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Magnetic treatment of herbicide spraying solutions to increase the activity of weed control with some wheat cultivars

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Abstract

Two field experiments were conducted on the fields of the Faculty of Agriculture, Karbala University, Iraq, during the winter season 2015-2016 and 2016-2017 to evaluation of magnetic treatment of herbicide spraying solutions to increase activity of weed control with five cultivars of wheat. The results showed the significant effect of magnetic herbicide solution at increasing the efficiency of herbicide absorption by weed and decreasing its density and biomass per m. Weed control percentage when the use of half recommendation for the herbicide under magnetic solution has exceeded the use of the full recommendation without a magnetization. Response of cultivars to herbicide spraying treatments according to the different susceptibility of the weeds competition to the different growth season. The weed control treatment were correlation with the grain yield of the wheat crop as a strongly negative (r^2 = 0.98 and r^2 = 0.97 for the first and second seasons respectively) and for all the weed control treatment. Liner regression model for the first season showed an increase in the density of weed, one plant on the square meter causes decrease in cereal yield by 76kg per h. In the second season, by 70kg per h, it is concluded that the use of the magnetization of solution spray for half herbicide amount may give an increase on the amount 518kg per h for the first season and by 538kg per h for the second season against the same treatment without magnetization.

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Introduction

The management of weeds in agricultural systems represents a major challenge to reduce productivity and poor quality. The cost of herbicides that used for weed control is estimated at about 21$ billion dollars yearly, which included economic benefits a 7.7 $ billion reduction in weed control costs and savings of about 13.3$ billion in potential crop losses (Farm Future, 2005). In addition to indirect costs of producers, consumers and the environment.

Although the many planning taken to prevent broadcasting weed, their proliferation is increasing annually as a result of their ability to deploy reproduction and adaptation to environmental conditions have made them a strong competitor and determinant of agricultural crops.

As a result of the significant losses caused by these pests in the agricultural field, many research and studies have been directed towards combating this pests by various means, mechanical, biological or chemical (Lahmod, 2012 and Lahmod and Asaadawi, 2014). Chemical control by herbicides is one of the most important applications used against the weed because it has a high ability of weed control, selectivity and ease application (Lahmod *et al.*, 2016 and Al-Eqaili *et al.*, 2017), however, the frequent use and increase of used chemicals has been increased the environmental pollution of soils and the biosphere (Weston 2005). The resistance of some weed or the low efficacy of some herbicides also forces farmers to increase the spraying rates to reach the best control of weed (Huffman *et al.*, 2016).

That resulted an increase in environmental pollution and the killing of useful microorganisms (Lewis *et al.*, 2002). The ability of the herbicide to suppression of target weed depending on the amount of the absorbed herbicide and arrived of active ingredient to plant's effect site. This depending primarily on several factors such as the type of the weed, the type of herbicide group and the concentration of the active ingredient on it, as well as the environmental factors and the time of spraying.

On the basis of the absorbed quantity of the active ingredient, some herbicides may be dependent on the selectivity (Nandula and Vencill, 2015).

The use of some applications to increase pesticide absorption from weed, contributes to high efficient control and reduces herbicide spraying rates and thus reduces environmental pollution and material cost (Hatami *et al.*, 2016). Water surface tensile and herbicide charge are essential and determinant of the quantity of the herbicide absorbed by the leaves, so several substances were used to reduce the surface tensile of the herbicide's at the spray, which were adding to solution as surface-tightening(Current Category, 2015). Chevalier 15 WG herbicide, which belongs to the sulfonyl-urea group, is one of the most important used in narrow -and broad-leaf seasonal weed control on wheat fields, which are usually added to a spraying material to reduce the surface tension and increase the absorption of the herbicide by weed leaves (Bayer Crop Science, 2004), however, a large proportion of the herbicide may be a not absorbed by the leaves due to environmental conditions or the closing of the stomata on the plan (Current Category, 2015).

