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COMBINING EFFECT OF (*Sorghum bicolor*) L. (MOENCH) RESIDUES AND REDUCED RATE OF TRIFLURALIN HERBICIDE ON WEEDS IN COWPEA *(Vigna unguiculata)*L. (WALP) FIELD

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ABSTRACT

A Field experiment was conducted to test the allelopathic potential of sorghum residues alone and in combination with half (1.2 L ha^{-1}) of recommended rate of trifluralin herbicide in controlling weeds in cowpea field. The experiment was conducted in the field of Department of Biology, college of Science, Baghdad University during the growing season of 2015. For preparation of sorghum residues, grains of sorghum cv. Enkath were grown in lines in plots of 4 × 3.5 m keeping 10 cm between grains and 75 cm between lines. Plots of the same area were left without cultivation to be used in the next experiment as a control. At physiological maturity of sorghum crop, the grains were harvested and the plants were left on the plots to dry under sun for 2 weeks. After that, the sorghum residues were incorporated in to the plot soil at 5 t ha^{-1} and 10 t ha^{-1}. Plots without residues, plots with half dose of trifluralin herbicide, plots with label rate of herbicide and weed free plots (removing weeds weekly) were also included for comparison.Additional experiments were also conducted to determine the total phenolics in soil and biological activity against test weeds at 0 , 2, 4, 6 and 8 weeks of decomposition periods. Incorporation of sorghum residues at 5 t ha^{-1} reduced weed density by 6% of control at 75 days after sowing, while incorporation of sorghum residues at 10 t ha^{-1}reduced weed density by 43% of control at 75 days after sowing and reduced dry weight biomass of weeds by 48 and 66% of control respectively.However, this reduction is further increased when half rate of herbicide was applied to plots amended with sorghum residues. Subsequent experiment proved that the suppression of weeds was due to total phenolicsreleased during the decomposition of sorghum residues in soil since a strong correlation was found between the concentration of total phenolics and the inhibition of seedling emergence and dry biomass of the test weeds.

It appears that the weed suppression was directly translated into yield so that significant improvement of dry weight biomass, biological yield and seed yield and yield components over weedy check treatment. Application of sorghum residues to the plots amended with half rate of trifluralin herbicide provided seed yield significantly higher than that achieved by sole application of label rate of herbicide.

INTRODUCTION

Weed infestation in field crops is a key issue contributing to direct loss in quality and quantity of produce, and weeds are identified as the most omnipresent class of pests interfering with crop plants through competition and allelopathy. Traditionally, weed management practices includes preventative, cultural, mechanical, biological, and chemical tactics (24). However, with the rapid increase in the number of effective herbicides after 1960's, weed management techniques have become more reliant on herbicides (45).The

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overdependence and irrational use of herbicides during the last 40 years has resulted in growing public concern over their impact upon human health, environment pollution and evolution of herbicide weed resistant (44,41). Due to these risks, much attention is being focused on the alternative methods of weed control. Allelopathy is suggested to offer a great prospective to manage weeds. Different strategies in which allelopathy is involved have been suggested such as using allelopathy in crop rotations, cover crops and mulches, smother crop, crop mixtures and intercropping and use of allelopathic crop residues or extracts (8).Allelopathic crop residues as mulch or incorporated into field soil have been found to be the most successful strategy in weed suppression (35,30). However, in most cases, the efficacy of allelopathic residues was generally below that of herbicides (11). Therefore, many researchers have discussed the possibility of integrating allelopathic residues with other managing options for weed control. (15). suggested that a herbicide applied in combination with allelopathic conditions could enjoy a complementary interaction, and may help to minimize herbicide usage for weed management in field crops. The combination of allelopathic crop extract with lower rate of herbicide for weed control was first explored by Cheema group in Pakistan during the last decade (17, 18, 19, 20). These scientists postulated that herbicide use can be reduced by 50–70% when herbicides are used in combination with aqueous sorghum extracts for weed control in field crops such as wheat, cotton, mung bean and maize. Although successful results have been obtained from allelopathic plants extract applied with low herbicide rates, however, to employ this technology, large volumes of sprays are required for field application. Also, additional work in other soil types and appropriate concentrations for each crop should be determined for large scale field operations (43). Due to these limitations, an alternative practical and feasible approach has been developed by Alsaadawi group where the residues of allelopathic crops including sorghum and sunflower have been left to dry under field conditions and then promptly incorporated into production sites for weed management (7,31). Low herbicide doses were applied along with residue incorporation. By using this approach with faba bean, wheat, barley, cowpea and mung bean, it was found that application of half the labeled rates of the test herbicide in field soil amended with sorghum or sunflower residues suppress weeds and generated crop yield similar to that of the label (full) rate of herbicide. Although information regarding the integration effect of allelopathic potential of sorghum residues with lower rate of herbicide on weeds of various crops is available. Nonetheless, combined allelopathic potential of sorghum residues with reduced rate of herbicide against weeds in cowpea have never been reported.

