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Phytotoxicity of imazethapyr 35% + Imazamox 35% WG (RM) on growth and yield of irrigated chickpea (*Cicer arietinum* L.) under vertisols of northern dry zone of Karnataka

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Abstract
A field experiment was conducted at Northern Dry Zone of Karnataka (Zone 3) at College of Agriculture, Vijayapur, Karnataka, India during *rabi* (October-December, 2021) to study the effect of pre and post-emergence herbicides on growth and yield of chickpea. The experiment was laid out in RCBD with three replications and 11 treatments involving two pre-emergence herbicides (Pendimethalin, Pendimethalin+Imazethapyr) and five post-emergence herbicides (Imazethapyr+Imazamox, Propaquizafop+Imazethapyr, Imazethapyr, Quizalofop ethyl and Aciflor+Clodinafop) and one treatment with intercultivation operation at 20 and 40 DAS. Among the herbicidal treatments, application of Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Propaquizafop 2.5%+Imazethapyr 3.75% W/W ME (RM) @ (125 g a.i. ha^{-1}) as PoE at 25 DAS recorded higher results with better growth and yield. However, application of Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha (Odyssey) as PoE at 25 DAS shows phytotoxicity and severe injury to the crop and causes stand loss. The injury was in the rate of 7.00 to 7.33 out of 10 at 7 days after application and was reduced to the range of 5.33 to 6.00 at 14 days after application. There is a drastic and irregular changes in plant height, number of branches, plant population and plant dry matter accumulation and also recorded lowest grain yield (923 kg/ha) and haulm yield (2098 kg/ha) and total biological yield (3021 kg/ha). The results were almost near to weedy check.

Keywords: Chickpea, Imazethapyr+Imazamox, phytotoxicity, growth, yield

1. Introduction
Pulses are important in Indian agriculture for long-term production, improved soil health, and environmental protection. Pulses play a significant role in India's agriculture sector next to cereals and oilseeds in terms of acreage, productivity, and economic value (Choudhary, 2009) [4]. The World Health Organization (WHO) recommends an average of 80 grams of pulses per person per day, with the Indian Council of Medical Research (ICMR) recommending a minimum of 47 grams. One of the most frequently cultivated pulse crops in India and the rest of the globe, after beans and peas, is chickpea (*Cicer arietinum* L.). It is also known by other names such as gram or Bengal gram, and is commonly referred to as chana in various parts of the nation. Chickpea is a cool-season quantitative long-day legume crop that belongs to the fabaceae family and the faboideae subfamily. It is prized for its nutritious seed, which has a large amount of protein (21.1%), carbohydrates (61.5%) and lipids (4.5%), and is being used as a meat substitute. India having an area of 9.99 million hectare with a productivity of 1192 kg/ha and leading with a production of 11.91 million tonnes (Anonymous, 2021) [1].
Weed is a biotic factor that competes with crops for nutrients, water, space, and carbon dioxide. This competition ultimately affects crop growth and development, limiting crop production (Chandrakar *et al*., 2015 and Das, 2015) [2, 6]. The presence of weeds throughout the crop season reduces the grain yield of chickpea by up to 68% (Kumar *et al*., 2014) [15]. *Avena ludoviciana, Chenopodium album, Cynodon dactylon, Phalaris minor and Medicago hispida, Anagali sarvensis, Melilotusindica, Melilotusalba, Cyperus rotundus, Argemone maxicana, Solanum nigrum, Vicia hirsute* and *Vicia sativa* were major weeds in chickpea field (Gupta *et al*., 2012)

[11]. Similar weeds were observed by Kashyap *et al*., 2022 [12]. The yield loss in chickpea due to weeds is ranged between 40%-90% (Gore *et al*., 2015) [10]. The first 60 days are thought to be the most important. Since chickpea is a short-statured crop with a delayed starting development and a wide range of weed infestation, early and strong flushes of weeds are regarded as a major bottleneck in achieving the full production potential of chickpea (Dubey *et al*., 2018) [9]. Weed control by mechanical hoeing and human weeding has been shown to be falling on a large scale as agricultural labourers are shifting to businesses in quest of higher and more secure pay. The herbicide application is feasible and attracts attention for weed management in this condition (Khope *et al*., 2011) [13]. Chemicals are expected to be employed as an effective weed control approach and to replace traditional weed control methods in intensive agriculture, based on present trends and future improvements.