Recently, the concept of use water magnetic technology on agriculture, or the so-called bio-magnetic stimulation of vegetation through the stimulation of plant metabolism and changes on the properties of cells membranes (Vasileveski, 2003). Sueda *et al.* (2007) and Pang (2008) found that hydrophobic magnetic treatment results of reduced surface tension and changes on the physical of water and making it easier to absorb from the plant. Also, the magnetization of the spray solution of herbicides increases the readiness of the nutrients when sprayed on the plant (Alfarttoosi, 2014).

The magnetization solution of the Glyphoset spray is 4 000 Gs, suppression the germination and growth of the *Lepidium sativum* by a greater proportion of herbicide spraying without magnetization (Ruzic *et al.*, 2008). Mohassel and Aliverdi (2012) found when using magnetic technology by 7000 Gsand the material adhesion frigate with a herbicide in control

of Wild oats there are moral differences in reducing surface tension, increasing herbicide penetration, and increasing the control of land-use in both technologies. Together as measured by the treatment of their individual use. Al-Chalabi and Al Alfarttoosi (2012) confirmed that the use of magnetic technology for the 500, 1000 and 2000Gsmagnetometer has improved the efficacy of the trifluralin herbicide used to control the weeds cotton crop. AL-Chalabi and AL-Jebbori (2012) found that the irrigation of corn with magnetic water 2000 Gshas reduced the density of the weed and increased the control percentage and may be approximate the effect of adding 2kg per h from the Atrazine was not significant from adding 4kg of the herbicide without magnetic water. Al-Chalabi and Al-khaldy (2014) obtained that magnetic treatment of the Glyphoset and fluazifop-butyl spray solution by 1000 and 2000 Gswith adding 75% of the recommended dose of herbicides may approximate their effect with the treatment of adding 100% of the recommendation of herbicides with normal water, which has increased the efficacy of the herbicides and reduced the number of tiller and rhizomes of *Pampas* grass.

Wheat crop is one of the weak-competitive crops of weed compared to other crops, however, the cultivars of wheat may be different their competitiveness of the dermis according to their morphological characteristics in terms of altitude, paper space and number Forests (Al-Chalabi and Al-Agidi, 2010). Therefore, the cultivation of highly competitive items, with increased efficacy of the herbicide with magnetization of the spray solution, will contribute to the best control of weeds without resorting to the use of high concentrations of herbicides, that is the objective for which the study was the basis of.

Materials and methods

Field preparations

A field trial was carried out in the fields of the Agricultural College of Karbala University during the winter seasons 2016-2015 and 2016-2017 with the aim of studying the role of magnetization the spraying of herbicides solution to increases the efficiency of weed control process and its effect on some of growth qualities and the quotient of five cultivars of wheat. The experiment applied on the silt-clay loam soil (Table 1). Soil tillage, fertilization, soil and crop service operations were carried out according to crop recommendations. Experimental unit was 6 $m^2$with dimensions 2×3m. Wheat was planted at a rate of 120kg. h^{-1} as lines (20cm distance lines). Fertilizer phosphate (triple super phosphate 48% P2O5) was added at a rate of 250kg per hat sowing and nitrogen fertilizer (urea 46% N) at 300kg per through seasons with four applications (Jadoaa, 2003), the first applied was added at sowing and the rest were added at different stages of plant growth (Tillering, potting and flowering).

Table 1. Some Physical and chemical properties of field soil.

Soil Separated (g per kg)	
Sand	%20
Clay	%45
Loame	%35
Soil texture	Silt -clay loam
pH	7.73
EC ($dS.m^{-1}$)	4.42
Nitrogen (Mg per kg)	38.2
Phosphorus (Mg per kg)	8.69
Available K(Mg per kg)	169.2
Organic matter (g per kg)	10.1

Field trial and Design

Randomized completely block design R.C.B.D. was used as split plot arrangement with three replications . Study was included planting five cultivars of Bread wheat: Iraq, Adnania, Fateh, Rashid, Latifih as main plot while the weed control treatment represented with use of the chevalier herbicide (mesosulfuron and iodosulfuron as the chevalier tread name) 100% of the recommendation (300g per h) alone, chevalier with a 50% of the recommendation alone or with magnetized spraying solution] and control treatment (without a herbicide). The amount of water was calculated on the 400 liters per hectare. The water magnetization device was used with the severity of 3000 Gs attached with spray tube on the treatments that which magnetic technology was used. Spraying of herbicide was applied at arrival of the weeds plant to fourth stage of the leaves at the early morning by backpack sprayer, under constant pressure.

