



Performance of Various Chemicals Weed Management in Chickpea an Irrigated Environment

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Chickpea is additional sensitive to weed competition than other crops. During early stages of crop growth competition is more severe because of slow growth rate and leaf area development. Weeds have been blamed for losses in India that range from 40 to 90 percent. Thus, adopting an effective weed management strategy is the only way to significantly increase chickpea yield. The experiment was conducted during *Rabi* season of 2011-12 at Agronomy Research Farm of NDU&T, Kumarganj, Ayodhya, Uttar Pradesh. The experiment was laid out in randomized block design with fourteen weed management treatments and replicated in thrice. According to the findings, weed management methods significantly affect the number of nodules, nutrient (N, P, K) uptake, yields, and economics of chickpea over weedy check at growth stage. Maximum yield (1.72 t ha⁻¹) and nutrient uptake (N- 63.60, P- 9.09 and K- 74.39 kg ha⁻¹) by chickpea were recorded in weed free treatment but maximum nitrogen, phosphorous and potassium (23.22, 2.68 and 50.42 kg ha⁻¹) uptake by weed were obtained in weedy check treatment and lowest in weed free treatment.

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1. INTRODUCTION

“Chickpea (*Cicer arietinum* L.) is an important pulse crop in India. The area under chickpea crop is 1.06 million hectares in 1966-67 and decreased to 0.60 million hectares in 2014-15 due to suffers badly by severe weeds competition for nutrients, light, water and space resulting slow initial growth” [1]. Due to severe infestation of weeds about 40-45% yield reduction in chickpea noted by Singh and Singh [2] whereas, Chaudhary et al., [3] up-to-date that 75% reduction in yield because of severe weeds competition with chickpea. One of the main causes limiting yields is poor weed control. Other factors include a lack of promising cultivars, ineffective fertilization, pest and disease infestations, and inappropriate fertilizing. “The first 60 days are thought to be the most important for weed competition with chickpea” (Singh and Singh [2] But continuing to deal with the labor shortage and rising cost of manual weed control has become a challenging challenge. For farmers to use this crop more successfully, the greatest alternative for controlling mixed weed flora is chemical weed management. These herbicides have made it possible to efficiently control a variety of weeds in pulses at a profitable price. The various researcher from different parts of the country has been reported that the application of pendimethalin as pre-emergence (PE) at 1.0 kg ha⁻¹ (Tewari et al., [4] and Vaishya et al.,[5] imazethapyras as a post-emergence (PoE) at 0.1 kg ha⁻¹ (Singh et al.,[6] cloinafop-propargyl (Topic 15 WP) as PoE at 0.03 kg ha⁻¹ (Marwat et al.,[7] and oxyfluorfen (600 g ha⁻¹) (Yousefi et al., [8] supplied chickpeas with efficient weed control for annual broadleaf and grassy weeds. There is no herbicide that can be applied as PoE to successfully control the emergent BLWs in chickpea, however pendimethalin at 1000 g ha⁻¹ applied as PE is a fairly common herbicide that is used to treat all types of weeds. Even if the PE herbicide treatment is skipped for any reason, it is still imperative to use PoE herbicide to manage both grassy and non-grassy weeds. There is currently no herbicide available that can be applied as PoE in pulses, notably chickpea, to control weeds, particularly BLWs. Although hand weeding has been proven to be quite effective, the lesser no of labor availability and higher cost raise severe concerns. Some very high-potency herbicide compounds have been created recently, and if these molecules are used in

combination, they may be more effective at controlling a variety of weeds, including those that affect chickpea. Weeds germinate and grow quickly in chickpea fields over numerous flushes, making the application of a single herbicide ineffective and expensive in these circumstances. Given this information, a field experiment involving the sequential and tank-mixed application of two or more herbicides was suggested to determine the most appropriate and efficient weed management technique for the chickpea during the crucial period of crop-weed interference.

