Original Research Article

Effect of combined application of herbicides on weed flora, Yield attributes Yield, and Profitability of chickpea (*Cicer arietinum* L.)

Abstract

A field experiment was conducted during the *rabi* season~~s~~ of 2021-22 at the Agronomy Research Farm of the Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (UP). The field experiment was laid out in a randomized block design~~assigning~~ eleven treatments viz., Pendimethalin 30 EC @ 1.0 kg a.i./ha PE, Imazethapyr 10% SL @ 0.06 kg a.i./ha PoE, Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE, Propaquizafop 10 EC @ 0.075 kg a.i./ha PoE, Quizalfop ethyl 5 EC @ 40 g a.i./ha PoE, Pendimethalin 30 EC @ 1.0 kg a.i./ha PE Fb by Imazethapyr 10% SL @ 0.06 kg a.i./ha PoE, Pendimethalin 30 EC @ 1.0 kg a.i./ha PE fb by Propaquizafop 10 EC @ 0.075 kg a.i./ha PoE, Pendimethalin 30 EC @ 1.0 kg a.i./ha PE fb by Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE, Pendimethalin 30 EC @ 1.0 kg a.i./ha~~p~~E fb by Quizalfop ethyl 5 EC @ 40 g a.i./ha PoE, Weed free and Weedy check, replicated thrice. Weed management was done as per treatment. ~~Other crop management practices were followed as per the recommendation of the area.~~ Pendimethalin @1.0 kg a.i./ha PE fb Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha as PoE during the experiment recorded significantly less weed density, weed dry matter, and higher weed control efficiency, yield attributes (number of pods/plant, number of seeds/pod and test weight), yield (grain yield, stover yield, biological yield, and harvest yield). ~~Economically it recorded~~ higher gross returns, the net return, and B:C ratio ~~was noted and proved to be more remunerative~~ as compared to other herbicide applications used in chickpea crop.

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Keywords: Herbicide combination, Chickpea, Weed management, Clodinafop propargyl

