Plant Archives Vol. 20, Supplement 1, 2020 pp. 556-561 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF DIFFERENT HERBICIDES ON WEED CONTROL AND THE GROWTH CHARACTERISTICS OF WHEAT *TRITICUM AESTIVUM* L. VARIETY IPA 95

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Abstract

A field experiment was conducted in the Field Crop Science Department/College of Agriculture /University of Diyala for the season 2018-2019, in order to evaluate the efficiency of the three selective herbicides effect CLODEX EC100, SPOTLIGHT WDG 75 and ATLANTIS WG in controlling the weed that associated to the wheat crop, variety IPA 95. The experiment was carried out in a clay loam soil with herbicides addition that was added with the recommended concentrations by its manufacturers in four treatments with the comparison treatment. Furthermore, the treatments were randomly distributed on three replicates according to the randomized complete block design (RCBD). All the selective herbicides applied in the experiment showed high efficiency in controlling the narrow and broad weed, and it achieved a reduction in the characteristic of weed intensity. The highest was at Atlantis WG + BioPower SL treatment with a control percentage of 88.35% and gave the lowest dry weight for the weed reached 35.6 g.m^{-2} compared with the comparison treatment, which reflected positively on increasing the average plant height. As well as, the number of tillers and the spike length, which caused an increase in the grain yield by 26%, compared to the comparison treatment.

Keywords: Herbicides, Weed, Wheat

Introduction

Wheat, *Triticum aestivum* L. is locally and internationally important strategic cereal crop due to its important role in achieving food security and produce bread loaf, which represents the main food for most of the world's population (Hammad and Ali, 2014). Furthermore, it provides about 20% of the total nutritional calories of the human race and supplies the human body for approximately 25% of his need for protein, so it is known as the king of cereal crops (Weegels *et al.*, 1996; Fischer, 2008). The world needs one billion tons of wheat in 2020 to meet the global need, which considered a higher rate if it compared to the current production that not exceed 600 million tons, with a yield rate of 2.5 ton.ha^{-1} (Khalil, 2008). Asia occupies the forefront of world wheat production, with a production of 253.9 million tons of total world production of 627.3 million tons for the year 2004, where the production increased by 2.3% in 2005 (Asseng *et al.*, 2015). However, the wheat crop is at the forefront of strategic crops in Iraq that depend on it to meet the nutritional needs, where the area planted with wheat in Iraq is estimated to be 70,000 hectares and represents 5% of the arable land. The growth of weed plants with this crop is one of the main factors that limit its productivity in general, as it causes losses in the crop of up to 50%, especially during the early stages of plant life because of its competition to the crop for growth space, nutrients, water, light, oxidized carbon and location. As well as, it is a host of many diseases, insects, and hinders the harvesting process and causes a reduction in production and quality (Dikci and Dundar, 2006). Therefore, the proliferation of weed in the agricultural fields and the looking for an effective way to eliminate them is an agricultural problem that challenges workers in this field. Among the most prominent weed associated this crop in Iraq are *Lolium rigidum*, *Lolium temulentum*, *Avena fatua*, *Raphanus raphanistrum*, *Silybum marianum* and *Malva pravi flora* (AL-AGIDI, 2010; Al-Wagaa 2018). Moreover, the use of herbicides gave the best methods to control and limit the growth of weed associated the wheat crop and reducing the damages, and this is proven by (Mekki *et al.*, 2010) studies and tests. Because of the chemical herbicide's success, many commercial companies specialized in manufacturing different herbicides have tended to produce many different herbicides belonging to different chemical groups. Some of which is selective and the other are non-selective, and this caused a difficult for the farmers to make the right decisions about a good herbicide and the right dose for the best results. Accordingly, the aim of this study was to choose the appropriate herbicide and concentration that achieves the best efficiency in controlling the weed associated with the wheat crop, var IPA 95.