2. MATERIALS AND METHODS

The experiment was carried out during *Rabi* season in 2011-2012 at Agronomy Research Farm of NDU&T, Ayodhya, Uttar Pradesh, India, situated at 26°47' N latitude, 82 °12' E longitude and an altitude is 113 meters above from mean sea level. Average minimum and maximum temperatures ranged from 5.0 °C to 15.1 °C and 15.3 °C to 32.1 °C respectively whereas, total 86.0 mm rainfall was received during the crop season. The soil conditions of the experimental field were alkaline in reaction, silt-loam, low in available nitrogen, phosphorus, organic carbon and medium in potash. The variety of chickpea is “PG-186” was sown at 4-5 cm deep with 40 cm rows spacing. The experiment was laid out in randomized block design with fourteen treatments combination replicated in thrice, 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, T₁₄: Weedy check. “Two hands weeding was done in weed free plot except weedy check. A uniform dose of fertilizers 20:40:40 N, P₂O₅, K₂O kg ha⁻¹ was applied at the time of sowing in furrows. PE herbicides were applied one day 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* when required in weed free treatment. Number of nodules was rerecorded at 45th, 60th, 75th, 90th day stages of crop growth. After harvesting yield of crop calculated by per plot basis and then it converted into t ha⁻¹ after that economics of different treatments was calculated”.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Number of root nodules: Every weed-control strategy significantly increased the amount of chickpea root nodules over weedy check at growth stage. (Table 1). “The highest number of root nodules was observed in weed free plot over weedy check over the herbicide treated plot there was a lesser number of root nodules at 45, 60, 75 and 90 DAS. While at 45 and 90 DAS the fewest number of root nodules was observed in PoE application of oxyfluorfen 200g fb by clodinafop 60g ha⁻¹ at 35 DAS. While the fewest root nodules were seen in the PoE application of oxyfluorfen 200g ha⁻¹ (PE) at 30 DAS at 60 and 75 DAS” [9]. This outcome could be caused by the herbicide's harmful effects on chickpea, which interfere with the growth of nodules in roots. Although weed-free conditions purportedly allowed for root growth and bacterial colonies, which ultimately led to increased crop nodulation, better weed control methods. A nearly same

trend was noted at the 60th day stage as well. When nodulation stopped and nodule drying began, the number of nodules in plant⁻¹ decreased during the 75th and 90th day stages, respectively. The above findings are agreement with the results of Vaishya et al., [10].

Nutrient (NPK) uptake by crop and weeds:

Data presented in Table 2 Maximum nitrogen, phosphorous and potassium (63.60, 9.09 and 74.39 kg ha⁻¹) uptake by chickpea were recorded in weed free treatment and among all the treatments, nitrogen (18.71 kg ha⁻¹) and potassium (22.63 kg ha⁻¹) uptake in PE of pendimethalin 750 g fb combined PoE application of quizalafop 60 g + oxyfluorfen 200 g ha⁻¹ at 35 DAS and Phosphorous (2.61 kg ha⁻¹) uptake in PoE of oxyfluorfen 200 g + quizalafop 60 g ha⁻¹ at 35 DAS. But maximum nitrogen, phosphorous and potassium (23.22, 2.68 and 50.42kg ha⁻¹) uptake by weed (Table 2) in weedy check and lowest in weed free treatment. “Among all the herbicidal treatment minimum nutrient (nitrogen, phosphorous and potassium) (1.86, 0.21 and 3.86 kg ha⁻¹) uptake in PE application of pendimethalin 750 g (PE) fb combined PoE application of quizalafop 60g + oxyfluorfen 200 g ha⁻¹ at 35 DAS” [11]. It could be as a result of BLWs having higher dry weight and nutrients than grassy weeds. These outcomes are consistent with Azad and Singh's research [12].

Table 1. Number of nodules per plant at different growth stages of chickpea in different weed control measures