INTRODUCATION

Pulses are an integral part of Indian agriculture. Chickpea (*Cicer arietinum* L.) commonly known as gram or Bengal gram belongs to the family Leguminaceae (Fabaceae). It's one of the most important *rabi* season pulse crops grown in India for economic importance and to improve soil fertility. In Indian pulses, chickpea is the second most important component of the diet after cereals. The net availability of food grains per capita increased day by day from 144.1 kg/year in1951 to 179.6 kg/year in 2019 despite population growth however the net obtainability of pulses has reduced from 25 kg/year in 1961 to 17.5 kg/year in 2019 (Anonymous, 2020). Chickpea is a major pulse in India which contributed about 71% of the world's area (13.57 million hectares) and 67% of the world's production. India ranked first in the area with 9.93 million hectares (34%) and first in production with 9.53 million tones (26%) in the world, followed by Pakistan, Australia, and Iran. In India, during 2019-20, pulses were cultivated over more than 29 million hectares of area and registered the highest ever production of 25.90 mt with a productivity level of 908 kg/hectares. The exponential growth rate in pulse production over the past year has been more than 9 percent. (Anonymous, 2020) The highest productivity of 6120 kg/ha is observed in Israel followed by Yemen, Canada, and Egypt. India's productivity was 920 kg/ha yields, (Anonymous, 2020). Today, 80% of total pulses production, in India, is realized in six states namely, Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, Karnataka, and Uttar Pradesh.The productivity of chickpea is low despite high-yielding varieties and new agronomic practices. One of the causes of poor productivity is the infestation of weeds in the field of chickpea. It is a poor competitor to weeds because of its slow growth rate and limited leaf area development at early stages. Crop yield losses due to non-adoption of weed management practices particularly in assured irrigated conditions. Poonia and Pithia (2013) reported a 54.7% loss in grain yield due to weed competition in chickpea under rainfed conditions.Major weeds associated with chickpea vary with crops and locations. The Directorate of Weed Research (DWR), Jabalpur, has developed a Weed Atlas for major weeds in major crops in 435 districts spread across 19 states of the country and published a handbook on weed identification (Naidu 2012). Its findings concluded that weeds have economic significance in specific crops (~~Rao *et al.*~~ Rao and Chauhan, 2014). Weeds for Chickpea are*; Chenopodium album* L.*, Avena fatua* L.*, Medicago denticulata, Chicorium intybus, Convolvulus arvensis* L.*, Lathyrus aphaca* L. *Lathyrus sativus* L.*, Vicia sativa, Cyperus rotundus* L.*, Phalaris minor, Avena ludoviciana, Euphorbia geniculata, and Melelotus spp.* etc. In the total annual loss of agricultural produce from various pests in India, weeds roughly account for 37%, insects for 29%, diseases for 22%, and other pests for 12% (Yaduraju, 2006).Weed emergence with the *rabi* sown chickpea crop creates competition unless controlled timely and effectively. There is, therefore, an urgent need to move from the costly manual mechanical weed control to chemical weed control (Marwat *et al*., 2003). The predominant method of weed control by mechanical hoeing and manual weeding over an extensive scale is found to decline because of a shift of agricultural laborers to industries for better and assured wages.Weed control methods such as manual weeding. However, hoeing is expensive, tedious, and time-consuming, and herbicides used individually cannot achieve complete weed control due to their selective destruction. Their use can be made more effective if supplemented by manual weeding and hoeing; it is a well-known fact that relying on a single weed control method is ineffective, and an integrated approach may be required. Among several herbicides in the market *viz.* Pendimethalin, Clodinafop propargyl, Quizalofop-ethyl, Propaquizafop, and Imazethapyr are currently being used for controlling both grassy and broad-leaved weeds but their effects under various climatic conditions are not well defined. It was recently found that the herbicide Clodinafop propargyl is very effective in controlling weeds in chickpea. This herbicide is active against broadleaf weeds and grasses but their effects may differ in different locations depending on soil type, intensity, and weed flora type, among other factors. As a result, it is important to compare the effectiveness of various promising herbicides in terms of chickpea productivity and weed competition in weed-free environments.Vaishya *et al*., (1996) reported that integrated weed management (pre-emergence application of Pendimethalin @ 1.0kg/ha *fb* one hand weeding) was found to be the most economical. Among the chemical weed control treatment, application of Pendimethalin @ 1.0 kg a.i./ha produced a higher yield and gave the highest net monetary returns and B: C ratio and was found most effective and economical in controlling weeds and increasing the yield of chickpea.A suitable herbicide for effective control of mixed weed flora is required for better adoption in this crop by farmers. The introduction of herbicides has made it possible to control a broad spectrum of weeds in pulses effectively at a reasonable cost. Weed management in chickpea is a crucial component of plant protection thus improving the production potential of the crop.

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MATERIALS AND METHODS

A field experiment was conducted during ~~*rabi* season~~ 2021-22 *rabi* season at Agronomy Research Farm of the Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (UP) India, which falls in a subtropical climate and situated at 26^0 47′ North latitude, 82^0 12′ East longitudes with an altitude of 113 meters above mean sea level. During the crop growing season of the year 2021-22, the weekly maximum and minimum temperatures, relative humidity, sunshine hours, wind velocity, evaporation ranged between 32.0 °C and 5.7 °C, 87.40 and 74.70 %, 9.0 and 4.7 hours, 5.5 and 2.0 kmph, 6.4 and 2.1 mm respectively. The soil of the experimental site was homogeneous in fertility with uniform textural makeup. The alluvial soils of Indo-Gangetic plains in general are deep, flat, and well drained with low available nitrogen and medium in available phosphorus and potassium. Chickpea variety RVG 202 was used ~~with a~~ at seed rate ~~was used~~of 80 kg/ha. Weed observations were recorded at 30, 60, and 90 DAS. The quadrate of 1 sq. m was randomly placed at three places in each plot and then species-wise and total weed counts were recorded. In weed biomass, all the associated weeds were collected, randomly from 0.25 m^2 quadrate at four places in each plot. The weeds were kept in paper bags and dried in the oven at $60^{\mathbf{0}}$C for 24-25 hours (up to constant weight) and dry weight was recorded at 30, 60, and 90 DAS ~~into~~ and expressed as g/m2. For weeds, the original values were transformed using the square root of X+0.5 transformations and analyzed statistically. Weed control efficiency (%) of treatment expressed in percentage for controlling weeds in comparison to weedy check and ~~worked out~~ based on the given formula. ~~Weed control efficiency (%) was computed based on the following formula:~~ In Crop, yield and yield attributing characters were recorded as the number of pods/plant on five randomly selected plants per plot were counted and their averages were calculated. The total number of pods from each five sample plants was threshed and the average number of seeds/pods was recorded. From a lot of threshed clean seeds of each plot, a random seed sample was taken and one hundred seeds were counted from the samples of each plot, and the weight of seeds was recorded on an electronic balance. Seed yield and ~~straw yield~~stover yield obtained from each plot were added to obtain biological yield in kilogram from each plot and converted to quintal per hectare. The weight of clean seeds obtained from each plot was recorded on a double pan balance. Finally, the seed yield/plot was converted into yield/ha by multiplying with the appropriate conversion factor. Stover yield was determined by subtracting the seed yield from the biological yield of each net plot under a particular treatment. Then, the values were converted into stover yields/ha by using the same conversion factor~~,~~. ~~which will be used in the case of conversion of seed yields~~. Harvest Index (%) refers to the ratio of economic yield (seed yield) to the biological (seed + stover) yield under a particular treatment and it was expressed in percentage.~~:~~

