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# Response of herbicide on root nodules, economics and phytotoxicity on chickpea

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**Abstract**
The field experiment was conducted during *Rabi* season of the year 2011 at Agronomy Research Farm of N.D. University of Agriculture and Technology, Kumarganj, Faizabad Uttar Pradesh to find out most suitable weed management practice for control of weeds in chickpea and increase the yield, net return and benefit cost ratio. Results indicated that weed free treatments significantly positive impact on fresh and dry weight of nodules per plant (mg) at different growth stages of chickpea over weedcontrol by different herbicide treatments. The significantly highest values of fresh and dry weight of nodules per plant (mg) at 45 DAS and 60 DAS was recorded in weed free plot at each growth stage except dry weight of nodules per plant (mg) at 45 DAS was maximum (392.0mg) in oxyfluorfen 200 g (PE) *fb*quizalofop 60 g/ha (PoE) plot and number of branches at 60 and 90 DAS was found highest in weed free plot (11.21 22.50) respectively and found statically at par with pendimethalin 1000 g/ha (PE), pendimethalin 1000 g(PE) *fb*quizalofop 60 g/ha ( PoE) and pendimethalin 1000 g(PE) *fb*clodinafop 60 g/ha ( PoE) plot at 60 DAS and at 90 DAS significantly lowest value of number of branches (11.10) in pendimethalin750 g(PE) fbquizalafop 60 g + oxyfluorfen 200 g/ha (PoE) plot. Pendimethalin750 g (PE) *fb*quizalafop 60 g + oxyfluorfen 200 g/ha (PoE) and oxyfluorfen200 g + quizalofop 60 g/ha (PoE) treatments where very severe toxicity (about 80 %) was observed followed by oxyfluorfen 200 g + *fb*clodinafop 60 g/ha (PoE) and pendimethalin 1000 g (PE) *fb*imazethapyr 75 g + quizalofop 60 g/ha(PoE), respectively. The maximum reduction in seed yieldof chickpea were recorded in pre-emergence application of pendimethalin 750g followed by combined post-emergence application of quizalofop-ethyl 60g + oxyfluorfen 200g/haat 35DAS this was caused due to phyto-toxicity among the herbicides under treatment. Maximum net monetary returns ( 53588.05/ha) and B:C ratio (2.24) were recorded in pre-emergence application of pendimethalin1000g and post-emergence application of clodinafop 60g/ha at 35 DAS, and next best net monetary returns  50448.05/ha and B:C ratio (2.05) obtained in pre-emergence application of pendimethalin1000g and post emergence application of quizalofop-ethyl 60 g/haat 35 DAS and pre-emergence application of pendimethalin 750g followed by combined post-emergence application of quizalofop-ethyl 60g + oxyfluorfen200g/haat 35 DAS and post-emergence application of oxyfluorfen200g + quizalofop-ethyl 60g/ha (PoE) the net monetary returns and B:C ratio were in negative.

**Keywords:** chickpea, clodinafop, oxyfluorfen, pendimethalin, imazethapyr pre-emergence and post-emergence, weed control, economics

## Introduction
Chickpea (*Cicerarietinum*) is the important pulse crop and it occupies around 92% of the area and 89% of the production in semiarid tropical (SAT) countries (Rathore 2000) [5]. In India the Area, production and productivity of chickpea are the 8.17 million hectares, 7.48 million tonnes and 915 kg/ha, respectively and in Uttar Pradesh it is cultivated on an area of 0.62 million hectares with a production 0.51 million tonnes and productivity 824 kg/ha. The area under chickpea crop has reduced to 0.60 million hectare in 2012-13 from 1.06 million hectare in 1966-67 (Anonymous 2013) due to slow initial growth, itsuffers badly by severe competition with weeds for nutrients, light, water and space and result into heavy reduction in yield and about 40-45% reduction in yield of chickpea due to severe infestation of weeds was