Materials and Methods

A field experiment was conducted in the Field Crop Science Department, College of Agriculture, University of Diyala for the season 2018-2019, in order to know the effect of herbicides CLODEX EC100, SPOTLIGHT WDG 75 and ATLANTIS WG to controlling the weed associated the wheat crop, var IPA 95. As well as, reflect the effect of these herbicides on the growth and yield characteristics, where the experiment land was plowed twice, then well leveled. Finally, the soil was a clay loam with physical and chemical properties as shown in Table 1. The field was divided into three replicates, and the distance between them was 1.5 m, each replicate includes four main treatments that included six experimental units with a dimension of 2 * 3 m^2 and the distance between them is 0.5 m^2. Moreover, the seeds were planted manually in lines, and the distance between one line and another was 20 cm, with a seeding rate of 120 kg.ha^{-1} on 26/11/ 2018, while the experiment was applied according to (RCBD) with three replicates. Additionally, Nitrogen fertilizer was added at a rate of 200 kg.ha^{-1} (urea 46% N) in two batches after 45 days of planting and in the elongation stage. In addition, triple superphosphate fertilizer with a concentration of (18% P) was added at a rate of 50 kg.ha^{-1} in one batch at planting (Sarwar *et al.*, 2008). The experimental plots were irrigated with the germinate irrigation and the irrigation continued whenever the need arises, three herbicides were used in the experiment as shown in Table 2 that describe the chemical, common and trade name of the used herbicides in the experiment, in addition to the comparison treatment (free weed), where the weed was allowed to grow naturally. After 50 days of cultivation, the weed in the field was diagnosed and identified their types as in Table 4 and counted their numbers after 30 and 60 days of control, which conducted over 45 days of cultivation, specifically after the tillering stage (Baghestani *et al.*, 2008). The herbicides were sprayed according to the studied treatments and concentrations, where a knapsack sprayer with a capacity of 20 liters was used under constant pressure directly above the crop plants and with good coverage. The amount of herbicide per plot was calculated based on 400 liters water.ha^{-1} according to the treatments indicated in Table 3, and it was harvested on 2/5/2019.

Table 1 : Some chemical and physical properties of the experiment soil before cultivation for the two seasons 2018-2019

Property		Unit	2018-2019
Available nitrogen		Mg.kg^{-1}soil	77.8
Available phosphorous		Mg.kg^{-1}soil	12.53
Available potassium		Mg.kg^{-1}soil	187.3
Organic matter		g.kg^{-1}soil	13.1
Soil separates	Clay	g.kg^{-1}soil	381
	Silt	g.kg^{-1}soil	440
	Sand	g.kg^{-1}soil	179
Texture			Silt clay loam soil

The degree of effectiveness in the weed was recorded after 20 and 45 days after the control, according to a visual-estimation (1 - 100) (Lutman *et al.*, 1996; Al-Wagga, 2019). As the number (1) means that there is no effect on the weed, and the number (100) means a full death of the weed. In the physiological maturity stage at (yellowing of the leaves of the crop plants), the crop was harvested on 2/5/2019, and the weed was cut at the soil level, they were collected for each experimental unit. Finally, it was placed in a bag and air-dried for a period of 9 days until the weight stabilized, where the control ratio was calculated according to the following equation:

- Control ratio = "the number of weeds in comparison treatment – their number in control treatment/number of weeds in comparison treatment x 100".

The inhibition percentage was calculated according to the following equation;

- Inhibition% = 100 - the dry weight of weed in the control treatment / dry weight of weed in comparison treatment x 100

The growth characteristics of the crop were also measured, including the plant height, which was calculated from the base of the plant at the soil surface to the end of the spike for five plants in each experimental unit and from which the plant rate was extracted. Secondly, the number of tillers from the middle line for each experimental unit, and then the number of spikes and components of the yield based on a quarter of a meter. Finally, the spike length was calculated based on the length of ten spikes were randomly selected from each experimental unit. As well as, the wheat plants were collected for a quarter of a meter after harvesting and weighed as wet weight, and then were air-dried by exposing them to the sunlight until the weight stabilized. The data were analyzed statistically using the SAS program according to (RCBD), where Least Significant Difference test (L.S.D) was used to compare between the arithmetic averages at the 5% probability level.

Table 2 : The common, chemical, and trade name for herbicides used in the research

Trade Name	Common Name	Chemical Name	
Clodex EC100	CLODEX 100EC	Clodinafop-propargyl 80 gr/lt Cloquintocet mexyl 20 gr/lt+	Control the narrow weed
Spotlight WDG 75	SPOTLIGHT WDG 75	Tribenuron-methyl 75 %	Control the broad weed
Atlantis WG	ATLANTIS WG	Mesosulfuron-methy 30 g + Iodosulfuron-methyl-sodium 6g+ Mefenpyr-diethyl 90g	Control the narrow and broad weed
Dispersing agent			
BioPower SL	BioPower SL	Alkyl-ether sulfate sodium salt 26.6 %ww+ 3.6 dioxaoctadecyisulfate sodium salt (70-75%)and dioxaoctadecyisulfate sodium salt (20-25%)	Dispersing agent added only with Atlantis WG