In the economic ~~Study~~ study of the crop, the cost of cultivation ~~of crops~~ was calculated treatment-wise, based on prevailing local market prices of different inputs used in the cultivation. Gross returns of grain yield and ~~straw yield~~ stover yield were computed in Rs/ha by using the minimum support prices for grains and prevailing local market price for straw. The gross return in each treatment was obtained by adding the monetary value of grain and ~~straw yield~~stover yield in Rs/ha., ~~treatment wise.~~ The net return for each treatment was calculated by

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deducting the cost of cultivation from the respective gross returns. Benefit: The cost ratio in terms of net return per rupee investment was calculated by using the following formula. The data obtained were subjected to statistical analysis as outlined by **Gomez & Gomez (1984)**. The treatment differences were tested by the least significant difference at a 5% level of significance.

$$\text{WCE}(\%) = \frac{\text{Dryweightofweedsincontrolplot} - \text{Dryweightofweedsintreatedplot}}{\text{Dryweightofweedsincontrolplot}} \times 100$$

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$$\text{Harvest Index} = \frac{\text{Economic Yield}}{\text{Biological Yield}} \times 100$$

$$\text{B: C ratio} = \frac{\text{~~Net~~ gross return (Rs/ha)}}{\text{Cost of cultivation (Rs/ha)}}$$

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RESULTS AND DISCUSSION

Weed Studies

The ~~D~~data on ~~of t~~~~T~~otal weed density (no. m^{-2}) given in Table 1 indicated that the effect of various weed management practices was significant on the density of weeds at 30, 60, and 90 DAS. Weed management practices exerted a significant effect on the density of total weeds. Weedy check recorded a significantly higher density of total weeds (8.96, 11.62, and 12.42) over the rest of the treatments at all stages of crop growth while weed-free treatments ~~noted~~ registered the least density of total weeds (0.71, 0.71, and 0.71). Among the herbicidal treatments at 30, 60, and 90 DAS the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* Clodinafop propargyl 15 WP @ 0.060 kg a.i./ha PoE recorded minimum density (5.23, 3.83, and 3.97) of weeds which were statistically at par with Pendimethalin EC @ 1.0 kg a.i./ha PE *fb* Imazethapyr 10 % SL @ 0.06 kg a.i./ha PoE but significantly ~~has lesser weed density~~lower than the rest of the weed management practices. This might be due to effective weed control by both herbicides at all stages of crop growth whereas weedy check treatment recorded significantly highest density of weeds (80.00, 135.00, and 154.00m^{-2}) at 30, 60, and 90 DAS respectively. ~~This might be due to no weed control measures being carried out in these treatments.~~ These results were in agreement with the results of **Yadav *et al.* (2017)** and **Jaswal and Menon (2020).** Data on dry matter of total weeds recorded at 30, 60, and 90, DAS ~~has been~~ given in Table 1 indicated that ~~the weed management treatments at various crop growth stages,~~ weedy check recorded maximum ~~weed~~ dry matter of total weeds (4.05, 9.38 and 10.09) at 30, 60 and 90, DAS respectively. While weed-free treatment recorded the lowest dry matter of total weeds at 30, 60, and 90, DAS due to better ~~weed management practices~~control of weeds. Among the herbicidal treatments, at 30 DAS application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* Clodinafop propargyl15 WP @ 0.060 kg a.i./ha as PoE recorded significantly ~~minimum~~ lesserdry matter (~~2.45~~ 2.34, 3.12 and 3.26 g/m2) which was statistically at par with Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* Imazethapyr 10 % SL @ 0.060 kg a.i./ha PoE while significantly lesser than the rest of the treatments. A similar trend was observed at ~~the~~ 60 and 90 DAS ~~stages~~ also during the experimentation which~~. This~~ might be due to effective ~~weed~~ control of weeds leading to ~~reducing~~

