

Original Research Article

Effect of herbicide on root nodules, phytotoxicity and economics of chickpea

ABSTRACT

The experiment was conducted during *Rabi* season 2011-12 at Agronomy Research Farm of N.D.U.A.&T., Kumarganj, Faizabad, Uttar Pradesh. To find suitable weed management practice for control of weeds in chickpea for increase the yield, net return and benefit cost ratio. The significantly highest values of fresh and dry weight of nodules per plant (mg) at 45 DAS and 60 DAS (day after sowing) 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 pre-emergence (PE) *fb* quizalofop 60 gha⁻¹ post emergence (PoE) plot and number of branches at 60 and 90 DAS was found highest in weed free plot (11.2122.50) respectively and found statically at par with pendimethalin 1000 gha⁻¹ PE, pendimethalin 1000g PE *fb* quizalofop 60 gha⁻¹ PoE and pendimethalin 1000 g PE *fb* clodinafop 60 gha⁻¹ PoE plot at 60 DAS and at 90 DAS significantly lowest value of number of branches (11.10) in pendimethalin 750 g PE *fb* quizalofop 60 g + oxyfluorfen 200 gha⁻¹ PoE plot. Pendimethalin 750 g PE *fb* quizalofop 60 g + oxyfluorfen 200 gha⁻¹ PoE and oxyfluorfen 200 g + quizalofop 60 gha⁻¹ PoE treatments where very severe toxicity (about 80 %) was observed followed by oxyfluorfen 200 g + *fb* clodinafop 60 gha⁻¹ PoE and pendimethalin 1000g PE *fb* imazethapyr 75g + quizalofop 60 gha⁻¹ PoE, respectively. The maximum reduction in seed yield of chickpea were recorded in pre-emergence application of pendimethalin 750g followed by combined PoE application of quizalofop-ethyl 60g + oxyfluorfen 200g ha⁻¹ at 35 DAS this was caused due to phytotoxicity among the herbicides under treatment. Maximum net monetary returns (₹ 53588.05 ha⁻¹) and B-C ratio (2.24) were recorded in PE application of pendimethalin 1000g and PoE application of clodinafop 60 gha⁻¹ and (2.05) obtained in PE application of pendimethalin 1000g and PoE application of quizalofop-ethyl 60 gha⁻¹ at 35 DAS and PE application of pendimethalin 750g followed by combined PoE application of quizalofop-ethyl 60g + oxyfluorfen 200g ha⁻¹ at 35 DAS and PoE application of oxyfluorfen 200g + quizalofop-ethyl 60g ha⁻¹ PoE the net monetary returns and B:C ratio were in negative.

Keywords: Economics, Herbicides, Phytotoxicity, Root nodulations and Weed control

INTRODUCTION

Chickpea (*Cicer arietinum*) is the topmost pulse crop and it covers around 92 percent area and 89 percent production in semiarid tropical countries (Rathore 2000). In India, the area, production and productivity of chickpea are 8.17 million hectares, 7.48 million tonnes and 915 kg ha⁻¹, respectively. The area under chickpea crop has reduced to 0.60 million hectares in 2012-13 from 1.06 million hectares in 1966-67 (Anonymous 2013) due to slow initial growth, it suffers badly by severe competition with weeds for nutrients, light, water and space, which results in heavy reduction in yield about 40-45 percent due to severe infestation of weeds (Singh and Singh 1992). It is a rich source of protein and therefore, agronomists desire to maximize its production while reducing or minimizing the use of herbicides. However, if herbicides are applied in chickpea field, nitrogen fixation and subsequently reduced the yield (Pahwa and Prakash 1992). Weeds cause a reduction in chickpea production about 40-90 percent, so herbicides are widely used (Ahlawat 2000). 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 herbicide on *Meso-rhizobium* with chickpea symbiosis, as a result, the fresh and dry weight of nodules plant⁻¹ (mg) decreases. Weed infestation in chickpea offers serious competition and causes yield reduction to the extent of 75 percent (Chaudhary *et al.* 2005). The initial 60 days period is considered being the critical for weed crop competition in chickpea (Singh and Singh 1992) but with the increase in labour cost and scarcity of labour, manual weed control has become a difficult task in chickpea. The herbicide application is an effective control of mixed weed flora, is required for better adoption in this crop by the farmers. Hence, present study was 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 chickpea.