Cowpea is an important legume crop in Iraq following sorghum in crop rotation. The field of cowpea is infected by various weed species which reduce growth and yield (1). Uncontrolled weeds may reduce cowpea yield as much as 50-90 % compared with weed free conditions (33).The weeds are customarily managed by application of pre emergence trifluralin herbicide (43). Information concerning the effect of combination of sorghum residues and lower rate of herbicide has not been explored for weed management in cowpea. The present study was, therefore, conducted to:

1-Evaluate the possibility of using of allelopathic sorghum residues in combination with reduced (50% of label rate) trifluralin rate for weed control with the objective of decreasing dependence on herbicide.

2-To test the incorporated residues of sorghum are responsible for the reduction of weeds in cowpea field.

MATERIALS AND METHODS

Site selection

Study proposed was conducted at Research field of Biology Department, College of Science, Baghdad University, Baghdad, Iraq. The site of the field is located at 33° 16' 13'' N latitude and 44° 22 ' 44'' E longitude, 40 m above sea level. During the summer season 2015, August where the previous field history showed heavy weed infestation. Some physical and chemical properties of field soil were determined. The soil at the experimental site was loam. Weeds in field were collected during the periods and identified by the specialists of Baghdad University Herbarium.

Seeds and Herbicides sources.

The Seeds of *Sorghum bicolor* (L.)Moench (Enqath cultivars) which were customarily grown by Iraqi farmers were brought from State Board for Agricultural Researches, Ministry of Agriculture, Iraq. Seeds of cowpea *Vignaunguiculata*L. (Walp) *cv.* California ramshorn, (USA), purchased from a local market it knows (Biader). Treflan (trifluralin) herbicide was brought from the national committee for pesticides registration & approval Ministry of Agriculture, Iraq. The herbicide is a product of Agar Company for herbicides and vertinary medicines industry.

Field experiment.

Preparation of sorghum residues.

The field was tilled twice In 16 of December 2014 by using a disc plough and divide in to 3 plots measure (3.5 x 4 m^2) with four replications (12 plots) were randomly selected in a field. Seeds of sorghumcv. Enkath were sown in March 18, 2015 in their respective plots in rows with a distance 10 cm between seeds and 75 cm between rows (13.3plant m^{-1})(2). Plots without crop were used as a control. The experiment was conducted in a randomized complete block design (RCBD) with four replications. Nitrogen fertilizers as urea (46% N) at 240 kg ha^{-1} and phosphorus as triple superphosphate (46% P_2O_5) at 160 kg ha^{-1} which were applied as recommended for this crop, all phosphorous and half of the nitrogen were applied at planting while the remaining half of the nitrogen (120 kg ha^{-1}) was applied at flowering stage (23). Pest Control and irrigation was applied as recommended for this crop. At physiological maturity, the heads were removed, mature sorghum plants were harvested in July, 2015, air dried for 2 weeks under sun during summer and chopped into pieces of about 2-3cm pieces by using a large scissor thenkept until use. Based on previous results by Al-Bedairy *et al*. (2) and Alkhateeb(5), it was found that 13.3 mature plants of sorghum that occupied 1 m^2 area added about 10 tons (t) of air - dried tops per hectare (ha) of soil to a depth of 30 cm; therefore residue rates at 5 and 10 t ha^{-1} were used in this experiment to test their effects on yield and yield components of cowpea crop and companion weeds.

Implementation of experiment

All plot previous field it was tilled twice and divided into 4 sup-plots measuring 1.5×1.5 m^2 on first of August 2015. Residues of sorghum cultivar were incorporated into the soil of field plots at rates of 5 and 10 t ha^{-1} Weedy checks without sorghum residues, weedy free and label rate of trifluralin herbicide (2.4 L ha^{-1}) and half label rate(1.2 L ha^{-1}),were included in the experiment for

comparison. Trifluralin herbicide was sprayed on plots two days before planting day of cowpea felid, it was applied on soil incorporation. Volume of spray was calibrated using water (300 L ha^{-1}). Using hand sprayer fitted with T- Jet nozzle at a pressure of 270 k Pa. After that the field soil were mixed by Comb to prevent volatilization and photolysis of trifluralin herbicide. Nitrogen as urea (46% N) at 80 kg ha^{-1} and phosphorus as triple super phosphate (46% P_2O_5) at 240 kg ha^{-1} were try applied to these plots as recommended by Ministry of Agriculture for cowpea crop. All phosphorus and half the nitrogen were applied during seed bed preparation, while remaining nitrogen was applied after one month of sowing. Uniform seeds of cowpea crop were manually sown in August 9, 2015 in all plots in 40 cm spaced crop rows keeping plant to plant distance of 20 cm(8.8 plant m^{-1}), (37). All plots received recommended irrigation during the entire course of study. Weeds from weedy free plots were removed every week by hand pulling throughout the crop's life span. The experiment was conducted in randomized complete block design (RCBD) with four replications. The experiment was consists of the following treatments:

1-Control (uncultivated sorghum field)(without residues and herbicide).
2-Residues at 5 t ha^{-1}.
3-Residues at 5 t ha^{-1} + 50% of label rate of trifluralin (1.2 L ha^{-1}).
4-Residues at 10 t ha^{-1}.
5-Residues at 10 t ha^{-1} + 50% of label rate of trifluralin (1.2 L ha^{-1}).
6-Label rate of trifluralin (2.4 L ha^{-1}) for comparison.
7-50 % of Label rate of trifluralin (1.2 L ha^{-1}) for comparison.
8-Weed free

Each treatment was replicated 4 times.

