Weed management in chickpea under soybean-chickpea cropping system

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DOI: https://doi.org/10.22271/chemi.2020.v8.i4j.9764

Abstract
A field experiment was conducted at Agriculture Research Station, Janawada, Bidar to study the efficacy of sequential application of herbicides on growth and yield of chickpea (Cicer arietinum L.) in north eastern transitional zone of Karnataka. Among the different herbicide treatments in chickpea the application of pendimethalin 38.7 CS @ 700 g a.i. ha\(^{-1}\) fb imazethapyr 10 SL @ 75 g a.i. ha\(^{-1}\) in chickpea crop recorded significantly higher seed yield (2198 kg ha\(^{-1}\)) due to higher growth parameters viz., plant height (42.32 cm), number of branches (6.89), leaf area (6.99 dm\(^2\) plant\(^{-1}\)), leaf area index (2.33), leaf area duration (47.38 day) and yield parameters viz., number of pods (40.01), pod weight per plant (19.23 g plant\(^{-1}\)), seed yield per plant (7.69 g plant\(^{-1}\)) and test weight (18.32 g plant\(^{-1}\)). This was mainly due to lower weed density 0.5 m\(^{-1}\) (3.12) and weed index (9.77\%) compared to other herbicide treatments respectively. However, weed free check recorded significantly higher growth and yield parameters due to weed free environment maintained through out the growth period of the crop compared to rest of the treatments.

Keywords: Efficacy, pendimethalin, imazethapyr, chickpea

Introduction
Chickpea (Cicer arietinum L.) is one of the important grain legume of the world which is grown in 45 countries across five continents. India is the largest producer of chickpea accounting to 75 per cent of the world production. The major chickpea growing states in India are Maharashtra, Andra Pradesh, Bihar, Karnataka, Madhya Pradesh, Rajasthan, Uttar Pradesh and Gujarath. Chickpea can fix up to 140 kg ha\(^{-1}\) of nitrogen and is an economical crop grown in rainfed farming system throughout India. It is used for human consumption as well as animal feeding. Both husks and bits of the daal are valuable cattle feed. Fresh green leaves are used as vegetable. It is a rich source of protein (21.1\%). Besides, it contain 61.5 per cent carbohydrates and 4.5 per cent fat and is also rich in Ca, Fe and Niacin. Its leaves secrete malic acid (90-95\%) and oxalic acid (5-10\%), which have medicinal properties important against stomachache, intestinal disorder and blood purification (Singh et al., 2003).

Weed competition is one of the most important causes of yield reduction in chickpea which is estimated to be 20-40 per cent depending on the weed species, their density and period of weed crop competition. The effective control of weeds can help in improving the productivity of chickpea. The weed free maintenance up to 45 days after sowing resulted in 96 per cent increase in seed yield of chickpea compared to uncontrolled weedy situations (Bhutada and Bhale, 2015) \([5]\). The effective and economical weed control in chickpea on large scale is not possible through hand weeding or use of mechanical tools because of time and labour intensiveness and difficulty due to intermittent rains. The herbicides like alachlor, fluchloralin and pendimethalin which are recommended for weed control in chickpea are being used by the farmers (Raskar and Bhoi, 2002) \([13]\). These herbicides have been quite effective on grasses and their continuous use has resulted in weed shift in some areas in favour of non-grassy weeds like Cleome viscosa, Celosia argentea, Trianthema monogyna and Commelina benghalensis,
Argemon mexicana, which are highly competitive with chickpea crop. Further, these herbicides proved ineffective against Cyperus rotundus and Commelina benghalensis. This could be due to immobility of herbicides from leaves to the tubers of Cyperus rotundus. Therefore, there is a need to have alternate herbicides which may provide wide spectrum of weed control to avoid weed shift and also possible development of herbicide resistance. The new herbicides namely; quizalofop-ethyl, Imazethapyr, chlorimuron-ethyl and fenoxyprop ethyl have been developed to control wide range of weeds in broad-leaved crops including chickpea. Therefore the experiment was carried out to study the weed management in chickpea under soybean-chickpea cropping system.

