MAS Journal of Applied Sciences
Uygulamalı Bilimler Dergisi
ISSN: 2757-5675
masjaps.com

OPEN ACCESS

DOI: http://dx.doi.org/10.5281/zenodo.14358364

Araştırma Makalesi / Research Article

The Effect of Alternative Weed Control Methods on Yield Parameters in Chickpea (*Cicer arietinum* L.)

Murat TUNC [1], Sibel IPEKESEN [2], Fatma BAŞDEMİR [3], Süreyya Betül RUFAIOGLU [4*]

[1] Harran University, Agriculture Faculty, Department of Field Crops, Sanliurfa

[2] Dicle University, Agriculture Faculty, Department of Field Crops, Diyarbakir

[3] Harran University, Ceylanpinar Agriculture Vocational High School Sanliurfa

[4] Harran University, Agriculture Faculty, Department of Soil Science and Plant Nutrition, Sanliurfa

*Corresponding author: sureyyarufaioglu@harran.edu.tr

Received: 16.08.2024 **Accepted**: 30.09.2024

Abstract

This study focused on the significance of weed control in organic chickpea (*Cicer arietinum* L.) cultivation and the effectiveness of alternative weed control methods. The environmental impacts of herbicide use and the development of resistance in weeds, which are among the chemical control methods, necessitate the improvement of alternative weed control methods for sustainable agricultural practices. In this study, the effectiveness of different methods, such as organic source materials, biological control agents, mechanical hoeing and other cultural practices on weed control was evaluated. The research was carried out in the area reserved for organic cultivation in the field crops application and research area of Dicle University Faculty of Agriculture, Faculty of Agriculture in the 2021 growing season. The experiment was set up according to the Randomized Block Design with 3 replications and Arda chickpea was used. Weedless control, weedy control, hand plucking before flowering, hoeing before flowering, hand plucking at pod stage, hand plucking at pod stage, hand plucking before flowering + pod stage, sowing with 20 cm spacing, sowing with 45 cm spacing, whey, whey + hoeing, pickle juice and pickle juice + hoeing were applied as weed control. Plant height, fresh weight, total number of pods, total pod weight, number of full pods, number of empty pods and number of grains per plant were investigated. Consequently, mechanical practices such as hoeing and manual weed control have reduced weed pressure and increased plant yield. Hoeing treatment increased the number of full pods by 28%, grain weight by 35%, and manual weed control reduced weed pressure by 20% and increased yield by 25% compared to other treatments. In the treatment without weed control, a 40% loss in yield was observed. By comparing different control methods in the research, it will contribute to the determination of sustainable weed management strategies and increase agricultural productivity. Furthermore, different control methods should be investigated in order to develop sustainable weed management strategies.

Keywords: Chickpea, weed control, sustainable agriculture, mechanical weed control, organic methods

1.Introduction

Chickpea (*Cicer arietinum* L.) is an essential legume species with high nutritional value that is widely cultivated worldwide, particularly in regions with Mediterranean climate (Türker et al., 2019). At the same time, it is important as a cheap and abundant source of protein, which is in ever-increasing demand. (Sozen and Peker, 2023). It is of great significance as a fundamental food source in human nutrition with its protein, carbohydrate, vitamin and mineral content. It also contributes to increasing soil fertility in agricultural ecosystems thanks to its ability to fix nitrogen (Kaya et al., 2020). The sustainability of chickpea production is of major value both economically and environmentally. There are many biotic and abiotic factors affecting yield and quality in chickpea production. These factors include drought, low or high temperatures, nutrient deficiency, weeds, diseases and pests. Weeds are among the most important biotic factors limiting chickpea yield. Nevertheless, one of the most important biotic problems encountered in chickpea cultivation is the presence of weeds (Adıyaman and Kahriman, 2021). Despite these sensitive characteristics, chickpeas play a vital role in human and animal nutrition in a wide geography (Ceritoglu et al., 2020). Weeds compete with chickpea plants for limited resources such as water, nutrients and light, and thus negatively affect the growth, development and yield of the plant. Intense weed pressure in chickpea fields can lead to considerable losses in crop yield and reduced quality (Chauhan and Johnson, 2019). This demonstrates the vital role that weed control plays in chickpea farming. Traditionally, herbicides have been widely used for weed control. Although the rapid and effective control provided by the use of herbicides is an attractive option for many producers, the environmental impact of these chemicals and their negative effects on non-target organisms is a major concern. It is also known that the use of herbicides develops resistance in weed species in the long term, which reduces the effectiveness of control strategies (Singh et al., 2021). Consequently, it is important to reduce the use of herbicides and develop alternative weed control methods within the scope of sustainable agricultural practices. In recent years, interest in environmentally friendly and sustainable methods for weed control in chickpea agriculture has increased. The use of organic materials, biological control methods, mechanical hoeing and other cultural practices are among the methods considered as alternatives or complements to herbicides (Türker et al., 2019). Increasingly, these approaches are gaining significance both to reduce environmental impacts and to maintain the yield of chickpea plants. The use of organic and biological methods has gained significance especially with the widespread use of organic farming practices and research on the effectiveness of these methods has been increased (Kaya et al., 2020). The control of weeds is of great significance not only to prevent yield losses but also to protect soil health and support biodiversity. The restriction of the use of chemical herbicides, especially in organic farming, necessitates the development and application of alternative control methods. Integrated control strategies using a combination of mechanical, biological and cultural methods are considered as an important solution in the agricultural sector by ensuring both economic and environmental sustainability (Kumar et al., 2020). Such methods are one of the most effective strategies that can be applied to reduce the density of weeds and maintain the productivity of cropland. In addition, raising farmers' awareness and supporting them with training is an important step to increase the success of weed control practices. Increasing farmers' knowledge and awareness of alternative methods can support the spread of sustainable agricultural practices by reducing dependence on chemical herbicides (Johnson and Chauhan, 2019). Adopting safer and more sustainable production