MATERIALS AND METHODS

The experiment was conducted during *Rabi* season of the year 2011-12 at Agronomy Research Farm of N.D.U.A&T, Kumarganj, Faizabad, U.P., India. The soil of the experimental field was clay-

loam, low inorganic carbon available nitrogen and phosphorus, medium in potash and alkaline in reaction. Chickpea variety “PG-186” was sown in early second fortnight of November, 2011 at 40 cm row spacing and 4-5 cm deep by using the *Kudali*. The experiment was laid out in randomized block design with fourteen treatments combinations viz. T₁: Pendimethalin 1000 g ha⁻¹ (PE), T₂: Pendimethalin 1000 g (PE) fb quizalofop 60 g ha⁻¹ (PoE), T₃: Pendimethalin 1000 g (PE) fb clodinafop 60 g ha⁻¹ (PoE), T₄: Pendimethalin 750 g (PE) fb quizalofop 60 g + oxyfluorfen 200 g ha⁻¹ (PoE), T₅: Oxyfluorfen 200 g ha⁻¹ (PE), T₆: Oxyfluorfen 200 g (PE) fb quizalofop 60 g ha⁻¹ (PoE), T₇: Oxyfluorfen 200 g (PE) fb clodinafop 60 g ha⁻¹ (PoE), T₈: Oxyfluorfen 200 g + quizalofop 60 g ha⁻¹ (PoE), T₉: Oxyfluorfen 200 g + fb clodinafop 60 g ha⁻¹ (PoE), T₁₀: Imazethapyr 75 g ha⁻¹ (PoE), T₁₁: Pendimethalin 1000 g (PE) fb imazethapyr 75 g ha⁻¹ (PoE), T₁₂: Pendimethalin 1000 g (PE) fb imazethapyr 75 g + quizalofop 60 g ha⁻¹ (PoE), T₁₃: Weed free, and T₁₄: Weedy check replicated in thrice. Two hands weeding was done in weed free plot except all treatments. A uniform dose of fertilizers 20-40-40, N-P₂O₅-K₂O kg ha⁻¹ was applied at the time of sowing in furrows. Pre-plant incorporation and PE herbicide 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 quadrat 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

Growth parameters

Fresh and dry weight: The evident of presented in Figure 1 the both 45 and 60 DAS, post-emergence application of either clodinafop or quizalofop 60 g ha⁻¹ each in the plots and pre-emergence application of either pendimethalin 1000 g ha⁻¹ recorded significantly higher fresh and dry weight of nodules plant⁻¹ as compared to the single applied herbicide treatment like pendimethalin 1000 g ha⁻¹ PE and oxyfluorfen 200 g ha⁻¹ PE. While imazethapyr 75 g ha⁻¹ as PoE and pendimethalin 1000 g PE fb imazethapyr 75 g ha⁻¹ recorded at par to each other with respect to fresh and dry weight of nodules. However, pendimethalin 1000 g fb quizalofop 60 g + oxyfluorfen 200 g, oxyfluorfen 200 g + quizalofop 60 g ha⁻¹, oxyfluorfen 200 g + clodinafop 60 g ha⁻¹ and pendimethalin 1000 g as PE fb imazethapyr 75 g + quizalofop 60 g ha⁻¹ as PoE recorded lower values of fresh and dry weight of nodules which were at

part to each other. These findings are in the conformity as reported by Nandan *et al.* (2011) and Singh *et al.* (2011).