Treatments	45 DAS	60 DAS	75 DAS	90 DAS
T ₁ : Pendimethalin 1000 g ha ⁻¹ (PE)	10.30	13.45	13.00	11.22
T ₂ : Pendimethalin 1000 g (PE) fb quizalofop 60 g ha ⁻¹ (PoE)	12.10	16.32	13.38	10.85
T ₃ : Pendimethalin 1000 g (PE) fb clodinafop 60 g ha ⁻¹ (PoE)	13.30	17.98	14.75	11.96
T ₄ : Pendimethalin 750 g (PE) fb quizalofop 60 g + oxyfluorfen 200 g ha ⁻¹ (PoE)	8.49	11.91	11.41	9.25
T ₅ : Oxyfluorfen 200 g ha ⁻¹ (PE)	9.10	10.53	10.10	9.00
T ₆ : Oxyfluorfen 200 g (PE) fb quizalofop 60 g ha ⁻¹ (PoE)	10.70	13.16	10.80	8.75
T ₇ : Oxyfluorfen 200 g (PE) fb clodinafop 60 g ha ⁻¹ (PoE)	11.10	14.46	11.86	9.62
T ₈ : Oxyfluorfen 200 g + quizalofop 60 g ha ⁻¹ (PoE)	8.15	11.20	10.95	8.88
T ₉ : Oxyfluorfen 200 g + fb clodinafop 60 g ha ⁻¹ (PoE)	8.14	10.86	10.55	8.75
T ₁₀ : Imazethapyr 75 g ha ⁻¹ (PoE)	9.60	13.37	11.95	9.80
T ₁₁ : Pendimethalin 1000 g (PE) fb imazethapyr 75 g ha ⁻¹ (PoE)	10.70	15.57	12.78	10.36
T ₁₂ : Pendimethalin 1000 g (PE) fb imazethapyr 75 g + quizalofop 60 g ha ⁻¹ (PoE)	8.26	12.20	11.10	9.00
T ₁₃ : Weed free	13.90	18.54	15.21	12.33
T ₁₄ : Weedy check	9.30	13.72	11.26	9.12
SEm±	0.52	0.87	0.68	0.49
CD at 5%	1.50	2.52	1.97	1.42

CD= Critical difference, SEm= standard error of mean

Table 2. N, P and K (kg ha⁻¹) uptake by crop and weeds in weed control treatments

Treatments	Uptake by crop			Uptake by weed		
	N	P	K	N	P	K
T ₁ : Pendimethalin 1000 g ha ⁻¹ (PE)	52.01	7.51	61.75	5.91	0.65	12.23
T ₂ : Pendimethalin 1000 g (PE) fb quizalofop 60 g ha ⁻¹ (PoE)	60.82	8.57	72.32	3.99	0.46	8.55
T ₃ : Pendimethalin 1000 g (PE) fb clodinafop 60 g ha ⁻¹ (PoE)	61.72	8.86	72.11	3.14	0.36	6.54
T ₄ : Pendimethalin 750 g (PE) fb quizalofop 60 g + oxyfluorfen 200 g ha ⁻¹ (PoE)	18.71	2.63	22.63	1.86	0.21	3.86
T ₅ : Oxyfluorfen 200 g ha ⁻¹ (PE)	48.91	6.95	58.14	6.23	0.70	13.17
T ₆ : Oxyfluorfen 200 g (PE) fb quizalofop 60 g ha ⁻¹ (PoE)	57.35	8.23	68.18	4.57	0.50	9.52
T ₇ : Oxyfluorfen 200 g (PE) fb clodinafop 60 g ha ⁻¹ (PoE)	58.56	8.30	69.26	3.63	0.40	7.61
T ₈ : Oxyfluorfen 200 g + quizalofop 60 g ha ⁻¹ (PoE)	18.87	2.61	23.14	2.38	0.27	5.11
T ₉ : Oxyfluorfen 200 g + fb clodinafop 60 g ha ⁻¹ (PoE)	20.13	2.85	24.56	2.76	0.31	5.63
T ₁₀ : Imazethapyr 75 g ha ⁻¹ (PoE)	46.16	6.54	54.66	6.04	0.69	12.67
T ₁₁ : Pendimethalin 1000 g (PE) fb imazethapyr 75 g ha ⁻¹ (PoE)	54.84	7.74	64.92	2.17	0.25	4.73
T ₁₂ : Pendimethalin 1000 g (PE) fb imazethapyr 75 g + quizalofop 60 g ha ⁻¹ (PoE)	38.75	5.44	46.39	1.18	0.13	2.50
T ₁₃ : Weed free	63.60	9.09	74.39	0.00	0.00	0.00
T ₁₄ : Weedy check	36.00	5.08	46.57	23.22	2.68	50.42
SEm±	2.82	0.40	3.35	0.28	0.03	0.59
CD at 5%	8.20	1.16	9.74	0.81	0.09	1.73

CD= Critical difference, SEm= standard error of mean

3.2 Yield Attributes and Yield

It is evident from the data presented in Fig. 1. when compared to the weedy check at all stages of crop growth, the crop's dry matter accumulation was noticeably increased by the various treatments. With the exception of a few cases when crop phytotoxicity was noted, all of the treatment combinations demonstrated increased dry matter accumulation when compared to the application of a single treatment. The combination application of the treatment pendimethalin 1000 g (PE) fb clodinafop 60 g ha⁻¹ (PoE) displayed effective control of BLWs as well as grassy. However, a single herbicide, such as pendimethalin or oxyfluorfen, may efficiently eradicate both types of weeds at an early stage, but weeds that grew at a later stage could eventually compete with the crop, lowering the crop's dry weight and yield levels. There was no discernible difference in the weight of 100 seeds (g) at the harvest stage of chickpeas, which may have encouraged better use of the available resources, such as nutrients, light, water, and space, by suppressing fewer weeds during the crucial phase of crop weed competition. These outcomes support the conclusions of

