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Studies on the bioefficacy of different herbicides to manage weeds in chickpea (*Cicer arietinum* L.)

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Abstract
The current study, titled "Studies on Bioefficacy of Different Herbicides for Weed Management in Chickpea [*Cicer arietinum* L.]", at the College of Agriculture in Badnapur. Ten treatments were used in the field experiment, which was set up using a randomised block design. Among herbicides, oxyfluorfen had the highest plant height values (41.67), number of leaves (122), and number of branches (8.67) at harvest. In terms of plant height, it was comparable to quizalofop-p-ethyl 100 g A.I/ha at 25 DAS (T_6) (40.33). The highest seed yield (1788 kg/ha) was recorded by the weed-free treatment (T_9), which was comparable to hand weeding at 30 DAS and hoeing at 45 DAS (T8) (1632 kg/ha), oxyfluorfen (23.5% EC) @ 0.17 Kg A.I/ha (PE) (T_3), and quizalofop-p-ethyl 100 g A.I/ha at 25 DAS (T_6). The herbicide oxyfluorfen (23.5% EC) @ 0.17 Kg a. i/ha (PE) (T_3) yielded the highest seed production (1574 kg/ha), which was comparable to quizalofop-p-ethyl 100 g A.I/ha at 25 DAS (T_6) (1525 kg/ha). The weed-free treatment (T_9) outperformed all other treatments in terms of seed yield (1788 kg ha^{-1}). *Parthenium hysterophorus*, *Medicago denticulate*, *Chenopodium album*, *Cynodon dactylon*, and *Echinochloa colonum* founds associated with chickpea during experimental period. Amongst herbicides oxyflourfen recorded (5) weed count, (5) dry matter of weed at harvest. Weedy check recorded (37) weed count and (54) weed dry matter. At harvest highest The effectiveness of weed control was noted (90.74) in (T_3) oxyfluorfen (23.5% EC) @ 0.17 Kg A.I/ ha (PE) followed by (T_8) hand weeding at 30 DAS & hoeing at 45 DAS (79.62) and lowest weed control efficiency recorded in (T_7) imazethapyr (10% S. L) @ 0.75 Kg A.I / ha at 21 DAS (PoE) (58.64%). Then, treatment oxyfluorfen (23.5% EC) @ 0.17 Kg A.I/ ha (PE) (T_3) (11.96%) recorded lowest and (T_{10}) weedy check (49.04%) recorded highest weed index, respectively.

Keywords: Chickpea, herbicide, weed, weed management, pre-emergence, post emergence

Introduction
The chickpea (*Cicer arietinum* L.) is a widely distributed cool-season edible legume. The name Cicer comes from the Greek word 'Kiros,' which alludes to the illustrious Roman family Cicero. The Latin word aries, which means "ram," is the source of the name arietinum, which alludes to the ram-like Afghan chickpea's head shape. Around the world, the chickpea is referred to by a variety of names, including grame, garbanzo, chana, Bengalgram, pois, hoos, hommos, and grao-de-beco. (Textbook of field crops production Vol-1 by Dr. Rajendra Prasad)

Chickpea (*Cicer arietinum* L.) belongs to leguminoceae family. It is considered as king of pulses. Chickpea is India's prime pulse crop. Chickpea is the impotant pulse crop of India. Chickpea is also referred to as Bengal Gramme or Gramme. Chickpeas are regarded as having therapeutic properties and are used to purify blood. A germinated seeds of chickpea are used in the treatment of scurvy disease. Specific sour test of Gram leaves is due to the presence of malic acid and oxalic acid.

Due to its ability to fix nitrogen, chickpea also contributes significantly to raising soil fertility. Chickpeas may replenish up to 140 kg of N per hectare during a growing season (Poonia and Pithia) [1]. These leaves supply a lot of organic matter to support and enhance the quality and fertility of soils as well as significant amounts of residual nitrogen for upcoming crops.

In the world, on the global basis, India ranks first in area and production. India is followed by Pakistan, Iran and Australia with respect to area and followed by Australia and Myanmar with respect to production. Total area under pulses was 89405 ha with 749190 Tonnes of production with average productivity of 4631 kg ha^{-1} in world. (Directorate of Economics & Statistics 2021).

In India, the chickpea is the most extensively grown pulse plant. During 2020–2021, India In India, the chickpea is the most extensively grown pulse plant.