Phytotoxicity: The data relating to phytotoxic effect of weed control treatments on chickpea have been given in Table 1. The tank mixed application of oxyfluorfen 200 g with either quizalofop or clodinafop 60 g ha⁻¹ each or imazethapyr 75 g + quizalofop 60 g ha⁻¹ applied as only post-emergence treatments or as follow up with pendimethalin 1000 g or oxyfluorfen 200 g ha⁻¹ applied as PE showed phytotoxicity symptom on crop plants within 1-15 DAHA. The phytotoxic symptoms observed from 3rd DAHA in case of PoE herbicides and maximum toxicity observed at 7-10 days of application in case of pendimethalin 750 g PE + quizalofop 60 g + oxyfluorfen 200 g ha⁻¹ PoE and oxyfluorfen 200 g + quizalofop 60 g ha⁻¹ PoE.

treatments where very severe toxicity about 80 percent was observed followed by oxyfluorfen 200 g + clodinafop 60 g ha⁻¹ PoE and pendimethalin 1000 g PE + imazethapyr 75 g + quizalofop 60 g ha⁻¹ PoE, respectively. However, in case of treatments viz. imazethapyr 75 g ha⁻¹ PoE, pendimethalin 1000 g PE + imazethapyr 75 g ha⁻¹ PoE and pendimethalin 1000 g PE + imazethapyr 75 g + quizalofop 60 g ha⁻¹ 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 200 g as PoE 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 3 DAHA and finally wilting was recorded at 10 DAHA. Almost similar degree of phytotoxicity was recorded in case of oxyfluorfen 200 g followed by oxyfluorfen 200 g + clodinafop 60 g ha⁻¹ having (about 70 %) toxicity. Ratnam *et al.* (2011) also reported the type phytotoxic symptoms of herbicides on chickpea crop.

Number of branches: The data pertaining to number of branches plant⁻¹ recorded at 60 and 90 DAS stages of crop growth have been presented in figure 2. Pre-emergence of pendimethalin 1000 g ha⁻¹ alone and in combination with quizalofop or clodinafop 60 g ha⁻¹ as a PoE each separately being at par and recorded significantly higher branches plant⁻¹ than weedy check. Likewise, oxyfluorfen 200 g PE alone and in combination with quizalofop and clodinafop 60 g ha⁻¹ PoE each separately as well as treatment imazethapyr 75 g ha⁻¹ PoE and pendimethalin 1000 g PE + imazethapyr 75 g ha⁻¹ PoE recorded significantly higher number of branches plant⁻¹.

¹overtreatment pendimethalin 750g PE / fb quizalofop 60 g + oxyfluorfen 200 g ha⁻¹ PoE, oxyfluorfen 200 g + quizalofop 60 g ha⁻¹ PoE and oxyfluorfen 200 g + fb clodinafop 60g ha⁻¹ PoE. At 60 and 90

DAS 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⁻¹ along with quizalofop 60 g PoE, pendimethalin 1000g PE, pendimethalin 1000g PE / fb imazethapyr 75 g PoE and oxyfluorfen 200 g PE along with clodinafop 60g ha⁻¹ PoE being at par recorded significantly higher number of branches plant⁻¹ as compared to weedy check. The similar trend was observed at 90th day stage also (Pahwa and Prakash, 1992). This may be because of the fact that treatments which have better weed control efficiency caused more horizontal crop growth as a result produced a greater number of branches plant⁻¹.

YIELD

All the weed-control measures had significantly positive impact on grain yield of chickpea over weedy check (Figure no. 2). The significantly highest values of Maximum reduction in seed yield (tha⁻¹) were recorded in pre-emergence application of pendimethalin 750g / fb with combined post-emergence application of quizalofop-ethyl 60g + oxyfluorfen 200g ha⁻¹ PoE (0.47tha⁻¹) at 35 DAS over weedy check (0.92tha⁻¹) and significantly at par with post-emergence application of oxyfluorfen 200g + quizalofop-ethyl 60g ha⁻¹ (0.48 tha⁻¹) at 35 DAS, and post-emergence application of oxyfluorfen 200g + clodinafop 60g ha⁻¹ PoE (0.52 tha⁻¹) 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).