Materials and methods
The experiment was conducted at Agricultural Research Station, Janawada, Bidar as part of Ph.D. research work to study the efficacy of weed management on chickpea (Cicer arietinum L.) in north eastern transitional zone of Karnataka during rabi 2014 and 2015. The land was ploughed once with mould-board plough and brought to fine tilth with two harrowing. The stubbles and weeds were collected and disposed off from the experimental area. At the time of sowing, the recommended dose of fertilizer for chickpea variety GBM-2 was treated with biofertilizer, mainly Rhizobium @ and PSB. The recommended seed rate was used for sowing. The pre-emergence herbicides viz., Pendimethalin 30 EC, Pendimethalin 38.7 CS, and Oxylfluoren 23.5 EC were sprayed uniformly one day after sowing of the crop. The pre-emergence application was made on the soil surface uniformly with minimum tillage. The post emergence herbicides viz., Imazethapyr 10 SL, Quizalofop-p-ethyl 5 EC and Fenoxyprop-p-ethyl 5 EC were applied uniformly at 21 DAS as per the treatment. The soil was medium deep black, neutral in reaction. The experiment was laid out in randomized block design with the twelve treatment and three replications. In the treatment (T10) one hand weeding (between 30-45 DAS) and two inter cultivations (30 and 45 DAS) were taken. The results have been discussed at the probability level of five per cent. The level of significance used in ‘F’ and ‘t’ test were p=0.05. Critical difference values were calculated whenever the ‘F’ test was significant. The data was analyzed statistically for test of significance following the procedure described by Gomez and Gomez (1984)[6].

Results and discussion
Effect of weed management on weed density and weed index
The total weed population differed significantly due to different weed control treatments at all the growth stages (Table 1 and Fig.1, 2). The study indicated that the highest weed density was recorded in weedy check (6.41, 7.14, 7.24 and 7.40/0.5 m² at 20, 40, 60 DAS and at harvest, respectively) and lowest with weed free check (0.71, 0.71, 0.71/ 0.5 m² at 20, 40, 60 DAS and at harvest). The effect of pre emergent herbicides was very effective at early stage and among the different weed control practices at 20 DAS, application of pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb imazethapyr @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) was very effective in controlling all types of weeds (3.12/ 0.5 m²) over weedy check. This was mainly due to effective control of weeds by pendimethalin as pre emergence besides use of imazethapyr as post emergence herbicide and one Intercultivation carried out during critical period of crop growth. These results are in conformity with findings of Baskaran and Kavimani et al. (2014)[1]. However, from 40 DAS onwards the total weed count recorded with the application of pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb imazethapyr @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (2.72, 2.96 and 3.16 at 40, 60 DAS and at harvest, respectively) was lower and it was followed by application of pendimethalin 30 EC @ 1 kg a.i. ha⁻¹ + IC (30 and 45 DAS) + one HW (between 30-45 DAS) (2.79, 3.03 and 3.23 at 40, 60 DAS and at harvest, respectively), pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb quizalofop p ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (2.86, 3.04 and 3.31 at 40, 60 DAS and at harvest, respectively) and pendimethalin 38.7 CS@ 700 g a.i. ha⁻¹ fb fenoxyprop p ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (2.88, 3.12 and 3.35 at 40, 60 DAS and at harvest, respectively) over weedy check (7.14, 7.24 and 7.40 at 40, 60 DAS and at harvest, respectively) indicating weed controlling efficiency of herbicides when applied in sequence. Similar results were also reported by Poonia and Pithia (2013)[10]. Among the various herbicides used, T10, T1, T3 and T5 registered significantly lower weed count at 20 DAS. The superiority of these treatments could be attributed to effective control of weeds by use of pre emergence herbicides and also post emergence herbicides. As a result of this number of grassy weeds, sedges and broad leaved weeds as well as total weeds were significantly lower in these treatments. The treatments comprising application of pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb imazethapyr @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (9.77), pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb fenoxyprop p ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (12.21%), pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb quizalofop p ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (12.23%) and pendimethalin 30 EC @ 1 kg a.i. ha⁻¹ + IC (30 & 45 DAS) + HW (30-45 DAS) (12.46%) recorded significantly lower weed index values and were found to be on par with each other. The lowest weed index was recorded with weed free check (0.00). Significantly higher weed index values were recorded with the application of imazethapyr @ 75 g a.i. ha⁻¹ at 20 DAS + IC (30 & 45 DAS) (36.04%), quizalofop p ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (30 & 45 DAS) (36.74%) and fenoxyprop p ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (30 & 45 DAS) (37.47%). More number of weeds offered maximum competition for basic resources like nutrient, moisture, space and light which was evident throughout the crop growth period as indicated through yield. This inturn was responsible for maximum reduction in the seed yield (1299 kg ha⁻¹). These results are in conformity with Poonia and Pithia (2013)[10] and Patil et al. (2017).

