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EFFECT OF THE SPRAY NOZZLE ON THE EFFICIENCY OF FOUR HERBICIDES ON CONTROL OF WEED COMPANIONED WITH *TRITICUM AESTIVUM* L.

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Abstract

A field experiment to study the effect of the type herbicides and spray nozzle, in the control weed accompaniment for wheat, at the field trials, Department of Field Crop Science, College of Agriculture / University of Diyala during the season 2018 in the in a clay loam soil with used in the, four herbicides CLODEX 100EC + SPOTLIGHT WDG 75, Atlantis WG, Logran extra 64 WG+ Topik plus and the Chevalier 15 WG. Applications in concentrations recommended by the company in the four herbicides with the treatment comparison without herbicides. The experiment was designed according to split plot design under randomized complete block design (RCBD) with three replications. The results all the selective herbicides applied in the experiment showed high efficiency in controlling in weed control. Gave Chevalier 15 WG on the rest of the herbicides achieved the highest rate and degree of killing 61.33 and 78.11 after 20 and 40 after the control respectively. The Logran extra 64 WG+ Topik was given the highest long spikes of 11.1 cm. The use of herbicides and the type of spray nozzle to increase the percentage of control and reduce the dry weight of the weed increase the percentage of inhibition of the growth weed, which resulted increase yields rate of 6.105 ton. ha^{-1} when the control while the treatment without a herbicides give less yield to 4.71 ton. ha^{-1}.This study has shown the great role of herbicides control and the use of the right spray nozzle can do better yields in the space unit.
Keywords: Nozzle, herbicides, weed companioned, *Triticum aestivum L.*

Introduction

Wheat *Triticum aestivum* L. is a strategic grain crop that is important locally and globally for its important role in achieving food security and the production of a bread loaf that is the main food for most of the world's population (Hammad and Ali, 2014). It provides about 20% of the total nutritional calories for the human race and supports the human body for approximately 25% of its protein requirement (Weegels *et al.,* 1996; Fischer, 2008). Furthermore, the growth of weed plants with this crop is one of the main factors that limit its productivity in general, which it causes a loss in the yield of up to 50%, especially during the early stages of plant life, as a result of its competition for crops to grow, nutrients, water, light, oxidized carbon and location. Moreover, it considers as a host too many diseases and insects hinders the harvesting process and causes reduced production and quality (Dikci and Dundar, 2006), where the discovering effective ways to eliminate the weed is an agricultural problem that challenges workers in this field. Among the most prominent companion weed of this crop in Iraq are *Lolium rigidum, Lolium temulentum, Avena fatua, Raphanus raphanistrum, Silybum marianum*, and *Malvapravi flora* (Al-Wagaa, 2018). However, the chemical control has given the best methods to reduce the weed effect on this crop, and the most efficient with the least damage to the crop (Mekki *et al.*, 2010). The success of the control depends on the efficiency of the spraying machine and its calibration, and the homogeneity of the distribution of herbicide solution on the leaf surface of weed plants. In addition to the best coverage in the control, where the herbicide spraying drops distribute well on the target surface, as the amount of spray resulting from the spraying is related to the type of nozzle tip. The spray nozzle affects the shape and size of herbicide solution drops that must reach a balance in the efficiency of their distribution over the target, and if they were large drops will fall off from the leaves and do not achieve perfect coverage, but they penetrate the shoot, and if they are small they were drifting away from the target, causing herbicide loss and greater pollution, but it may give better coverage (Zhu *et al.*, 2014). Therefore, the success of the control is closely related to the type of spray nozzle. Accordingly, the aim of this research was to choose the type of spray nozzle and the appropriate type of herbicide, which would achieve the best control in companion weed the wheat crop.

