Effect of weed management practices on growth and yield of zero till chickpea (*Cicer arietinum* L.)

ABSTRACT

A field experiment was conducted to study the "Effect of weed management practices on growth and yield of zero till chickpea (*Cicer arietinum* L.)" at Regional Agricultural Research Station, Polasa, Jagtial during *rabi*, 2022. The experiment was laid out in randomized block design with seven treatments by replicating thrice. The treatments include T_1- Pendimethalin 38.7 % CS @ 700 g a.i. ha^{-1} at 48 hours after sowing, T_2- Topramezone 33.6 % SC @ 20.6 g a.i. ha^{-1} applied at 2-3 leaf stage of weed, T_3- Quizalofop ethyl 7.5 % + Imazethapyr 15 % EC @ 100 g a.i. ha^{-1} applied at 2-3 leaf stage of weed, T_4- Propaquizafop 2.5 % + Imazethapyr 3.75 % (w/w) ME @ 125 g a.i. ha^{-1} applied at 2-3 leaf stage of weed, T_5- Two hand weedings at 15 and 30 DAS, T_6- Weed free (Season long) and T_7- Un-weeded (Check). Obviously, weed free treatment and hand weeded plots show highest growth and yield attributing characters because of season-long weed-free conditions and better microclimate during critical period of crop. Among different herbicides, Topramezone treated plot recorded higher growth parameters viz.; plant height (38.7 cm), dry matter accumulation (320.8g m^{-2}) and yield attributing characters viz.; total number of pods $plant^{-1}$ (30.97), with seed yield (1397 kg ha^{-1}), haulm yield (2518 kg ha^{-1}) and harvest index (35.7 %). Post emergence herbicide topramezone can be effectively adopted for getting higher yield of chickpea in rice fallow zero tillage conditions.

Key words: *zero till, chickpea, weed management, herbicides, topramezone, toxicity, growth and yield parameters.*

INTRODUCTION

Pulses are the third-largest crop in India after cereals and oilseeds in terms of production, acreage and economic value (Choudhary, 2009). Chickpea (*Cicer arietinum* L.), is a legume of the family Fabaceae. Chickpea ranks as the second-most important pulse crop and the third-most important food legume (Niranjan *et al*., 2020). Chickpea is valued for its nutritional quality in the vegetarian diet as it is an important source of proteins and minerals (Nair *et al*., 2014).

In world, chickpea is grown on 13.7 million ha of area and produces 12.8 million tonnes annually (Afzal, 2021). In India, chickpea is grown on an area of 9.9 million ha with a production of 11.9 million tonnes and productivity is 1192 kg ha^{-1}. In Telangana, chickpea is grown on an area of 1.43 lakh ha with a production of 2.38 lakh tonnes and productivity is 1667 kg ha^{-1} (Indiastat, 2021).

According to the ICMR, the daily recommended intake of pulses is 75 g, but only 47.2 g are now accessible. To close this gap, the chickpea crop production must be increased, but due to a variety of biotic and abiotic factors, chickpea productivity is relatively very poor. Due to the vulnerability of the chickpea to weeds, severe weed infestation is one of the significant factors limiting higher output (Nath *et al*., 2018). Chaudhary *et al*. (2005) reported that weed infestation

UNDER PEER REVIEW

can cause up to 75 % yield losses in chickpea due to its shorter plant and poor early vigour. The first 30 days are too crucial for weed crop competitiveness in chickpea (Singh and Singh, 2000).

Recent years, conservation tillage techniques such as minimal or no tillage systems have gained relevance. On of the conservation tillage techniques is zero-tillage systems, where soil disturbance is limited to sowing activities. It keeps crop leftovers on the soil surface, which raises the amount of soil organic carbon and enhances soil quality and health. In comparison to conventional tillage, zero tillage systems typically needed less maintenance and provided higher economic returns (Smart and Bradford, 1999). This zero tillage reduces cost by 3.8 % to 13.7 % and frees up at least 8 days for the growth of succeeding crops. Zero tillage farming is an option for low-income farmers (Quddus *et al*., 2020).

No-tillage chickpea yield was significantly greater (24–57 %) than under reduced, minimum or conventional tillage and chickpea could be replaced by conservation tillage systems that increase yield and will likely improve soil properties in the long term (Hemmat and Eskandari, 2004). But, in comparison to conventional systems, weed control is more difficult in conservation tillage systems (Rajkumar *et al*., 2014). When a conservation tillage system is used, the weed flora alters. According to Bergtold and Sailus (2020), perennial weeds are more likely to cause issues in conservation tillage systems.