Weed management practices on growth parameters
The predominant attribute of growth would be the plant height which was responsible for producing more number of leaves and in turn leaf area for higher contribution to photosynthesis of the plant. At harvest, weed free check recorded 86.84 per cent increased plant height over weedy check. Lower plant height at harvest was recorded with weedy check (25.08 cm). While the treatments like application of pendimethalin 30 EC @ 1 kg a.i. ha⁻¹ + IC (30 & 45 DAS) + HW (30-45 DAS) (41.06 cm) recorded on par plant height along with pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb imazethapyr @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (40.82 cm), pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb quizalofop p
ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (41.20 cm) and pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb fenoxyprop p ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (41.14 cm) have recorded higher but on par plant height, but significantly higher compared to weedy check (25.08 cm). Total number of branches was significantly higher with weed free check (7.72) when compared to weedy check (4.08) (Table 2). The unfavorable condition created by the weeds in case of weedy check might be the reason for lower number of branches whereas the uninterrupted availability of all the growth resources in weed free check resulted in more number of branches in weed free check. The possible reason for the more number of branches may be attributed to reduced crop weed competition and providing favourable environment for growth of chickpea at early growth stages. These results are in line with Adhikari and Ghosh (2014) [1], Purena et al. (2015) [11] and Patil et al. (2017).

Leaf area increased from 30 to 60 DAS. At 60 DAS, the pooled data revealed that application of pendimethalin 30 EC @ 1 kg a.i. ha⁻¹ + IC (30 & 45 DAS) + HW (30-45 DAS) (6.79 dm² plant⁻¹) recorded on par leaf area along with pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb imazethapyr @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (6.99 dm² plant⁻¹), pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb quizalofop p ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (6.81 dm² plant⁻¹) and pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb fenoxyprop p ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (6.80 dm² plant⁻¹). It is well known that the persistence of the assimilatory surface area is a prerequisite for prolonged photosynthetic activity and ultimately crop productivity. The leaf area indicates the photosynthetic area available for synthesis of food. Higher leaf area assimilates leads to higher dry matter thus increasing the growth attribute like plant height and intern higher source to sink relationship. Simila trend was observed with LAI and LAD. Similar findings were reported by Ranjeeth et al. (2013) [12] and Shekhar et al. (2014) [15].

