Iraqi Journal of Agricultural Sciences –2026:57(4):1093-1100
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/5vbtvg77

EFFECT OF DIFFERENT ALLELOPATHIC MULCHES ON WEED AND YIELD OF WHEAT IN Iraq

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ABSTRACT

Afield study was conducted in winter 2023–2024 at the Plant Protection Directorate, Abu-Ghraib, Baghdad, Iraq using randomized complete block design (RCBD) with four replication to investigate the effects of corn or sorghum mulch alone and in combination with half dose of Time line trio herbicide on weed management, soil moisture content and wheat yield. Results indicated that using corn or sorghum mulch with 50% herbicide provided higher significant results in all test parameters just like full herbicide rate .The reduction in weed density was 95.22 and 93.20%at 60 DAS, and 91.13 and 92.32% of weedy check at 90 DAS, and the reduction in weed dry weight at 120 DAS was 98.71 and 98.91%of weedy check, respectively. Grain yield was 5.66 and 5.65 t/ha, Biological yield was17.80, 17.58 t/ha respectively. Both mulch treatments affect significantly soil moisture content. This approach could be used for weed management with the objective of conserving environment and promoting sustainable agricultural system.

Keywords: organic mulch, plant residue, weed control, sustainable agriculture.
***part of M.Sc. Thesis of the 1st author**

Received: 4/8/2024, Accepted: 1/12/2024, Published: 30/4/2026

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most economically significant cereal crops in the world. It is considered as a main source of human nutrition and has a vital role in national food security. Many countries in the world including Iraq are looking to increase wheat productivity due to the continuous demand for this crop (Mustafa &Jbara,2018). Research tends to focus on improving the productivity and sustainability of wheat farming as crop yield, quality and sustainable production are critical for domestic food security in developing countries. Weeds are an important factor that has negative influence on wheat growth and productivity. Yield loss from weed may reach 10 - 65% , and according to previous studies in Iraq, weeds can cause yield reduction in wheat by 13-43% .due to its competition with wheat for space, nutrients and water, host pathogens and insects that damage crop .Many methods are used for managing weeds which involve mechanical methods like tillage implements, hand weeding and burning ,biological methods that depend on natural enemies like insects, animals and competitive plants; cultural method like crop rotation, cover crop and mulching and finally using chemical herbicides (Scavo & Mauromicale, 2020). Yet weed control strategies have become increasingly dependent on herbicides for its quick results and selectivity. The excessive use of herbicide leads to several environmental and ecological problems such as herbicide resistance in weed plants, harmful effects on soil and ground water as well as effects on human health due to its toxicity (Tudararo-Aherobo & Ataikiru, 2020).Studies show that herbicide use can be decreased without reducing yields, which can reduce environmental damage and production costs by using one of the sustainable agricultural weed management methods including herbicidal and non-herbicidal strategies. One of non-herbicidal strategies is prevention of weed growth like mulch with

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crop residues, including those with allelopathic activity: the ability to suppress the growth of other plants by chemicals released from the allelopathic plants (Vencill *et al*, 2012; Alsaadawi *et al*, 2017). Mulching is the process of applying organic or inorganic cover to the soil surface. It reduces weed growth, increase crop production and reduce soil moisture loss (Kader *et al*, 2019). Allelopathic plant residue as organic mulch like sorghum and maize have the ability to reduce weeds through their physical and chemical effect (Alsaadawi *et al*, 2019). Yet the use of organic mulch alone is not sufficient for weed reduction, compared to chemical herbicides (Alsaadawi *et al*, 2020). Studies have shown that allelopathic crop residues in combination with reduced dose of herbicide could be effective as much as full dose of herbicides (Bhowmik & Inderjit, 2003; Alsaadawi *et al*, 2024). This study investigates weed management strategies using soil mulching with corn or sorghum residues with and without reduced amount of Timeline trio herbicide and their effects on weeds density and wheat production was studied.

MATERIALS AND METHODS

Experimental Site: A field study was carried out during 2023–2024 at the research field of Plant Protection Directorate, Ministry of Agriculture, Abu-Ghraib, Baghdad, Iraq. (33°18' 48"N latitude and 44°13' 14"E longitude, 40 meters above sea level). The soil type of the field was loamy, EC and pH were 5.3mS/cm and 7.34 respectively.