Chemicals are anticipated to be used in zero till agriculture as it continues to grow and replace traditional weed control methods where there is a labour shortage and rising labour costs make manual weeding problematic. Pendimethalin as pre-emergence is the ruling herbicide, however, post-emergence herbicides are limited in this crop particularly for managing broad-leaved weeds. So, our aim is to identify a selective post-emergence herbicide.

Therefore, this present investigation was conducted to evaluate the effect of different weed management practices on zero till chickpea, which can be cost effective and acceptable to the chickpea growers.

MATERIALS AND METHODS

A field experiment was conducted at Regional Agricultural Research Station (RARS), Polasa, Jagtial, Telangana during *rabi*, 2022. The RARS was located at an altitude of 243.4 m above mean sea level (MSL) on 18˚84’26” N latitude and 78˚95’24” E longitude and it is categorized under Northern Telangana Zone (NTZ). The weekly mean maximum and minimum temperature during the crop growth period ranged from 30.4˚C to 34.2˚C with an average of 31.34 ˚C and 13.4 ◦C to 19.6 ˚C with an average of 15.92˚C respectively. The weekly mean relative humidity in the morning (7.14 AM) and afternoon (2.14 PM) during the crop season ranged from 80.9 to 93.7 % with an average of 87.84 % and from 23 to 48.6 % with an average of 38.62 % respectively. The weekly mean wind velocity ranged from 0.2 to 41.9 km hr^{-1} with

UNDER PEER REVIEW

an average of 4.95 km hr^{-1}. The weekly mean bright sunshine hours day^{-1} ranged from 5.1 to 9.1 hr day^{-1} with an average of 7.35 hr day^{-1}. The weekly mean evaporation (USWB Class-A open pan evaporimeter) ranged from 2.2 to 2.9 mm day^{-1} with an average of 2.55 mm day^{-1}. The total rainfall received during the crop growth period was nil.

The experiment was laid out in randomized block design with seven treatments by replicating thrice. The treatments include T_1- Pendimethalin 38.7 % CS @ 700 g a.i. ha^{-1} at 48 hours after sowing, T_2- Topramezone 33.6 % SC @ 20.6 g a.i. ha^{-1} applied at 2-3 leaf stage of weed, T_3- Quizalofop ethyl 7.5 % + Imazethapyr 15 % EC @ 100 g a.i. ha^{-1} applied at 2-3 leaf stage of weed, T_4- Propaquizafop 2.5 % + Imazethapyr 3.75 % (w/w) ME @ 125 g a.i. ha^{-1} applied at 2-3 leaf stage of weed, T_5- Two hand weedings at 15 and 30 DAS, T_6- Weed free (Season long) and T_7- Un-weeded (Check). The soil of experimental field was a sandy clay loams in texture, soil pH (7.31), EC (0.30 dsm^{-1}), low in available nitrogen (179.7 kg ha^{-1}) and available phosphorus (10.9 kg ha^{-1}) but high in available potash (358.4 kg ha^{-1}). After harvesting of rice crop, in *rabi* season within a week duration paraquat was sprayed at 5 ml L^{-1} to kill the rice stubbles and existing weeds. For ensuring good germination, healthy and good quality NBeG-3 variety seeds were used with seed rate of 65 kg ha^{-1} with planting geometry of 30 cm x 10 cm. The recommended dose of fertilizer 20:50:20 kg ha^{-1} of NPK was applied at the time of sowing. Three uniform irrigations were given to the crop at pre sowing, pre flowering and pod development stages. The pre-emergence herbicide sprayed at 48 hours after sowing and post emergence herbicides were sprayed when the weeds are 2-3 leaf stage (18 DAS). The amount of various herbicides needed for the corresponding plots was calculated based on the amount of the active ingredient mentioned in the treatment. Herbicides were sprayed using a knapsack sprayer with a flat fan nozzle to the corresponding plots by mixing the exact amount of herbicides and measured water at a rate of 500 L ha^{-1}. The data was analysed by the method of "Analysis of Variance" as described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSIONS

GROWTH PARAMETERS: All the growth parameters were significantly influenced by different weed management practices in zero till chickpea and are presented in Table 1.

Plant height (cm)

Data on plant height from table depicts that weed free treatment produced tallest plants (43.6 cm) and it was on par with hand weeding treatment (42.0 cm). Among herbicides, treatment topramezone recorded higher plant height (38.7 cm) due to maintaining weed free conditions during critical period of crop by applying herbicide that exerted less competition from weeds and produced taller plants. Similar results were found with Quddus *et al*. (2020) and Ratnam *et al*. (2011).