Determination of total phenolics in sorghum residues amended soil.

This experiment was conducted to determine if the phenolics dynamic in soil contribute in the allelopathic potential of the incorporated sorghum residues in soil. Folin-Denis was used for phenolics analysis (32) and ferulic acid was used as standard since it is an allelopathic agent present in sorghum plant (25). Soil samples were taken from plots amended with 5t ha^{-1}, 10t ha^{-1} residue and from plots without residue (control) at a depth of 30 cm at 1, 14, 28, 42, and 56 days after sowing (DAS). The soils were mixed thoroughly and allowed to dry at room temperature for 3 days. Samples of 250 g dry soil were extracted separately in 250 ml of distilled water by shaking for 24 h at 200 rpm (14). Soil suspensions were filtered through Whatman No. 2 filter paper under vacuum. Folin-Denis reagent (0.5 ml) and Na_2CO_3 (one ml) were added to one ml of soil water extract and left to stand for 30 minutes. Absorbance was determined at 750 nm on a spectrophotometer (16). The phenolic content was obtained by standard curve using different concentrations of ferulic acid.

Weeds measurements

At the physiological maturity of cowpea crop (75 days after sowing), weed density were recorded from tow randomly selected quadrates (25×25 cm^2) in each experimental unit (plot). Number of weeds was recorded from the selected quadrate and weed density was determined following equation(21). For dry weight biomass determination, the weeds in the selected quadrate were clipped at the soil surface, stored in Paper bags and brought to laboratory for recording their biomass. The biomass was determined after air-drying the plant materials

in oven at 70 ˚C for three days using digital balance. Data on weed density and biomass were converted and expressed as in m^2.

Bioassay of soil amended with sorghum residues against weeds

This experiment was conducted to test if the phenolics released from decomposed sorghum residues in soil are responsible for the poor growth of weeds observed in cowpea field. Soil samples were taken biweekly from soil of plots amended with sorghum residues at 10 t ha^{-1}, plots with 100 % Herbicide, plots with sorghum residues at 10 t ha^{-1} + 50 % herbicides and plots of zero residues and herbicides (control) at a depth of 30 cm at 1, 14, 28, 42 and56 days after sowing. The soils were mixed thoroughly and allowed to dry at room temperature for 3 days. The soil was packed in plastic pots of 200 g capacity and twenty seeds of each of pigweed and Mallowweeds were sown separately in their respective plots. The pots were arranged in randomized completes were irrigated with appropriate amount of water whenever needed. Seed germination was recorded at 15 days after sowing, after which time, the seedling were thinned to 3 per pot and allowed to grow for additional two weeks. The plants were pulled from the pots using running water. Total dry weight of pigweed and Mallow was determined after oven drying the plants at 70 Ċ for 3 days. The weight was measured using an electrical balance.

Cowpea crop measurements.

At harvesting (75 days after sowing), ten plants were randomly selected from each plot to count number of pods, number of seeds per pod, weight of 100-seed, seed yield (t ha^{-1}), cowpea straw (t ha^{-1}), biological yield and harvest indexwere recorded using standard procedures (2).

Statistical analyses

The data were subjected to statistical analysis using analysis of variance (ANOVA) by GENSTAT computer software package. Differences among treatment averages were compared using Least Significant Difference (LSD) at 0.05 probability level, (39).

RESULTS AND DISCUSSION

Weed flora of the experimental site.

Weed flora dominated the cowpea field during the study comprised mainly of *Sorghum halepense L., Cynodondactylon L., Portulaca oleracea L., Convolvulus arvensis L., Echinochloa colonum (L.) Link,Cyperus rotundus L. Setaria viridis* (L.) P.Beauv,*Corchorus olitorius L., Malva rotundifolia L.*

Effect of different rates of sorghum residues alone or in combination with reduced rate of trifluralin herbicide on density and dry biomass of weeds in cowpea field,

Weed density was reduced by all treatments over control at 75 days after sowing (DAS) with the exception of residue rate of 5 t ha^{-1} which did not affect weed population (Table 1). Incorporation of sorghum residues at 10 t ha^{-1} reduced weed density by 43% over control. However, combination of the reduced rates of herbicide with the sorghum residues at 5 and 10t ha^{-1}showed more suppression to weeds density 77 and 81 % of control, than sorghum residues applied alone 6 and 43 % of control and was on par with the label rate of trifluralin herbicide 75% of control.