Experimental Design: The study investigates the effects of mulching with two different allelopathic plant residues on weed management and its effect on wheat yield. Residues of *Sorghum bicolor* (L.) cv. Enkath and residues of Zea*mays* (L.) were selected as they were easily available in the study area and are known for their allelopathic effects. Plant parts were chopped and kept until use. The study used a randomized complete block design (RCBD) for six treatments and four replicates for each as follow:

T1: control (weedy check)
T2: herbicide 100%
T3: *Sorghum bicolor* (L.) mulch at 6 t ha^{-1}
T4: *Zea mays* (L.) mulch at 6t ha^{-1}
T5: *Sorghum bicolor* (L.) mulch + herbicide 50%
T6: *Zea mays* (L.) mulch + herbicide 50%.

Field preparation

The field was prepared for planting; tilled twice and divided into 24 plots (2*3m) with 23 cm between rows. Seeds of wheat crop Buhooth 22 cv was sown at seeding rate 140 kg ha^{-1}on 17 November, 2023. After sowing, mulch of sorghum and corn residues were applied at 3.6 kg/plot of chopped plant that is equal to 6t/ha as recommended in a previous study by (Singh *et al*, 2019).Chemical fertilizers, Nitrogen as urea (46% N) and Diammonium phosphate DAP: (18:46:0) were used as recommended for wheat crop (Burjus *et al*, 2020). All phosphorous and half of the nitrogen were applied during seed bed preparation. Thirty days after plantation, the Timeline trio herbicide (Pinoxaden, Clodinafop-propargyl, and Florasulam) from **Syngenta Co.** was administered at a full dosage of 1.25 L ha^{-1} and a half dose of 0.625 L ha^{-1}. This selective and systematic herbicide which applied post emergence is effective against both narrow leaf and broad leaf of weeds. Pest control and irrigation were applied as recommended for this crop.

Weed data collection

Weed density was recorded after 60 and 90 days after sowing (DAS) by counting weeds in randomly selected quadrates (100×100 cm) for each experimental unit. Reduction % of weed control at 90 DAS was recorded following the equation:

Weed control % =

$$\frac{No.of\ weeds\ in\ the\ Weedy\ check - No.of\ weeds\ in\ the\ control\ treatment}{No.of\ weeds\ in\ the\ Weedy\ check} \times 100$$

For weed dry weight biomass (g/m^2) determination (120 DAS) the weeds in selected quadrate (100×100 cm) were clipped at the surface of the soil from each plot and placed in paper bags, oven dried at 70 ˚C for three days, and record biomass using digital balance. Weed dry biomass inhibition was calculated according to the following equation

$$\text{Inhibition\%} = 100 - \left(\frac{dry\ weight\ of\ weed\ in\ weed\ control\ treatment}{dry\ weight\ of\ weed\ in\ weedy\ check}\right) \times 100$$

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Yield data collection for wheat: At physiological maturity 1m^2 was harvested near the top of the soil from each plot. Grain yield was determined by separating grain from straw and weighed. Biological yield was taken as the dry biomass of the 1m^2 harvested plants. Both yield parameters were then converted to ton/h. Harvest index was then calculated using the following equation (Mutar *et al*,2022):

$$\textbf{Harvest index} = \frac{Grain\ yield}{Biological\ yield} \times 100$$

Statistical analysis

Collected data were subjected to statistical analysis using analysis of variance (ANOVA) by GENSTAT 12 computer software package. Differences among treatment means were compared using Least Significant Difference (LSD) at 0.05 probability level (Steel *et al*,1997).