estimated (Singh and Singh 1992) [7]. It is a rich source of protein and therefore, agronomists desire to maximize its production while reducing or eliminating the use of herbicides.However, nitrogen fixation and consequently the yield of chickpea are reduced, if herbicides are applied (Pahwa and Prakash 1992) [3]. Weed causes a reduction of 40–90% in chickpea production and so herbicides are widely used (Ahlawat 2000) [1]. Since earlier studies have demonstrated the adverse effects of herbicides on Rhizobium growth and its symbiosis with other legume crops, and insufficient information is available on the effect of herbicides on Mesorhizobium-chickpea symbiosis, as a results the fresh and dry weight of nodules per plant (mg) decreases. Weed infestation in chickpea offer serious competition and cause yield reduction to the extent of 75% (Chaudhary *et al*. 2005) [2]. The initial 60 days period considered being the critical for weed crop competition in chickpea (Singh and Singh 1992) [7] but with the increase in labour cost and scarcity of labour, manual weed control has become a difficult task in chickpea. Suitable herbicide for effective control of mixed weed flora is required for better adoption in this crop by farmers.

Hence, present study was therefore carried out under field conditions in order to evaluate the effects of soil applications of different herbicides on the phytotoxic effect *viz.* crop discoloration, chlorosis, stunting and wilting of crop plants were taken into account, fresh and dry weight of nodule and yield of chickpeaat Kumarganj, Faizabad in Uttar Pradesh.

**Materials and methods**

The field experiment was conducted during *Rabi* season of the year 2011at Agronomy Research Farm of N.D. University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) India. The soil of the experimental field was clay-loam, low in organic carbon available nitrogen and phosphorus, medium in potash and alkaline in reaction. Chickpea variety "*PG-186*" was sown on 19 November, 2011 in rows, at 40 cm apart at 4-5 cm deep by using the Kudalithe experiment was laid out in randomized block design with fourteen weed control treatments, *viz.*pendimethalin 1000g/ha (PE), pendimethalin 1000g (PE) *fb*quizalofop-ethyl 60g/ha (PoE), pendimethalin 1000g (PE) *fb*clodinafop 60g/ha (PoE), pendimethalin (PE) 750g *fb*quizalofop-ethyl 60 g + oxyfluorfen 200g/ha (PoE), oxyfluorfen 200g/ha (PE), oxyfluorfen 200g (PE) *fb*quizalofop-ethyl 60 g/ha (PoE), oxyfluorfen 200g (PE) *fb*clodinafop 60g/ha (PoE), oxyfluorfen 200g + quizalofop-ethyl 60g/ha (PoE), oxyfluorfen 200g +clodinafop 60g/ha (PoE), imazethapyr 75 g/ha (PoE), pendimethalin 1000g (PE) *fb*imazethapyr 75 g/ha (PoE), pendimethalin 1000 g/ha (PE) *fb*imazethapyr 75 g + quizalofop-ethyl 60 g/ha (PoE), Weed free and Weedy check. Two hands weeding in weedy check and weed free plot and experiment was carried out in three replication recommended package of practices except weed control treatments were followed for raising the crop. A uniform dose of fertilizers 20,40,40 N, $P_2O_5$, $K_2O$ kg/ha was applied at the time of sowing in furrows. Pre-plant incorporation and pre-emergence herbicides were applied one day before and after sowing, respectively using a knapsack sprayer fitted with flat fan nozzle with a spray volume of 600 litres of water per hectare. Hand weeding was done with the help of khurpi as when required in weed free treatment. Weed dry weight was recorded by placing a quadrate of 0.25 m at three random places in each plot and then weighed for all weeds separately after oven drying 45 days after sowing and harvesting.

**Results and discussion**

**Fresh and dry weight of nodules/plant**

The data on fresh & dry weight of nodules per plant as affected by different herbicides have presented in table-1 and at 45th day stage, post-emergence application of either clodinafop or quizalofop 60 g/ha each in the plots and pre-emergence application of either pendimethalin 1000 g/ha or oxyfluorfen 200 g/ha in same plots recorded significantly higher fresh and dry weight of nodules/plant as compared to the single applied herbicide treatment like pendimethalin 1000 g/ha(PE)and oxyfluorfen 200 g/ha(PE). While imazethapyr 75 g/ha as PoE and pendimethalin 1000 g (PE) *fb*imazethapyr 75 g/ha recorded at par to each other with respect to fresh and dry weight of nodules. However, treatment pendimethalin 1000 g *fb*quizalofop 60 g+ oxyfluorfen 200 g,oxyfluorfen 200 g + quizalofop 60 g/ha, oxyfluorfen 200 g + clodinafop 60 g/ha and pendimethalin 1000g as PE *fb*imazethapyr 75 g + quizalofop 60 g/ha as PoErecorded lower values of fresh and dry weight of nodules which were at par to each other.