Materials and Methods

A field experiment was carried out at the farm of the Department of Field Crop Science- College of Agriculture - Diyala University, during the 2018-2019 season, with the aim of studying the effect of the spray nozzle and the herbicide type that achieves the best control percentage in the companion weed the wheat crop. As well as, the reflection effect of these two factors on the characteristics of growth and yield. Six herbicides and two types of spray nozzles (Hollow cone nozzle and Flat fan 11004) were used in this experiment as shown in Table 2. In addition, the experiment soil was well prepared and the soil was a silty clay texture, and its physical and chemical properties are shown in Table 1. The field consists of 18 experimental units with an area of (2 * 3) m, with three replicates; each replicate contains 6 experimental units. Where the seeds were sown on 25/11/2018 manually at a seeding rate of 120 kg.ha^{-1}, and with a distance of 20 cm between one line and another. The RCBD was used, and the nitrogen fertilizer was added at a rate of 180 kg.ha^{-1} (urea 46% N) in two batches after 40 days of planting at elongation, and a three-concentration of superphosphate fertilizer (18% P) was added at a rate of 45 kg.ha^{-1} at planting. (Sarwar *et al.*, 2008), while the irrigation is done according to plant needs. Additionally, the weed in the field was identified after 30 days of control, which was carried out at stage 5-7 leaves of wheat plant age (Baghestani *et al.,* 2008). As the herbicides were added with a knapsack sprayer, the capacity of 20 liters and under constant pressure after making the sprayer calibrated on the basis of 400 l. ha^{-1} according to the treatments indicated in Table 3. The wheat was harvested on 10/5/2019, and the effect degree caused by the herbicides in weed after the periods of 20 and 40 days after the control was calculated according to a visual scale (1 - 100) (Visual-estimation) (Lutman et al 1996 and Al-Wagga, 2019). Since the number (1) means that there is no effect in the weed, and the number (100) means a complete death of the weed (Al-Wagga and Al-Juboory, 2013).

The growth characteristics of the crop (plant height, number of tillers, number of spikes, spike length) was measured, and the data were collected and analyzed statistically using the computer by adopting the SAS program according to the RCBD.

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

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

Trade name	**Chemical name**	**Type weed control**
CLODEX 100EC	Clodinafop-propargyl 80 gr/lt Cloquintocet mexyl 20 gr/lt+	Control narrow weed
SPOTLIGHT WDG 75	Tribenuron-methyl 75 %	Control Broad leaf weed
Atlantis WG	Mesosulfuron-methy 30 g + Iodosulfuron-methyl-sodium 6g + Mefenpyr-diethyl 90g	Control narrow and Broad leaf weed
Logran extra 64 WG	Butafenacil 200 g/Kg +Triasulfuron 520 g/Kg	Control Broad leaf weed
Topik plus	Clodinafop-Propargyl240 g/L + Cloquintocet-Mexyl 60 g/L	Control narrow weed
Chevalier 15 WG	mesosulfuron-methyl 15 gr + 30 gr Iodosulfuron + mefenpyr 90 g /kg	Control narrow and Broad leaf weed

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

Herbicide names	**Usage rate**	**Addition method**	**Addition date**
Weed-chock	**0.0**	Without control	The weed growth throughout the season
CLODEX 100EC+ SPOTLIGHT WDG 75	60 g. ha^{-1} + 80 g. ha^{-1}	Post-emergence	When the weed height 5 cm
Atlantis WG	80 g. ha^{-1}	Post -emergence	Wheat at age 5 leaves
Logran extra 64 WG + Topik plus	50 g. ha^{-1} + 65 g. ha^{-1}	Post -emergence	Wheat at age 5-7 leaves
Chevalier 15 WG	320 g. ha^{-1}	Post -emergence	Wheat at age 5-7 leaves

Table 4 : Names and types of weed associated wheat crop

English name	**Scientific name**
Broad leaf weed	
Milk thistle	*Silybum marianum*
Mallow	*Malva pravi flora*
Wild radish	*Raphanus raphanistrum*
Hoary cross	*Cardora drobo.*
Brassica napus	*Raphanu sraphanistrum* L.
Toothed medic	*Medicage hispida*
Hoary cross	*Cardora drobo*
Narrow weed	
Annual darnel	*Lolium temulentum*
Rigidry grass	*Lolium rigidum*
Wild oat	*Avena fatua*
Nut grass	*Cyperus rotundus*
Lesser canary	*Phalaris minor*

Results and Discussion

Effect of weed herbicides and spray nozzle type on the killing intensity after 20 to 45 days of control

The measure of the effect degree is an important indicator that shows the efficiency of herbicides used in controlling the weed in closed or apart periods. Table 5 indicates that there were significant differences between the averages of the control treatments, which they all superiority over the comparison treatment without control. The treatment of Chevalier 15 WG was superior and achieved the highest killing degree reached 61.33 and 78.11 after 20 and 40 days of control when using a Flat fan 11004 spray nozzle, followed by the Atlantis WG treatment with a killing degree in 55.33 and 74.67 after 20 and 40 days of control also with the flat fan 11004. In general, it was observed that the effect degree for all treatments increases with the flat fan 11004. This confirms that the distribution of herbicide solution drops or the coverage provided by this nozzle was better than the Hollow cone nozzle, and the difference between killing degrees achieved in Chevalier 15 WG according to the type of spray nozzle was 14.72 and 13.45%, respectively, after 20 and 40 days of control. This percentage in the difference is large for the same herbicide, which confirms the efficiency of using the Flat fan 11004 spray nozzle, which continued to exceed even after 40 days of control (AL-Hailly *et al.*, 2018). It was also observed from Table 5 that the effectiveness of all used herbicides has increased with the increase in the time period after control, and this result indicates the effectiveness and killing effect of the used herbicides compared with the comparison treatment. As well as, the presence of the difference in the effect intensity may be due to the type of herbicide and its effectiveness in addition to the resistance of the plant type to these chemical compounds and this result is consistent with (Al-Wagaa, 2018).