An appropriate herbicide for the efficient management of mixed weed flora is required for farmers to adopt this crop more readily. Herbicides have made it feasible to efficiently and affordably control a wide range of weeds in pulses. In order to improve weed control efficiency with minimum application costs, use of formulated or tank mix herbicide mixtures (Chandrakar *et al*., 2014, Patel *et al*., 2014) [2, 20] as well as integration of herbicides along with manual or mechanical weeding (Choudhary *et al*., 2012, Kumar *et al*., 2013) [5, 17] seems better option. However, Herbicide combinations like Imazethapyr 35%+Imazamox 35% WG (RM) causes phytotoxicity on crop and leads to stand loss resulted in yield reduction. These results are in conformity with those of Ratnam *et al*. (2011) [22], Singh *et al*. (2014) [25], Kumar and Chinnamuthu (2014) [16].

2. Materials and Methods

Field experiment was conducted during *rabi* (October-December, 2021) at College of Agriculture, Vijayapur, Karnataka, India on *Vertisol* having pH 8.11 and EC 0.24 dS/m. The soil was Low in organic carbon content (0.49%) and available N (175 kg/ha), P_2O_5 (26.3 kg/ha), and K_2O (398 kg/ha) The experimental site was located at 16°45′ North latitude, 75°44′ East longitude and at an altitude of 593.8 m above the mean sea level in Northern Dry Zone of Karnataka (Zone 3).

The variety JG-11 was used in this experiment. There were 11 treatments. The experiment was laid out in randomized complete block design and replicated thrice. Nitrogen, phosphorous and potassium were applied at the rate of 10:20:0 kg/ha and in the form of urea and di-ammonium phosphate. Crop was sown on 13th October 2021 with spacing of 45×10 cm. During the experimental year (2021–22), a total rainfall of 632.8 mm was recorded in 52 rainy days and which was more than the average rainfall of (594.4 mm) 40 years (1981–2020) by 38.4 mm. The weather conditions prevailed during the cropping season encouraged the growth of both crop and the weeds. Spraying of pre-emergent herbicides was taken up after 2 DAS and post-emergent herbicides was after 20 DAS. Observations on weed density, weed dry matter and weed control efficiency were recorded at 30 and 45 days after sowing (DAS). Yield was also recorded.

3. Results and Discussion

3.1. Phytotoxicity rating

3.1.1. Pre-emergence herbicide

At 7 and 14 DAA (Days after application) the visual observations on crop phytotoxicity were recorded for pre-emergence herbicides (Table 1). At 7 DAA (Days After Application), Pendimethalin 30% EC+Imazethapyr 2% EC (RM) shows slight discoloration with a rating of 0.67 and at 14 DAA (Days After Application) it was reduced to 0.33. No phytotoxicity with Pendimethalin 38.7% CS was observed.

3.1.2. Post-emergence herbicide

At 7 DAA (Days after application), the treatments with application of Imazethapyr 35%+Imazamox 35% WG (RM) showed severe injury to crop and causes stand loss. The injury was in the range of 7.00 to 7.33 and was reduced to the range of 5.33 to 6.00 at 14 DAA (Days after application). Whereas Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Propaquizafop 2.5%+Imazethapyr 3.75% W/W ME (RM) showed no phytotoxicity on crop. Similar results were reported by Kashyap *et al*. (2022) [12] and Kumar *et al*. (2015) [14].

3.2. Phytotoxic effect on crop growth

Among all the herbicidal treatments, T_3: Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS and T_8: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS showed visual symptoms of phytotoxicity like severe injury to crop and causes stand loss and recovery was doubt full. These injuries may be due to slightly higher doses of the herbicides. Nath *et al*. (2017) [18] stated that the phytotoxicity of these herbicides was extended up to flowering stage with poor recovery of crop plants. The poor recovery of crop in treatments with imazethapyr 50 g a.i. ha^{-1}, Imazethapyr+Imazamox 40 g a.i./ha and Imazethapyr+Imazamox 60 g a.i./ha was due to higher toxic effect of these herbicides on chickpea. Almost similar results were recorded by Rana *et al.* (2019) [21] in black gram.

3.3. Plant height

The plant height of chickpea was found to be increased progressively at every stage of the crop growth till maturity *(Table 2)*. There was a rapid increase in plant height during 30 to 60 DAS and there after it increased marginally up to maturity. At 30 DAS, the plant height of chickpea differed non-significantly with different treatments.