At 60th day stage of chickpea significantly higher fresh and dry weight of nodules/plant was recorded with weed free treatment. Among herbicide treatment pendimethalin 1000 g/ha as PE along with clodinafop 60 g/haPoE and pendimethalin 1000 g/haas PE along with quizalofop 60 g/ha PoE being at par recorded significantly higher weight fresh and dry nodules/plant over pre-emergence applied herbicide. The similar trend was recorded with treatment oxyfluorfen200 g/ha(PE), oxyfluorfen200g (PE) *fb*quizalofop 60 g/ha (PoE) and oxyfluorfen200 g (PE) *fb*clodinafop 60 g/ha (PoE). However, pendimethalin 1000 g (PE) along with imazethapyr 75 g (PoE) and imazethapyr 75 g/ha (PoE) were at par with each other. While, lower fresh and dry weight of nodules/plant was recorded with pendimethalin 750g as PE along with quizalofop 60 g + oxyfluorfen 200 g/ha and pendimethalin 1000g as PE along with imazethapyr 75 g/ha + quizalofop 60 g/ha being at par recorded with other treatments *e.g.*oxyfluorfen 200 g/ha + quizalofop or clodinafop at 60 g/ha separately. With respect a combination of either quizalofop or clodinafop at 60 g/haeach tank mixed with oxyfluorfen 200 g/ha applied as post-emergence caused the lower fresh and dry weight of nodules/plant due to phytotoxic effect on crop plants to a greater extent.

**Table 1:** Effect of weed control treatments on fresh and dry weight of nodules per plant (mg) at different growth stages of chickpea

| Treatments | Fresh weight | | Dry weight | |
|---|---|---|---|---|
| | 45 DAS | 60 DAS | 45 DAS | 60 DAS |
| Pendimethalin 1000 g/ha (PE) | 752.00 | 1125.00 | 260.46 | 320.12 |
| Pendimethalin 1000 g(PE) *fb*quizalofop 60 g/ha ( PoE) | 819.00 | 1251.00 | 298.23 | 382.43 |
| Pendimethalin 1000 g(PE) *fb*clodinafop 60 g/ha ( PoE) | 873.00 | 1333.75 | 318.16 | 408.37 |
| Pendimethalin 750 g(PE) *fb*quizalafop 60 g + oxyfluorfen 200 g/ha (PoE) | 524.00 | 950.00 | 225.00 | 300.00 |
| Oxyfluorfen 200 g/ha (PE) | 630.00 | 874.00 | 239.44 | 307.33 |
| Oxyfluorfen 200 g (PE) *fb*quizalofop 60 g/ha(PoE) | 756.00 | 1003.00 | 392.00 | 325.45 |
| Oxyfluorfen 200 g (PE) *fb*clodinafop 60 g/ha (PoE) | 767.00 | 1072.50 | 302.00 | 376.06 |
| Oxyfluorfen 200 g + quizalofop 60 g/ha (PoE) | 585.00 | 960.00 | 236.16 | 256.00 |
| Oxyfluorfen 200 g + *fb*clodinafop 60 g/ha (PoE) | 590.00 | 978.00 | 242.00 | 303.00 |
| Imazethapyr 75 g/ha (PoE) | 648.90 | 1020.00 | 244.23 | 303.54 |
| Pendimethalin 1000 g (PE) *fb*imazethapyr 75 g/ha ( PoE) | 756.00 | 1155.00 | 275.52 | 353.64 |
| Pendimethalin 1000 g (PE) *fb*imazethapyr 75 g + quizalofop 60 g/ha (PoE) | 620.00 | 1020.00 | 245.00 | 307.33 |
| Weed free | 900.00 | 1375.00 | 328.00 | 421.00 |
| Weedy check | 666.00 | 1017.50 | 242.72 | 311.54 |
| LSD (p=5%) | 100.38 | 196.92 | 39.17 | 60.35 |

