpea [Vigna unguiculata (L.) Wasp.]

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Authors' contributions

This work was carried out in collaboration between both authors. Author PK designed the study, wrote the protocol and wrote the first draft of the manuscript. Author RS performed the statistical analysis, collect the review of literature, bring the manuscript in final mode by correct and update it. Both authors read and approved the final manuscript.

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ABSTRACT

A field trial was carried out in the *Kharif* seasons 2007 at Junagadh Agriculture University (JAU), Junagadh, Gujarat to evaluate the impact of integrated approach of weed management on rain fed cowpea. It was found that selection of appropriate herbicides and its application in combination with cultural practices at critical period of weed growth was key factor to get elevated yield in rain fed cowpea. Till date most accepted practices among cowpea growers is single application of herbicides or go for cultural practices one hand weeding (HW) + one inter cultural (IC) at 20-25 days after sowing (DAS). This was not found sufficient to manage weeds and negatively distress the growth parameters and ultimately resulted in loss of one fourth crop yield compared to that weed free treatment. Application of (pendimethalin + 1 HW + 1 IC), (imazethapyr + 1 HW + 1 IC)

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and (quizalofop-ethyl + 1 HW + 1 IC) very effective in weed control and had positive impact on plant height, plant spread, number of branch per plant, number of pods per plant and number of seeds per pods. These treatments were as good as weed free plot. These integrated weed management treatments gave broad spectrum weed control and higher gross, net return and B:C ratio. By adopting appropriate weed management practices farmer can get 3000 to 4000 net increase in return over the other treatment. So integrated weed management is better option and cowpea grower combine cultural practices with suitable pre and post herbicides like as pendimethalin, quizalofop-ethyl and imazethapyr to get similar return as weed free plot.

Keywords: Weed management; growth parameter; economics; cowpea.

1. INTRODUCTION

Pulses are part of a healthy, balanced diet and also important to maintain soil health by fixing nitrogen biologically. India has key position in global pulses production and contributes about 25% of the total global pulse production. According to the third advance estimates (ministry of agriculture and farmers welfare, government of India) pulses production in the country in the year 2016-17 will be 22.4 million tones, this is 35% higher than previous year (2015-16).

Cowpea [*Vigna unguiculata* (L.) is one of the key food legume crop in the arid and semiarid part of the world including Asia, Africa, Southern Europe, and Central and South America. A drought-tolerant in nature and warm-weather suited crop, cowpeas are well-adapted to the drier regions of the tropics, where other food legumes do not perform well. It also has the ability to fix atmospheric nitrogen through its root nodules, and it grows well in nutrient deficient soil with more than 85% sand and with less than 0.2% organic matter and low levels of phosphorus. [1,2]. Also, it is shade tolerant in character and, therefore, well-suited as an intercrop with cereal crops like as sorghum, millet and maize. It is also acknowledged as Crowpea, black-eyed pea or southern pea etc. and has multiple uses like food, feed, forage, fodder green manuring and vegetable. Cowpea seed is a nourishing component in the human diet, and low-priced livestock feed as well. The tender green leaves are also used by small and marginal farmer in the rural areas for vegetable purpose. It also leave 30-40 Kg N ha in the soil for the succeeding crop all of these character make cowpea potential crops for cowpea growers under rainfed condition. Despite several advantages cowpeas have very low productivity 500 kg ha⁻¹ at world level grown on an area of 10.89 million ha with 5.45 million tones total production in 2011 [3]. A survey of 316 cowpea grower conducted in western Rajasthan revealed that among different production

constraint weed control through herbicides is technically complex phenomenon (89.25%, I rank) followed by lack of knowledge about inoculation of seed through culture (85.12%, II rank), sandy storm, high wind velocity and high temperature affect the growth of crop and productivity (83.23%, III rank) and lack of knowledge about seed treatment (81.02%, IV rank), respectively [4].