processes in terms of agricultural productivity, environmental protection and human health is considered as a long-term strategy in chickpea cultivation. In this respect, our research aimed to comprehensively examine the effects of alternative weed control methods used in chickpea cultivation on plant yield parameters. In particular, the effectiveness of organic and mechanical methods on yield was evaluated in order to minimize the negative environmental and health effects of herbicides.

In this regard, the comparison of environmentally friendly and sustainable alternative methods that can be used instead of herbicides aimed to create positive impacts on agricultural productivity and ecosystem sustainability. The results of the study are expected to contribute to the development of sustainable weed management strategies and the identification of alternative control methods for farmers.

2.Materials and Methods

This research was conducted as a field experiment in the research and application area of Dicle University, Faculty of Agriculture, Department of Field Crops in 2021. The experimental area reserved for organic cultivation was used for the field trial experiment (Figure 1).

2.1. Material

The soil of the experimental area was clay loamy, slightly saline, slightly alkaline, low in phosphorus, high in potassium, very low in organic matter, very low in nitrogen, sufficient in iron and magnesium and high in calcium (Table 1).

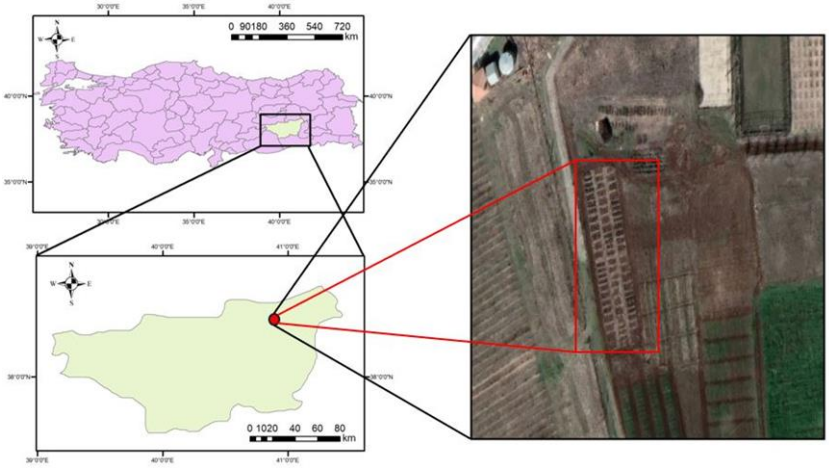

Figure.1. Study area

Table 1. Results of physical and chemical analysis of 0-30 cm soil of the experimental area

Soil parameters	
Texture	72.6
EC (ds cm^{-1})	0.042
Clay (%)	7.46
pH	7.76
P_2O_5 (kg ha^{-1})	18.8
K_2O_5 (kg ha^{-1})	1363
Organic matter (%)	0.65
N (%)	0.03
Fe (ppm)	37
Ca (ppm)	93.74
Mg (ppm)	5639

Source: Gübretaş Soil-Plant Analysis Laboratory (Yarımca/İzmit Ministry of Agriculture Reference Laboratory

Analysis of the growing season 2021 climatic data, during which the experiment was carried out, revealed that the average temperature was 15.6°C, that it dropped between January and March, rose sharply between April and June, and peaked in June at 28.6°C. Total rainfall during the experiment was 147.7 mm, with the highest rainfall (57.9 mm) in March and a rapid decrease in the April-June period. January had the highest humidity of 71.8%, with a decrease in humidity in the April-June period in inverse proportion to temperature (Figure 2).