ECONOMICS

The data is evident from figure no. 2 maximum net monetary returns (₹ 53588.05ha⁻¹) and B:C ratio (2.24) were recorded in pre-emergence application of pendimethalin 1000g (PE) / fb post-emergence application of clodinafop 60g ha⁻¹ at 35 DAS by registering net monetary returns ₹ 50448.05ha⁻¹ and B:C ratio (2.05) in pre-emergence application of pendimethalin 1000g / fb by PoE application of quizalofop-ethyl 60g ha⁻¹ at 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 200 g ha⁻¹ at

35DAS and post-emergence combined application of oxyfluorfen 200g + quizalofop-ethyl 60g ha⁻¹ at 35DAS, then net monetary returns and B:C ratio were in negative because of high cost of cultivation (Pedde *et al.* 2013).

CONCLUSION

The PE application of pendimethalin 1000 g ha⁻¹ along with PoE application of either clodinafop propargyl 60 g ha⁻¹ or quizalofop ethyl 60 g ha⁻¹ proved superior over rest of the treatments with respect to fresh weight, dry weight, number of branches, grain yield, B-C ratio, net returns and economics of chickpea followed by oxyfluorfen 200 g ha⁻¹ as PE along with PoE application of clodinafop propargyl or quizalofop ethyl 60 g ha⁻¹ each. However, PoE application of tank mixed herbicides caused the phytotoxicity to the chickpea.

REFERENCES:

- Ahlawat, I.P.S. (2000). Bengalgram. In P.S. Rathore (Ed.), *Technique and management of field crop production* (pp. 317-335). New Delhi, India: Agrobios publications.
- Chaudhary, B.M., Patel, J.J., & Devadia, D.R. (2005). Effect of weed management practices and seed rates on weeds and yield of chickpea. *Indian Journal of Weed Science*, 37(3-4), 271-272.
- Nandan, Brij; Sharma, B.C.; Kumar, Anil and Sharma, Vikas (2011). Efficacy of pre and post-emergence herbicides on weed flora of urd bean under rainfed subtropical Shiwalik foothills of Jammu & Kashmir. *Indian Journal of Weed Science*, 43 (3&4) :172-174.
- Pahwa, S.K., & Prakash, J. (1992). Effects of some herbicides on the growth, nodulation and nitrogen fixation in chickpea (*Cicer arietinum L.*). *Indian Journal Plant Physiology*, 35, 207-212.
- Pedde, K.C. (2013). Integrated weed management in chickpea. *Indian Journal of Weed Science*, 45(4), 299.
- Rathore, P.S. (2000). Techniques and management of field crop production. In *Bengalgram* (pp. 336-340). Jodhpur, India: Agrobios.
- Ratnam, M., Rao, A.S., & Reddy, T.Y. (2011). Integrated Weed Management in Chickpea (*Cicer arietinum L.*). *Indian Journal of Weed Science*, 43(1-2), 70-72.

Singh, G., & Singh, D. (1992). Weed-crop competition studies in chickpea. *Indian Journal of Weed Science*, 24, 1-5.

Singh, V.K.; Dixit, Vivek; Singh, R. and Barthwal, Ashutosh (2011). Efficacy of mechanical, cultural and chemical methods on weed suppression and yield of lentil. *Indian Journal of Weed Science*, 43 (3 & 4) : 192-194.