Weed and crop measurements

When arrival of the crop plants to physiological stage maturity, the existing weeds were counted and their types diagnosed in each experimental unit in the way Squares. The intensity of the weed and its dry weight are estimated in each experimental unit when the crop reaches the stage of physiological maturity by dropping a wooden square in the middle of each transaction. The components of the product are calculated from a random sampling area of square meters, which takes from the middle of the experimental units.

Statistical analysis

The data were analyzed statistically according to the variation analysis method (ANOVA) for R.C.B.D, the sequencing of splinter panels and the use of the last significant difference test (L.S.D) to compare arithmetic means of treatment at a level of probability (5%).

Result

Weed density (plant per m²)

Although the different intensity of the weeds in both seasons, the weed species were similar. Ten species of narrow -and broad-leaf weeds were observed to spread on the winter crop fields. The narrow-leaf weed consisted of *Avena fatua* L, *Lolium temulentum* L, *Phalaris minor* L., and the wild cane, While the weed was a broadleaf, it was a Malva L, *Chenopodium album* L, *Silybum marianum* L, *Melilotus indicus* L, *Euphorbia tinctoria* L, Table 2 indicates that there is a significant effect of the chevalier herbicide against the weed at both seasons and for all wheat cultivars, but the magnetic of the spray solution has improved the efficacy of the herbicide in reducing the density of the weed in both seasons. The full herbicide recommendation and half of the recommendation alone was recorded percent of weed control about 70.2 and 63.0%.

Table 2. Effect of magnetization herbicide solution and cultivars of wheat on weed density (plant per m²).

First season (2015 - 2016)						
	Wheat Cultivars					
Herbicide treatment	Iraq1	Adnania	Fateh	Rashid	Latifya	*Mean*
Control (Water magnetization only)	35.0	40.0	45.0	41.0	71.7	46.5
Herbicide (Recommended dose) without magnetization	5.0	12.0	3.3	13.3	37.3	14.2
herbicide(Half Recommended dose) without magnetization	10.0	11.0	8.0	9.0	45.3	16.7
Herbicide (Half Recommended dose) with magnetization	4.0	6.0	5.0	3.0	28.0	9.2
L.S.D 0.05			ns			7.8
Mean	13.5	17.3	15.3	16.6	45.6	
L.S.D 0.05			4.8			
second season (2016-2017)						
Control (Water magnetization only)	65.3	65.3	37.0	60.0	84.0	62.3
Herbicide(Recommended dose) without magnetization	5.3	3.0	8.0	25.0	19.3	12.1
herbicide(Half Recommended dose) without magnetization	15.3	12.3	18.0	24.3	21.3	18.3
herbicide(Half Recommended dose) with magnetization	2.3	2.3	5.0	17.7	8.0	7.1
L.S.D 0.05			10.3			6.3
Mean	22.1	20.7	17.0	31.8	33.2	
L.S.D 0.05			4.5			

While half recommendation of herbicide with a solution magnetization was registered a percent of weed control about at 81% that has surpassed the full recommendation alone, which is a good indicator for reducing the amount of the herbicide and increasing the control rate. Wheat cultivars differed on their response to the herbicide control process at both seasons, noting that Latifia cultivar was less competitive than the others of the cultivars, which increased from the density of the weed with him (45.6 and 33.2 plants per m² for both seasons) in most of the weed control treatment compared with Alfateh cultivars as an example (15.3 and 17.0 plants per m² for both seasons).