During 2020-2021, India will produce 9.85 million/ha, 11.99 MT, and an average of 1217 kg ha-1 of chickpeas. (Economics & Statistics Directorate 2021).

In India Madhya Pradesh has largest acreage and production followed by Rajasthan. In Madhya Pradesh area and production of chickpea is 2.10 million Ha and 3.13 million tonnes (Directorate of economics & statistics report 2020-2021).

In Maharashtra Amravati district leads in chickpea production, with a share of 8%, followed by Ahmadnagar (7%), Akola (7%), Hingoli (6%), Washim (5%), Buldhana (5%), Latur (5%), Osmanabad (5%), Nagpur (5%), Jalgaon (5%), Nanded (5%) and other district in the state by 38%. (Mafwda 2021).

Chickpea production (7.96 lakh tonnes), productivity (707 Kg/ha), and area (9.89 lakh/ha) in the Marathwada region were all noted in the years 2020-21. The region contributes 36.53% of the state's area and produces 35.38% of the state's average output over the past ten years. (Chief Statistician Committee of Agriculture Report, Pune, 2020-2021).

There are many reasons why the average yield of chickpeas is so low, But weed, which competes with the crop for moisture, nutrients, space, and light, is one of the main reasons for this low productivity in chickpea. In the winter, *Asphodelus tenuifolius* L. pulses that have been irrigated and rainfed are home to lamb's quarters (*Chenopodium album* L.), scarlet pimpernel (*Anagallis arvensis* L.), and (*Fumaria parviflora* L.). In northern and central India on light soils, it appears in various flushes and causes problems for rainfed lentil and chickpea crops (Kumar, 2010) [8]. The growth of weeds makes it difficult to increase chickpea yield and facilitate harvesting. Chickpea is a weed competitor because it grows slowly and only develops a small amount of leaf area in the early stages of crop growth and establishment. The amount of yield loss brought on by weed competition varies greatly depending on the degree of weed infestation and the present plant species. Despite this, almost all values accurately reflect how serious the weed problem is.

Weeds are a major issue for the chickpea crop since, at the moment, fewer herbicides are advised for chickpea than for other commercial crops, and because hand weeding is impractical because of the high costs of farm labourers. Weeds compete fiercely with this crop for all growth factors because of its modest height and slow beginning growth. The losses caused by weeds may range from 40 to 80 percent, based on the extent of the infestation and the severity of the weed flora (Vaishya *et al*., 1996) [7]. By using an efficient pesticide in conjunction with superior crop management that can effectively control these weeds, the per unit yield of this crop can be increased.

Older herbicides like pendimethalin, alachlor, and oxyfluorfen are still used frequently to control weeds in chickpea. The brand-new herbicide that targets post-emergence Topramezone needs to be tested on chickpeas. It has wide-ranging weed control. At 45 and 95 DAS, respectively, topramezone reduces 68-70% and 48-51% reductions in total weed density less than the unweeded control (research gate net). Accordingly, the effectiveness of Imazethapyr and Quizalofop in chickpea needs to be compared to that of ethyl and topramezone.

Weeds affect crop plant development, yield and quality as well as soil fertility, accessible soil moisture and nutrients competing for space and sunlight with crop plants. Weeds are a serious threat to chickpea crops in both rainfed and irrigated environments. According to Vaishya *et al*. (1996) [7], weeds can reduce seed yield by 40-87 percent.

Materials and Methods

The current study, titled "Studies on Bioefficacy of Different Herbicides for Weed Management in Chickpea [*Cicer arietinum* L.]", was completed at the Badnapur College of Agriculture. Complete levelling and drainage were performed on the test area. The clayey soil had some moderately accessible nitrogen, a high level of available potassium, a low amount of accessible phosphorus, and responded somewhat alkaline. Environmental conditions were favourable for the chickpea crop's typical growth and maturity during the trial period. Ten treatments were included in the field experiment using a randomised block design. Treatments comprised of treatment comprised of (T_1) pendimethalin (30% EC) @ 0.50 Kg A.I/ ha (PE), (T_2) alachlor (50% EC) @ 0.30 kg A.I /ha (PE), (T_3) oxyfluorfen (23.5% EC) @ 0.17 Kg A.I / ha (PE), (T_4) topramezone 25.7 g A.I / ha at 14 DAS (PoE), (T_5) topramezone 25.7 g A.I / ha at 21 DAS (PoE), (T_6) quizalofop ethyl (5% EC) @0.80 kg A.I/ ha at 21 DAS (PoE), (T_7) imazethapyr (10% S. L) @ 0.75 Kg A.I / ha at 21 DAS (PoE), (T_8) hand weeding at 30 DAS & hoeing at 45 DAS, (T_9) weed free (hand weeding as and when Required), (T_{10}) weedy check. Gross and net plot sizes for each experimental unit were 4.5 m x 5.0 m and 3.6 m x 4.8 m, respectively. On October 19, 2021, seeds were sown using the dibbling method with a 45 cm x 10 cm spacing. As recommended for all treatments, seed treatment, pest management, irrigation, and fertiliser management were carried out. 25: 50: 00 kg NPK ha-1 of fertiliser was advised for the chickpea crop.