RESULTS AND DISCUSSION

Effect of various treatments on weed density: Weed flora grown in wheat field during the study were many types of broad and narrow leaf weeds as shown in **table 1.**

Table 1. Weed flora found in the experimental field

Scientific name	Common name	Family	Type
***Malva rotundifolia*L.**	**Mallow**	**Malvaceae**	**Broad leaf weed**
***Chenopodium album*L.**	**White goosefoot**	**Chenopodiaceae**	**Broad leaf weed**
***Beta valgaris* L.**	**Wild beets**	**Chenopodiaceae**	**Broad leaf weed**
***Silybum marianum* L.**	**Milk thistle**	**Asteraceae**	**Broad leaf weed**
***Avena fatua* L.**	**Wild oat**	**Poaceae**	**Narrow leaf weed**
***Lolium rigidum* L.**	**Ryegrass**	**Poaceae**	**Narrow leaf weed**
***Hordeum spontaneum* L.**	**Wild barley**	**Poaceae**	**Narrow leaf weed**

mulch of sorghum and corn significantly reduced weed density /m^2 in comparison to the control treatment at 60 DAS (Table2). The highest inhibition of weed density was found in full dose of herbicide followed by corn mulch with 50% of herbicide and sorghum mulch with 50% herbicide with no significant differences between them (1.25, 1.25 and 2.75 p/m^2 respectively). While sorghum and corn mulches alone recorded 27.50 and 29.50 p/m^2 respectively, with no significant differences between them. Corn mulch and sorghum mulch with 50% of herbicide showed no significant differences in comparison to full dose of herbicide and recorded highest significant percentage of weed control over control treatment which was 95.22, 93.20 and 95.15% respectively with no significant differences between them followed by sorghum and corn mulches alone which recorded significant reduction over control treatment (32.75 and 27.70 % respectively) with no significant differences between them (Table 2). At 90 DAS, the maximum reduction in weed density over control was occurred by full dose of herbicide and in sorghum and corn mulches with 50% herbicide 1.75, 2.00 and 2.25 p/m^2 respectively followed by 17.25 p/m^2 which was observed by sorghum mulch alone, while corn mulch alone showed no significant difference over control treatment in weed density which was 24.25 p/m^2. Treatments of sorghum mulch and corn mulch with 50% herbicide showed reduction percent 92.32, 91.13 and 94.69 % respectively, flowed by sorghum and corn mulch alone which was 37.40 and 17.04 % respectively over control.

Table 2. Impact of sorghum and corn mulches alone and in combination with 50% of Time line trio on weeds density in wheat field at 60 and 90 days after sowing (DAS).

Treatments	Weed density p/m^2 at 60 DAS	% of weed control	Weed density p/m^2 at 90 DAS	% of weed control
Control (Weedy check)	**42.00**	**0.00**	**33.25**	**0.00**
100% Timeline trio	**1.25**	**95.15**	**1.75**	**94.69**
Sorghum mulch at 6t/ha	**27.50**	**32.75**	**17.25**	**37.40**
Corn mulch at 6t/ha	**29.50**	**27.70**	**24.25**	**17.04**
Sorghum mulch + 50% Time line trio	**2.75**	**93.20**	**2.00**	**92.32**
Corn mulch + 50% Timeline trio	**1.25**	**95.22**	**2.25**	**91.13**
L.S.D.	**6.583**	**17.38**	**13.94**	**14.64**

***Each number is mean of four replicates; means within a column with different letters differ significantly by**

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LSD at P ≤0.05

Effect of various treatments on dry biomass of weeds: Results in **Table 3** reveal that weed dry weight biomass at **120 DAS** decreased significantly by adding mulch of test plant species. Maximum reduction over control was recorded by sorghum and corn mulches with 50% herbicide and by full dose of herbicide which was 2.6, 3.1 and 3.1g/m^{2}respectively with no significant deference among them, followed by sorghum and corn mulches alone (167.5 and 175 g/m^2 respectively) with no significant deference between them, also Sorghum mulch and corn mulch alone at 120 DAS significantly reduced dry weed biomass by 33.38 and 29.75 %of control respectively. However, adding 50% of full dose of herbicide to sorghum and corn mulches shows the maximum reduction (98.91and 98.71% of control respectively) which are just similar to full dose of herbicide.

Table 3. Impact of sorghum mulch and corn mulch alone and in combination with 50% of Time line trio on biomass of weeds in wheat field after 120 days after sowing (DAS).