Weed dry biomass was significantly affected by all treatments over weedy check (Table 1). Incorporation of sorghum residues in to field soil significantly suppressed weed dry biomass over control and the suppression increased with the

increased residues rate. However, higher suppression was recorded by combination of sorghum residues with lower rate of herbicide than by sorghum residue rates and lower rate of herbicide when applied alone. The combination of sorghum residues and half rate of trifluralin herbicide is also provided weed suppression similar to that of the label rate of herbicide. The reduction in weed density and biomass seems an outcome of inhibitory effects exerted by sorghum residues incorporated in to the field soil. Such a reduction is believed to originate by the release of phytotoxic allelochemicals from sorghum residues in the immediate vicinity during their decomposition. No attempt was made to identify the allelochemicals in the residues; however sorghum contains several putative allelochemicals responsible for biological activity*viz*, P.coumaric acid, syringic acid, vanillic acid, p- hydroxybenzoic acid and ferulic acid (31,11). These phytotoxins are reported to have inhibitory effects on several processes such as inhibition of chlorophyll biosynthesis, respiration, photosynthesis, ions uptake, hormones biosynthesis and cell division, inhibition of the activity of some enzymes involved in essential metabolic processes and others (10, 26,42). Also, most of these allelochemicals are water soluble and when imbibed by the germinating weed seeds, hampered their germination and subsequent seedling growth, thus contributing to overall decline in the density, vigor and stand establishment of the weed community (22). In most cases, greater weed inhibition was observed by higher residue incorporation rate. (29, 28) pointed out that suppression magnitude in allelopathic interactions is directly proportional to the applied dose of an allelopathic product. This result confirms the earlier work of Al-ObaidiandAlsaadawi (6) who reported that sorghum residues incorporated into the field soil at 10 t ha^{-1} reduced weed population and dry weight biomass in mung bean up to 42 and 51% of control, respectively. Although sorghum residues showed significant reduction in weed population density and dry weight biomass, their efficacy could not comparable with that of the label rate of trifluralin herbicide. This result is in accordance with several investigators who reported that the efficacy of allelopathic crop residue was below that of commercial herbicides (5,13,40,43). However, when herbicide application at 50% of label rate was applied to plots amended with test rates of sorghum residues, a similar or even greater weed suppression was recorded than sole application of trifluralin herbicide (Table 1). These results confirmed hypothesis proposed byBohwmik and Inderjit (15), that lower dose of herbicide applied in combination with allelopathic conditions could enjoy a complementary interaction and may help to minimize herbicide usage for weed management in field crops. Also, these results are in line with those obtained byAlsaadawi *et al.*(9) who reported similar suppression of weed population and biomass in faba bean with sorghum residues when applied in combination with reduced rate of trifluralin. Furthermore, Al-Eqaili*et al.* (3,4) found that combined sunflower residues and reduced rate (50% of full dose) of chevalier herbicide were effective as the label rate of herbicide in suppression weed density and dry weight in wheat field. It seems from these results that a reduced level of trifluralin herbicide is feasible for providing satisfactory weed control when it works simultaneously with allelopathic conditions.

Table1:Effect of different rates of sorghum residues alone or in combinationwith reduced rate of trifluralin herbicide on density and dry biomass of weeds in cowpea field

Treatments	Total number of weeds/m^2	Reduction (%) of control	Dry weight(g/m^2)	Reduction (%) of control)
Weedy check (control)	73.0	-	524.0	-
Residues at 5 t ha^{-1}	68.5	6.2	271.0	48
Residues at 5 t ha^{-1} + 50% label rate of trifluralin	16.5	77	18.0	97
Residues at 10 t ha^{-1}	41.5	43	179	66
Residues at 10 t ha^{-1} + 50% label rate of trifluralin	14.0	81	6.0	99
50 of % Label rate of trifluralin (1.2 L ha^{-1})	48.0	34	215.0	59
Label rate of trifluralin (2.4 L ha^{-1})	18.0	75	17.0	97
L.S.D. ≤ 0.05	18.7	-	152.4	-

*Each number is an average of four replicates (Plots).

Determination of total phenolics in field of sorghum residues amended soil.

Total phenolics in field soil significantly increased after incorporation of sorghum residues and reached its peak at 4 weeks of residues decomposition, then decreased significantly at 6 weeks and vanished at 8 weeks (Figure 1).