Table 1: Effect of different treatments on growth attributing characters of chickpea.

Treatments	Plant Height (cm) at harvest	No. of functional leaves at 60 DAS	Dry matter plant^{-1} (g) at harvest	No. of branches plant^{-1} at harvest	Number of pods plant^{-1}
T_1: Pendimethalin (30% EC) @ 0.50 Kg A.I/ ha (PE)	37.36	121.66	25.89	7.96	51.33
T_2: Alachlor (50% EC) @ 0.30 Kg A.I /ha (PE)	37.03	117.33	25.02	7.93	46.33
T_3: Oxyfluorfen (23.5% EC) @ 0.17 Kg A.I / ha (PE)	41.67	125.67	27.02	8.67	53.67
T_4: Topramezone 25.7 g A.I / ha at 14 DAS (PoE)	35.90	112.33	21.33	7.73	36.00
T_5: Topramezone 25.7 g A.I / ha at 21 DAS (PoE)	36.00	113	22.00	7.80	36.33
T_6: Quizalofop ethyl (5% EC) @ 0.80 kg A.I/ha at 21 DAS (PoE)	40.33	117	26.47	8.53	47
T_7: Imazethapyr (10% S. L) @ 0.75 Kg A.I / ha at 21 DAS (PoE)	37	110.33	23.05	7.86	40.33
T_8: Hand weeding at 30 DAS & Hoeing at 45 DAS	42.67	126.67	27.64	8.70	54.67
T_9: Weed free (Hand Weeding as and when Required)	44.00	128.33	28.00	8.93	55.67
T_{10}: Weedy check	34.66	110	19.6	7.7	35.33
SEm±	1.90	1.18	0.49	0.11	4.09
CD at 5%	5.64	3.49	1.45	0.32	12.15
General Mean	38.66	118.23	24.60	8.18	45.67

Table 2: Effect of different treatments on yield attributing characters and yield of chickpea.

Treatments	Pod yield plant^{-1} (g)	Seed yield plant^{-1}(g)	Seed index (g)	Seed Yield (kg ha^{-1})	Straw Yield (kg ha^{-1})	Biological Yield (kg ha^{-1})	Harvest Index (%)
T_1: Pendimethalin (30% EC) @ 0.50 Kg A.I/ ha (PE)	17.63	14.3	17.93	1505	2777	4282	35.14
T_2: Alachlor (50% EC) @ 0.30 Kg A.I /ha (PE)	17.06	14	17.73	1471	2732	4203	34.99
T_3: Oxyfluorfen (23.5% EC) @ 0.17 Kg A.I / ha(PE)	17.33	14.67	18.3	1574	2872	4446	35.40
T_4: Topramezone 25.7 g A.I / ha at 14 DAS (PoE)	11.33	10.00	17.03	1252	2427	3679	34.03
T_5: Topramezone 25.7 g A.I / ha at 21 DAS (PoE)	11.67	10.67	17.07	1300	2500	3800	34.21
T_6: Quizalofop ethyl (5% EC) @ 0.80 Kg A.I/ha at 21 DAS (PoE)	17.03	13.66	18	1525	2778	4303	35.44
T_7: Imazethapyr (10% S. L) @ 0.75 Kg A.I / ha at 21 DAS (PoE)	14.33	11.66	17.33	1391	2617	4008	34.70
T_8: Hand weeding at 30 DAS & Hoeing at 45 DAS	18.67	15.07	18.97	1632	2946	4578	35.64
T_9: Weed free (Hand Weeding as and when Required)	19.97	16.67	19.67	1788	3128	4916	36.37
T_{10}: Weedy check	9.33	8	16.33	911	2025	2936	31.02
S.Em±	1.12	1.08	1.55	138	161	253	-
CD at 5%	3.32	3.20	NS	410	478	753	-
General Mean	15.44	12.87	17.84	1434	2680	4115	34.69