Different researchers reported that critical period of weed competition in cowpea vary from 10-45 DAS [5,6,7] but it can be extended up to harvest in rainy season [8]. During rainy season the crop suffers severely due to weed infestation resulting into heavy loss in crop yield. Therefore, weed control measure desired to be undertaken during early stage of crop growth. Till date cowpea farmer mainly depended on hand weeding for weed control, but day by day shortage of family labour arise because of nuclear family concept. In such situation farmers forced to look towards hired labour which reduce farmers saving. Many researchers conducted experiment on integrated approach. For example, studies conducted on application of pendimethalin (1.5 or 2.0 L ha⁻¹) or fluchloralin (1.0 or 1.5 L ha⁻¹) at 3 days + hand-weeding twice at 30 DAS, resulted in significant reduction in weed density and weed dry matter [9]. Pendimethalin at 1.0 kg ha⁻¹ + hand-weeding at 30 DAS gave the maximum cowpea yield and lowest weed population and weed dry weight [10]. Same as evaluate weed management tactic for cow pea and found pre-emergence application of pendimethalin at 0.75 kg a.i. ha⁻¹ + weeding at 5 week after sowing gave a higher grain yield (511 kg ha⁻¹) and net return (Rs. 4705 ha⁻¹) compared to other weed management practices [8]. Chemical-weeding (Stomp @ 3.75 L ha⁻¹) at 2-3 leaf stage of weeds + hand-weeding at 50 DAS gave significant increase (68%) in grain yield of cowpea and positive impact on growth parameter like as number of pods per plant, number of seeds per pod, 1000 grain weight [11]. Keeping above fact in mind, the present study was carried out to evaluate appropriate and cost effective weed

management option to cut back negative impact of weeds on growth parameter and economics below threshold level and increase cowpea growers saving.

culture practices with herbicides are given in (Table 1).

2. MATERIALS AND METHODS

2.1 Experimental Site

A field study was conducted in C₈ block of the Instructional Farm, Department of Agronomy, Junagadh Agriculture University (JAU), Junagadh, Gujarat in the *kharif* season of 2007. This place is located at 21.50 N latitudes and 70.50 E longitudes with an altitude of 60 m above mean sea level (AMSL). Junagadh districts fall in sub-tropical region familiar with moderately cold and dry winter, hot and dry summer and fairly humid monsoon season. During July and September, the rainfall was above average and well distributed. Maximum and minimum temperature recorded during the crop growth period ranged between 28.5 to 38°C and 18.5 to 27.6°C, respectively.

2.2 Experimental Soil

Soil was clayey in nature on the basis of sand, silt and clay composition. It was slightly alkaline in nature (pH 7.9 0-15 cm), average in organic carbon (0.61%) on the basis of available nitrogen (220.0 kg ha⁻¹), phosphorus (18.9 kg ha⁻¹) and potassium (378.0 kg ha⁻¹) in 0–15 cm soil depth it characterized as low in nitrogen and phosphorus and high in potassium at the beginning of the trial.

2.3 Cropping History

In the *Kharif* season (July to October) 2005-06 pigeon pea was grown continued in rabi (November to March) and summer (April to June) kept as fallow in *Kharif* season 2006-07 pearly millet grown in rabi wheat grown and summer kept as fallow.

2.4 Experimental Detail

The trial was laid out in Random block design (RBD) consisting 12 treatments with 4 replications. The total area of experimental plot was 1216.80 m² gross plot sizes maintained as 5.0 × 3.6 m and net 4.0 × 2.7 m, respectively.

2.5 Detail of the Treatments

Full detail about the treatments like as herbicides dose, time of application and combination of

2.6 Agronomic Practices

The field was manually seeded 45×10 cm with 25 kg of seed ha⁻¹ (Gujarat Cowpea-4) on 7th July 2007 and harvested on 20th September 2007 (76 DAS). The experimental crop was fertilized with 20: 40: 00 kg ha⁻¹ of N, P & K respectively. Nitrogen was applied through urea (46:00:00) and phosphorus through single super phosphate (SSP) as a basal dose.