**Effect of herbicide phytotoxicity on crop**

The data pertaining to phytotoxic effect of weed control treatments on chickpea have been given in Table-2 and 3The visual observations on phytotoxicity of different herbicides on chickpea plants were recorded from 1-15 days after herbicides application (DAHA). A number of indicators *e.g.* crop discoloration, chlorosis, stunting and wilting of crop plants were taken into account. Phytotoxicity symptoms scoring and rating chart of chickpea having 0-10 scale was followed, where '0' denote no injury or normal and '10' denotes complete destruction of plants or plant parts. The tank mixed application of oxyfluorfen 200 g with either quizalofop or clodinafop at 60 g/ha each or imazethapyr 75 g + quizalofop 60 g/ha applied as only post-emergence treatments or as follow up with pendimethalin 1000 g or oxyfluorfen 200 g/ha applied as pre-emergence showed phytotoxicity symptom on crop plants within 1-15 DAHA. The phytotoxic symptoms observed from 3rd day after herbicide application (DAHA) in case of post-emergence herbicides and maximum toxicity observed at 7-10th day of application in case of pendimethalin750 g (PE) *fb*quizalafop 60 g + oxyfluorfen 200 g/ha (PoE) and oxyfluorfen200 g + quizalofop 60 g/ha (PoE) treatments where very severe toxicity (about 80 %) was observed followed by oxyfluorfen 200 g + *fb*clodinafop 60 g/ha (PoE) and pendimethalin 1000 g (PE) *fb*imazethapyr 75 g + quizalofop 60 g/ha(PoE), respectively. However, in case of treatments *viz.* imazethapyr75 g/ha (PoE), pendimethalin1000 g (PE) *fb*imazethapyr 75 g/ha( PoE) andpendimethalin1000 g (PE) *fb*imazethapyr 75 g + quizalofop 60 g/ha (PoE), slightly rejuvenation of crop plants (20-30 %) was recorded through visual observations. This recovery took place within fortnight period of crop growth after the appearance of toxicity.

The tank mixed application of quizalofop 60 g + oxyfluorfen 200g as PoE (T4) caused the very severe phytotoxicity (upto 80 %) to the crop and showed the discoloration, chlorosis of leaves and finally wilting the chickpea plant and symptoms observed from 3rd day of herbicide application and finally wilting was recorded at 10th day. Almost similar degree of phytotoxicity was recorded in case of oxyfluorfen 200 g followed by oxyfluorfen 200 g + clodinafop 60 g/ha having about 70 % toxicity. Ratnam *et al.* (2011) [6] also reported the type phytotoxic symptoms of herbicides on chickpea crop.

**Table 2:** Visual observation on phytotoxicity on chickpea due to different herbicides (Score 0-10)

| Treatments | Crop discolouration on DAHA | | | | | | Chlorosis on DAHA | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 3 | 5 | 7 | 10 | 15 | 1 | 3 | 5 | 7 | 10 | 15 |
| Pendimethalin 1000 g/ha (PE) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pendimethalin 1000 g(PE) *fb*quizalofop 60 g/ha ( PoE) | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pendimethalin 1000 g(PE) *fb*clodinafop 60 g/ha ( PoE) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pendimethalin 750 g(PE) *fb*quizalafop 60 g + oxyfluorfen 200 g/ha (PoE) | 0 | 1 | 2 | 7 | 8 | 3 | 0 | 2 | 2 | 4 | 8 | 8 |
| Oxyfluorfen 200 g/ha (PE) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oxyfluorfen 200 g (PE) *fb*quizalofop 60 g/ha(PoE) | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oxyfluorfen 200 g (PE) *fb*clodinafop 60 g/ha (PoE) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oxyfluorfen 200 g + quizalofop 60 g/ha (PoE) | 0 | 2 | 5 | 8 | 8 | 8 | 0 | 1 | 5 | 6 | 8 | 8 |
| Oxyfluorfen 200 g + *fb*clodinafop 60 g/ha (PoE) | 0 | 2 | 4 | 7 | 7 | 7 | 0 | 1 | 4 | 5 | 7 | 7 |
| Imazethapyr 75 g/ha (PoE) | 0 | 1 | 3 | 5 | 7 | 3 | 0 | 4 | 5 | 7 | 5 | 2 |
| Pendimethalin 1000 g (PE) *fb*imazethapyr 75 g/ha ( PoE) | 0 | 1 | 3 | 5 | 7 | 3 | 0 | 4 | 5 | 7 | 5 | 2 |
| Pendimethalin 1000 g (PE) *fb*imazethapyr 75 g + quizalofop 60 g/ha (PoE) | 0 | 1 | 3 | 7 | 8 | 4 | 0 | 4 | 5 | 8 | 6 | 3 |
| Weed free | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Weedy check | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