**Weed management practices on yield parameters**

Significant differences were observed with respect to seed yield of chickpea due to different weed control treatments. In the present study, pooled data indicated that weed free check recorded significantly higher seed yield (2438 kg ha⁻¹) over weedy check (1299 kg ha⁻¹). The increase in yield was to the tune of 87.68 per cent (Table 3 and Fig.3). Among the different weed control treatments, significantly higher seed yield was recorded with the application of pendimethalin 30 EC 1 kg a.i. ha⁻¹ + IC (30 & 45 DAS) + HW (30-45 DAS) (2133 kg ha⁻¹) and sequential application of pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb imazethapyr @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (2198 kg ha⁻¹), pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb quizalofop p ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (2140 kg ha⁻¹) and pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb fenoxyprop p ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (2137 kg ha⁻¹) recorded 69.21, 64.74 and 64.51 per cent increased yield over weedy check which were on par with each other and the same was attributed to better control of weeds and higher weed control efficiency when herbicides were applied in sequence. This gives the clear indication that, under scarcity of labour, use of sequential application of herbicide could be followed as an alternative method of weed control. Seed yield was closely associated with straw yield which followed similar trend. The above results are in accordance with the findings of Ranjeet et al. (2013) [12], Sangwan et al. (2016) [14] and Bheiru Singh et al. (2017) [4].

This gives the clear indication that, under scarcity of labour, use of sequential application of herbicide could be followed as an alternative method of weed control. Seed yield was closely associated with straw yield which followed similar trend. The above results are in accordance with the findings of Shekhar et al. (2014) [15]. The higher seed yield may be attributed to improved yield components viz., number of pods plant⁻¹, pod weight plant⁻¹ and seed weight plant⁻¹. Application of pendimethalin 30 EC @ 1 kg a.i. ha⁻¹ + IC (30 & 45 DAS) + HW (30-45 DAS) (38.22 & 18.88 and 7.47 g, respectively) and sequential application pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb imazethapyr @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (40.01, 19.23 and 7.69 g, respectively) and pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb quizalofop p ethyl @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) (38.90, 18.70 and 7.48 g, respectively) have recorded on par data of the above said yield contributing parameters which were attributed to on par seed yield among them (Table 3). Weedy check recorded lower number of pods (23.71) over weed free check (44.37), thus noticed substantially reduced seed yield. Increase in pod weight in these treatments accommodated higher seed weight. Weedy check showed lower seed weight (4.56 g) over weed free check (8.53 g). The results corroborate findings of Navell Chander et al. (2014) [8], Goud et al. (2013) [7], Shekhar et al. (2014) [15] and Bheiru Singh et al. (2017) [4].

The sequential application of pendimethalin 38.7 CS @ 700 g a.i. ha⁻¹ fb imazethapyr @ 75 g a.i. ha⁻¹ at 20 DAS + IC (35 DAS) was the effective weed management practice in reducing the weed biomass and increasing the yield of chickpea under scarcity of labour.
**Table 1**: Effect of herbicides on weed count at different growth stages and weed index in chickpea (2 year pooled data)

| Treatments | Total weed count (No. 0.5 m²) | Weed index (%) |
|------------|-------------------------------|----------------|
|            | 20DAS | 40DAS | 60DAS | At harvest |
| T₁         | 3.12 (3.92) | 2.72 (12.76) | 2.96 (3.44) | 3.16 (4.08) | 9.77 |
| T₂         | 3.73 (5.97) | 3.33 (14.58) | 3.51 (5.19) | 3.65 (5.68) | 20.16 |
| T₃         | 3.19 (4.10) | 2.86 (3.17) | 3.04 (3.67) | 3.31 (4.51) | 12.23 |
| T₄         | 3.75 (6.05) | 3.45 (13.98) | 3.59 (5.44) | 3.73 (5.96) | 24.98 |
| T₅         | 3.24 (4.28) | 2.88 (3.19) | 3.12 (3.93) | 3.35 (4.64) | 12.21 |
| T₆         | 3.82 (6.31) | 3.57 (5.40) | 3.70 (5.86) | 3.81 (6.27) | 28.04 |
| T₇         | 4.77 (10.45) | 4.44 (8.88) | 4.67 (9.94) | 4.82 (10.65) | 36.04 |
| T₈         | 4.81 (10.57) | 4.51 (9.19) | 4.73 (10.99) | 4.84 (10.73) | 36.74 |
| T₉         | 4.84 (10.75) | 4.52 (9.27) | 4.76 (10.36) | 4.85 (10.82) | 37.47 |
| T₁₀        | 3.24 (4.26) | 2.79 (2.93) | 3.03 (3.63) | 3.23 (4.27) | 12.46 |
| T₁₁        | 6.41 (19.81) | 7.14 (24.68) | 7.24 (25.38) | 7.40 (26.56) | 46.91 |
| T₁₂        | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.00 |