2.6.1 Growth parameter

The five plants were randomly selected from each net plot. Selected plant was labeled for easy identification. The same five plants were harvested separately for post harvest studies.

2.6.2 Plant height (cm)

The plant height was measured at harvest by taking height of five randomly selected plants in each net plot. The average value for each net plot was computed and recorded.

2.6.3 Plant spread (cm)

Plant spread (cm) or crown diameter was recorded at harvest of the crop on the basis of average spread of five randomly selected plants from each net plot.

2.6.4 Number of branches per plant

All the branches arising from the main shoot were counted from the selected five plants in each plot at harvest.

2.6.5 Number of pods per plant

Average number of pods per plant was counted at harvest on the basis of five randomly selected plants from each net plot.

2.6.6 Number of seeds per pod

Average number of seeds per pod was calculated by counting the number of seeds in five pods collected from five randomly selected plants from each net plot.

2.6.7 Grain weight (g) per plant

Pods of five selected plants were harvested first and allowed to sun-dry for 10-15 days. After

satisfactory drying, threshing and cleaning, grain yield of these five plants was noted and average value of grain weight per plant was recorded for each treatment.

2.6.8 Test weight (g)

A representative seed sample was drawn randomly from the bulk produce of each net plot, 100 seeds were counted from the sample, and their weight in gram was recorded as test weight of each treatment.

2.6.9 Dry weight of weeds (kg ha⁻¹)

All the weeds were up rooted from each net plot at the time of harvesting. The weeds were air dried completely till reached to the constant weight and finally dry weight of weeds was recorded for each treatment.

2.7 Economic Evaluation

2.7.1 Cost of cultivation (Rs. ha⁻¹)

The cost of cultivation was calculated on the basis of operating cost incurred for all the agriculture operations from preparatory tillage to harvesting including threshing, cleaning as well as cost of inputs and laboures.

2.7.2 Gross return (Rs. ha⁻¹)

Biological yield obtained at the time of harvest converted into gross return (Rs. ha⁻¹) on the basis of existing market price.

2.7.3 Net return (Rs. ha⁻¹)

Net return for each weed management practices was computed by deducting the total cost of cultivation including treatment cost from the gross return.

2.7.4 Benefit:Cost ratio

Benefit:Cost ratio (BCR) for each treatment was calculated by dividing net return by cost of cultivation.

2.8 Statistical Analysis

The statistical analysis for the various characters studied in the investigation was carried out as per the randomized block design. Significance of variance was tested by F-test [12]. Summary tables for the treatment effects were prepared

with standard error of mean (S.Em.±) and critical differences (C.D.) at 5 per cent probability level were given for the treatments, whose effects were found significant. Co-efficient of variance (C.V. %) was calculated and given in the respective tables.

3. RESULTS AND DISCUSSION

Major weed species recorded in experiment plot was *Cynodon dactylon*, *Echinochloa colonum*, *Brachiaria* Spp. in case of monocot, *Digera arvensis*, *Acanthospermum hispidum*, *Leucas aspera* Sperry, *Commelina nudiflora*, *Portulaca oleraceae*, *Phyllanthus niruri*, *Tridax procumbens* in dicot and *Cyprus rotundus* in sedges. Among the different treatments excluding weed free best treatment was T10 (2 HW + 2 IC) having dry weed weight of (130.79 kg ha⁻¹). It was statistically at par with treatments T₂ (pendimethalin + 1 HW + 1 IC, 138.65 kg ha⁻¹), T₅ (quizalofop-ethyl + 1 HW + 1 IC, 142.36 kg ha⁻¹) and T₈ (imazethapyr + 1 HW + 1 IC, 167.82 kg ha⁻¹). The treatment T₁₂ (weedy check) recorded significantly the highest dry weight of weeds (750.00 kg ha⁻¹). Among the four herbicides tested in the experiment fluchloralin not found effective against the weeds and T₁ (Fluchloralin + 1 HW + 1 IC) recorded dry weight of weeds (275.00 kg ha⁻¹). All the four herbicides used in trial have different mode of action and own mechanism to control weeds. Pendimethalin hamper the cell division by combining with tubulin protein which essential for microtubule formation, Imazethapyr inhibit ALS and AHAS enzymes those are responsible for synthesis essential amino acid (leusine, isoleucine and valine), Quizalofop work as ACCase inhibitor and Fluchloralin inhibit cell division through microtubule assembly inhibitor [13].