UNDER PEER REVIEW

Number of branches plant^{-1}

The number of branches plant^{-1} varied significantly due to different treatments. Data from table 1 shows that number of branches plant^{-1} registered highest in weed free (30.51) followed by hand weeding (26.32). Among herbicides, higher number of branches plant^{-1} registered in topramezone (25.95), due to maintaining weed free conditions during critical period of crop that favours the crop to spread freely. Similar results documented with Sanketh *et al*. (2021).

Leaf area (cm^{-2} plant^{-1})

Leaf area was significantly affected by weed management treatments and Table 1 depicts data at 75 DAS, where higher leaf area plant^{-1} recorded in weed free treatment (433.99 cm^2) which was comparable with hand weeding treatment (410.48 cm^2). Among herbicides, topramezone recorded higher leaf area plant^{-1} (403.75 cm^2) due to weed free conditions at critical period of crop that results in taller plants coupled with higher number of branches that finally leads to higher leaf area plant^{-1}. After 75 DAS leaf area plant^{-1} decreases due to leaf senescence. These results are in line with those of Thakur *et al*. (2019).

Dry matter accumulation (g m^{-2})

Dry matter accumulation was significantly influenced by different weed management treatments. An overview of the data from table 1 shows that weed free plot accumulated maximum dry matter (383.5 g m^{-2}) which was followed by hand weeded plot (344.2 g m^{-2}). Among herbicides, topramezone accumulated maximum dry matter (320.8 g m^{-2}). This might be due to improved crop growth parameters viz.; (Plant height, Number of branches plant^{-1} and Leaf area plant^{-1}). Similar findings were seen with Kumar and Hiremath (2018) and Thakur *et al*. (2019).

YIELD PARAMETERS: An overview of the yield attributes data from table 2 revealed that there were significant differences among different weed management treatments except pod weight, number of seeds pod^{-1} and test weight.

Total number of branches plant^{-1} at harvest

From the data on yield attributes, weed free treatment depicts significantly higher number of branches plant^{-1} (30.51) followed by hand weeding treatment (26.32). Among herbicides, topramezone recorded higher number of branches (25.95). This could be due to lower weed density at critical period of crop that facilitated crop towards optimum utilization of resources (Sunlight, Water, Space and Nutrients) that reflected in higher number of branches plant^{-1}. Similar results were earlier documented by Sanketh *et al*. (2021).

Number of pods branch^{-1}

UNDER PEER REVIEW

Data on yield attributes (Table 2) depicted that weed free produced higher number of pods branch^{-1} (2.78) which was comparable with hand weeding (2.52) and among herbicidal treatments higher number of pods branch^{-1} observed in topramezone (2.19). This was due to higher number of branches plant^{-1} in turn results in higher number of pods branch^{-1}.

Total number of pods plant^{-1}

An overview on yield attributes, weed free plot registered highest total number of pods plant^{-1} (33.93) and it was statistically on par with hand weeding plot (31.20). While, among herbicidal treatments highest total number of pods plant^{-1} were registered in topramezone (30.97) due to higher number of branches plant^{-1} and number of pods branch^{-1}. These results find support from those of Tiwari *et al*. (2019).

Pod weight (g)

Data on yield attributes had shown that there were no significant differences among different weed management practices on pod weight. Because it was also purely a genetical character.

Number of seeds pod^{-1}

Yield attributes from table, it was clear that different weed management practices had no significant effect on number of seeds pod^{-1}. This could be attributed to the fact that number of seeds pod^{-1} is a genetic character and hence not be altered by any weed management practices. The results are in accordance with findings of Sanketh *et al*. (2021).

Test weight (100 seeds) (g)

It could be inferred that from the data on yield attributes (Table 2) test weight of different weed management practices was shown as non-significant. This might be due to varietal genetic character. These results corroborate with those of Ratnam *et al*. (2011).

YIELD: Seed yield of zero till chickpea was significantly influenced by different weed management practices and it ranged from 903 to 1621 kg ha^{-1} across the treatments which were presented in Table 2 and Fig 1.