Use of the full recommendation of the herbicide or half of the recommendation was more integrated with the cultivars that ability of weed competition, such as the Alfateh cultivar compared to the Latifia cultivar. In addition, the magnetization of the spray solution has improved the efficacy of the herbicide in the competitive varieties. However, 20% of the total weeds on the treatment of control has not been affected by the herbicide in all treatment, which may be due to the physiological resistance of those weeds against the herbicide, which many references refer to (Powles and Yu, 2010 and William *et al.*, 2011). From the above, it is clear that the magnetization spraying solution and the use of the highly competitive cultivars can be reduced by half the amount of the Chevalier and achieves control over the use of the herbicide with full recommendation.

Weed biomass (g per m²)

The escape of some weeds or resistance it to the herbicide depends on the efficacy of the herbicide itself and the success of the spray process or the ability of the weed to resistance.

The survival of this percentage of the weeds allows to continue to compete the crop and drain the elements of growth, which is probably related to the ability of the crop cultivar to compete and reduce of the biomass (Table 3). The dry weight of the weed biomass that resistance of herbicide is shown in a group of wheat cultivars planted in southern Iraq. The results show that the spraying of the chevalier herbicide was inhibition from the biomass of the weeds on the unit area for both seasons with varying depending to the type of treatment, the above was with the case of spraying solution magnetization with half of the herbicide recommendation. In the first season, the biomass of the weeds in the treatment of herbicide spraying with full recommendation or half of the recommendation to 83 and 81% during the first season, 51 and 46% during the second season.

The addition of half herbicide recommendation with the magnetization of spraying solution was recorded at 89% on dry weight of weed (biomass), during the first season and 55% during the second season. Wheat cultivar differed on their ability to competition of the weeds during both seasons. As the average biomass of the weeds, the highest dry weight of the weed was recorded with the Latifia cultivar (80 g per m²) during the first season and Rashid cultivar (196.7g/m²) during Season 2. As for the interference with herbicide treatment, the response was different.

Table 3. Effect of magnetization herbicide solution and cultivars of wheat on weed biomass (g per m²).

	First season (2015 - 2016)					
	Wheat Cultivars					
Herbicide treatment	Iraq1	Adnania	Fateh	Rashid	Latifya	*Mean*
Control (Water magnetization only)	228.3	110.0	120.0	175.0	250.0	176.7
Herbicide (Recommended dose) without magnetization	25.0	33.3	28.3	40.0	25.0	30.3
Herbicide (Half Recommended dose) without magnetization	28.3	40.0	31.3	43.3	25.0	33.6
Herbicide (Half Recommended dose) with magnetization	19.0	23.3	16.7	21.3	20.0	20.1
L.S.D 0.05			29.5			17.2
Mean	75.2	51.7	49.1	69.9	80.0	
L.S.D 0.05			13.2			
second season (2016-2017)						
Control (Water magnetization only)	285.3	192.0	376.0	333.3	280.0	293.3
Herbicide (Recommended dose) without magnetization	90.7	158.7	166.7	160.0	144.0	144.0
Herbicide (Half Recommended dose) without magnetization	173.3	153.3	129.3	174.7	150.7	156.3
Herbicide (Half Recommended dose) with magnetization	120.0	124.0	114.7	166.7	127.3	130.5
L.S.D 0.05			56.8			27.5
Mean	167.3	157.0	196.7	208.7	175.5	
L.S.D 0.05			26.8			

In the first season, the Fateh and Iraq cultivars were the highest density of the weed on the control treatment (220 and 208g per m²), but the same two cultivars showed the highest percentage of decrease of biomass under three herbicide spraying coefficients (full recommendation half recommendation, half recommendation with magnetization), 87, 86, 92%. The Alfateh, 89, 86, and 90% respectively compared to the others cultivars, which did not exceed this percentage. In the second season, the response of the two varieties (Alfateh and Iraq) were similar to the first season, although, the different intensity and quality of the weeds between the two seasons. The difference of the percentage inhibition on biomass of the weeds with the two cultivars (Alfateh and Iraq may indicate that these cultivars are more responsive to agricultural process, including the weed control.