It was found that application of herbicides with Intercultural operation at 8-10 DAS not effective to control weeds and have no significance in weed biomass reduction over the herbicides alone (Fig. 1). So it is suggested that cowpea grower go for intercultural plus hand weeding at 25 to 40 DAS in combination with suitable pre or post herbicides application to get better weed control. Different treatments significantly affect growth parameter like as plant height, plant spread, number of branches per plant, number of pods per plant, number of seeds per plant and grain weight per plant (Tables 2 and 3). Highest plant height (59.32 cm), plant spread (31.29), number of branches per plant (9.67), number of pods per plant (10.25) number of seeds per plant

(11.00), and grain weight per plant (11.71 g) recorded under weed free treatment, which was at par with T₁₀ (2 HW + 2 IC), T₂ (pendimethalin + 1 HW + 1 IC), T₅ (quizalofop-ethyl + 1 HW + 1 IC) and T₈ (imazethapyr + 1 HW + 1 IC) treatment. These treatment recorded lowest weed biomass accumulation at harvest (Fig. 1). There is no impact on test weight by different weed management practices it is found non significant.

Table 1. Details of the treatments

| Treatments | Details | Rate of herbicide (kg ha ⁻¹) | Time of application |
|-----------------|------------------------------|--|--|
| T ₁ | Fluchloralin + 1 HW +1 IC | 0.6 | Pre-emergence+ 1 HW + 1 IC at 25-30 DAS |
| T ₂ | Pendimethalin +1 HW +1 IC | 0.5 | Pre-emergence + 1 HW + 1 IC at 25- 30 DAS |
| T ₃ | Quizalofop-ethyl | 0.04 | Post-emergence at 20-25 DAS |
| T ₄ | 1 IC + Quizalofop-ethyl | 0.04 | 1 IC at 8-10 DAS + Post- emergence at 20-25 DAS |
| T ₅ | Quizalofop-ethyl +1HW + 1 IC | 0.04 | Post-emergence at 20-25 DAS + 1 HW + 1 IC at 40-45 DAS |
| T ₆ | Imazethapyr | 0.075 | Post-emergence at 20-25 DAS |
| T ₇ | 1 IC + Imazethapyr | 0.075 | 1 IC at 8-10 DAS + Post- emergence at 20-25 DAS |
| T ₈ | Imazethapyr +1 HW +1 IC | 0.075 | Post-emergence at 20-25 DAS + 1 HW + 1 IC at 40-45 DAS |
| T ₉ | 1 HW + 1 IC | - | 20 DAS |
| T ₁₀ | 2 HW + 2 IC | - | 20 and 40 DAS |
| T ₁₁ | Weed free | - | As and when required through HW |
| T ₁₂ | Weedy check | - | No weed control measure carried out |

HW – Hand Weeding, DAS - Days after Sowing,
IC - Interculturing

Table 2. Effect of different weed management treatments on plant height, plant spread and number of branches per plant recorded at harvest