DAHA-Day after herbicide applied

**Number of branches/plant**

The data pertaining to number of branches/plant recorded at 60th and 90th day stages of crop growth have been presented in table-4. Pre-emergence of pendimethalin 1000 g/ha alone and in combination with quizalofop or clodinafop 60 g/ha as post-emergence each separately being at par and recorded significantly higher branches/plant than weedy check. Likewise oxyfluorfen 200 g PE alone and in combination with quizalofop and clodinafop 60 g/ha post-emergence each separately as well as treatment imazethapyr75 g/ha (PoE) and

pendimethalin 1000g (PE) *fb*imazethapyr 75 g/ha (PoE)recorded significantly higher number of branches/plantover treatment pendimethalin 750 g (PE) *fb*quizalafop 60 g + oxyfluorfen 200 g/ha(PoE), oxyfluorfen 200 g + quizalofop 60 g/ha(PoE) and oxyfluorfen 200 g + *fb*clodinafop 60 g/ha(PoE).

At 60th and 90th day stages of crop growth, weed free treatment did not show much difference as compared to pendimethalin 1000 g (PE) along with clodinafop 60 g (PoE), pendimethalin 1000 g/ha along with quizalofop 60 g (PoE), pendimethalin 1000 g (PE), pendimethalin 1000 g (PE) *fb*imazethapyr 75 g (PoE) and oxyfluorfen 200 g (PE) along with clodinafop 60 g/ha(PoE) being at par recorded significantly higher number of braches/plant as compared to weedy check.

The similar trend was observed at 90th day sage also. This may be because of the fact that treatments which have better weed control efficiency caused more horizontal crop growth as a result produced more number of branches/plant.

**Effect of yield**

All the weed-control measures had significantly positive impact on grain yield of chickpea over weedy check (table 4). The significantly highest values of Maximum reduction in seed yield (t/ha) were recorded in pre-emergence application of pendimethalin 750g *fb* with combined post-emergence application of quizalofop-ethyl 60g + oxyfluorfen 200g/ha (PoE) (0.47t/ha) at 35 DAS over weedy check (0.92t/ha) and significantly at par with post emergence application of oxyfluorfen 200g + quizalofop-ethyl 60g/ha (0.48 t/ha) at 35 DAS, and post-emergence application of oxyfluorfen 200g + clodinafop 60g/ha (PoE) (0.52 t/ha) treatment this is might be due to less reduction of weed and phyto-toxicity of herbicide in pendimethalin as pre-emergence followed by mix post-emergence of quizalofop-ethyl 60g + oxyfluorfen were less effective, and hindered during critical period of growth. (Ratnam. *et al* 2011) [6].

**Table 3:** Visual observation on phytotoxicity on chickpea due to different herbicides (Score 0-10)

| Treatments | Stunting on DAHA | | | | | | Wilting on DAHA | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 3 | 5 | 7 | 10 | 15 | 1 | 3 | 5 | 7 | 10 | 15 |
| Pendimethalin 1000 g/ha (PE) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pendimethalin 1000 g(PE) *fb*quizalofop 60 g/ha ( PoE) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pendimethalin 1000 g(PE) *fb*clodinafop 60 g/ha ( PoE) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pendimethalin 750 g(PE) *fb*quizalafop 60 g + oxyfluorfen 200 g/ha (PoE) | 0 | 1 | 2 | 8 | 8 | 8 | 0 | 2 | 3 | 8 | 8 | 8 |
| Oxyfluorfen 200 g/ha (PE) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oxyfluorfen 200 g (PE) *fb*quizalofop 60 g/ha(PoE) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oxyfluorfen 200 g (PE) *fb*clodinafop 60 g/ha (PoE) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oxyfluorfen 200 g + quizalofop 60 g/ha (PoE) | 0 | 0 | 5 | 8 | 8 | 8 | 0 | 2 | 3 | 8 | 8 | 8 |
| Oxyfluorfen 200 g + *fb*clodinafop 60 g/ha (PoE) | 0 | 1 | 2 | 5 | 7 | 7 | 0 | 2 | 3 | 7 | 7 | 7 |
| Imazethapyr 75 g/ha (PoE) | 0 | 0 | 0 | 1 | 2 | 3 | 0 | 0 | 0 | 1 | 0 | 0 |
| Pendimethalin 1000 g (PE) *fb*imazethapyr 75 g/ha ( PoE) | 0 | 0 | 0 | 1 | 2 | 3 | 0 | 0 | 0 | 1 | 0 | 0 |
| Pendimethalin 1000 g (PE) *fb*imazethapyr 75 g + quizalofop 60 g/ha (PoE) | 0 | 0 | 0 | 1 | 3 | 4 | 0 | 0 | 2 | 3 | 4 | 4 |
| Weed free | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pendimethalin 1000 g/ha (PE) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