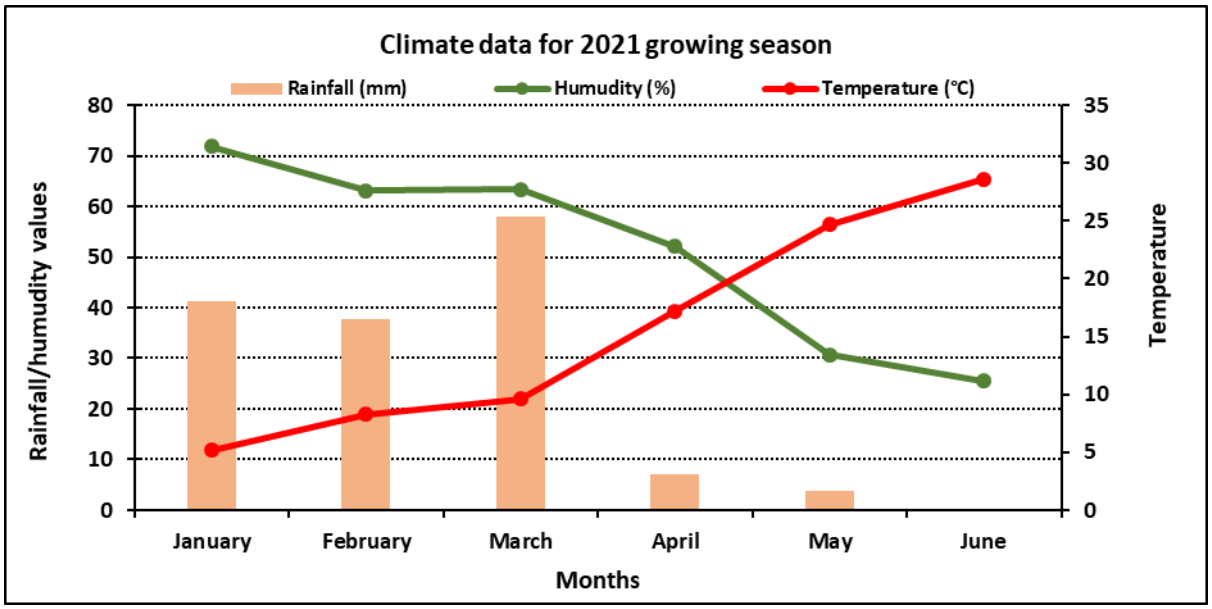

Figure 2. Climate data for the experimental year (Diyarbakir MGM)

The suitability of alternative weed control techniques for organic chickpea farming was investigated in this single year study. Weedless control, weedy control, hand weeding before flowering, hoeing before flowering, hand weeding at pod stage, hand weeding at pod stage, hand weeding before flowering + pod stage, sowing at 20 cm spacing, sowing at 45 cm spacing, whey, whey + hoeing, pickle juice and pickle juice + hoeing were applied as weed control (Table 2). Arda chickpea variety obtained from GAP International Agricultural Research and Training Center was used in the experiment. Arda variety has high adaptability to Southeastern Anatolia Region, plant height between 64-85 cm, ripening days between 163-182 days, drought and lodging resistant, suitable for machine harvesting, yield 250-350 kg ha^{-1} and tolerant to wilt and anthracnose disease.

The field experiment was conducted according to the Randomized Block Design with 3 replications. Each plot was 4 m long and 4 rows with 45 cm between rows. Sowing was performed in the first week of February and harvesting in the last week of June. Plant height, fresh weight, total number of pods, total pod weight, number of full pods, number of empty pods and number of grains per plant were determined.