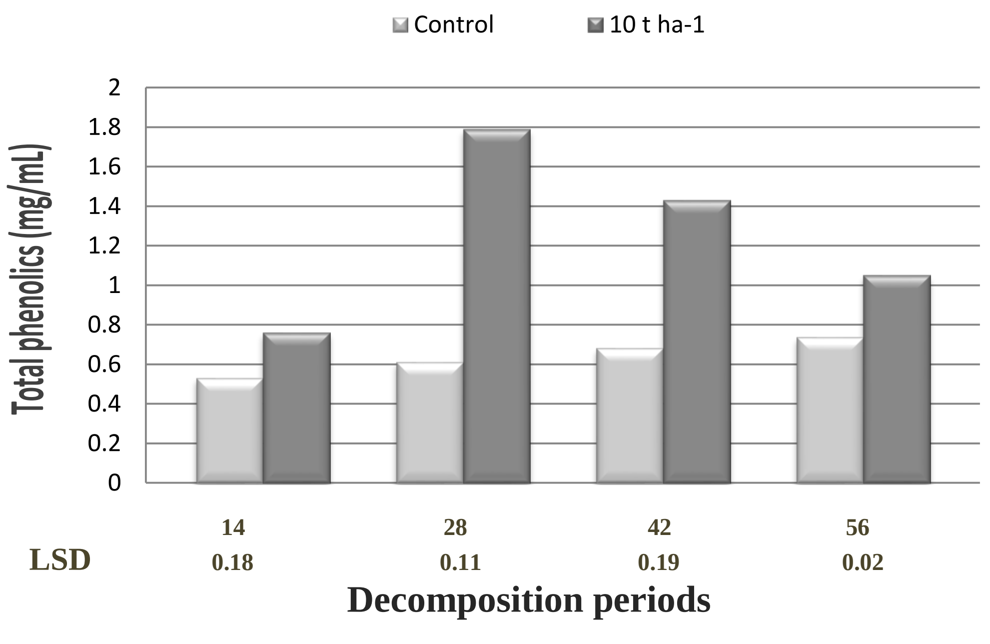

Figure 1: Total phenolics release in field soil amended with sorghum residues at 10 t ha^{-1} during different decomposition periods. *Each value is an average of four replicates.

Effect of decomposing *Sorghum bicolor* residues in to field soil amended with half label rate of trifluralin at different decomposition periods on the seeding emergence and dry weight of test weeds.

Effect on pigweed

Seedling emergence of pigweed was significantly suppressed by all treatments at all decomposition periods with the exception of sorghum residues where the suppression started at 2-week decomposition period (Table 2). The

highest suppression of seedling emergence was recorded by the label rate of trifluralin, followed by the combination of sorghum residues and lower rate of herbicide. In most of treatments, the suppression of seedling emergence seedling started at 2-week and remained higher even at 8-week of decomposition period.
Dry weight biomass of pigweed was significantly suppressed by all treatments and at all decomposition periods (Table 3). The highest weed suppression was recorded by the combination of sorghum residue with lower rate of herbicide, followed by the label rate of trifluralin herbicide.

Table 2: Effect of decomposing *Sorghum bicolor* residues in soil amended with halflabel rate of trifluralin at different periods on seedling emergence of Pigweed

Treatments	of Seedling emergence (%)			
	Decomposition periods (Week)*			
	2	4	6	8
Weedy check (Control)	77.5	66.2	66.2	61.2
Residues at 10 t ha^{-1}	65.2	40.0	43.8	36.2
Residues at 10 t ha^{-1} + 50% oflabel rate of trifluralin	42.5	30.0	32.5	27.5
Label rate of trifluralin (2.4 L ha^{-1})	16.2	18.8	21.2	12.5
L.S.D. ≤ 0.05	15.4	10.8	8.5	13.9

*Each number is an average of four replicates.

Table 3: Effect of decomposing *Sorghum bicolor* residues in soil amended with half label rate of trifluralin at different periods on dry weight biomass of pigweed

Treatments	Seedling dry weight biomass (mg)			
	Decomposition Periods (Week)*			
	2	4	6	8
Weedy check (Control)	11.1	9.4	8.5	6. 7
Residues at 10 t ha^{-1}	8.9	6.3	5.7	5.5
Residues at 10 t ha^{-1} + 50% oflabel rate of trifluralin	7.2	6.0	5.3	5.5
Label rate of trifluralin (2.4 L ha^{-1})	6.1	5.9	4.9	4.0
L.S.D. ≤ 0.05	2.0	2.1	1.4	1.2

*Each number is an average of four replicates.

Effect on Mallow weed

Seedling emergence of mallow was significantly reduced at all decomposition periods compared to the control treatment (Table 4). The highest inhibition of seedling emergence was achieved by label rate of trifluralin and the combination of sorghum residues and lower rate of herbicide treatments with no significant differences between them.

Seedling dry weight of mallow weedwas significantly reduced at all decomposition periods compared to the control treatment (Table 5). The highest inhibition of seedling emergence was recorded by label rate of trifluralin and the combination of sorghum residues and lower rate of herbicide treatments with no significant differences between them. The phytotoxicity of sorghum residues in soil alone or in combination with the half full rate of trifluralin herbicide against weeds started at early stage after planting and persist for more than 8 weeks (Tables 2-5). This period ofphytotoxicity was coincided with the period of

maximum weed suppressive activity observed under field condition, which explains the activity of phytotoxins on weed suppression. Subsequent experiment proved that the suppression of weeds was due to the total phenolics released during decomposition of sorghum residues in soil since significant correlation was found between the total phenolics and the % of seedling emergence and dry biomass of the test weeds, respectively at all decomposition periods (Figure 1:Table 6). The inhibitory activity of phenolics released from different allelopathic crops including sorghum against weeds has been reported by several investigators and in most of these studies they found that phenolics quantities increased significantly during the early stage of residues decomposition (the first 40 days) and thereby reducing greatly weed seed germination and seedling growth, while in the subsequent stages, the same residues may enhance growth and development of the crop due to microbial degradation and improve nutritional characteristics , organic matter content, water holding capacity and bulk density of soil as shown in this study in plots receiving sorghum residues. This could furnish a suitable growth condition for cowpea crop to grow and become highly competitive to weeds.