Grain yield of wheat (ton per h)

Successful weed control means reducing the volume of competition for the harvest and allowing it to build a good vegetative total. Increasing the number of fertility tillers comes as a direct result of the availability of growth requirements due to lack of competition (Lahmod, 2012). Herbal treatment with a herbicide was effective in reducing the density and dry weight of the weed (Table 2. and 3.) This was positively reflected in increase in the cereal crop during both seasons of study (Table 4).

Table 4. Effect of magnetization herbicide solution and cultivars of wheat on grain yield (ton per h).

Ferist season (2015 - 2016) Herbicide treatment	Cultivers					*Mean*
	Iraq1	Adnania	Fateh	Rashid	Latif ya	
Control (Water magnetization only)	4.14	5.11	3.93	3.09	4.50	4.15
Herbicide (Recommended dose) without magnetization	6.58	7.02	7.99	5.30	5.22	6.42
Herbicide (Half Recommended dose) without magnetization	6.25	7.01	7.49	4.87	5.03	6.13
Herbicide (Half Recommended dose) with magnetization	8.28	7.23	7.69	5.52	7.50	7.25
L.S.D 0.05			0.91			0.38
Mean	6.31	6.59	6.77	4.70	5.56	
L.S.D 0.05			0.44			
second season (2016-2017)						
Control (Water magnetization only)	1.62	2.25	1.70	2.00	3.51	2.22
Herbicide (Recommended dose) without magnetization	4.60	4.30	4.80	4.11	4.11	4.38
Herbicide (Half Recommended dose) without magnetization	3.09	4.10	4.73	3.95	4.25	4.02
Herbicide (Half Recommended dose) with magnetization	7.15	4.55	4.98	4.51	4.74	5.19
L.S.D 0.05			1.31			0.59
Mean	4.12	3.80	4.05	3.64	4.15	
L.S.D 0.05			ns			

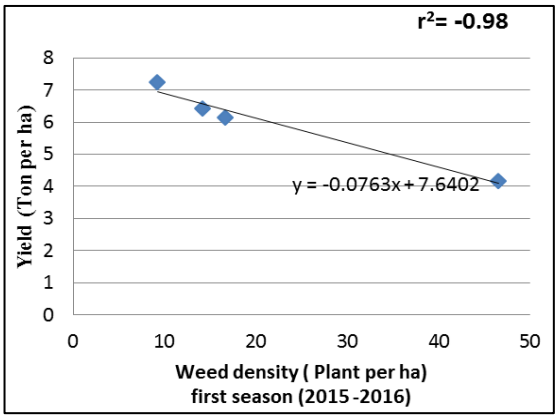
Follower, in both seasons, the cereal product has increased the treatment of a herbicide spray with full recommendation or half of the recommendation alone or with magnetization of the spray solution compared with control treatment (without herbicide), but the magnetization process improved the productivity of the crop so that half of the herbicide recommendation was recorded above the treatment of using the full recommendation alone. In the first season, the weed control treatment with full recommendation or half of the recommendation recorded an increase of 35 and 32% compared to the control treatment, while the treatment of magnetization of the spray solution recorded 42% increase compared with control treatment. In the same direction the control coefficients were giving rise in the grain product in the second season, this result indicates an improvement the yield of crop due to the solution magnetization process.

The response of the wheat cultivars to herbicide spraying treatment different according to the variance susceptibility of the cultivars to the weed competition and to the different season.

In the first season, Rashid cultivar was the lowest on the grain yield (4.7 ton per h), while the second cultivars (Fateh and Adnania) were registered as the highest grain yield (6.77 and 6.59 ton per h respectively). In the second season, the cultivars did not differ morally from each other under the 5% static level, but it was noted that the Rasheed cultivar was least on grain yield

Fig. 1 and 2. The correlation and regression relationship model between the weed control and grain yield on the unit area. The low density of the weeds per m^2 was strongly correlated with the grain yield of the two seasons (r^2=0.98 and r^2=0.97 for the first and second seasons respectively). The liner model of regression for the first season also showed that increasing the density of the weeds one plant per square meter causes a decrease on the grain yield by 76kg per h. In the second season, by 70kg per h, the use of the spray solution for half of the herbicide amount may give an increase about 518kg per h for the first season and by 538kg per h for the second season against the same treatment without magnetization.