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~~the~~ reduction in dry weight. In the weedy check treatment, the dry matter of weeds was significantly ~~maximum~~ higherbecause of the high~~est~~ weed population and ~~higher~~ greater capacity of weeds in utilizing the sunlight, nutrients, moisture, CO2, space, *etc*., over the rest of the treatments. In treatment, weed-free for up to 90 days and application of pre-emergence herbicides in combination with PoE application of herbicides ~~reported~~ recordedthe less weed population at a critical stage of crop growth resulting in lower weed dry matter. These results were ~~by the~~ similar to the findings of **Singh *et al.* (2006), Bhutada and Bhale (2014)**, **Kumar *et al.* (2015)**, and **Kumar *et al.* (2020).** The data regarding weed control efficiency as influenced by various weed control treatments are given in Table 1. ~~In weed management treatmentsat~~ At harvest, the weed control efficiency was highest in the ~~treatment of~~ weed-free (100%) treatment which was significantly superior to all other treatments.~~, while weedy check treatment recorded the lowest weed control efficiency (0.00%).~~Among herbicidal treatments the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* Clodinafop propargyl 15 WP @ 0.060 kg a.i./ha noted significantly greater value (90.00%) of weed control efficiency which was found at par with ~~treatment~~ Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* Imazethapyr 10 % SL @ 0.060 kg a.i./ha (POE) (89.61) ~~while~~ and significantly ~~higher than the~~ superior over rest of the herbicidal treatments. The application of herbicide~~s~~ Pendimethalin ~~and oxyfluorfen~~ before emergence reduce~~ds~~d the density of ~~the~~ weeds and result~~s~~ed in high efficiency ~~in~~ of weed control, ~~this~~ which could be attributed to the ~~herbicide's~~ maximum uptake and more assimilation of herbicide occurring immediately after weed emergence. ~~after the~~ PoE application of Clodinafop propargyl and Imazethapyr reduced the weed intensity and dry weight than weedy check, which could be ~~one of the reasons~~ due to for their superior weed control efficiency. These findings were parallel to the conclusions of **Singh and Jain (2017)**, **Rathod *et al.* (2017)**, and **Singh *et al.* (2020).**

Comment [h16]: oxyflorfen herbicide is not found in the treatments

Yield attributes

The ~~D~~ data ~~about~~ on yield contributing characters *viz.* numbers of pods/plant, the number of seeds/pod, and the weight of 1000 seeds (g) are presented in Table 2. It is obvious from the results that the number of pods/plant~~s~~ was affected significantly due to different weed management practices.

~~In~~ among differentweed management practices the maximum number of pods/plant (57.00) was recorded with weed-free treatments and the minimum (33.00) was with the weedy check. Herbicidal treatments also significantly influenced the number of pods/plant~~s~~. The maximum number of pods/plant (54.60) was recorded with the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* ~~by~~ Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE which was at par with the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Imazethapyr 10% SL @ 0.06 kg a.i./ha PoE (53.4) and significantly higher ~~number of pods~~ than the rest of the chemical treatments ~~except weed free~~. ~~It is clear from the data thatthe~~ The number of seeds/pod~~s~~ was also affected significantly due to different weed management practices of the chickpea crop. ~~In weed management practices the~~ The maximum number of seeds/pod (1.96) was recorded with weed-free treatment~~s~~ and the minimum (1.32) with the weedy check. Among the herbicidal treatments, the maximum number of seeds/pod (1.88) was recorded with the application of

Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* ~~by~~ Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE being at par with the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* ~~by~~ Imazethapyr 10% SL @ 0.06 kg a.i./ha PoE (1.85).~~While~~and proved significantly higher than the rest of the treatments. Maximum test weight (200.40g) was recorded with weed-free treatments and minimum (178.80g) with the weedy check. Among the herbicidal treatments, the maximum test weight (197.70g) was recorded with the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE. ~~Almost~~ Aall parameters related to yield *viz,* number of pods/plant, number of seeds/pod (Table 2) were significantly influenced by weed management practices ~~and~~ while the test weight failed to reach the level of significance. Significantly higher values for yield attributes (Table 2) were observed with the application of Pendimethalin30 EC @ 1.0 kg a.i./ha PE *fb* Clodinafop propargyl 15 WP @ 0.060 kg a.i./ha PoE. This might be due to effective control of weeds reducing the weed ~~completion and resulting in leads~~competition leading to the ~~formation of a higher number~~ better expression of yield attributes. ~~Almost s~~Similar findings were reported by **Kachhadiya *et al.* (2009), Khope *et al.* (2011)**, and **Singh *et al* (2019)**.

Yield~~s~~

Grain yield is a function of the source and sink~~s~~ relationship,wherein source is the various growth parameters and sink are yield attributes parameters like dry matter accumulation, number of nodules/plant, number of pods/plant, number of seeds/pod, and test weight. ~~It is the most important parameter to compare the effectiveness of different treatments~~. Different weed management treatments influenced significantly the seed~~, yield,~~ and stover yield of chickpea and the data are embodied in Table 2. ~~In~~ the weed-free treatment recorded maximum ~~grain~~ seed yield (20.60 q/ha) and minimum ~~grain~~ seedyield (13.80 q/ha) ~~were~~ was noted with weedy check~~.treatment resulting due to severe~~ Severe crop weed competition in weedy check might have effected crop growth and recorde low yields as weeds utilize a large amount of moisture and nutrients than crop ~~which was~~ due to no weed management practice. Among the herbicidal treatments the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE recorded a significantly higher seed yield (19.80 q/ha) being at par with Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* Imazethapyr 10 % SL @ 0.06 kg a.i./ha PoE, while significantly higher than the rest of the herbicidal treatments. This might be due to effective control of weeds resulting in higher yield. Similar findings were reported by **Punia *et al*. (2011)** and **Singh *et al*. (2014).** ~~Amongweed~~ Weed management practices showed a significant variation in stover yield of chickpea. Weed-free treatment recorded maximum stover yield (37.43 ~~kg~~q/ha) and ~~minimum~~ minimum was with the weedy check (26.50 ~~kg~~ q/ha). Data further reveals that among herbicidal treatments the maximum stover yield (36.27 q/ha) was recorded with Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE which was statistically at par with ~~an~~ the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* Imazethapyr 10 % SL 0.06 kg a.i./ha PoE while significantly higher than the rest of the herbicidal treatments. These results were in ~~the~~ agreement with those of **Poonia *et al.* (2013), Chavada *et al.* (2018)~~,~~** and **Singh *et al.* (2020).** Among weed management practices significantly higher biological yield (58.03 q/ha) was observed with weed-free treatment~~s~~ and least biological yield (39.85 q/ha) with weedy check treatment~~s~~. In the case of herbicidal treatments,~~with~~ the application of Pendimethalin 30 EC @1.0 kg a.i./ha PE *fb* Clodinafop propargyl 15 WP @ 0.060 kg a.i./ha PoE ~~which~~ was statistically at par with ~~an~~

the application of Pendimethalin 30 EC@ 1.0 kg a.i./ha PE *fb* Imazethapyr 10 % SL @ 0.06 kg a.i./ha PoE ~~while~~ but significantly higher than ~~the~~ rest of the herbicidal treatments. This might be due to effective control of weeds by avoiding ~~above~~ weed competition and resulting in higher biomass production.Similar results were reported by **Kumar *et al.* (2014)** and **Singh *et al.* (2020).** Among the weed management treatments, the maximum harvest index was recorded with weed-free (35.49 %) and minimum with the weedy check (34.62 %). Among herbicidal treatments the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* Clodinafop propargyl 15 WP @ 0.060 kg a.i./ha PoE recorded a maximum harvest index of ~~(~~35.38 %~~)~~. The similar result was obtained by **Chavada *et al.* (2018).**