Seed yield (kg ha^{-1})

Weed free plot recorded significantly higher seed yield (1621 kg ha^{-1}) followed by hand weeding (1453 kg ha^{-1}) but among the herbicidal treatment topramezone recorded highest seed yield (1397 kg ha^{-1}). It was due to the proper utilization of moisture, nutrients, light and space by the chickpea crop in the absence of weed competition during critical period of crop. While, lowest seed yield was recorded from Un-weeded (Check) plot (903 kg ha^{-1}) due to highest crop-

UNDER PEER REVIEW

weed competition. Similar results were reported by those of Kumari *et al*. (2021), Mishra *et al*. (2012), Quddus *et al*. (2020), Banjara *et al*. (2022) and Sesharee *et al*. (1996).

Haulm yield (kg ha^{-1})

The haulm yield of zero till chickpea (Table 2) was significantly influenced by different weed management practices.

An overview from the data showed that weed free plot registered higher haulm yield (2648 kg ha^{-1}) followed by hand weeding plot (2527 kg ha^{-1}). On the other hand, topramezone (2518 kg ha^{-1}) treatment among herbicides recorded highest haulm yield. The higher stover yield in above treatments might be due to lesser weeds during early crop growth period, higher yield attributes and pod yield which leads to higher stover yield. Quddus *et al*. (2020) and Banjara *et al*. (2022) found similar results.

Harvest index (%)

From the table 2 it could be inferred that significantly higher harvest index (38.0 %) observed in weed free treatment, which was statistically comparable with remaining treatments. The minimum harvest index was obtained (33.3 %) under un-weeded (check) due to low seed yield and more crop-weed competition. Maximum harvest index under these treatments might be due to proper reproductive growth due to timely translocation of photosynthesis from source to sink thus increase the seed production ratio in total produce. Quddus *et al*. (2020) and Thakur *et al*. (2019) observed similar output.

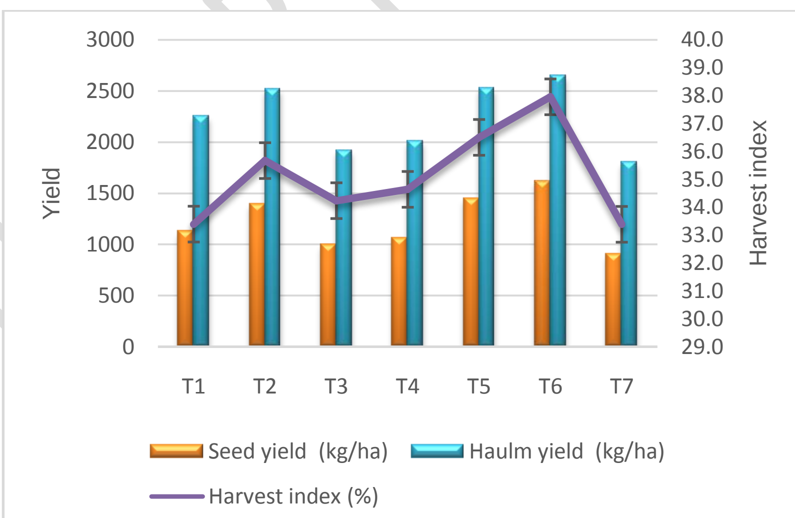

Fig. 1 Seed yield, Haulm yield and Harvest index as influenced by different weed management practices in zero till chickpea

CROP PHYTOTOXICITY

Visual scoring for crop phytotoxic symptoms such as yellowing, stunting, chlorosis and necrosis were taken at 3^{rd} day after spray of herbicide up to 25 days based on the rating scale. It was noted according to 1-9 scale method (Table 3). For chickpea, 1 meant no to very slight phytotoxicity and 9 for complete destruction of plant (Jiddimani *et al*., 2017). A score of < 3 was considered as acceptable (Rao, 2000).

Topramezone treated plot showed yellowing and stunting symptoms (Scale < 2) (Table 4) and recovered completely 10 days after application (DAA) due to the new meristematic growth and initiation of branching. Similar findings on yellowing and stunting in chickpea crop were documented earlier by (Nath *et al*., 2018) and (Sanketh *et al*., 2021).

In contrast, treatment T_3 and T_4 showed chlorotic symptoms of phytotoxicity (Score < 4) (Table 4) which was higher at 7 DAA leads to necrosis due to death of apical tissue. But, at 30 DAA the crop started producing new branches and associated growth by new meristematic activity in the apical buds. This prolonged phytotoxicity affected the crop phenological development as evident from lower seed yield. Similar results of phytotoxicity due to application of imazethapyr leads to leaf chlorosis followed by necrosis were in line with (Kumar *et al*., 2015), (Dubey *et al*., 2018), Dubey and Chaudhary (2021), Lyon and Wilson (2005) and (Sanketh *et al*., 2021).