At 60 DAS, all the weed control treatments recorded significantly higher plant height as compared to T_{11}: weedy check (34.22 cm). Among the various treatments, weed free check recorded significantly higher plant height (44.93 cm) compared to other treatments, however, it was comparable with T_7: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Propaquizafop 2.5%+Imazethapyr 3.75% W/W ME (RM) @125 g a.i./ha as PoE at 25 DAS (42.44 cm). Similar results were confirmed by findings of Dhakad *et al*. (2022) [7].

3.4. Phytotoxic effect on plant height (Table 2)

Lowest plant height among the herbicidal treatments were recorded in T_3: Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS and T_8: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS. This was mainly due to phytotoxic effect of Imazethapyr 35%+Imazamox 35% WG (RM) herbicide on the crop plants that leads to stunted growth. This was in conformity with the results of Nath *et al.* (2017) [18], Rana *et al.* (2019) [21] and Ratnam *et al*. (2011) [22]

3.5. Number of branches/plant

3.5.1. Number of primary branches/plant at 30 and 60 DAS (Table 2)

At 30 DAS, the number of primary branches/plant of chickpea

differed non-significantly due to various treatments (Table 2). At 60 DAS, the number of primary branches/plant of chickpea differed significantly due to various treatments. Among the different treatments, T_3: Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS recorded significantly higher number of primary branches/plant (10.44) and was followed by T_8: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS (10.09) and they were comparable with T_{10}: Weed free check (9.70) and T_7: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Propaquizafop 2.5%+Imazethapyr 3.75% W/W ME (RM) @125 g a.i./ha as PoE at 25 DAS (9.55). Significantly lower number of primary branches/plant was recorded with T_{11}: weedy check (6.30). Similar results were reported by Channabasavanna *et al*. (2017) [3].

3.5.2. Number of secondary branches/plant at 60 DAS (Table 2)

At 60 DAS, the number of secondary branches/plant of chickpea differed significantly due to various weed management treatments. Among the treatments, T_3: Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS recorded significantly higher number of secondary branches/plant (29.10) and was found to be on par with T_8: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS (28.36). The lower number of secondary branches/plant was recorded with T_{11}: weedy check (16.66). (Dhayal *et al*. (2022)) [8].

3.5.3. Phytotoxic effect on number of branches/plant (Table 2)

However, among the herbicidal treatments T_8: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS and T_3: Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS shows stunted growth and lower plant height but there is a drastic change in number of branches plant^{-1}. These treatments showed irregular branching habitat and when compared to the other herbicidal treatments these two treatments show large difference by protruding large number of branches/plant that to secondary branches increased in larger number compared to primary branches. Similar results were obtained by Nath *et al*. (2017) [18]. He reported that Phytotoxicity in terms of chlorosis and epinasty in treatments with Imazethapyr 50 g a.i. ha^{-1}, Imazethapyr+Imazamox 40 g a.i./ha and Imazethapyr+Imazamox 60 g a.i./ha started at 15 DAA with bushy growth and narrow leaves in chickpea crop.

This drastic difference in number of branches/plant in these two treatments is due to phytotoxic effect of Imazethapyr 35%+Imazamox 35% WG (RM) herbicide on the crop plants (Nath *et al*. (2017)) [18]. There is an imbalance of plant metabolic activity due to the alteration of the activity of acetolactate synthase (ALS) enzyme (common enzyme in the biosynthesis of the branched-chain amino acids valine, leucine, and isoleucine) by this herbicide.

3.6. Total dry matter accumulation at 30 and 60 DAS (Table 2)

Non-significant difference with regards to total dry matter accumulation was noticed at 30 DAS due to the effect of different weed management treatments.

At 60 DAS, T_{10}: Weed free check recorded significantly higher total dry matter accumulation (5.91 g plant^{-1}) when compared to other treatments and it was comparable with T_8: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS (5.76 g plant^{-1}), T_3: Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS (5.70 g plant^{-1}), T_7: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Propaquizafop 2.5%+Imazethapyr 3.75% W/W ME (RM) 125 g a.i./ha as PoE at 25 DAS (5.52 g plant^{-1}) and T_6: Aciflor 16.5%+Clodinafop 8% EC (RM) @245 g a.i./ha as PoE at 25 DAS (5.46 g plant^{-1}). However significantly the lower total dry weight was recorded with T_{11}: weedy check (4.50 g plant^{-1}). These results were similar in accordance with Sandil *et al*. (2015) [23].