The increase of the biomass of the weeds on the unit area was also negatively correlations with the decrease in grain yield of wheat by -0.95 and -0.96 for the two seasons respectively (Fig. 2), whereas the slope of the regression line indicates a reduction on the yield about 16 kg of cereal product per hectare for two seasons when the weed weight increase grams per square meters. Therefore, There was an increase of 217.6 and 403kg for the two seasons respectively in the treatment of magnetization of the spray solution for half of the pesticide recommendation in relation to non-magnetization.



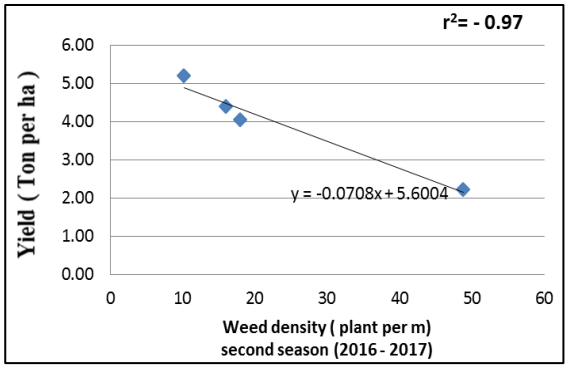
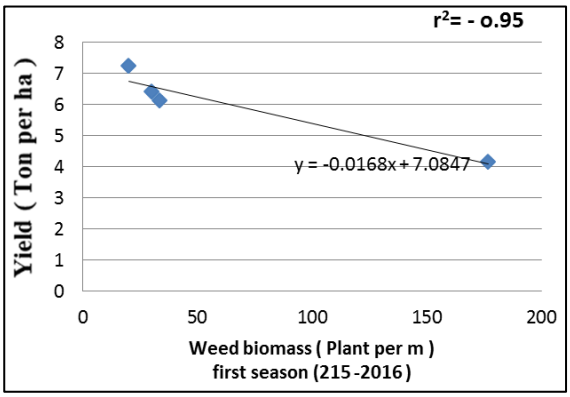


Fig. 1. Liner model of regression and correlation between yield and weed density (Plant per m).



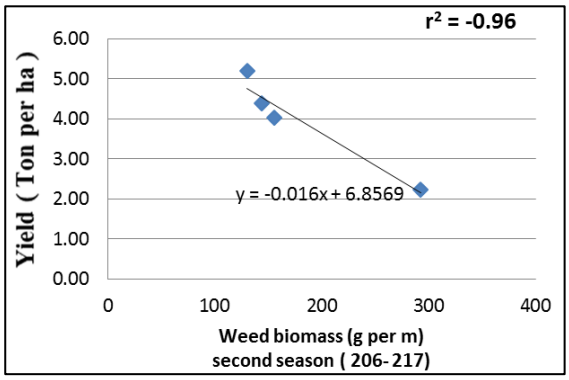


Fig. 2. Liner model of regression and correlation between yield and weed biomass (g per m).

Discussion

The results confirm that the loss of the wheat crop increases with the different types of weeds, density and its dry weight per unit area (Fig. 2, 3 and 4). Success of weed control depending on the efficiency of controlling weed process (Almutrafi *et al*, 2014). It may also depend on the ability of the variety of crop to competitive the weed and success a good economic yield (Habiband Alshamma, 2002 Lahmod and Al-Chalabi, 2012).