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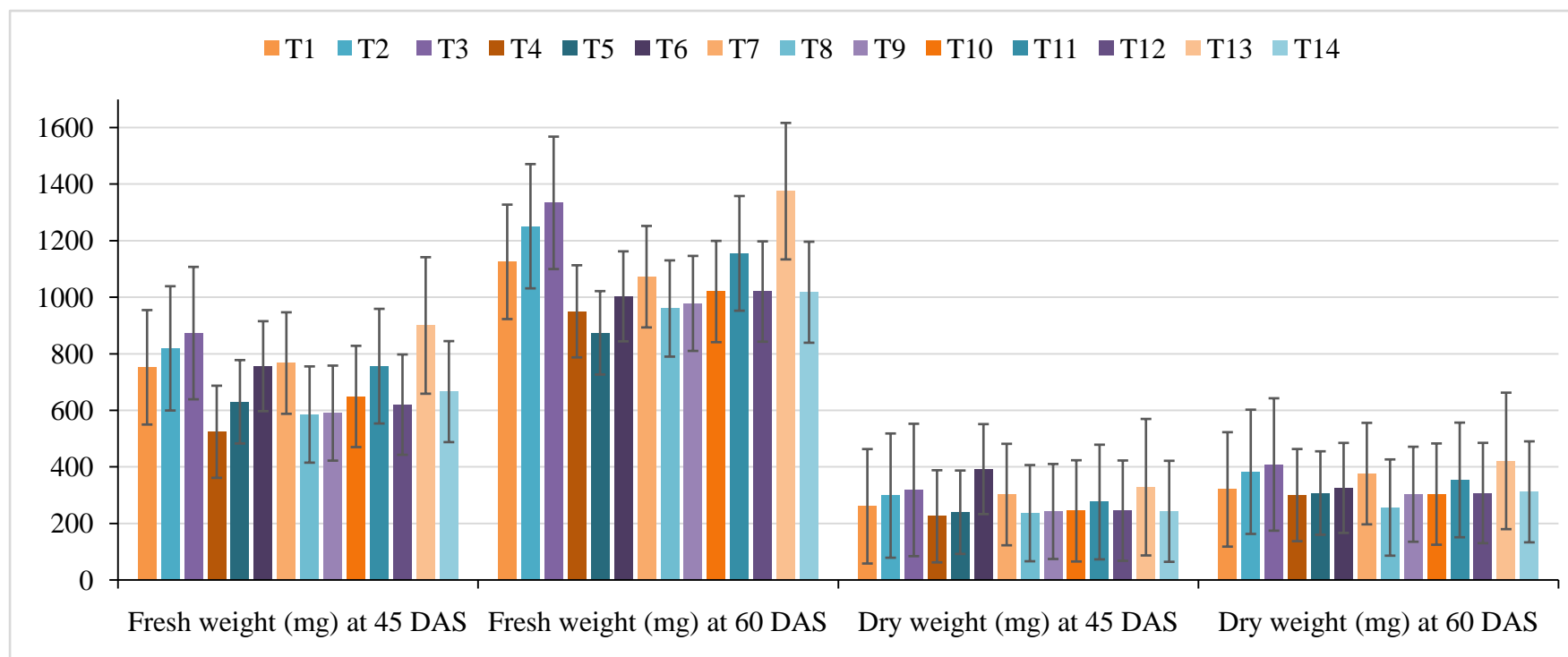


Figure no.1: Effect of weed control treatments on fresh and dry weight of nodules per plant at 45 and 60 DAS of chickpea

T₁: Pendimethalin 1000 g ha⁻¹ (PE), T₂: Pendimethalin 1000 g (PE) fb quizalofop 60 g ha⁻¹ (PoE), T₃: Pendimethalin 1000 g (PE) fb clodinafop 60 g ha⁻¹ (PoE), T₄: Pendimethalin 750 g (PE) fb quizalofop 60 g + oxyfluorfen 200 g ha⁻¹ (PoE), T₅: Oxyfluorfen 200 g ha⁻¹ (PE), T₆: Oxyfluorfen 200 g (PE) fb quizalofop 60 g ha⁻¹ (PoE), T₇: Oxyfluorfen 200 g (PE) fb clodinafop 60 g ha⁻¹ (PoE), T₈: Oxyfluorfen 200 g + quizalofop 60 g ha⁻¹ (PoE), T₉: Oxyfluorfen 200 g + fb clodinafop 60 g ha⁻¹ (PoE), T₁₀: Imazethapyr 75 g ha⁻¹ (PoE), T₁₁: Pendimethalin 1000 g (PE) fb imazethapyr 75 g ha⁻¹ (PoE), T₁₂: Pendimethalin 1000 g (PE) fb imazethapyr 75 g + quizalofop 60 g ha⁻¹ (PoE), T₁₃: Weed free, and T₁₄: Weedy check.