3.7. Phytotoxic effect on total dry matter accumulation (Table 2)

Although there is phytotoxicity in T_8 and T_3 treatments they recorded higher dry matter at 60 DAS. It is because of more number of branches/plant and more number of leaves/plant resulted due to phytotoxicity leads to higher dry weight of stem and leaves. These results are corroborating according to the findings of Nath *et al*. (2017) [18]. However, at harvest, lower dry weight was recorded in T_8: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS and T_3: Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS. It might be due to phytotoxic effect of Imazethapyr 35%+Imazamox 35% WG (RM) herbicide on the crop plants resulted in lowest dry matter accumulation in reproductive parts. These results are accordance with the findings of Nath *et al*. (2017) [18].

3.8. Total plant population per hectare (Table 2)

Among all the treatments, T_{10}: Weed free check recorded highest total plant population per hectare (2,22,222) and it was comparable with herbicidal treatment with application of Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Propaquizafop 2.5%+Imazethapyr 3.75% W/W ME (RM) @125 g a.i./ha g/ha as PoE at 25 DAS (2,14,815).

3.8. Phytotoxic effect on plant population (Table 2)

Lowest plant population per hectare was recorded with T_3: Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS (74,074) followed by T_8: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS (96,296). This is because of severe stand loss caused due to phytotoxicity effect of Imazethapyr 35%+Imazamox 35% WG (RM).

3.9. Phytotoxic effect on yield

3.9.1. Seed yield (kg/ha) (Table 3)

Seed yield of chickpea differed significantly due to various weed management treatments. Among the herbicidal treatments, significantly higher seed yield was obtained in the treatment T_7: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Propaquizafop 2.5%+Imazethapyr 3.75% W/W ME (RM) @125 g a.i./ha as PoE at 25 DAS (2197 kg/ha). Similar results were recorded by Sandil *et al*., 2015 [23], Panda *et al*., 2017 [19] and Sanketh *et al*., 2021 [24].

However, significantly lower seed yield was recorded wherever Imazethapyr 35%+Imazamox 35% WG (RM) was applied in the treatments *viz*,.T_3: Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS (923 kg/ha) and T_8: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25

DAS (945 kg/ha) and which were comparable with treatment that recorded lowest seed yield *i.e.* T_{11}: Weedy check (896 kg/ha).It might be due to phytotoxic effect of Imazethapyr 35%+Imazamox 35% WG (RM) herbicide on the crop plants resulted in lowest dry matter accumulation in reproductive parts. These results are in accordance with the findings Rana *et al.* (2019) [21]. He stated that application of Imazethapyr+Imazamox @70 g/ha at 20 DAS recorded lower seed yield of black gram (984 kg/ha) with a crop phytotoxicity of 10%. These results were in conformity with those of Ratnam *et al*. (2011) [22], Singh *et al*. (2014) [25], Kumar and Chinnamuthu (2014) [16].

3.9.2. Haulm yield (kg/ha) (Table 3)

Haulm yield of chickpea differed significantly due to various weed management treatments. Among herbicidal treatments, significantly higher haulm yield was obtained with application of Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Propaquizafop 2.5%+Imazethapyr 3.75% W/W ME (RM) @125 g a.i./ha as PoE at 25 DAS (2766 kg/ha). Similar results were recorded by Khope *et al*., 2011 [13] and and Sanketh *et al*., 2021 [24].

However, significantly lower haulm yield was recorded wherever Imazethapyr 35%+Imazamox 35% WG (RM) was applied in the treatments like T_3: Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS (2098 kg/ha) and T_8: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS (2115 kg/ha) and which were comparable with treatment that recorded lower haulm yield *i.e*.T_{11}: Weedy check (2056 kg/ha).

3.9.3. Total Biological yield (kg/ha) (Table 3)

The total biological yield of chickpea differed significantly due to the effect of different weed management treatments. Among all herbicidal treatments, significantly higher biological yield was obtained with application of Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Propaquizafop 2.5%+Imazethapyr 3.75% W/W ME (RM) @125 g a.i./ha as PoE at 25 DAS (4962 kg/ha). These results were in accordance with Khope *et al*., 2011 [13].