Treatments	Dry weight biomass g/m^2	Inhibition of dry weight biomass %
Control (Weedy check)	**256.2**	**0.00**
100% Timeline trio	**3.1**	**98.64**
Sorghum mulch at 6t/ha	**167.5**	**33.38**
Cornmulch at 6t/ha	**175**	**29.75**
Sorghum mulch + 50% Time line trio	**2.6**	**98.91**
Corn mulch + 50% Timeline trio	**3.1**	**98.71**
L.S.D.	**48.92**	**14.65**

***Each number is mean of four replicates; means within a column with different letters differ significantly by LSD at P≤ 0.05**

The results of this study are in agreement with the results of previous studies which indicated that mulch has a role in weed management primarily by acting as a physical barrier to exclude light and prevent seed germination and seedlings emergence (Marble & Christopher, 2015). It is reported that sorghum and corn mulches have allelopathic potential against several metabolic pathways such as disrupting protein synthesis and reducing photosynthesis (Hameed &Shahwany, 2017; Al-Khateeb *et al*, 2017; Al-Obaidi & Alsaadawi, 2015). This study indicates that adding reduced amount of Timeline trio herbicide with organic mulch controlled weeds similar to full dose herbicide. Previously, study by Alsaadawi *et al.* reported that a lower dose of herbicide in combination with corn mulch gave comparable results to the full label rate of herbicide in cowpea field (Alsaadawi *et al*, 2024).

Effect of various treatments on grains and biological yields of wheat: The results in Table 4 indicated that the grain yield was increased significantly by adding sorghum or corn mulch by 4.640 t/ha and 4.573 t/h of control respectively with no significant differences between them while control was 3.383 t/ha. Adding 50% of the label rate of herbicide to sorghum and corn mulch treatments result gave grain yield reach 5.655 t/ha and 5.668 t /ha respectively, full label rate of herbicide gave 5.685 t /ha with no significant differences between them. Biological yield result reveled that combination of corn and sorghum mulches with 50% herbicide treatments and full dose of herbicide showed the highest significant effect over control (17.80, 17.58, and 17.27 t/ha) respectively. The harvesting index is the ability of plant to convert photosynthesis products to grains and represented the ratio of the grain yield to the biological yield. The results show that sorghum and corn mulches treatments with 50% of full dose of herbicide significantly increased harvest index in comparison to the control treatment by (34.70 and 34.98%, over control respectively), just like the full dose of herbicide which increased by 35.75%, while sorghum and corn mulch treatments have no significant effect either with the control treatment or with other treatments which were 31.96 and 31.81% (table 4). These results are in agreement with the results of previous studies (Uwah & Iwo, 2011; Singh *et al*, 2015) which indicated that

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organic mulch at 6t/ha improves performance of maize and wheat. The increase in grain yield and other parameters related to biological yield are due to the effect of sorghum and corn mulches with allelopathic chemicals which cause reduction and inhibition in weeds, which in turn caused a good wheat plant growth and increase grain yield (Ahmad *et al*, 2020, Al-Behadili & Fadhel, 2023).The other reason for grain yield increasing could be the effect of corn and sorghum mulch on physical and chemical characters of soil, enhance organic matter content and improve soil water holding capacity and soil structure and total porosity, all these factors directly affect the plant growth and production (Iqbal *et al*, 2020; Minhas *et al*, 2023).

Table 4. Impact of sorghum mulch and corn mulch alone and in combination with 50% of Time line trio on grains yield and biological yields of wheat crop.

Treatments	Grains Yield (t/ ha)	Biological Yield (t /ha)	Harvest index (%)
Control (Weedy check)	3.38	14.25	28.13
100% Timeline trio	5.68	17.27	35.75
Sorghum mulch at 6 t/h	4.64	15.32	31.96
Corn mulch at 6t/h	4.57	15.05	31.81
Sorghum mulch + 50% Timeline trio	5.65	17.58	34.70
Corn mulch + 50% Timeline trio	5.66	17.80	34.98
L.S.D.	0.674	0.909	3.108

***Each number is mean of four replicates; means within a column with different letters differ significantly by LSD at P ≤0.05**

Effects of organic mulches on soil moisture content: The results in Table 5 revealed that both mulch treatments had significantly increased soil moisture content compared to control (un-mulched plots) with no significant differences between them. In sorghum or corn mulches the maximum moisture content was 25.33 and 25.63% respectively in 45 DAS while the minimum was 18.29, 18.71% respectively at the end of the experiment. Organic mulches have been shown to improve the moisture retention of soil, manage soil temperature by preventing direct sun light from reaching soil surface, decrease water evaporation and reduced soil water loss as compared to un-mulched (Yasmina *et al*, 2020).