Table 2. Methods of control used in the experimental field of organic chickpea cultivation

Treatments Code	Treatments	Treatment period
T1	**Control group (No applications)**	During the vegetation period
T2	**Control group (Weed control was manually realized)**	During the vegetation period
T3	**Herbicide** Content: 600 g l^{-1} Aclonifen: 125 ml da^{-1}	Weeds with 4-5 leaves
T4	Manuel Weed Control	Pre-Blooming stage
T5	**Manuel Weed Control**	Pre-Blooming + Podding stages
T6	**Manuel Weed Control**	Podding stage
T7	**Pre-flowering + Broad Bean period hand plucking**	Pre-Blooming + Podding stages
T8	**20 cm spacing planting**	Hand plucking twice pre-blooming stage
T9	**45 cm spacing**	Hand plucking twice pre-blooming stage
T10	**Whey** Content: Water: 90% Protein 0.45 Fat: 0.05% Lactose: 3.0 Mineral Matter: 0.1-0.5 Salt: 6.0%	Weeds with 4-5 leaves
T11	**Whey+hoeing**	Weeds with 4-5 leaves
T12	**Pickle Juice** Content: Water: % 89,6 Salt: % 10.4	Weeds with 4-5 leaves
T13		**Pickle Juice +hoeing** Weeds with 4-5 leaves

2.2. Data evaluation

The data were analyzed using Jump-Pro 17 statistical package programs according to the randomized block design. Differences between means were compared according to LSD test.

3. Result and Discussion

The impacts of weed control methods on various plant growth and yield parameters in organic chickpea cultivation are shown in (Table 3). As can be clearly seen in the table, fresh weight, total number of pods, number of full pods, number of seeds and seed weight parameters were found to be significant ($p < 0.05$). Whereas no statistically significant difference was obtained for plant height and pod weight. As a consequence, weed control methods have significant effects on yield.

Table 3. Effect of weed control methods on plant growth and yield parameters in organic chickpea cultivation

Parameters	P Value
Fresh Weight	0,01**
Plant Height	0,11
Pod Weight	0,23
Number of Total Pod	0,00**
Number of Filled Pod	0,00**
Number of Empty Pod	0,02*
Number of Grain	0,01**
Grain Weight	0,03*

**; significant level at P≤0.05

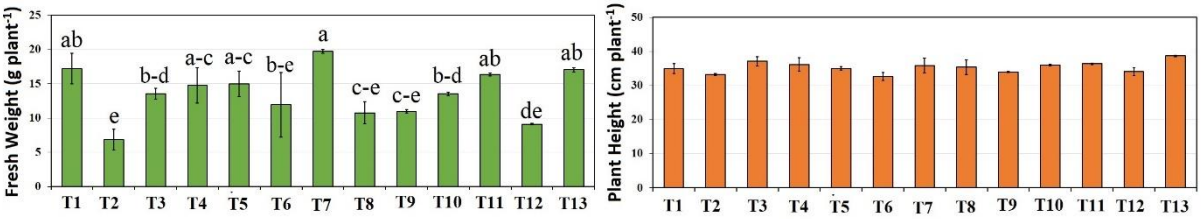

Figure 3. Effects of different weed control methods on fresh weight and plant height of chickpea plants

T7 (Hoeing before flowering) application reached the highest fresh weight value. T1 (Manual weed control) and T11 (45 cm spacing) applications had similar fresh weight values and there was no statistically significant difference between these three treatments. T2 (Control, no weed control) and T12 (Whey + hoeing) had the lowest fresh weight values. T3 (Pickle juice + hoeing), T4 (Manual weed control before flowering), T5 (Manual plucking before flowering + pod stage) and T6 (Manual plucking at pod stage) treatments showed moderate fresh weight values. T9 (Herbicide) and T8 (Pickle juice) treatments showed similar fresh weight values. Results showed that the effectiveness of weed control methods varies depending on the time of application and the material used. Similarly, Avola et al. (2008) reported that mechanical application was successful in chickpea cultivation (Figure.3). T13 (Whey) application reached the highest plant height value and statistically significantly differed from the other applications. Whey positively affected plant height with its nutrients and growth-promoting components. T3 (Pickle juice + hoeing) and T4 (Manual weed control before flowering) treatments also showed high plant height values and there was no significant difference between these two treatments, indicating that these methods supported plant growth. T2 (No weed control) and T6 (Manual weeding at pod stage) treatments showed low plant height values, indicating that weeds negatively affected plant growth and lack of control suppressed development. The other treatments (T1, T5, T7, T8, T8, T9, T10, T11, T12) showed moderate plant height values and the difference between them was not statistically significant. This indicates that these methods provided similar levels of weed control and made a particular impact on plant growth. Merga and Alemu (2019), in their study investigating different weed control methods, reported that the combination of herbicide and hand plowing was effective compared to weed-free control (Figure.3).