Table 4: Effect of decomposing *Sorghum bicolor* residues in soil amended with half label rate of trifluralin at different periods on seedling emergence of mallow weed

Treatments	of Seedling emergence (%)			
	Decomposition Periods (Week)*			
	2	4	6	8
Weedy check (Control)	63.8	72.5	66.2	76.2
Residues at 10 t ha^{-1}	47.5	45.0	48.8	48.8
Residues at 10 t ha^{-1} + 50% of label rate of trifluralin	31.2	27.5	33.8	41.2
Label rate of trifluralin (2.4 L ha^{-1})	25.0	26.2	23.8	25.0
L.S.D. ≤ 0.05	9.9	10.2	12.4	16.3

*Each number is an average of four replicates.

Table 5: Effect of decomposing *Sorghum bicolor* residues in soil amended with half label rate of trifluralin at different periods on dry weight biomass of mallow weed

Treatments	Plant dry weight biomass (mg)			
	Decomposition Periods (Week)*			
	2	4	6	8
Weedy check (Control)	18.9	18.0	23.5	23.3
Residues at 10 t ha^{-1}	10.3	8.3	8.9	15.1
Residues at 10 t ha^{-1} + 50%label rate of trifluralin	8.2	7.1	7.9	10.3
Label rate of trifluralin 2.4 L ha^{-1}	10.6	8.8	9.9	10.8
L.S.D. ≤ 0.05	3.9	4.8	3.5	3.4

*Each number is an average of four replicates

Correlation coefficient between seedling emergence and growth of test weeds total and phenolics in the field soil amended with 10 t ha^{-1} sorghum residues at different decomposition periods.

Statically analyses indicated that a high negative correlation between seeding emergence and dry weight growth of the test weeds and concentration of total phenolics in field soil amended with sorghum residues decomposed at different times (Table 6).

Table 6: Correlation coefficient between total soil phenolics and seedling emergence and growth of test weeds grown in the field soil amended with 10 t ha^{-1} sorghum residues at different decomposition periods.

Decomposition period (week)	*Portulaca oleracea*		*Malva rotundifolia*	
	Seedling emergence	Seedling dry weight (mg)	Seedling emergence	Seedling dry weight (mg)
2	0.61*	0.66*	0.60*	0.67*
4	0.63*	0.78*	0.63*	1.00*
6	0.62*	0.73*	0.62*	0.82*
8	0.62*	0.65*	0.62*	0.76*

*Significant at 0.05 level.

Effect of different rates of sorghum residues on yield components of cowpea

Effect on number of pods per plant

All treatments significantly increased the number of pods per plant cowpea compared to control (Table 7). Incorporation of sorghum residues at 5 and 10 t ha^{-1} increased the number of pods by 106 and 79% of control. While application 50% of label rate of trifluralin treatments alone recorded 84% of control. Incorporation of sorghum residues at 5 t ha^{-1} in soil amended with reduced rate of trifluralin to 50% increased the dry weight by 171 % of control. Incorporation of sorghum residues at 10 t ha^{-1} amended with 50 % of label rate of trifluralin recorded significantly different 245% over control. While weedy free treatment and label rate of trifluralin treatments. recorded increased in number of pods by 130 and 121% over control respectively.

Table 7:Effect of different rates of sorghum residues alone or in combination with reduced rate of trifluralin herbicide on number of pods of cowpea.

Treatments	Number of pods /plant	Number of seeds /pod	Weight of 100 seeds (g)
Weedy check (control)	6.4	4.87	18.66
Residues at 5 t ha^{-1}	13.2	5.80	22.84
Residues at 5 t ha^{-1} + 50% of label rate of trifluralin	17.4	5.60	22.18
Residues at 10 t ha^{-1}	11.5	5.73	22.49
Residues at 10 t ha^{-1} + 50 % of label rate of trifluralin	22.1	6.91	23.53
Label rate of trifluralin (2.4 L ha^{-1})	14.2	5.35	22.98
50 % of Label rate of trifluralin (1.2 L ha^{-1})	11.8	5.15	19.55
Weed free (without residues)	14.7	5.50	19.67
L.S.D. ≤ 0.05	4.18	0.76	0.512

*Each number is an average of four replicates (Plots).

Effect on number of seeds per pod

Incorporation of sorghum residues at 5 and 10 t ha^{-1} significantly increased theseeds per pod by 19 and 18% of control. While application of half of the label rate of trifluralin in to the field soil alone did not affect number of seeds per pod (Table 7). However Incorporation of sorghum residues at 5 and 10 t ha^{-1} in field soil amended with half rate of trifluralin herbicide increased number of seeds per pod by 15 and 42 % of control, respectively. Interestingly, combination of sorghum residues at 5 and 10 t ha^{-1}with reduced rate of trifluralin number of seeds by 5 and 29 % over label rate of herbicide and 2 and 26% over weed free treatment, respectively.