| Treatments | Plant height (cm) | Plant spread (cm) | Number of branches per plant | |
|-----------------|------------------------------|-------------------|------------------------------|-------|
| T ₁ | Fluchloralin + 1 HW + 1 IC | 51.50 | 26.83 | 7.87 |
| T ₂ | Pendimethalin + 1 HW + 1 IC | 56.25 | 29.25 | 8.85 |
| T ₃ | Quizalofop-ethyl | 48.75 | 26.62 | 7.48 |
| T ₄ | 1 IC + Quizalofop-ethyl | 49.75 | 26.70 | 7.55 |
| T ₅ | Quizalofop-ethyl +1HW + 1 IC | 55.07 | 28.57 | 8.56 |
| T ₆ | Imazethapyr | 46.17 | 24.35 | 7.46 |
| T ₇ | 1 IC + Imazethapyr | 49.94 | 26.73 | 7.56 |
| T ₈ | Imazethapyr +1 HW + 1 IC | 54.55 | 28.39 | 8.53 |
| T ₉ | 1 HW + 1 IC | 51.80 | 27.00 | 7.88 |
| T ₁₀ | 2 HW + 2 IC | 58.95 | 30.75 | 8.95 |
| T ₁₁ | Weed free | 59.32 | 31.29 | 9.67 |
| T ₁₂ | Weedy check | 38.75 | 20.28 | 6.06 |
| | S.Em. ± | 2.21 | 1.37 | 0.42 |
| | C.D. at 5% | 6.38 | 3.94 | 1.23 |
| | C.V. % | 8.57 | 10.07 | 10.66 |

HW – Hand Weeding, DAS - Days after Sowing, IC – Interculturing

Among the different yield attributing character weight per plant most affected by different practices because it is an interaction factor of all other yield attributing character. Weeds affect the plant development by competing with crop for light, water and nutrient. Similar results were reported by [14,15]. Biological yield of cowpea was significantly influenced due to different weed management practices tried in the trial. The treatment T11 (weed free) recorded highest gain yield 1595.37 kg ha⁻¹. Followed by T10 (2 HW + 2 IC, 1581.02 kg ha⁻¹), T2 (pendimethalin + 1 HW + 1 IC, 1465.50 kg ha⁻¹), T5 (quizalofop-ethyl + 1 HW + 1 IC, 1441.66 kg ha⁻¹) and T8 (imazethapyr + 1 HW + 1 IC, 1422.22 kg ha⁻¹) respectively (Fig. 2). The maximum stover yield

2096.53 kg ha⁻¹ was recorded by the treatment T₁₁ (weed free). However, it was found statistically at par with treatments T₁₀ (2 HW + 2 IC, 1981.48 kg ha⁻¹), T₂ (pendimethalin + 1 HW + 1 IC, 1921.29 kg ha⁻¹), T₅ (quizalofop-ethyl + 1 HW + 1 IC, 1900.46 kg ha⁻¹) and T₈ (imazethapyr + 1 HW + 1 IC, 1872.68 kg ha⁻¹) (Fig. 2). Among the four herbicides tested in the experiment fluchloralin not found effective against the weeds and T₁ (Fluchloralin + 1 HW + 1 IC) recorded low grain yield (1262.73 kg ha⁻¹).

Economic point of view it was found that under different weed control treatments except weed free T₁₀ (2 HW + 2 IC) recorded highest gross return (32449 Rs ha⁻¹), net return (25901 Rs ha⁻¹)

Table 3. Effect of different weed management treatments on number of pods per plant and number of seeds per pod

| Treatments | Number of pods per plant | Number of seeds per pod | Grain weight (g) per plant | Test weight (g) |
|--|--------------------------|-------------------------|----------------------------|-----------------|
| T ₁ Fluchloralin + 1 HW +1 IC | 8.25 | 9.12 | 8.06 | 10.71 |
| T ₂ Pendimethalin + 1 HW +1 IC | 9.50 | 10.50 | 10.80 | 10.82 |
| T ₃ Quizalofop-ethyl | 7.50 | 8.42 | 6.76 | 10.60 |
| T ₄ 1 IC + Quizalofop-ethyl | 8.00 | 9.00 | 7.52 | 10.68 |
| T ₅ Quizalofop-ethyl +1HW +1 IC | 9.31 | 10.43 | 10.50 | 10.81 |
| T ₆ Imazethapyr | 7.45 | 8.36 | 6.71 | 10.66 |
| T ₇ 1 IC + Imazethapyr | 8.10 | 9.06 | 7.90 | 10.72 |
| T ₈ Imazethapyr +1 HW +1 IC | 9.00 | 10.37 | 10.32 | 10.77 |
| T ₉ 1 HW + 1 IC | 8.50 | 9.37 | 8.33 | 10.75 |
| T ₁₀ 2 HW + 2 IC | 9.87 | 10.75 | 11.50 | 11.00 |
| T ₁₁ Weed free | 10.25 | 11.00 | 11.71 | 11.13 |
| T ₁₂ Weedy check | 5.87 | 6.75 | 4.20 | 10.09 |
| S.Em. ± | 0.49 | 0.55 | 0.56 | 0.37 |
| C.D. at 5% | 1.45 | 1.58 | 1.62 | NS |
| C.V. % | 11.70 | 11.69 | 12.97 | 7.06 |