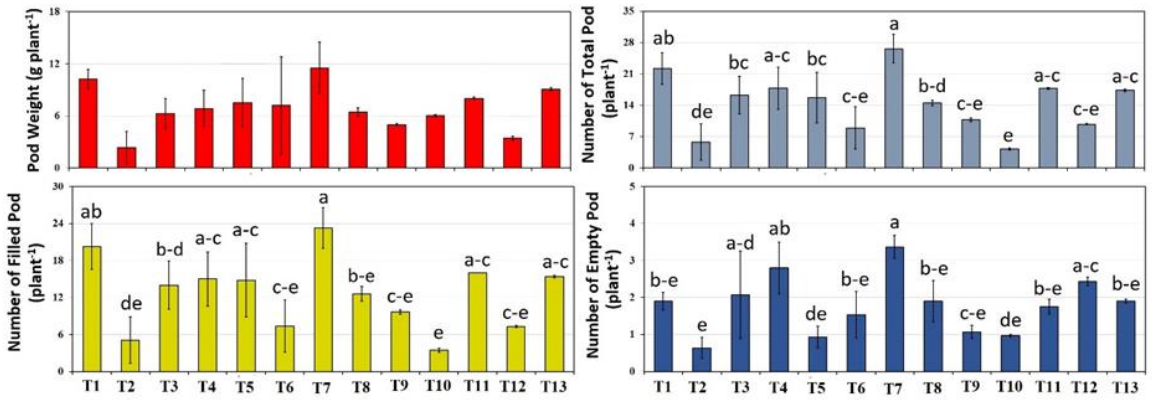

Figure 4. Effects of different weed control methods on pod weight, total number of pods, number of filled pods and number of empty pods of chickpea plants

T7 (Hoeing before flowering) application reached the highest pod weight and differed statistically significantly from the other applications. Hoeing reduced weed pressure and increased plant growth and pod yield. T1 (Manual weed control) likewise reached the highest pod weight values and the results were similar to T7. The lowest pod weight was observed in T2 (No weed control), indicating that weeds compete with the plant, limiting nutrient, water and light utilization. Treatments T6 (Hand plucking at pod stage) and T13 (Whey) also achieved high pod weights, indicating that natural practices and manual weed control methods can support plant growth. The other treatments (T3, T4, T5, T8, T9, T10, T11, T12) showed moderate pod weight values. Especially T12 (Whey + hoeing) showed a lower performance. Dubey et al. (2018) reported that weed control methods can increase yield and producer income in chickpea, and it is important to determine appropriate control methods for this purpose (Figure.4). T7 (Hoeing before flowering) and T1 (Manual weed control) applications reached the highest total number of pods and differed significantly from the other treatments. Hoeing and manual control increased yield by reducing weed pressure. T2 (No weed control) treatment had the lowest total number of pods, indicating that weeds negatively affect yield when not controlled. The other treatments (T3, T4, T5, T13, T10, T12, T8, T9) showed low or medium pod number. Korkmaz and Kayan (2010) also reported that manual control methods were effective in increasing chickpea yield (Figure4).

T7 (hoeing before flowering) application reached the highest number of full pods and was determined to be significantly superior to the other applications. It indicates that hoeing is effective in controlling weeds and increasing the number of full pods. T1 (Manual weed control) also achieved a similarly high number of full pods. T2 (No weed control) treatment had the lowest number of full pods, indicating that weeds negatively affected yield. The other treatments, which had a moderate number of pods, showed some efficacy but were not as successful as mechanical hoeing. In overall, T7 (hoeing) and T1 (manual control) were the most effective treatments. Aslam et al. (2007) also reported that manual plucking and herbicide applications were effective in weed control to increase yield (Figure.4). T7 (Hoeing before Flowering) treatment reached the highest number of empty pods, and this was significantly different from the other practices. According to the results, hoeing may cause stress on the plant and increase the occurrence of empty pods. T4 (Manual control before flowering) and T3 (Pickle juice + hoeing) also had relatively high number of empty pods. The lowest number of empty pods was observed in T2 (No weed control) treatment. T1 (Manual control), T6 (Hand plucking at pod stage), T9 (Herbicide) and T10 (20 cm spacing) treatments showed low number of empty pods. T12 (Whey + hoeing) and T13 (Whey) treatments had relatively high numbers of empty pods. In general, T7 had the highest number of empty pods, indicating that excessive mechanical intervention may have a negative impact on plant growth. The fact that T2 had the lowest number of empty pods indicates that plants experienced less stress when weed control was not applied, but the overall yield decreased. Demir et al. (2005) compared different herbicides and hoeing methods and reported that hoeing was the most effective method for weed control (Figure.4).