Results and Discussion

Growth attributes

The growth-attributing characteristics were plant height (cm), the number of functional leaves, dry matter plant^{-1}, the number of branches plant-1, and the number of pods plant^{-1}. weed-free treatment significantly influenced (T_9) at all growth stages of the crop, which was comparable to hand weeding at 30 DAS and hoeing at 45 DAS (T_8), oxyfluorfen (23.5% EC) @ 0.17 Kg A.I /ha (PE) (T3), and quizalofop ethyl (5% EC) @ 0.80 Kg A.I/ha at 21 DAS (PoE) (T_6), respectively. In addition, and Bhale and reported on the highest plant height caused by the application of oxyfluorfen and pendimethalin, respectively. Imazethapyr was applied at lower doses, according to Goud *et al*., leading to taller plants. It is possible to link comparable plant height after herbicide application and weed-free treatment to improved crop growth as a result of early weed control. The lowest competition between weeds and chickpea for space, nutrients, and water may be responsible for the highest plant height in weed-free treatment. Due to increased competition between weeds and chickpea for space, nutrients, and water, the weedy check treatment resulted in the shortest plant height.

Yield attributes

Different treatments had a big impact on the yield-attributing system. characteristics of chickpea, including Biological Yield (Kg ha^{-1}), Seed Yield Plant^{-1} (Kg ha^{-1}), Seed Index (g), Straw Yield (Kg ha^{-1}), and Pod Yield Plant^{-1} (g) (Table 2). Maximum number of Straw Yield (3128 Kg ha^{-1}), Seed Yield (1788 Kg ha^{-1}), Pod Yield Plant^{-1} (19.97 g), and Seed Yield Plant^{-1} (16.67 g) per plant. The weed-free treatment (T9) produced a biological yield of 4916 kg ha-1, which was comparable to the yields obtained with the following treatments: hand weeding at 30 DAS and hoeing at 45 DAS (T_8), oxyfluorfen (23.5% EC) at 0.17 kg A.I./ha (PE), (T_3), pendimethalin (30% EC) at 0.50 Kg A.I./ha (PE), (T_1), and was significantly higher than topramezone (25.7 g A.I/ha at 14 DAS (T_4), imazethapyr (10% S. L) @ 0.75 Kg A.I / ha at 21 DAS (PoE), and topramezone (25.7 g A.I/ha at 21 DAS (T_5). Weedy check (T_{10}) had a lower total pod yield plant-1 (9.33g) than the other treatments. Poonia and Pithia (2013) [1] also noted an increase in pod yield following the application of oxyfluorfen (17.33) and pendimethalin (17.63) over weedy check (T_4) (9.33). According to Goud *et al*. (2013) [5], imazethapyr application at lower doses (@ 0.75g ha-1) resulted in the highest pod yield. Better pod yield due to timely weed control may be explained by comparable branches of herbicide application with weed free treatment. The higher pod yield in the weed-free treatment may be due to less competition from weeds for water, nutrients, and space. Weeds and chickpea may compete more fiercely for resources like space, nutrients, and water in the weedy check treatment, which results in a lower number of pod yield. Kachhadiya *et al*. (2009) [3] and Pooniya *et al*. (2009) [2] reported similar findings.

Conclusion

According to the findings of the current study, oxyfluorfen (23.5% EC) @ 0.17 Kg A.I/ ha (PE) application has a significant impact on plant height, number of leaves, leaf area, dry matter, as well as yield parameters like filled seed count, test weight, weight of seed per plant, biological yield, harvest index, seed yield, net financial return, and benefit cost ratio. The application of imazethapyr (10% S. L) at 0.75 Kg A. I / ha at 21 DAS (PoE) resulted in the lowest weed control efficiency (58.64%), while oxyfluorfen (23.5% EC) at 0.17 Kg A.I/ ha (PE) produced the highest weed control efficiency (90.74%).

In the weedy check, a higher reduction yield, or weed index (49.04%), was noted. The lowest weed index (11.96) among herbicide treatments was found in oxyfluorfen (23.5 EC) at 0.17 Kg A.I. / ha (PE).

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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