(Dungerwal et al., [13]. The Maximum lessening in straw and grain yield were recorded in PE application of pendimethalin 750 g ha⁻¹fb combined PoE application of quizalofop-ethyl 60 g + oxyfluorfen 200 g ha⁻¹ (PoE) (0.47 and 0.94 t ha⁻¹) at 35 DAS over weedy check (0.92 and 1.80 t ha⁻¹) and significantly at par with PoE application of oxyfluorfen 200g + quizalofop-ethyl 60 g ha⁻¹ (0.48 and 0.96 t ha⁻¹) at 35 DAS and PoE application of oxyfluorfen 200g + clodinafop 60 g ha⁻¹ (PoE) (0.52 and 1.00 t ha⁻¹), this might be brought on by the herbicides' phytotoxic effects on crop plants and the insufficient removal of weeds from the field. During the key stage of growth, pendimethalin as PE and a mix PoE of 60 g of quizalofop-ethyl and oxyfluorfen were less effective and impeded. The portion of total biomass (total dry matter accumulation) that becomes accessible as economic yield is known as the grain yield. The bio-physiological processes and the source-sink relationship culminate in the grain yield. Different yield variables, such as the number of pods plant⁻¹, the number of grains pod⁻¹, the weight of the grains pod⁻¹, and the weight 100 grains⁻¹, all contribute to the grain yield. In terms of stover yield, it is the outcome of growth characteristics such as plant