Table1: Visual observation on phytotoxicity on chickpea due to different herbicides (Score 0-10)

Treatments	Crop discoloration on DAHA						Chlorosis on DAHA						Stunting on DAHA						Wilting on DAHA					
	01	03	05	07	10	15	01	03	05	07	10	15	01	03	05	07	10	15	01	03	05	07	10	15
Pendimethalin 1000 g ha ⁻¹ (PE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pendimethalin 1000 g (PE) fb quizalofop 60 g ha ⁻¹ (PoE)	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pendimethalin 1000 g (PE) fb clodinafop 60 g ha ⁻¹ (PoE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pendimethalin 750 g (PE) fb quizalofop 60 g + oxyfluorfen 200 g ha ⁻¹ (PoE)	0	1	2	7	8	3	0	2	2	4	8	8	0	1	2	8	8	8	0	2	3	8	8	8
Oxyfluorfen 200 g ha ⁻¹ (PE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxyfluorfen 200 g (PE) fb quizalofop 60 g ha ⁻¹ (PoE)	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxyfluorfen 200 g (PE) fb clodinafop 60 g ha ⁻¹ (PoE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxyfluorfen 200 g + quizalofop 60 g ha ⁻¹ (PoE)	0	2	5	8	8	8	0	1	5	6	8	8	0	0	5	8	8	8	0	2	3	8	8	8
Oxyfluorfen 200 g + fb clodinafop 60 g ha ⁻¹ (PoE)	0	2	4	7	7	7	0	1	4	5	7	7	0	1	2	5	7	7	0	2	3	7	7	7
Imazethapyr 75 g ha ⁻¹ (PoE)	0	1	3	5	7	3	0	4	5	7	5	2	0	0	0	1	2	3	0	0	0	1	0	0
Pendimethalin 1000 g (PE) fb imazethapyr 75 g ha ⁻¹ (PoE)	0	1	3	5	7	3	0	4	5	7	5	2	0	0	0	1	2	3	0	0	0	1	0	0
Pendimethalin 1000 g (PE) fb imazethapyr 75 g + quizalofop 60 g ha ⁻¹ (PoE)	0	1	3	7	8	4	0	4	5	8	6	3	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	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	0	0	0	0	0	0	0	0	0	0	0	0