S.E.m ±

C.D. at 5%

| 0.07 | 0.06 | 0.06 | 0.07 | 0.05 | 2.53 |
| 0.21 | 0.19 | 0.22 | 0.15 | 7.43 |

Figures in the parentheses indicate the original value, data subjected for transformation using\(x^*\), where \(x\) is weed count

T₁: Imazethapyr @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)

T₂: Oxyfluorfen @ 0.1 kg a.i. ha\(^{-1}\) (PRE) fb Imazethapyr @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)

T₃: Pendimethalin 38.7 CS @ 700 g a.i. ha\(^{-1}\) (PRE) fb Imazethapyr @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)

T₄: Pendimethalin @ 1 kg a.i. ha\(^{-1}\) (PRE+ POE (30 & 45 DAS)+ IC and one HW (between 30 to 45 DAS)

T₅: Pendimethalin 38.7 CS @ 700 g a.i. ha\(^{-1}\) (PRE) fb Fenoxaprop-p-ethyl @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)

T₆: Weed check

T₇: Oxyfluorfen @ 0.1 kg a.i. ha\(^{-1}\) (PRE) fb Fenoxaprop-p-ethyl @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)

T₈: Weed free check

**Table 2**: Growth of chickpea at different growth stages as influenced by weed management practices (2 year pooled data)

| Treatment | Plant height (cm) at harvest | No. of branches at harvest | Leaf area (dm² plant\(^{-1}\)) | LAI | LAD (30-60DAS) | Dry matter production (g plant\(^{-1}\)) |
|-----------|-----------------------------|---------------------------|------------------|-----|---------------|----------------------------------------|
| T₁        | 42.32                       | 6.89                      | 6.99              | 2.33 | 47.58         | 19.27                                  |
| T₂        | 37.46                       | 6.10                      | 6.19              | 2.06 | 41.94         | 17.09                                  |
| T₃        | 41.20                       | 6.71                      | 6.81              | 2.27 | 46.13         | 18.76                                  |
| T₄        | 35.16                       | 5.73                      | 5.81              | 1.94 | 39.37         | 16.00                                  |
| T₅        | 41.14                       | 6.70                      | 6.80              | 2.27 | 46.07         | 18.73                                  |
| T₆        | 33.77                       | 5.50                      | 5.58              | 1.86 | 37.81         | 15.40                                  |
| T₇        | 30.07                       | 4.90                      | 4.97              | 1.66 | 33.66         | 13.77                                  |
| T₈        | 29.72                       | 4.84                      | 4.91              | 1.64 | 33.28         | 13.62                                  |
| T₉        | 29.40                       | 4.79                      | 4.86              | 1.62 | 32.92         | 13.39                                  |
| T₁₀       | 41.06                       | 6.69                      | 6.79              | 2.26 | 45.98         | 18.77                                  |
| T₁₁       | 25.08                       | 4.08                      | 4.15              | 1.38 | 28.08         | 11.42                                  |
| T₁₂       | 46.86                       | 7.72                      | 7.76              | 2.59 | 52.54         | 21.54                                  |
| S.E.m ±   | 1.08                        | 0.19                      | 0.19              | 0.06 | 1.29          | 0.55                                   |
| C.D. at 5%| 3.18                        | 0.58                      | 0.55              | 0.18 | 3.78          | 1.62                                   |