Table 3 : Herbicide names, usage rate, method, and the date of addition

Herbicide names	Usage rate	Addition method	Addition date
Weed-chock		Without control	The weed growth throughout the season
CLODEX 100EC + SPOTLIGHT WDG 75	15 g . ha $^{-1}$ + 20 g . ha^{-1}	Post-emergence	When the weed height 5 cm
CLODEX 100EC + SPOTLIGHT WDG 75	20 g . ha $^{-1}$ + 25 g . ha^{-1}	Post -emergence	Wheat at age 5 leaves
Atlantis WG	20 g . ha $^{-1}$	Post -emergence	Wheat height 10cm
Atlantis WG +BioPower SL	20 g . ha $^{-1}$ + 500 ml . ha^{-1}	Post -emergence	Wheat height 10cm

Table 4 : Types of weed associated wheat crop, variety IPA 95

Local name	English name	Scientific name
Broad weed		
Milk thistle	Milk thistle	*Silybum marianum*
Dwarf mallow	Mallow	*Malva pravi flora*
Wild radish	Wild radish	*Raphanus raphanistrum*
Qunabrey	Hoary cress	*Cardaria draba.*
Narrow weed		
Rigid ryegrass	Rigid ryegrass	*Lolium rigidum*
Annual darnel	Annual darnel	*Lolium temulentum*

Results and Discussion

The effect of herbicides on the killing intensity after 20 and 45 days of control

The scale of the effect degree is an important indicator that shows the efficiency of herbicides used in controlling the weed in close or far apart periods. Table 5 indicates that there was a significant difference between the control treatments averages, where the Atlantis WG + BioPower SL was superior and gave the highest average of the effect degree after 20 and 45 days of 52.3 and 67.6, respectively, (according to the visual scale) compared with the comparison treatment and the other treatments. As well as, the difference between them and between the additions of the same herbicide alone without the dispersing agent was 29.63% after 20 days of addition, and this was a large percentage, which confirms the efficiency of using the dispersing agent.

This progress in the control percentage continues till after 45 days, and the reason may be due to the role of the dispersing agent in breaking the surface stress of the herbicide drops, which increases its absorption and its moves within the plant and this was consistent with what (Lins *et al.*, 2019) findings. It was also observed from Table 5 that the efficiency of all the used herbicides increased with the increase of the time after the control. Therefore, this result indicates the efficiency and the killer effect of the herbicide in the plant, which starts to increase until 45 days and confirms the continuity of the herbicides act for a long period. However, it depends on the herbicide type and its efficiency, in addition to the resistance of the plant type to these chemical compounds, and this result is consistent with (Al-Wagaa, 2018).

The used herbicide effect on weed numbers m^{-2} during the crop growth period

The results of Table 6 showed that there were significant differences for the used herbicides in the characteristic of weed types and their numbers in the growth stages 30 and 60 days after control. As the Atlantis WG achieved the lowest average number of weeds, it reached 11.2 and 15.3 m^{-2} respectively, whereas, the comparison treatment gave the highest average during the weed types in the studied time periods amounting to 112.5 and 134.3m^{-2} respectively. Thus, the Atlantis WG had caused a reduction in the weed percentage of about 89.6 and 88.6%, respectively, compared with the comparison treatment. It may also be noted that there was no significant difference between Atlantis WG and the same herbicide when adding the dispersing agent BioPower. As well as, it was noted that there was no significant difference when using the CLODEX 100EC + SPOTLIGHT WDG 75 in low or high concentration in this trait. Furthermore, It was observed that the herbicides have the same effect in reducing the number of weeds as the time period increases after control. Finally, it also clearly shows that mixing of the herbicide CLODEX 100EC narrow leaves and the SPOTLIGHT WDG 75 broad leaves was playing a role in reducing the effect of both types of weed, and this finding is consistent with (Nahed *et al.* 2007).