Among the herbicidal treatments significantly lower biological yield was noticed wherever Imazethapyr 35%+Imazamox 35% WG (RM) was applied *viz*, T_3: Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS (3021 kg/ha) and T_8: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS (3060 kg/ha), which are comparable with treatment that recorded lower biological yield *i.e*. T_{11}: Weedy check (2953 kg/ha). These results were due to phytotoxicity of Imazethapyr 35%+Imazamox 35% WG (RM) which caused lower grain yield and lower haulm yield which results in lower biological yield. These results are in conformity with those of Ratnam *et al*. (2011) [22], Singh *et al*. (2014) [25], Kumar and Chinnamuthu (2014) [16].

3.9.4. Harvest index (%) (Table 3)

Harvest index of chickpea differed significantly due to various weed management practices. Within the various treatments, T_{10}: Weed free check (44.31%) recorded significantly higher harvest index compared to other treatments. But, it was on par with almost all the treatments except T_8: Pendimethalin 38.7% CS @800 g a.i./ha as PE *fb* Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 DAS, T_3: Imazethapyr 35%+Imazamox 35% WG (RM) @ 70 g a.i./ha as PoE at 25 DAS and T_{11}: Weedy check with a harvest index of 30.51%, 30.46% and 30.43% respectively.

Due to phytotoxic effect of Imazethapyr 35%+Imazamox 35% WG (RM), the seed yield and total biological yield of the crop has been declined so that the harvest index of a crop due to application of Imazethapyr 35%+Imazamox 35% WG (RM) in chickpea was less in spite of its weed control efficiency. These results are in conformity with those of Ratnam *et al*. (2011) [22] and Singh *et al*. (2014) [25].

Table 1: Phytotoxicity rating (0-10 scale) in chickpea (*Cicer arietinum* L.) as influenced by different weed management treatments

Treatment		Pre-emergence herbicides effect		Post-emergence herbicides effect	
		7 DAA	14 DAA	7 DAA	14 DAA
T_1	Pendimethalin 38.7% CS @ 1.0 kg a.i. /ha as PE	0.33	0.00	0.00	0.00
T_2	Pendimethalin 30% EC + Imazethapyr 2% EC (RM) @ (1000 g a.i. ha^{-1}) or 3 L/ha as PE	0.67	0.33	0.00	0.00
T_3	Imazethapyr 35% + Imazamox 35% WG (RM) @ 70 g a.i./ha as PoE at 25 DAS	0.00	0.00	7.33	6.00
T_4	Imazethapyr 10% SL @ 70 g a.i./ha as PoE at 25 DAS	0.00	0.00	2.00	1.33
T_5	Quizalofop ethyl 5% EC @ 50 g a.i./ha PoE	0.00	0.00	1.00	0.67
T_6	Aciflor 16.5% + Clodinafop 8% EC (RM) @ 245 g a.i./ha as PoE at 25 DAS	0.00	0.00	1.00	0.67
T_7	Pendimethalin 38.7% CS @ 800 g a.i./ha as PE *fb* Propaquizafop 2.5% + Imazethapyr 3.75% W/W ME (RM) @ (125 g a.i. ha^{-1}) as PoE at 25 DAS	0.33	0.00	0.67	0.33
T_8	Pendimethalin 38.7% CS @ 800 g a.i./ha as PE *fb* Imazethapyr 35% + Imazamox 35% WG (RM) @ 70 g a.i./ha as PoE at 25 DAS	0.33	0.00	7.00	5.33
T_9	Intercultivation at 20 and 40 DAS (Farmers practice)	0.00	0.00	0.00	0.00
T_{10}	Weed free check	0.00	0.00	0.00	0.00
T_{11}	Weedy check	0.00	0.00	0.00	0.00

DAA (DAYS AFTER APPLICATION) = Days after treatment

Table 2: Effect of different weed management treatments on the growth attributes of chickpea (*Cicer arietinum* L.)