Table 5. Impact of sorghum and corn mulch on soil moisture content% at 0-20cm depth.

	Soil moisture content (%)				
Treatments	15 DAS	30 DAS	45 DAS	60 DAS	130 DAS
Control	16.63	17.18	17.67	19.15	15.50
Sorghum mulch	24.36	24.67	25.33	22.94	18.29
Corn mulch	22.43	22.91	25.63	22.01	18.71
L.S.D.	2.969	2.394	2.773	2.413	1.997

***Presented numbers are mean of four replicates, data collection was conducted every 15 days except on rainy days**

CONCLUSION

In conclusion, mulching with sorghum and corn residues potentially conserved soil moisture and reduced evaporation losses during the growing season of wheat crop as compared to un- mulched soil, making it a water saving technique. Minimize weed growth and weed density as compared to non-mulched treatments, Sorghum and Corn mulches acts as allelopathic and release toxic chemicals which affect weeds growth. All these factors are beneficial for overall wheat crop growth and wheat productivity.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHORS' DECLARATION

The authors declare that this manuscript is original, has not been published previously, and is not currently under consideration by any other journal. All figures and tables are original and prepared by the authors. Any material obtained from third parties has been included with the required permissions. All authors have read and approved the final manuscript.

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AUTHORS' CONTRIBUTION STATEMENT

All authors made equal contributions to the study design, methodology, experimental work, data analysis, and manuscript writing. All authors reviewed and approved the final version of the manuscript.

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Iraqi Journal of Agricultural Sciences –2026:57(4):1093-1100
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Iraqi Journal of Agricultural Sciences –2026:57(4):1093-1100
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/5vbtvg77

تاثير التغطية بالمخلفات الاليلوباثية المختلفة على ادغال وحاصل الحنطة في العراق

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[*2]دائرة وقاية المزروعات / وزارة الزراعة / العراق

المستخلص

اجريت تجربة حقلية في الموسم الشتوي 2023-2024 في دائرة وقاية المزروعات/ابو غريب/بغداد/العراق وفق تصميم ألقطاعات ألكاملة المعشاة لدراسة ثاثير التغطية باستخدام مخلفات الذرة الصفراء او البيضاء مع او بدون نصف التوصية من المبيد الكيمائي Time line trio في مكافحة الادغال المصاحبة لمحصول الحنطة والمحتوى الرطوبي للتربة وتأثيرهما في انتاجية الحنطة. بينت النتائج ان استعمال التغطية بمخلفات الذرة الصفراء او البيضاء مع نصف التوصية من المبيد الكيميائي قد اثر بشكل معنوي في جميع الصفات واعطى نتائج مقاربة لمعاملة التوصية الكاملة من المبيد مع عدم وجود فروقات معنوية بينها حيث بلغت نسبة مكافحة الادغال بعد 60 يوم من الزراعة في معاملة التغطية بالذرة الصفراء 95.22% وفي الذرة البيضاء 93.20% عن معاملة المقارنه، وبعد 90 يوم كانت النسبة 91.13 و92.32% عن معاملة المقارنة،اما نسبة التثبيط في الوزن الجاف للادغال بعد 120 يومكانت 98.91 و98.71 %و بلغ حاصل الحبوب 5.66 و5.65 طن/هكتار والحاصل البايولوجي 17.80 و 17.58 طن/هكتار بالتتابع، وقد اثر كلا النوعين من التغطية بصورة معنوية في المحتوى الرطوبي للتربة. ممكن تطبيق هذة الطريقه في ادارة الادغال كأحد ممارسات الزراعة الحافظة والمحافظة على البيئة.

الكلمات المفتاحية: االغطاء العضوي، المخلفات النباتية، السيطرة على الادغال، الزراعة المستدامه.

***جزء من رسالة ماجستير للباحث الاول .**