Economics

The Economics of the weed control treatments was worked out based on input-output analysis. ~~Various components of economics are described here~~. ~~The details have been given in Table 3.~~ The cost of cultivation (Rs/ha) incurred on different weed control treatments was added to the common cost of ~~different~~ treatments and arrived ~~which gave~~ the total cost of cultivation. The data on economic analysis presented in Table 3 showedthat the highest cost of cultivation (39024 Rs/ha) was recorded under the treatment weed free and the lowest was with the weedy check (36024 Rs/ha). Among herbicide treatments, the higher cost (38564 Rs/ha) was recorded with the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE. In Table 3 the data on gross return computed under different treatments showed that the highest gross return (108803 Rs/ha) was achieved with weed-free treatment~~s~~ and the lowest with the weedy check (72985 Rs/ha). Among herbicidal treatments, the highest gross return (104595 Rs/ha) was recorded with the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE. Data on net return computed under different treatments showed that the highest net return (66031 Rs/ha) was obtained with the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE. The ~~In Table 3~~ data on B:C ratio computed under different treatments showed that the highest B:C ratio(1.71 Rs/Rupees investment) was recorded with the application of Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE and lowest with the weedy check (1.02 Rs/Rupee~~s~~ investment). ~~A similar~~ the present finding confi~~io~~rms with the finding of **Dungarwal *et al.* (2002), Ratnam *et al.* (2011), Meena *et al.* (2011)**~~,~~ and **Dubey *et al.* (2018).**

Table:1Effect of herbicide combinations on Weed density, Weed dry weight (g) at 30, 60, 90 DAS, and Weed control efficiency (%) of Chickpea

Treatments	Weed density (no/m^{-2}) ~~(DAS)~~			Weed dry weight (g/m^{-2}) ~~(DAS)~~			Weed control efficiency (%)
	30 DAS	60DAS	90 DAS	30DAS	60DAS	90 DAS	

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Pendimethalin 30 EC @ 1.0 kg a.i./ha PE	5.54 (30.30)	6.35 (40.00)	6.67 (44.00)	2.55 (6.06)	5.14 (26.00)	5.43 (29.04)	71.43
Imazethapyr 10% SL @ 0.06 kg a.i./ha PoE	7.46 (55.40)	5.95 (35.20)	6.20 (38.00)	3.40 (11.08)	4.82 (22.88)	5.05 (25.08)	75.32
Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE	7.83 (61.20)	5.83 (33.60)	6.12 (37.00)	3.56 (12.24)	4.72 (21.84)	4.97 (24.42)	75.97
Propaquizafop 10 EC @ 0.075 kg a.i./ha PoE	8.51 (72.00)	7.12 (50.40)	7.43 (55.00)	3.85 (14.40)	5.76 (32.76)	6.06 (36.30)	64.29
Quizalfop ethyl 5 EC @ 40 g a.i./ha PoE	7.66 (58.40)	6.39 (40.40)	6.63 (43.80)	3.48 (11.68)	5.17 (26.26)	5.41 (28.91)	71.56
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Imazethapyr 10% SL @ 0.06 kg a.i./ha PoE	5.29 (27.60)	3.93 (15.00)	4.06 (16.00)	2.36 (5.10)	3.19 (9.75)	3.31 (10.56)	89.61
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Propaquizafop 10 EC @ 0.075 kg a.i./ha PoE	5.42 (29.00)	4.45 (19.31)	4.67 (21.40)	2.51 (5.80)	3.62 (12.63)	3.69 (13.95)	75.13
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE	5.23 (27.00)	3.83 (14.20)	3.97 (15.40)	2.34 (5.02)	3.12 (9.23)	3.26 (10.16)	90.00
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Quizalfop ethyl 5 EC @ 40 g a.i./ha PoE	5.47 (29.40)	4.51 (20.00)	4.73 (22.00)	2.52 (5.88)	3.67 (13.00)	3.87 (14.52)	76.34
Weed free	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	100.00
Weedy check	8.96 (80.00)	11.62 (135.0)	12.42 (154.00)	4.05 (16.00)	9.38 (87.75)	10.09 (101.64)	0.00
SEm±	**0.29**	**1.00**	**0.51**	**0.17**	**0.61**	**0.76**	**0.89**
CD (p = 0.05)	**0.88**	**2.89**	**1.53**	**0.53**	**1.83**	**2.26**	**2.52**

Figuers in paral thesis or original values

Table:2Effect of herbicide combination on Yield attributes, Yields, and Harvest Index (%) of Chickpea