Treatment		Plant height		Number of primary branches		Number of secondary branches	Total dry matter accumulation (g plant^{-1})		Plant population ha^{-1}
		30 DAS	60 DAS	30 DAS	60 DAS	60 DAS	30 DAS	60 DAS	
T_1	Pendimethalin 38.7% CS @ 1.0 kg a.i. /ha as PE	26.44	40.55	4.22	9.24	19.59	1.12	5.14	185185
T_2	Pendimethalin 30% EC + Imazethapyr 2% EC (RM) @ (1000 g a.i. ha^{-1}) or 3 L/ha as PE	25.44	39.55	4.20	9.13	18.18	1.11	4.96	177778
T_3	Imazethapyr 35% + Imazamox 35% WG (RM) @ 70 g a.i./ha as PoE at 25 DAS	28.11	38.76	4.13	10.44	29.10	1.17	5.70	74074
T_4	Imazethapyr 10% SL @ 70 g a.i./ha as PoE at 25 DAS	25.33	41.93	4.28	9.33	21.17	1.13	5.28	185185
T_5	Quizalofop ethyl 5% EC @ 50 g a.i./ha PoE	25.77	40.95	4.24	9.29	20.11	1.11	5.19	185185
T_6	Aciflor 16.5% + Clodinafop 8% EC (RM) @ 245 g a.i./ha as PoE at 25 DAS	27.11	42.33	4.49	9.41	21.44	1.16	5.46	207407
T_7	Pendimethalin 38.7% CS @ 800 g a.i./ha as PE *fb* Propaquizafop 2.5% + Imazethapyr 3.75% W/W ME (RM) @ (125 g a.i. ha^{-1}) as PoE at 25 DAS	27.66	42.44	4.74	9.55	21.67	1.21	5.52	214815
T_8	Pendimethalin 38.7% CS @ 800 g a.i./ha as PE *fb* Imazethapyr 35% + Imazamox 35% WG (RM) @ 70 g a.i./ha as PoE at 25 DAS	27.44	35.44	4.12	10.09	28.36	1.14	5.76	96296
T_9	Intercultivation at 20 and 40 DAS (Farmers practice)	26.67	42.30	4.33	9.39	21.42	1.15	5.33	207407
T_{10}	Weed free check	28.71	44.93	4.82	9.70	22.23	1.27	5.91	222222
T_{11}	Weedy check	23.78	34.22	3.93	6.30	16.66	1.10	4.50	162963
S.Em±		1.80	1.59	0.25	0.31	1.36		0.06	0.18
C.D. (*p*=0.05)		NS	4.66	NS	0.93	4.00		NS	0.52

Table 3: Seed yield (kg/ha), haulm yield (kg/ha), Biological yield and Harvest index (%) of chickpea (*Cicer arietinum* L.) as influenced by different weed management treatments

Treatment		Seed yield (kg/ha)	Haulm Yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
T_1	Pendimethalin 38.7% CS @ 1.0 kg a.i. /ha as PE	1638	2476	4114	39.58
T_2	Pendimethalin 30% EC + Imazethapyr 2% EC (RM) @ (1000 g a.i. ha^{-1}) or 3 L/ha as PE	1611	2487	4097	39.29
T_3	Imazethapyr 35% + Imazamox 35% WG (RM) @ 70 g a.i./ha as PoE at 25 DAS	923	2098	3021	30.46
T_4	Imazethapyr 10% SL @ 70 g a.i./ha as PoE at 25 DAS	1839	2556	4395	41.74
T_5	Quizalofop ethyl 5% EC @ 50 g a.i./ha PoE	1696	2523	4218	40.27
T_6	Aciflor 16.5% + Clodinafop 8% EC (RM) @ 245 g a.i./ha as PoE at 25 DAS	2001	2685	4686	42.71
T_7	Pendimethalin 38.7% CS @ 800 g a.i./ha as PE *fb* Propaquizafop 2.5% + Imazethapyr 3.75% W/W ME (RM) @ (125 g a.i. ha^{-1}) as PoE at 25 DAS	2197	2766	4962	44.28
T_8	Pendimethalin 38.7% CS @ 800 g a.i./ha as PE *fb* Imazethapyr 35% + Imazamox 35% WG (RM) @ 70 g a.i./ha as PoE at 25 DAS	945	2115	3060	30.51
T_9	Intercultivation at 20 and 40 DAS (Farmers practice)	1976	2604	4580	43.21
T_{10}	Weed free check	2315	2910	5224	44.31
T_{11}	Weedy check	896	2056	2953	30.43
S.Em±		116.44	118.13	143.42	2.49
C.D. (P=0.05)		341.53	346.47	420.66	7.30

4. Conclusion

Application of Imazethapyr 35%+Imazamox 35% WG (RM) @70 g a.i./ha as PoE at 25 days after sowing showed phytotoxicity on crop and despite its better weed control efficiency, it showed severe injury to the crop and caused stand loss as well. Hence it is concluded that, application of this herbicide is not economic in cultivation of chickpea as it recorded lower Yield and BC ratio compared to rest of the herbicides.

5. References

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