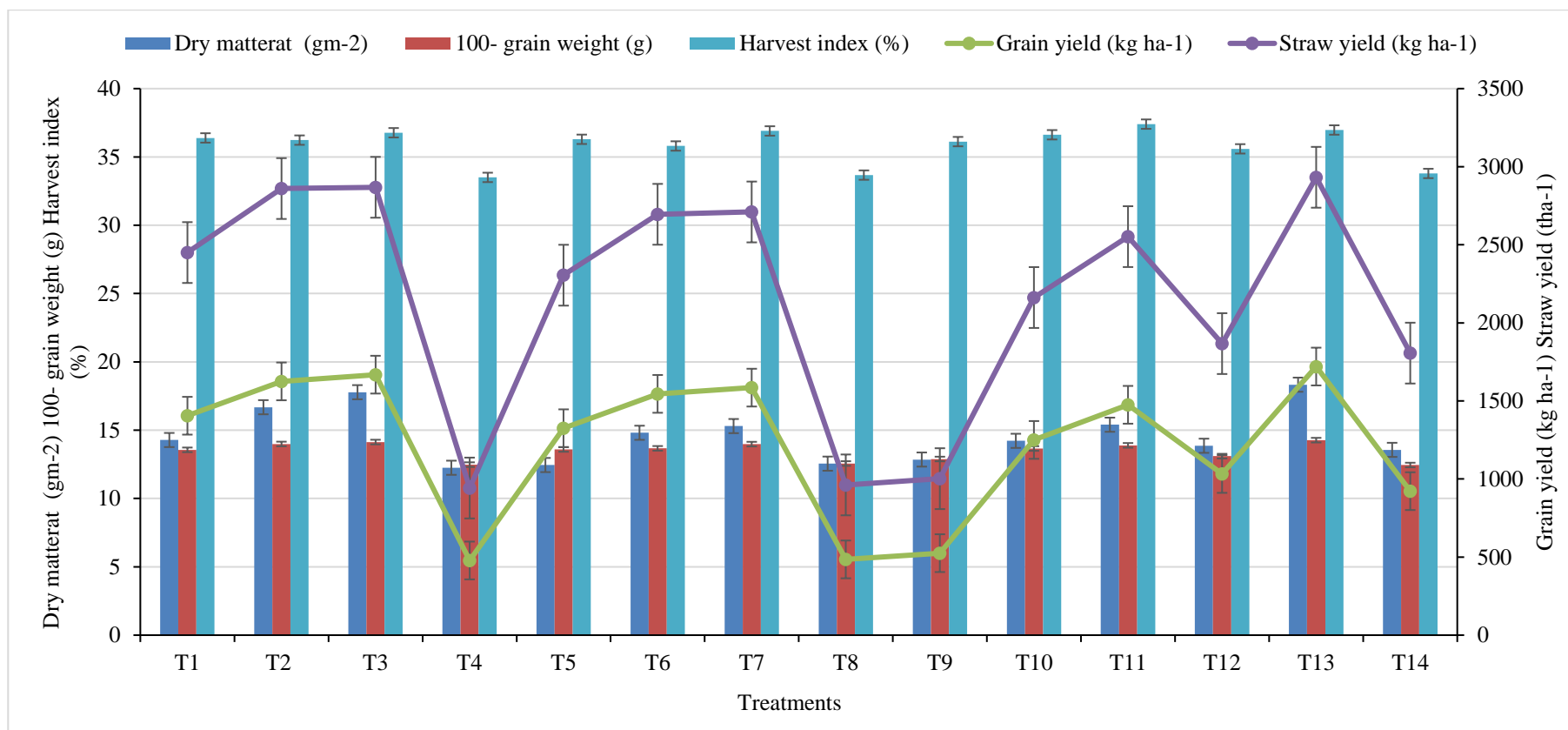


Fig. 1. Effect of herbicides on dry matter (gm^{-2}), 100- grain weight (g), harvest index (%), grain yield (kg ha^{-1}) and straw yield (tha^{-1}) of chickpea