T₁: Pendimethalin 38.7 CS @ 700 g a.i. ha\(^{-1}\) (PRE) fb Imazethapyr @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)

T₂: Pendimethalin @ 75 g a.i. ha\(^{-1}\) (POE- 20 DAS) + IC (35 DAS)

T₃: Oxyfluorfen @ 0.1 kg a.i. ha\(^{-1}\) (PRE) fb Imazethapyr @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)

T₄: Imazethapyr @ 75 a.i. ha\(^{-1}\) (POE- 20 DAS) + IC (35 DAS)

T₅: Pendimethalin 38.7 CS @ 700 g a.i. ha\(^{-1}\) (PRE) fb Fenoxaprop-p-ethyl @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)

T₆: Pendimethalin @ 1 kg a.i. ha\(^{-1}\) (PRE+ POE (30 & 45 DAS)+ one HW (between 30 to 45 DAS)

T₇: Pendimethalin 38.7 CS @ 700 g a.i. ha\(^{-1}\) (PRE) fb Fenoxaprop-p-ethyl @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)

T₈: Weed check

T₉: Oxyfluorfen @ 0.1 kg a.i. ha\(^{-1}\) (PRE) fb Fenoxaprop-p-ethyl @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)

T₁₀: Weed free check
Table 3: Number of pods, pod weight, seed yield and hundred seed weight of chickpea as influenced by weed management practices in soybean-chickpea cropping system

| Treatment | Number of pods (plant<sup>1</sup>) at harvest | Pod weight (g plant<sup>-1</sup>) | Seed yield (g plant<sup>-1</sup>) | Hundred seed weight (g) | Seed yield (kg ha<sup>-1</sup>) | Haulm yield (kg ha<sup>-1</sup>) |
|-----------|---------------------------------------------|---------------------------------|---------------------------------|------------------------|-----------------------------|---------------------------------|
| T<sub>1</sub> | 40.01                                      | 19.23                           | 7.69                            | 18.32                  | 2198                        | 4500                            |
| T<sub>2</sub> | 35.42                                      | 17.03                           | 6.81                            | 16.22                  | 1946                        | 4177                            |
| T<sub>3</sub> | 38.95                                      | 18.73                           | 7.49                            | 17.83                  | 2140                        | 4401                            |
| T<sub>4</sub> | 33.25                                      | 15.98                           | 6.39                            | 15.22                  | 1827                        | 3939                            |
| T<sub>5</sub> | 38.90                                      | 18.70                           | 7.48                            | 17.81                  | 2137                        | 4417                            |
| T<sub>6</sub> | 31.93                                      | 15.35                           | 6.14                            | 14.62                  | 1754                        | 3800                            |
| T<sub>7</sub> | 28.43                                      | 13.67                           | 5.47                            | 13.02                  | 1562                        | 3523                            |
| T<sub>8</sub> | 28.10                                      | 13.51                           | 5.40                            | 12.87                  | 1544                        | 3498                            |
| T<sub>9</sub> | 27.80                                      | 13.36                           | 5.35                            | 12.73                  | 1527                        | 3475                            |
| T<sub>10</sub> | 38.82                                      | 18.88                           | 7.47                            | 17.78                  | 2133                        | 4555                            |
| T<sub>11</sub> | 23.71                                      | 11.40                           | 4.56                            | 10.86                  | 1299                        | 3138                            |
| T<sub>12</sub> | 44.37                                      | 21.33                           | 8.53                            | 20.31                  | 2438                        | 4669                            |
| S.Em ± | 1.08                                        | 0.52                            | 0.20                            | 0.49                   | 59                          | 130                             |
| C.D. at 5% | 3.19                                        | 1.53                            | 0.61                            | 1.46                   | 175                         | 381                             |