CONCLUSION

Experimental results revealed that topramezone treated plots recorded higher value for growth and yield contributing characters. Hence, topramezone 33.6 % SC @ 20.6 g a.i. ha^{-1} applied at 2-3 leaf stage of weed is suggested for controlling the diversified weed flora under zero tillage conditions in rice-fallow chickpea.

UNDER PEER REVIEW

Table. 1 Growth parameters of zero till chickpea as influenced by weed management practices

Treatment details	Plant height (cm)	Number of branches plant^{-1}	Leaf area (cm^{-2} plant^{-1})	Dry matter accumulation (g m^{-2})
T_1-Pendimethalin 38.7 % CS @ 700 g a.i. ha^{-1} at 48 hours after sowing	35.5	19.61	372.42	277.9
T_2-Topramezone 33.6 % SC @ 20.6 g a.i. ha^{-1} applied at 2-3 leaf stage of weed	38.7	25.95	403.75	320.8
T_3-Quizalofop ethyl 7.5 % + Imazethapyr 15 % EC @ 100 g a.i. ha^{-1} applied at 2-3 leaf stage of weed	34.2	16.66	321.29	244.0
T_4-Propaquizafop 2.5 % + Imazethapyr 3.75 % (w/w) ME @ 125 g a.i. ha^{-1} applied at 2-3 leaf stage of weed	34.6	17.13	337.64	263.9
T_5-Two hand weedings at 15 and 30 DAS	42.0	26.32	410.59	344.2
T_6-Weed free (Season long)	43.6	30.51	433.99	383.5
T_7-Un-weeded (Check)	31.0	14.14	285.92	233.2
SEm±	0.6	0.8	4.8	13.9
CD (P=0.05)	1.9	2.3	14.8	42.9

Table. 2 Yield and yield attributes of zero till chickpea as influenced by weed management practices

Treat No.	Total number of branches plant^{-1} at harvest	Number of pods branch^{-1}	Total no. of pods plant^{-1}	Pod Weight (g)	No. of seeds pod^{-1}	Test weight (g)	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest index (%)
T_1	19.61	1.70	26.80	0.27	1	23.00	1129	2253	33.4
T_2	25.95	2.19	30.97	0.28	1	23.67	1397	2518	35.7
T_3	16.66	1.08	20.67	0.27	1	23.00	1000	1922	34.2
T_4	17.13	1.18	21.43	0.27	1	23.00	1067	2014	34.6
T_5	26.32	2.52	31.20	0.28	1	23.67	1453	2527	36.5
T_6	30.51	2.78	33.93	0.29	1	24.00	1621	2648	38.0
T_7	14.14	1.08	18.67	0.27	1	23.00	903	1802	33.3
SEm±	0.8	0.3	1.3	0.008	-	0.4	31.4	37.9	0.5
CD (P=0.05)	2.3	0.8	3.9	NS	-	NS	96.6	116.9	1.6

UNDER PEER REVIEW

Table. 3 Phytotoxicity score

Rating	Phytotoxicity %	Description
1	0-10	No to very slight discoloration
2	11-20	More severe but not lasting
3	21-30	Moderate and more lasting
4	31-40	Medium and lasting
5	41-50	Moderately heavy
6	51-60	Heavy
7	61-70	Very heavy
8	71-80	Nearly destroyed
9	81-100	Destroyed

Source: Jiddimani *et al*. (2017)

Table. 4 Phytotoxicity rating (Scale 1-9) as influenced by weed management practices on zero till chickpea

Treatment details	Dosage (ml ha^{-1})	Phytotoxicity rating
T_1-Pendimethalin 38.7 % CS @ 700 g a.i. ha^{-1} at 48 hours after sowing	1808	-
T_2-Topramezone 33.6 % SC @ 20.6 g a.i. ha^{-1} applied at 2-3 leaf stage of weed	61.3	1-2
T_3-Quizalofop ethyl 7.5 % + Imazethapyr 15 % EC @ 100 g a.i. ha^{-1} applied at 2-3 leaf stage of weed	444.4	3-4
T_4-Propaquizafop 2.5 % + Imazethapyr 3.75 % (w/w) ME @ 125 g a.i. ha^{-1} applied at 2-3 leaf stage of weed	2000	3-4
T_5-Two hand weedings at 15 and 30 DAS	-	-
T_6-Weed free (Season long)	-	-
T_7-Un-weeded (Check)	-	-

UNDER PEER REVIEW

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UNDER PEER REVIEW