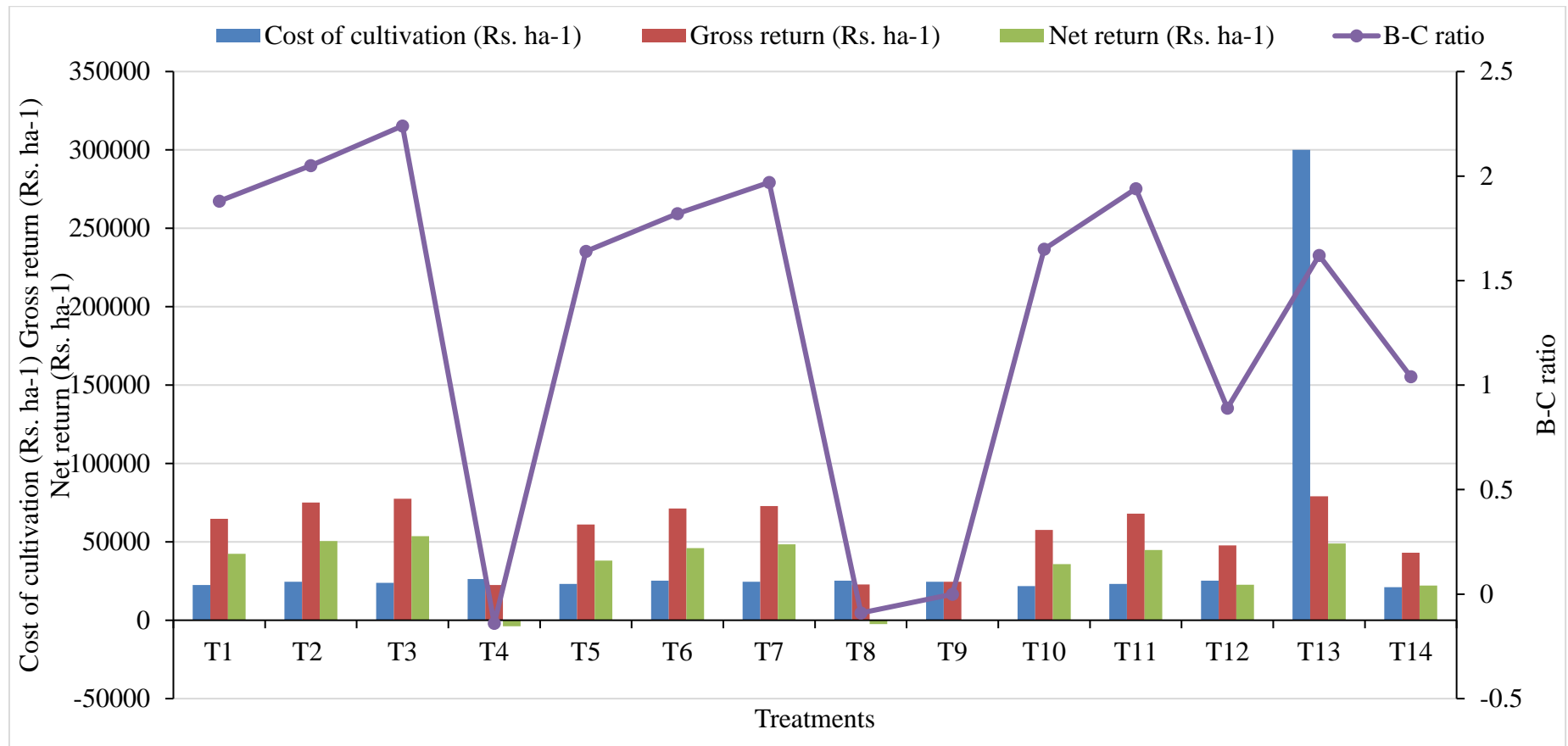


Fig. 2. Effect of herbicides cost of cultivation (Rs. ha⁻¹) gross return (Rs. ha⁻¹) net return (Rs. ha⁻¹) and B-C ratio of chickpea

population, plant height, dry matter accumulation, and leaf area index, among others. These characteristics are specifically impacted by the crop-weed competition phenomenon. The treatments that effectively controlled weeds ultimately gave crops a better environment for growth, which led to improved grain and stover yields. These outcomes are in line with the work of Singh et al., [6] and Ratnam et al., [14]. The harvest index of chickpea crop is noticeably. Nevertheless, the supreme harvest index (37.4 %) was noted with the application of pendimethalin 1000 g (PE) followed by imazethapyr 75 g ha⁻¹ PoE followed by oxyfluorfen (PE) 200 g fb clodinafop 60 g ha⁻¹ PoE (36.9 %). On the other side, weedy check had the lowest harvest index value (33.81%). The parallel outcomes were also seen by Singh et al., [6] and Ratnam et al., [14].

3.3 Economics

The maximum cost of cultivation sustained in weed free treatment (₹30072.90 ha⁻¹) by recording cost of cultivation (₹26299.95 ha⁻¹) in PE of pendimethalin 750 g followed by combined PoE application of quizalofop 60 g + oxyfluorfen 200 g ha⁻¹ at 35 DAS found to be the next best treatment (Fig. 2) maximum gross monetary returns (₹79062.00 ha⁻¹) was recorded in weed free by recording gross monetary returns (₹77478.00ha⁻¹) in PE of pendimethalin 1000 g followed by PoE application of clodinafop 60 g ha⁻¹ observed to be best treatment. Maximum net monetary returns (₹53588.05 ha⁻¹) and B-C ratio (2.24) were noted in PE application of pendimethalin 1000g (PE) fb PoE application of clodinafop 60g ha⁻¹ at 35 DAS by recording net monetary returns (₹50448.05ha⁻¹) and B-C ratio (2.05) in PE application of pendimethalin 1000 g fb by PoE application of quizalofop-ethyl 60 g ha⁻¹ at 35 DAS, observed to be the next best treatment and PE application of Pendimethalin 750 g followed by combined PoE application of quizalofop-ethyl 60 g + oxyfluorfen 200g ha⁻¹ at 35 DAS and PoE combined application of oxyfluorfen 200 g + quizalofop-ethyl 60 g ha⁻¹ at 35 DAS, the net monetary returns and B-C ratio were in undesirable because of high cost of cultivation [15]. These above findings are in the orthodoxy with the results of Meena et al., [16] and Ratnam et al., [14,17].

4. CONCLUSION

The higher number of nodules were produced by weed free as well as better weed control

treatments e.g., follow up application of clodinafop or quizalofop at 60 g ha⁻¹ each as PoE in the PE treatment of either pendimethalin 1000 g ha⁻¹ or oxyfluorfen 200 g ha⁻¹, which were at par among each other significantly superior over rest of the treatments. The application of pendimethalin 1000 g ha⁻¹ along with PoE of clodinafop propargyl 60 g ha⁻¹ or quizalofop ethyl 60 g ha⁻¹ verified superior over rest of the treatments with respect to weed control efficiency, grain yield 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, the chickpea developed phytotoxicity as a result of PoE use of tank mixed herbicides. By creating a favorable environment for the growth and development of the crop as well as increasing input usage efficiency, effective weed management improves crop results.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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