The Chevalier herbicide is one of the most widely used systemic herbicides against wheat weed in Iraq (Lahmod and Alsaadawi, 2014). However, the efficacy of herbicide relies heavily on spraying time and the amount of herbicide absorbed by the leaves (Busi *et al.*, 2013), especially with a large proportion of resistance weed to herbicides such as Rigid Ryegrass and Wild Barley (Llewellyn and Powles, 2001, Powles and Yu, 2010). Use of water magnetization technology has been referred to in many scientific references as a method of reducing surface tension and increasing the permeability of water through membranes (Sueda *et al.,* 2007 and Pang, 2008). Therefore, the magnetization of the herbicide spray solution may increase the amount of herbicide absorbed by the leaves and thus increase the efficiency of the weed control process, which is reflected in the results of table 1. Spraying solution coefficients have recorded a moral increase in the control rate and reduce weed density. Half the amount of the herbicide with the magnetization of the solution is less dense than that of the solution without magnetization, as well as its superiority over the treatment of the recommendation for herbicides without a magnetization. This is useful in reducing herbicide quantity and minimizing the costs of weed control and reducing pollution (Khan *et al.*, 2000). This result is similar to Al-Chalabi and AL-Khalidi (2014) study against cotton weeds through the spray solution.

Wheat cultivars differed morally in their ability to suppressive of weed and their response to control, and this response may be the result of different these cultivars on their growth, morphological, height and leaf area, which gives them greater ability to competition and suppression growth of weed . Al-Chalabi & Al-Agidi (2010) noted the differences among wheat cultivars on weed competition and the extent of the effect on growth of weeds. Researcher confirmed that the cultivars with high growth and large leaves area corresponded with cultivars that high weed competition. The high-capacity of wheat cultivar on weed competition or the tolerance to weed competition will increase the herbicide's efficiency more than susceptible cultivar to competition, therefore, the use of half recommendation of the herbicide with magnetization of the spray solution is compatible with a highly competitive cultivar that may be a good combination. To reduce weed damage to the wheat product without resorting to increased concentration of the herbicide. The results in table 1 are noted that Alfateh cultivar was the more compete with the weed and reduce its growth. This ability has contributed to increasing the efficiency of the herbicide control process, reversing to good yield, while the two cultivars (Latifia and Iraq) were recorded the highest density of the weed during the first season, but the two varieties have also made a good response for herbicide weed control. The density of the weed has been reduced and is clearly reflected on the grain yield under the weed control treatment. This response has appeared on both seasons. Magnetization of spray solution with the use of half of the herbicide recommendation recorded a moral superiority in the grain yield of Iraq and Rashid cultivars in both seasons. This increase in the product may be due to the response of these two farmers to the control process.

Strong correlation between weed growth and grain yield. Increasing of yield with low weed density and dry weight (Fig. 2, 3, 4) confirms that the reduction of both types of weed (narrow and broadleaf) from the early stages of crop growth to physiological maturity stage, led to the opportunity for wheat plants to be better exploited and Optimized for key growth requirements such as light, nutrients and humidity; this has led to increased rates of photosynthesis and growth rates and has been reflected in the accumulation of dry matter in cereals (Silva *et al.*, 2007). The presence of competition between weeds and crop plants on the necessary growth factors was causing adverse effects in the product. Therefore, the decrease of competition from the weeds has indirectly encouraged the accumulation of dry material at the downstream end of the grain as a result of improved penetration of light and increased photosynthesis, thus increasing the quantity of assimilation outputs destined to spikes and that resulting on more yield (Tambuci *et al.*, 2011). It is conclude from the above that the cultivars differed with susceptibility of their competitors to the weeds.

The magnetic treatment reduces the angle bond between oxygen and hydrogen atoms on the water molecule from 104° to 103°, and that change in angles make water molecules accumulate as smaller groups about 6-7 groups after they were made up of 10-12 groups, and this small grouping leads to better absorption for water through cell walls as a result of reduced surface area pressure (Rao, 2002), which facilitates the penetration of the magnetically treated water for cellular membranes (Atak *et al.*, 2003) have better water absorption and faster entry into the root cells, which has the effect of increasing herbicide absorption by weed leaves. It can be concluded that magnetization of the spray solution with the competition cultivars of the weed can reduce the amount of herbicides used against the weeds and achieve the highest rate of control with an improvement on growth and yield of wheat crop.

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