The used herbicide effect on weed dry weight and end-season inhibition percentage (When harvesting the crop)

The results in Table 7 indicated that there was a significant difference between the used herbicides in the weed dry weight characteristic. The Atlantis WG + BioPower SL gave the lowest dry weight of 35.6 g/ m^2, and it did not differ significantly from adding the same herbicide alone without the dispersing agent, which gave a dry weight of 43.5 g/ m^2 compared with the highest average achieved in this characteristic reached 305.6 g / m^2 in the comparison treatment. Thus, this herbicide has inhibited the weed by 88.35 and 85.76%, respectively of the herbicide with the dispersing agent and without it. It was also observed from the same Table that, each of the CLODEX 100EC + SPOTLIGHT WDG 75 achieved the inhibition percentage at low and high concentration reached 74.37 and 78.53%, respectively. This indicates that the concentration increasing may not necessarily mean achieving a higher control percentage in the associated weed. Generally, it was observed that the dry weight decreased in all control treatments, and this may be attributed to the used herbicide concentrations that caused killing the live tissue of the plant, which causes the f photosynthesis process to stop and increase the demolition process. Thus, the accumulation of dry matter decreases and this result is consistent with what (Christopher *et al.* 1991; Zand *et al.* 2007) mentioned that the use of herbicides leads to killing the weed and reducing their dry weight.

The used herbicide effect on plant height, number of tillers, and spike length

In general, the availability of the growth requirements needed by the plant during the growth stages causes an excess of dry matter resulting from the photosynthesis process that stored in the plant parts such as stems, leaves, and even roots. Part of it may be exported to grains that lead to raising the yield and increasing production (Ecarnot *et al.*, 2013). The results in Table 8 indicated that the addition of herbicides had a clear effect on increasing the plant height, although the difference is less, but it can be reflected in increasing the yield, as Atlantis WG + BioPower SL achieved the highest average height of 107.5 cm. The reason for this may be that the herbicide or the dispersing agent contains substances that cause elongation in the plant cells, where the plant height may be related to hormonal factors, and that this increase means that the crop has more ability to compete with the associated weed and obtain the growth requirements. Moreover, Table 8 showed that there was a difference in the averages of the tiller number, and it was noted that the number of tillers was more in all herbicide treatments compared to the comparison treatment that gave the lowest number of tillers reached 112.4. Because of the fact that the weed has reduced the ability of the crop plants to form tillers as a result of the competition requirements for growth, this result is consistent with (Crook *et al.*, 2004). Whereas Atlantis WG + BioPower SL gave the highest number of tillers reached to 146.8, and the increase in the number of tillers at the control gives a positive indication of improving productivity if they are connected with the success of those branches to carrying fertile spikes, and this was consistent with (Sarwar *et al.*, 2010) findings. In other ways, the ability of tillers to carrying the spikes was related to the ability of the plant to compete with the weed or with the crop itself on the necessary growth elements. Since the control eliminated competition with the weed, this means an increase in the probability of an increase in the number of tillers that carrying spikes, and thus increasing the yield.

Additionally, it was observed from the same Table that the average length of the spike was affected by the various control treatments. All the herbicide treatments were superior in increasing the spike length compared to the comparison treatment, which their average length was 8.8 cm. While Atlantis WG gave the highest average spike length amounted to 12.1 cm, followed by Atlantis WG + BioPower SL with a length reached 10.1 cm. This characteristic is related to the yield components, which have a great role in increasing production, as the spike length is positively related to the number of grains in the spike. Finally, it can conclude from this study that the use of herbicides achieved positive results, especially Atlantis WG + BioPower SL, which had a role in reducing the weed competition with the crop plants by inhibiting their growth and reducing their dry weight. As well as, it caused an increase in the plant height, the number of tillers, and the length of the spikes, which are expected to be positively reflected in increasing and improving the quality. This is consistent with (Soltani *et al.*, 2006) findings.

Grain yield (ton.ha^{-1})

The results of Table 9 indicate that the weight of 1000 grains in all control treatments using herbicides increased compared to the comparison treatment without control and reached 37.69 g in the Atlantis WG + BioPower SL treatment, while it reached to 34.42 g in the weed treatment. The absence of a competition factor between the crop and the associated weed has an effect on increasing the weight of 1000 grains, as one of the yield components, the reason may be attributed to the fact that the phase of filling the grains comes in the late stages of crop growth. Therefore, the filling duration length and the source's ability to supply the photosynthetic products affected the weight of the grain, thus it distributed to the grains as finally sinks. The grains are the final receptor for this; the weed competition leads to supply the largest amount of water and the primary elements to use them in the photosynthesis process (Elía *et al.*, 2018). The results of Table 9 also indicate that there was a significant difference between the experimental treatments. As the weed treatment gave the lowest yield reached 4.85 ton.ha^{-1} compared with all control treatments that achieved a yield of (6.10) (5.82) (5.60) (5.40) tons.ha^{-1} for each of Atlantis WG + BioPower SL, Atlantis WG, CLODEX 100EC + SPOTLIGHT WDG 75 and CLODEX 100EC + SPOTLIGHT WDG 75, respectively. Through an increase in yield of 26% compared to the Atlantis WG + BioPower SL treatment, so it is observed that the crop's ability to grow better decreases with increasing the competition time with the weed which reflects negatively on the amount of a thousand grains weight. Therefore, controlling the weed at the beginning of the crop growth made it grow better as a result of the lack, or the absence of the competition of weed and the opportunity for crop plants to benefit from the necessary materials for full growth. Thus, increasing the efficiency of the physiological processes of the crop and increase the materials supplied during the grain filling duration, which increases the weight of the grains (Mohammadi and Ismail, 2018).