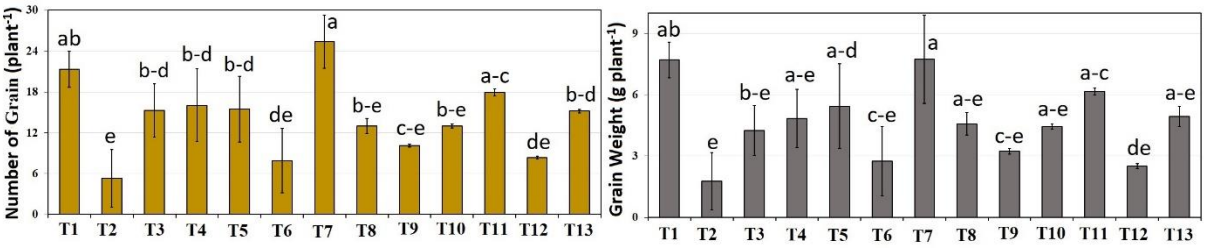

Figure 5. Effects of different weed control methods on grain number and weight of chickpea plants

Number of grains is an important indicator of plant yield. T7 (Hoeing before flowering) had the highest grain number and was statistically significantly superior to the other applications. T1 (Manual weed control) and T11 (45 cm spacing) also had the highest grain number, indicating that hoeing and manual control were effective in increasing yield. T2 (no weed control) had the lowest grain number, indicating that weed pressure negatively affected yield. Peruzzi et al. (2008) reported that mechanical hoeing was effective, while Suso et al. (2003) emphasized the positive effects of different weed control methods on yield (Figure.5). T7 (Hoeing before flowering) treatment reached the highest grain weight and was significantly different from the other treatments, indicating that hoeing effectively controlled weeds and enabled the plant to efficiently utilize the resources provided (Figure.5). T1 (Manual weed control) and T11 (45 cm spacing) also reached high grain weight and were effective in reducing weed pressure and increasing yield. The lowest grain weight was observed in T2 (No weed control) application, indicating the limiting effect of weeds on plant resources. The other treatments (T3, T4, T5, T13) showed moderate grain weight, while T12, T8 and T9 treatments had low grain weight values. Fontinelli et al. (2015) and Suso et al. (2003) reported that hoeing and mechanical methods are significant in weed control and yield improvement. Results in general emphasize the effectiveness of mechanical and manual weed control methods in terms of yield increase (Figure.5).

4. Conclusion

Weed control in chickpea cultivation is a critical requirement for agricultural productivity and sustainability. The environmental impacts of conventional herbicide use and the development of resistance in weeds necessitate the development and application of sustainable alternative methods. In this research, we evaluated the efficacy of different weed control methods and reported that mechanical and organic methods were successful in reducing weed pressure and increasing chickpea yields. In particular, mechanical methods such as hoeing and manual weed control have emerged as an important option for weed control. Furthermore, the dissemination of sustainable weed management strategies and raising awareness of farmers on this issue is of great importance in increasing agricultural productivity and achieving environmental protection goals. For this reason, future studies should focus on assessing the wider applicability and long-term impacts of these methods.

Declaration of Author Contributions

The authors declare that they have contributed equally to the article. All authors declare that they have seen/read and approved the final version of the article ready for publication.

Declaration of Conflicts of Interest

All authors declare that there is no conflict of interest related to this article.

Acknowledgment

This research is within the scope of YOK 100/2000 Priority Areas Organic

Agriculture and was produced from the second author's doctoral dissertation. The study was supported by Dicle University Scientific Research Projects (DUBAP) with the project numbered "DUBAP ZIRAAT.21.006".

References

Adıyaman, C., Kahriman, A., 2021. Determination of resistance and morphological characteristics of chickpea (*Cicer arietinum* L.) genetic sources to ımı group herbicides. *ISPEC Journal of Agricultural Sciences*, 5(3): 678–689.