DAHA: Days after herbicide applied

**Table 4:** Effect of weed control treatments on number of branches, yield, and economics of different weed control treatments in chickpea

| Treatments | Number of branches at | | Grain yield (q $ha^{-1}$) | Net return ($ha^{-1}$) | B:C ratio |
|---|---|---|---|---|---|
| | 60 DAS | 90 DAS | | | |
| Pendimethalin 1000 g/ha (PE) | 10.20 | 19.85 | 14.05 | 42313.05 | 1.88 |
| Pendimethalin 1000 g(PE) *fb*quizalofop 60 g/ha ( PoE) | 10.42 | 22.15 | 16.25 | 50448.05 | 2.05 |
| Pendimethalin 1000 g(PE) *fb*clodinafop 60 g/ha ( PoE) | 10.87 | 22.26 | 16.68 | 53588.05 | 2.24 |
| Pendimethalin 750 g(PE) *fb*quizalafop 60 g + oxyfluorfen 200 g/ha (PoE) | 6.25 | 11.10 | 4.78 | -3882.95 | -0.14 |
| Oxyfluorfen 200 g/ha (PE) | 9.20 | 19.98 | 13.25 | 37992.55 | 1.64 |
| Oxyfluorfen 200 g (PE) *fb*quizalofop 60 g/ha(PoE) | 9.38 | 21.16 | 15.45 | 46057.55 | 1.82 |
| Oxyfluorfen 200 g (PE) *fb*clodinafop 60 g/ha (PoE) | 9.74 | 21.60 | 15.85 | 48382.05 | 1.97 |
| Oxyfluorfen 200 g + quizalofop 60 g/ha (PoE) | 6.45 | 11.30 | 4.85 | -2407.95 | -0.09 |
| Oxyfluorfen 200 g + *fb*clodinafop 60 g/ha (PoE) | 6.75 | 11.75 | 5.25 | 4.05 | 0.00 |
| Imazethapyr 75 g/ha (PoE) | 9.16 | 20.10 | 12.50 | 35859.05 | 1.65 |
| Pendimethalin 1000 g (PE) *fb*imazethapyr 75 g/ha ( PoE) | 9.92 | 20.95 | 14.75 | 44835.05 | 1.94 |
| Pendimethalin 1000 g (PE) *fb*imazethapyr 75 g + quizalofop 60 g/ha (PoE) | 7.10 | 12.25 | 10.32 | 22617.55 | 0.89 |
| Weed free | 11.21 | 22.50 | 17.20 | 48989.10 | 1.62 |
| Weedy check | 8.30 | 17.60 | 9.22 | 22048.05 | 1.04 |
| LSD (p=5%) | 1.27 | 3.19 | 2.15 | 42313.05 | - |

**Effect of economics**

Maximum net monetary returns ( 53588.05/ha) and B:C ratio (2.24) were recorded in pre-emergence application of pendimethalin 1000g (PE) *fb* post emergence application of clodinafop 60g/haat 35 DAS by registering net monetary returns Rs 50448.05/ha and B:C ratio (2.05) in pre-emergence application of pendimethalin 1000 g *fb*by post emergence application of quizalofop-ethyl 60 g/haat 35 DAS, found to be the next best treatment and pre-emergence application of Pendimethalin 750 g followed by combined post-emergence application of quizalofop-ethyl 60g + oxyfluorfen 200g/haat 35 DAS and post emergence combined application of oxyfluorfen 200g + quizalofop-ethyl 60g/haat 35 DAS, the net monetary returns and B:C ratio were in negative because of high cost of cultivation (Pedde *et al.* 2013) [4].

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