Effect on weight of 100 seeds (g)

All treatments significantly affected weight of 100 seeds of cowpea over control (Table 7). Incorporation of sorghum residues at 5 and 10 t ha^{-1} increased 100-seed weight by 22 and 21% of control. While application 50% of label rate of trifluralin treatments alone increased 100-seed weight by 5% of control. However, incorporation of sorghum residues at 5 and 10 t ha^{-1} in field soil amended with 50% of the label rate of trifluralin increased the weight of 100 seeds by 19 and 26% of control, respectively. Interestingly, half rate of trifluralin accompanied with sorghum residues at 10 t ha^{-1} recorded cowpea 100-seed weight of 23.530 g , which was statistically higher than achieved with the label trifluralin rate applied alone (22.980g) and weedy free treatment (19.670 g).

Effect of different rates of sorghum residues on seeds and biological yields of cowpea

Effect on seeds yields

Both herbicide and sorghum residues applications and their interactions significantly affected seeds yield over control (Table 8). Incorporation of sorghum residues into field soil at 5 and 10 t ha^{-1} increased seeds yield by 107 and 98 of control while application of 50 % of label rate of trifluralin treatments alone increased seeds yield by 73 % of control. Integration of sorghum residues at 5 and 10 t ha^{-1} and half dose of trifluralin provide the maximum seeds yield (1.80 and 2.70 t/ha), which was 190 and 336 % over control, followed by weedy free treatment (1.41 t/ha) and label rate of trifluralin (1.67 t/ha).which increased yield by 127 and 169 % of control, respectively.

Effect on biological yield

All treatments significantly affected biological yield of cowpea (Table 8). Incorporation of sorghum residues into field soil at 5 and 10 t ha^{-1} increased biological yield by 62 and 85% over control, respectively. While application 50% of label rate of trifluralin treatments alone increased biological yield by 55% of control. However, integration of sorghum residues at 5 and 10 t ha^{-1} and 50% of full rate of trifluralin produced maximum biological yield (5.92 and 7.65 t/ha) which was increased by 142 and 212 of control, respectively. Weedy free treatment increased seed biological yield by 98% over control. Trifluralin at 50% of its label rate accompanied with sorghum residues at 5 and 10 t ha^{-1} recorded biological yield statistically higher than that achieved when the label rate of this herbicide was applied alone. The increase of cowpea biological and seed yields (Table8) by application of sorghum residues alone and in combination with reduced herbicide rate of trifluralin over weedy check treatment seems an outcome of reduced weed–crop competition for any of the growth factors which might have contributed to higher yield and biomass. By Minimizing competition due to better weed control, cowpea plants uptake more water and nutrients that resulted in vigorous growth and seed yield. Furthermore, incorporation of sorghum residues into the field soil improved physical, chemical and biological properties of soil and this could explain why the higher rate (10 t ha^{-1}) of sorghum residues along with reduced (50% of full dose) rate of trifluralin herbicide showed better yield and dry biomass of cowpea than sole application of label rate of trifluralin. There are many earlier reports available that signify the role of reduced doses of commercial herbicides in combination with allelopathic plant residues to enhance grain and biological

yield (7,31,12,9). Apparently, the higher grain yield by all the test treatments was attributed to improve all the three factors of yield components (number of pods per plant, 100–seed weight and number of seeds per pod). The increase in yield by combination of allelopathic residues and lower rate of herbicide was reported to be crop dependent. Several investigators showed that the increase in yield of crops such as mung bean, broad bean, wheat and barley was due to increase one or two of the three yield components factors (8,40,6). Many researchers have stressed the need for decreasing the use of herbicides in crop production. Residues of the allelopathic plants can serve as the means of using allelopathy for practical weed management. Use of allelopathic crop residues and reduced rates of herbicides have been effective for weed management in field crops such as mung bean, barley and wheat (3,6,7,8,40).

Table 8:Effect of different rates of sorghum residues cv. Enkath alone or in combination with reduced rate of trifluralin herbicide on seeds and biological yields of cowpea

Treatments	Seeds yield (t/ha)*	Biological Yield (t/ha)*
Weedy check (control)	0.62	2.45
Residues at 5 t ha^{-1}	1.28	3.97
Residues at 5 t ha^{-1} + 50% of label rate of trifluralin	1.80	5.92
Residues at 10 t ha^{-1}	1.23	4.52
Residues at 10 t ha^{-1} + 50% of label rate of trifluralin	2.70	7.65
Label rate of trifluralin 2.4 L ha^{-1}	1.67	5.03
50 % Label rate of trifluralin 1.2L ha^{-1}	1.08	3.80
Weed free (without Residues)	1.41	4.85
L.S.D. ≤ 0.05	0.33	1.51

*Each number is an average of four replicates (Plots).

Finally, the present study revealed that sorghum residues used with 50% of full rate of trifluralin herbicide is highly effective approach in controlling weeds in cowpea field, improving seeds yield of cowpea crop and increasing environmental safety by reducing reliance on synthetic herbicides. Besides that, the allelopathic residues have a great advantage for improving chemical, physical and nutritional status of the soil, and can be applied on large scale. Indeed, plant residues affect soil pH and play significant role through improvement in soil fertility by cycling nutrients and adding organic matter (27). For example, Prasad and Sinha (34) reported that about 50-80% of zinc, copper and manganese taken up by wheat and rice can be recycled through residue incorporation.Moreover, certain organic acids released after residue decomposition are important for changes in soil pH and availability of micronutrients. The organic acids which are released during residue decomposition may alter the mobility and bioavailability of metals such as copper and manganese (27). Crop residue retention also affects soil temperature, evapotranspiration, leaching, Soil organic matter and prevent the runoff of the nutrients due to runoff (36, 38).