NS – Non significant
T<sub>1</sub>; Pendimethalin 38.7 CS @ 700 g a.i. ha<sup>-1</sup> (PRE) fb Imazethapyr @ 75 g a.i. ha<sup>-1</sup> (POE-20 DAS) + IC (35 DAS)
T<sub>2</sub>; Oxyfluorfen @ 0.1 kg a.i. ha<sup>-1</sup> (PRE) fb Imazethapyr @ 75 g a.i. ha<sup>-1</sup> (POE-20 DAS) + IC (35 DAS)
T<sub>3</sub>; Quizalofop-p-ethyl @ 75 g a.i. ha<sup>-1</sup> (POE-20 DAS) + IC (35 DAS)
T<sub>4</sub>; Pendimethalin 38.7 CS @ 700 g a.i. ha<sup>-1</sup> (PRE) fb Quizalofop-p-ethyl @ 75 g a.i. ha<sup>-1</sup> (POE-20 DAS) + IC (35 DAS)
T<sub>5</sub>; Fenoxaprop-p-ethyl @ 75 g a.i. ha<sup>-1</sup> (POE-20 DAS) + IC (35 DAS)
T<sub>6</sub>; Oxyfluorfen @ 0.1 kg a.i. ha<sup>-1</sup> (PRE) fb Quizalofop-p-ethyl @ 75g a.i. ha<sup>-1</sup> (POE-20 DAS) + IC (35 DAS)
T<sub>7</sub>; Pendimethalin @ 1 kg a.i. ha<sup>-1</sup> (PRE)+ IC (30 & 45 DAS)+ one HW (between 30 to 45 DAS).
T<sub>8</sub>; Pendimethalin 38.7 CS @ 700 g a.i. ha<sup>-1</sup> (PRE) fb by Fenoxaprop-p-ethyl @ 75 g a.i. ha<sup>-1</sup> (POE-20 DAS) + IC (35 DAS)
T<sub>9</sub>; Weedy check
T<sub>10</sub>; Oxyfluorfen @ 0.1 kg a.i. ha<sup>-1</sup> (PRE) fb Fenoxyprop-p-ethyl @ 75 g a.i. ha<sup>-1</sup> (POE-20 DAS) + IC (35 DAS)
T<sub>11</sub>; Weed free check

![Image](http://www.chemijournal.com)

Figure 1: Total weed count in chickpea at different growth stages as influenced by weed management in soybean-chickpea cropping system

“1185”
T1: Pendimethalin 38.7 CS @ 700 g a.i. ha\(^{-1}\) (PRE) fb Imazethapyr @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)
T7: Imazethapyr @ 75 a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS),
T2: Oxyfluorfen @ 0.1 kg a.i. ha\(^{-1}\) (PRE) fb Imazethapyr @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)
T8: Quizalofop-p-ethyl @ 75 a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS),
T3: Pendimethalin 38.7 CS @ 700 g a.i. ha\(^{-1}\) (PRE) fb Quizalofop-p-ethyl @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)
T9: Fenoxyprop-p-ethyl @ 75 a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS),
T4: Oxyfluorfen @ 0.1 kg a.i. ha\(^{-1}\) (PRE) fb Quizalofop-p-ethyl @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)
T10: Pendimethalin @ 1 kg a.i. ha\(^{-1}\) (PRE)+ IC (30 & 45 DAS)+ one HW (between 30 to 45 DAS),
T5: Pendimethalin 38.7 CS @ 700 g a.i. ha\(^{-1}\) (PRE) fb by Fenoxyprop-p-ethyl @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)
T11: Weedy check
T6: Oxyfluorfen @ 0.1 kg a.i. ha\(^{-1}\) (PRE) fb Fenoxyprop-p-ethyl @ 75 g a.i. ha\(^{-1}\) (POE-20 DAS) + IC (35 DAS)
T12: Weed free check

**Fig 2:** Weed index of weeds in chickpea as influenced by weed management in soybean-chickpea cropping system

**Fig 3:** Seed and haulm yield of chickpea as influenced by weed management in soybean-chickpea cropping system
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