Table 5 : Effect of herbicides on the killing intensity 20 and 45 days after control

Herbicides	Usage rate	Killing intensity (the day from control)	
		20	**45**
CONTROL		1	1
CLODEX 100EC + SPOTLIGHT WDG 75	15 g . ha^{-1} + 20 g . ha^{-1}	45	58.66
CLODEX 100EC + SPOTLIGHT WDG 75	20 g . ha $^{-1}$ + 25 g . ha^{-1}	48.3	68.33
Atlantis WG	20 g . ha $^{-1}$	36.8	60.23
Atlantis WG +BioPower SL	20 g . ha $^{-1}$ + 500 ml . ha^{-1}	52.3	67.6
%5L.S.D		8.7	7.6

Table 6 : The used herbicides effect on weed numbers m^{-2} during the crop growth period

Herbicides	Usage rate	Weed numbers m^{-2} after	
		30	**60**
CONTROL	0.0	112.5	134.3
CLODEX 100EC + SPOTLIGHT WDG 75	15 g . ha^{-1} + 20 g . ha^{-1}	51.2	54.2
CLODEX 100EC + SPOTLIGHT WDG 75	20 g . ha $^{-1}$ + 25 g . ha^{-1}	52.6	58.3
Atlantis WG	20 g . ha $^{-1}$	11.2	15.3
Atlantis WG +BioPower SL	20 g . ha $^{-1}$ + 500 ml . ha^{-1}	13.2	16.2
%5L.S.D		6.3	10.3

Table 7 : The used herbicides effect on weed dry weight and end-season inhibition percentage (when harvesting the crop)

Herbicides	Usage rate	Weed dry weight (g/ m^2)	Inhibition percentage %
CONTROL	0.0	305.6	00
CLODEX 100EC + SPOTLIGHT WDG 75	15 g . ha^{-1} + 20 g . ha^{-1}	78.3	74.37
CLODEX 100EC + SPOTLIGHT WDG 75	20 g . ha^{-1} + 25 g . ha^{-1}	65.6	78.53
Atlantis WG	20 g . ha^{-1}	43.5	85.76
Atlantis WG +BioPower SL	20 g . ha^{-1} + 500 ml . ha^{-1}	35.6	88.35
%5L.S.D		19.6	

Table 8 : The used herbicide effect on plant height, number of tillers, and spike length

Herbicides	Usage rate	Plant height cm	number of tillers m^{-2}	Spike length cm
CONTROL	0.0	95.3	112.4	8.8
CLODEX 100EC + SPOTLIGHT WDG 75	15 g . ha^{-1} + 20 g . ha^{-1}	93.2	121.3	9.2
CLODEX 100EC + SPOTLIGHT WDG 75	20 g . ha^{-1} + 25 g . ha^{-1}	92.3	131.6	10.5
Atlantis WG	20 g . ha^{-1}	102.3	137.5	12.1
Atlantis WG +BioPower SL	20 g . ha^{-1} + 500 ml . ha^{-1}	107.5	146.8	10.1

Table 9 : The used herbicide effect on the weight of 1000 grain and the grains yield ($ton.ha^{-1}$)

Herbicides	Usage rate	weight of 1000 grains/g	Yield $ton.ha^{-1}$
CONTROL	0.0	b34.42	b4.85
CLODEX 100EC + SPOTLIGHT WDG 75	15 g . ha^{-1} + 20 g . ha^{-1}	a 36.10	a5.60
CLODEX 100EC + SPOTLIGHT WDG 75	20 g . ha^{-1} + 25 g . ha^{-1}	a 37.12	a5.40
Atlantis WG	20 g . ha^{-1}	a 36.70	a5.82
Atlantis WG +BioPower SL	20 g . ha^{-1} + 500 ml . ha^{-1}	a 37.69	a6.10

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