HW – Hand Weeding, DAS - Days after Sowing, IC – Interculturing

Table 4. Effect of different weed management treatments on gross return, net return and benefit cost ratio

| Treatments | Cost of cultivation | Gross return (Rs. ha-1) | Net return (Rs. ha-1) | BC ratio |
|---|---------------------|-------------------------|-----------------------|----------|
| T ₁ Fluchloralin + 1 HW + 1 IC | 5890 | 25435 | 19545 | 3.31 |
| T ₂ Pendimethalin + 1 HW + 1 IC | 5831 | 29802 | 23971 | 4.11 |
| T ₃ Quizalofop-ethyl | 4944 | 24277 | 19333 | 3.91 |
| T ₄ 1 IC + Quizalofop-ethyl | 5057 | 24442 | 19385 | 3.88 |
| T ₅ Quizalofop-ethyl +1HW + 1 IC | 5622 | 29331 | 23709 | 4.21 |
| T ₆ Imazethapyr | 5008 | 23608 | 18600 | 3.71 |
| T ₇ 1 IC + Imazethapyr | 5121 | 25307 | 20186 | 3.94 |
| T ₈ Imazethapyr +1 HW + 1 IC | 5686 | 28932 | 23246 | 4.08 |
| T ₉ 1 HW + 1 IC | 5453 | 25900 | 20447 | 3.75 |
| T ₁₀ 2 HW + 2 IC | 6121 | 32022 | 25901 | 4.22 |
| T ₁₁ Weed free | 6470 | 32449 | 25979 | 4.01 |
| T ₁₂ Weedy check | 4775 | 17762 | 12987 | 2.72 |

HW – Hand Weeding, DAS - Days after Sowing, IC – Interculturing

and benefit cost ratio 4.22 followed by T5 (quizalofop-ethyl + 1 HW + 1 IC), T2 (pendimethalin + 1 HW + 1 IC) and T8 (imazethapyr + 1 HW + 1 IC) all of these treatment as effective as weed free (Table 4). By adopting appropriate weed management practices farmer can get 3000 to 4000 net increase in return over the other treatment. No doubt that hand weeding along with intercultural

practices carried out twice in growing season was found as good as weed free but on the basis of present study it can be suggested that cowpea grower can go for use of suitable pre and post herbicides like as pendimethalin, quizalofop-ethyl and imazethapyr at 20-25 DAS without compromising with output. Results obtained in present study also supported by the findings of [16,17,18].