Treatments	**Yield attribute**			**Yields(q/ha)**			**Harvest Index (%)**
	Pods/plant	**Seeds/pod**	**Test Weight (g)**	**Grain Yield**	**Straw Yield**	**Biological yield**	
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE	45.03	1.42	180.00	16.50	30.78	47.28	34.89

Imazethapyr 10% SL @ 0.06 kg a.i./ha PoE	46.80	1.40	180.60	17.00	31.63	48.63	34.95
Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE	47.00	1.38	181.80	17.20	31.44	49.15	34.99
Propaquizafop 10 EC @ 0.075 kg a.i/ha PoE	43.60	1.46	179.20	16.00	30.05	46.02	34.82
Quizalofop ethyl 5 EC @ 40 g a.i./ha PoE	44.00	1.44	179.80	16.30	30.47	46.77	34.85
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Imazethapyr 10% SL @ 0.06 kg a.i./ha PoE	53.40	1.85	196.00	19.60	35.83	55.43	35.35
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Propaquizafop 10 EC @ 0.075 kg a.i./ha PoE	47.90	1.45	192.00	16.78	31.07	48.19	35.30
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Clodinafop propargyl 15 WP @ 0.06 kg a.i. /ha PoE	54.60	1.88	197.70	19.80	36.27	55.95	35.38
Pendimethalin 30 EC @ 1.0 kg a.i /ha PE *fb* by Quizalofop ethyl 5 EC @ 40 g a.i./ha PoE	48.00	1.47	190.70	16.83	30.66	47.79	35.19
Weed free	57.00	1.96	200.40	20.60	37.43	58.03	35.49
Weedy check	33.00	1.32	178.80	13.80	26.05	39.85	34.62
SEm±	**0.65**	**0.12**	**9.41**	**0.87**	**1.49**	**1.34**	**1.25**
CD(p = 0.05)	**1.95**	**0.38**	**NS**	**2.58**	**4.41**	**4.00**	**NS**

Table:3Effect of herbicide combination on Cost of cultivation, Gross return, Net return, and B: C ratio of Chickpea

Treatments	**Cost of cultivation (Rs ha^{-1})**	**Gross return (Rs ha^{-1})**	**Net return (Rs ha^{-1})**	**B: C ratio**
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE	38004	87228	49224	1.29

Comment [h17]: revise the data as per formula

Imazethapyr 10% SL @ 0.06 kg a.i./ha PoE	36905	89863	52958	1.43
Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE	36584	90915	54331	1.48
Propaquizafop 10 EC @ 0.075 kg a.i./ha PoE	36976	84595	47619	1.28
Quizalfop ethyl 5 EC @ 40 g a.i./ha PoE	36944	86177	49233	1.33
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Imazethapyr 10% SL @ 0.06 kg a.i./ha PoE	38885	103543	64658	1.66
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Propaquizafop 10 EC @ 0.075 kg a.i./ha PoE	38956	100382	61426	1.57
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha PoE	38564	104595	66031	1.71
Pendimethalin 30 EC @ 1.0 kg a.i./ha PE *fb* by Quizalfop ethyl 5 EC @ 40 g a.i./ha PoE	38924	99342	60418	1.55
Weed free	46024	108803	69779	1.51
Weedy check	36024	72985	36961	1.02
~~**SEm±**~~	—	—	—	—
~~**CD(p = 0.05)**~~	—	—	—	—

Comment [h18]:

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Comment [h19]:

Conclusion

~~As per the discussed problem higher weed infestation~~ the study on effect of different weed management practices in chickpea, revealed that application of pendimethalin @1.0 kg a.i./ha PE fb Clodinafop propargyl 15 WP @ 0.06 kg a.i./ha as PoE ~~may~~ proved to be the best way to control weeds ~~*i.e.*~~ as it has recoreded ~~S~~significantly less weed density, weed dry matter, ~~and~~ higher weed control efficiency, yield attributes (number of pods/plant, number of seeds/pod and test weight) and culminated in ~~,~~ yield (grain yield, stover yield, biological yield, and harvest ~~yield~~ index). Economically ~~it~~ also it recorded higher gross returns, ~~the~~ net return, and ~~B:C ratio~~ proved to be more remunerative as compared to other herbicide applications used in chickpea crop.

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