DAHA=Day after herbicide applied

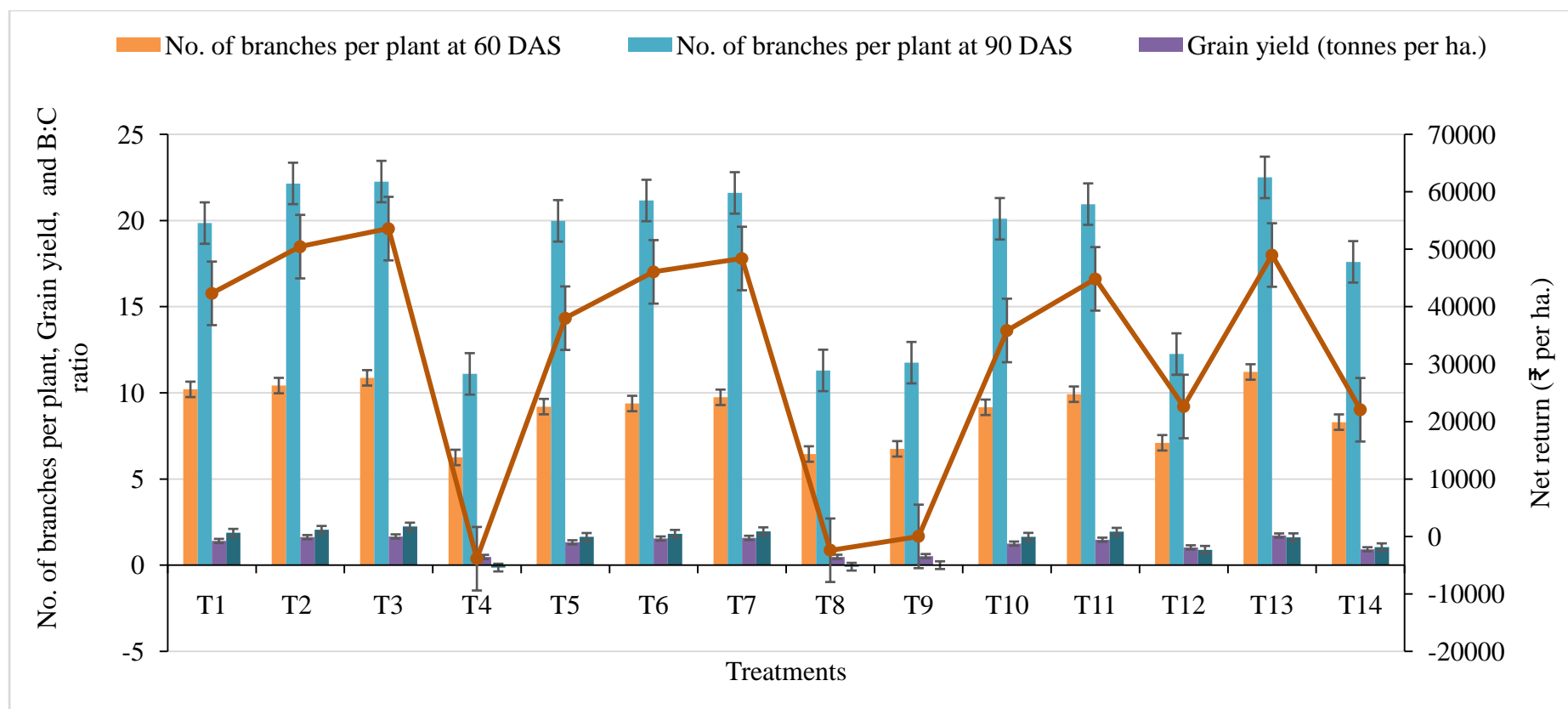


Figure No. 2: Effect of herbicides on number of branches, yield, and economics of chickpea

T₁: Pendimethalin 1000 g ha⁻¹ (PE), T₂: Pendimethalin 1000 g (PE) fb quizalofop 60 g ha⁻¹ (PoE), T₃: Pendimethalin 1000 g (PE) fb clodinafop 60 g ha⁻¹ (PoE), T₄: Pendimethalin 750 g (PE) fb quizalofop 60 g + oxyfluorfen 200 g ha⁻¹ (PoE), T₅: Oxyfluorfen 200 g ha⁻¹ (PE), T₆: Oxyfluorfen 200 g (PE) fb quizalofop 60 g ha⁻¹ (PoE), T₇: Oxyfluorfen 200 g (PE) fb clodinafop 60 g ha⁻¹ (PoE), T₈: Oxyfluorfen 200 g + quizalofop 60 g ha⁻¹ (PoE), T₉: Oxyfluorfen 200 g + fb clodinafop 60 g ha⁻¹ (PoE), T₁₀: Imazethapyr 75 g ha⁻¹ (PoE), T₁₁: Pendimethalin 1000 g (PE) fb imazethapyr 75 g ha⁻¹ (PoE), T₁₂: Pendimethalin 1000 g (PE) fb imazethapyr 75 g + quizalofop 60 g ha⁻¹ (PoE), T₁₃: Weed free, and T₁₄: Weedy check.

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