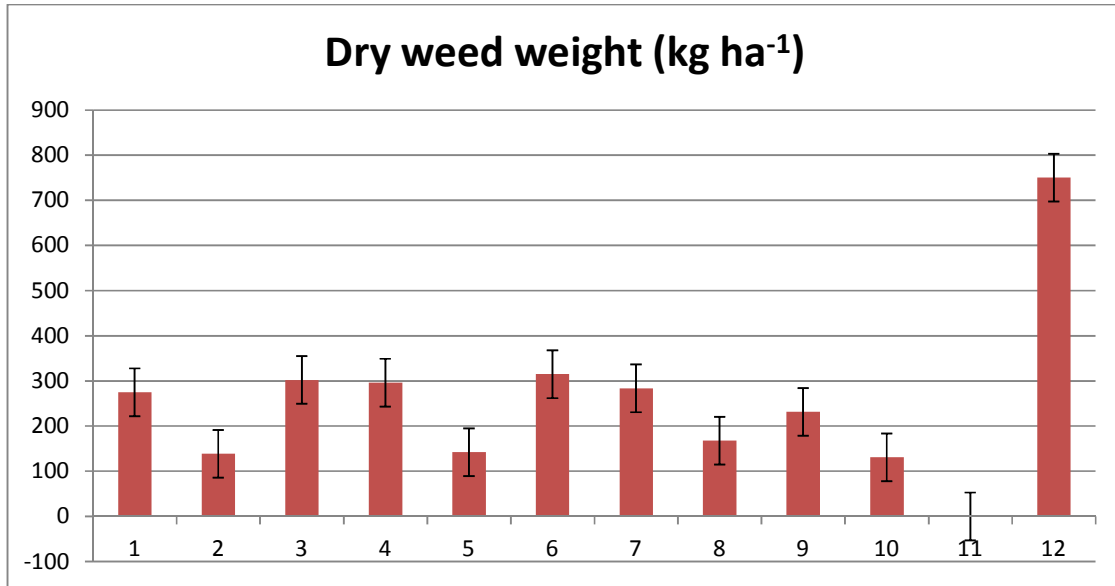


Fig. 1. Effect of different weed management treatments on dry biomass of weeds at harvest

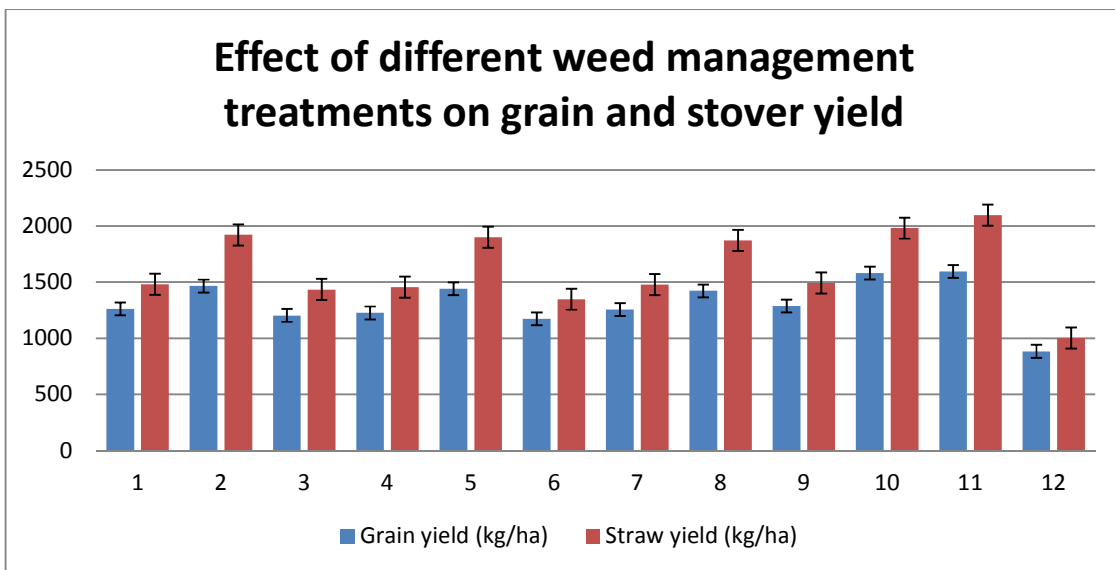


Fig. 2. Effect of different weed management treatments on grain and stover yield

4. CONCLUSION

It was found that selection of appropriate herbicides and its application in combination with cultural practices at critical period of weed growth was key factor to get elevated yield in rain fed cowpea. On the basis of present study it can be suggested that cowpea grower in rainfed area, can go for use of suitable pre and post herbicides like as pendimethalin, quizalofop-ethyl and imazethapyr at 20-25 DAS without compromising with output, but it is only one year data so further study required in this research aspect.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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