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مجلة الزراعة العراقية (البحثية) مجلد21 عدد2 ص217-232 كانون اول/2016

تأثير مخلفات الذرة البيضاء مع جرعة منخفضة من مبيد الترفلان في الادغال النامية في حقل اللوبياء

حسام مالح مطر ابراهيم شعبان السعداوي

الملخص

نفذت تجربةحقلية ومختبريةلأختبارالجهدالاليلوباثي لمخلفات الذرة البيضاءصنف أنقاذ بمفردها اومع نصف الجرعة الموصى بها (1.2 لتر ه$^{-1}$) من مبيد الترفلان في مكافحة الادغال النامية في حقل اللوبياء في الموسم 2015 وذلك في حقل تجارب قسم علوم الحياة، كلية العلوم، جامعة بغداد، اذتم اولا زراعة حبوب الذرة البيضاء صنف إنقاذ في الواح مساحتها 4×3،5م على خطوط المسافة بين جورة واخرى 10 سم وبين خط واخر 75 سم للحصول على المادة الجافة. وعند النضج الفسيولوجي للمحصول حصدت الحبوب وتركت النباتات في الالواح لتجف. وبعد الجفاف خلطت مخلفات الذرة البيضاء بمعدل 5 طن ه$^{-1}$ (من خلال تخفيف اعداد النباتات المعدة لها الى النصف) و10طن ه$^{-1}$ (ترك اعداد النباتات دون خف) في تربة الالواح بصورة منفردة أومع نصف الجرعة الموصى بها من مبيد الترفلان لدراسة تاثيرها في مكافحة ادغال لحقل اللوبياء. كما تضمنت الدراسة معاملة بدون مكافحة (مدغلة) ومعاملة مبيد بالجرعة الموصا بها ومعاملة نصف الجرعة الموصى بها لوحدها و معاملة خالية من الادغال (تزال منها الادغال كل اسبوع) للمقارنة كما تم تحديد المحتوى الكلي للفينولات في تربة الالواح المضاف اليها مخلفات الذرة البيضاء بمعدل 5 و10 طن ه$^{-1}$ وتربة الالواح الخالية من المخلفات بعد يوم و14 و28 و42 و56 يوما من اضافة المخلفات. ونفذت تجربة اخرى في اصص لتقدير النشاط الحيوي للتربة الممزوجة بالمخلفات على بزوغ ونمو دغلي البربين والخباز في اثناء المدد الزمنية المذكورة آنفا لمعرفة فيما اذا كان التثبيط الحاصل في نمو اللدغلين ناجما عن وجود المركبات الفينولية في التربة.

ادت اضافة مخلفات الذرة البيضاء لتربة الحقل بمعدل 5 طنه$^{-1}$ الى خفض متوسط كثافة الادغال لبنسبة 6% عن المقارنة بعد 75يوما من الزراعة. وازداد الخفض عند اضافة مخلفات الذرة البيضاء بمعدل 10 طن ه$^{-1}$ ليصل الى 43% عن المقارنة بعد 75 يومامن الزراعة. الا ان الاختزال في عدد الادغال ازداد بشكل كبير عندما اضيفت نصف الجرعة الموصى بها من المبيد الى المعاملات الحاوية على المخلفات ،بحيث اصبح الاختزال غير مختلف معنويا عن معاملة الجرعة الكاملة من المبيد. كما ادى خلط مخلفات الذرة بمعدل 5 و 10 اطنانه$^{-1}$ الى اختزال الوزن الجاف للادغال بنسبة 48 و66% عن المقارنة على التوالي. غير ان هذا الاختزال قد ازداد بشكل كبير في الالواح الحاوية على المخلفات و نصف الجرعة الموصى بها من المبيد مقارنة بالالواح الحاوية عليهما بشكل منفرد. اذ اصبح الاختزال غير مختلف معنويا عن معاملة الجرعة الكاملة من المبيد. وبنيت النتائج ايضا ان الانخفاض الحاصل في الادغال ناجم بالدرجة الاساس من تحرر المركبات الفينولية من المخلفات المضافة الى تربة الحقل والتي كانت لها ارتباط ايجابي مع نسبة الاختزال للفروع ونموالادغال بالاضافة الى كثافتها ضمن وحدة المساحة. وقد انعكس الاختزال في كثافة الادغال واوزانها الجافة ايجابيا على حاصل المادة الجافة وحاصل البذورومكوناته والحاصل البيولوجي. وقد اعطت النباتات النامية في الالواح المضاف الى تربتها مخلفات الذرة البيضاء بتركيز 10 طنه$^{-1}$ ونصف الجرعة من مبيد الترفلان حاصل بذور اعلى من ما حققته معاملة المبيد بكامل التوصية.

كلية العلوم، جامعة بغداد، بغداد، العراق.