Aslam, M., Ahmad, H.K., Ahmad, E., Himayatullah, M.A., Sagoo, A.G., 2007. Effect of sowing methods and weed control techniques on yield and yield components of chickpea. *Pakistan Journal of Weed Science Research*, 13(1-2): 49-61.

Avola, G., Tuttobene, R., Gresta, F., Abbate, V., 2008. Weed control strategies for grain legumes. *Agronomy for Sustainable Development,* 28(3): 389-395.

Chauhan, B.S., Johnson, D.E., 2019. Weed management in organic cropping systems. *Annual Review of Phytopathology*, 57: 225-246.

Ceritoğlu, M., Erman, M., Yıldız, F., 2020. Effect of salinity on germination and some agro-morphological traits in chickpea seedlings. *ISPEC Journal of Agricultural Sciences*, 4(1): 82–96.

Demir, A., Tepe I., Erman, M., 2005. Effect of different control methods on weeds, yields, some yield components and nodulation in chickpea (*Cicer arietinum* L.). *Yuzuncu Yıl University Journal of Agricultural Sciences*, 15(1): 71-75.

Dubey, S.K., Kumar, A., Singh, D., Partap, T., Chaurasiya, A., 2018. Effect of different weed control measures on performance of chickpea under irrigated condition. *International Journal of Current Microbiology and Applied Sciences*, 7(5): 3103-3111.

Johnson, D.E. Chauhan, B.S., 2019. Farmer education and weed management. *Journal of Agricultural Science*, 28(4): 345-358.

Kaya, M., Türker, O., Yılmaz, A., 2020. Nohut yetiştiriciliğinde yabancı ot kontrolü. *Tarla Bitkileri Dergisi*, 25(2): 123-132.

Korkmaz, Y., Kayan, N., 2010. Effects of different sowing methods and weed control on yield and yield components in chickpea (*Cicer arietinum*). *Mediterranean Agricultural Sciences*, 23(2): 157-162.

Kumar, V., Chauhan, B.S., Johnson, D.E., 2020. Integrated weed management in pulse crops. *Journal of Weed Science*, 68(3): 301-309.

Merga, B., Alemu, N., 2019. Integrated weed management in chickpea (*Cicer arietinum* L.). *Cogent Food & Agriculture*, 5(1): 1620152.

Fontanelli, M., Frasconi, C., Martelloni, L., Pirchio, M., Raffaelli, M., Peruzzi, A., 2015. Innovative strategies and machines for physical weed control in organic and integrated vegetable crops. *Chemical Engineering Transactions*, 44: 211-216.

Peruzzi, A., Raffaelli, M., Fontanelli, M., Frasconi, C., Ginanni, M., Lulli, L., 2008. Physical Weed Control in Organic Carrot in Sicily (Italy). Cultivating the Future Based on Science. Volume 1: Organic Crop Production. *In Proceedings of the Second Scientific Conference of the International Society Of Organic Agriculture Research (ISOFAR), Held At The 16th IFOAM Organic World Conference in Cooperation with the International Federation of Organic Agriculture Movements (IFOAM) and the Consorzio Modenabio in Modena*, Italy, p. 20.

Singh, R.P., Kumar, V., Sharma, A., 2021. Herbicide resistance in weeds: challenges and management strategies. *Weed Science*, 69(4): 423-435.

Sözen, Ö., Peker, G.N., 2023. Determination of quality characteristics of advanced chickpea genotypes. *ISPEC Journal of Agricultural Sciences*, 7(3): 533–547.

Suso, M., Pardo, A., Hernandez, J., Vılla, F., Fernandez-Cavada, S., Zaragoza, C., 2003. Different weed control systems in tomato crop. *Actas IX Congreso 2003 Sociedad Española De Malherbología, Barcelona*, 4-6 De Noviembre, Madrid, Spain, pp.156-159.

Türker, O., Yılmaz, A., Demir, S., 2019. Nohut (*Cicer arietinum* L.) tarımında yabancı ot yönetimi. *Tarım Bilimleri Dergisi*, 24(1): 45-54.

To Cite: Tunc, M., Ipeksen, S., Basdemir, F., Rufaioğlu, S.B., 2024. The Effect of Alternative Weed Control Methods on Yield Parameters in Chickpea (*Cicer arietinum* L.). *MAS Journal of Applied Sciences*, 9(4): 1120–1129.
DOI: http://dx.doi.org/10.5281/zenodo.14358364.