Table 5 : Effect of weed herbicides and spray nozzle type on the killing intensity after 20 to 45 days of control

Herbicides	Rate (g. ha $^{-1}$)	20 day after control		40 day after control	
		Hollow cone nozzle	Flat fan 11004	Hollow cone nozzle	Flat fan 11004
CONTROL	0.0	1.00	1.00	1.00	1.00
CLODEX 100EC + SPOTLIGHT WDG 75	60 g. ha^{-1} + 80 g. ha^{-1}	45	50	58.66	68.33
Atlantis WG	80 g. ha^{-1}	48.3	55.33	68.33	74.67
Logran extra 64 WG + Topik plus	50 g. ha^{-1} + 65g. ha^{-1}	36.8	42.67	60.23	65.36
Chevalier 15 WG	320 g. ha^{-1}	52.3	61.33	67.6	78.11
%5L.S.D		9.63		8.47	

Effect of use herbicides on plant height, number of tillers and spike length

In general, the availability of growth requirements needed by the plant during the growth stages causes an excess of dry matter resulting from the photosynthesis process, which is stored in the plant parts such as stems, leaves and even roots, then part of it is exported to grains, which will lead to raising the yield and increasing production (Ecarnot *et al*., 2013). The results indicated in Table 6 that the addition of weed herbicides had a clear effect on increasing the plant height, although the difference is small, but it can be reflected in increasing the yield. As the two herbicides Chevalier 15 WG and Logran extra 64 WG + Topik plus achieved a higher height amounted to 108.22 and 108.6 cm respectively, compared to the treatment without herbicide, which gave the lowest height of 96.4 cm. Furthermore, the reducing of the plant height in this treatment was due to the plants competition strength between and weed in light, water, and nutrients. However, the comparison of plant height with the treatment without herbicide may be due to the wheat competition strength with the weed, where whenever the herbicide was effective in eliminating the weed, which encourages better crop growth through obtaining growth requirements (Lemerle *et al.*, 1996). In addition, the difference in height may be related to hormonal factors in the plant, which were affected by the difference in the used herbicide type by the difference in the chemical composition of each herbicide, which was reflected on the difference in plant height. It was also observed from the same Table that there were significant differences in the averages tillers number, if the control treatments by herbicides achieved a higher tillers number compared to the treatment without herbicide at the spray nozzle 11004 and Hollow cone nozzle, which gave 131.4 and 111.4 m^{-2} respectively, and the CLODEX 100EC + SPOTLIGHT WDG 75 achieved the highest tillers number 191.3 m^{-2}. The increase in the tiller number per unit area occurs when the weed population density decreases, the increase in the tiller number when controlling gives a positive indication of improving productivity if it is associated with the success of those branches by carrying fertile spikes, this is consistent with (Sarwar *et al.,* 2010) findings. The Table indicates that there were significant differences when using weed herbicides in the spike length, and this characteristic is related to the yield components, which have a main role in increasing production, as the spike length is positively correlated with the grains number in the spike. It was observed that the herbicide Logran extra 64 WG + Topik plus was superior by giving length spike reached 11.1 cm compared to the comparison, which was 9.1 cm. The reason may be that the weed intensity leads to high competition with the crop plants, which negatively affects the spike seedling and development stage, which coincides with the early stage of plant life, which is tillering and elongation, as well as the growth herbicides may have a role in improving crop growth, which increases the spike length (Chauhan *et al*., 2017). The Table showed in general, that the flat fan 11004 is more superior than the Hollow cone nozzle in achieving the highest plant height, spike length and tiller number in the unit area, the reason is attributed to its efficiency in limiting the weed growth due to that the herbicide solution drops resulting from it were more, compared to the hollow cone nozzle, thereby increasing the coverage that achieved a better weed control rate.

Table 6 : Effect of use herbicides on plant height, number of tillers and spike length.

Herbicides	Rate (g. ha $^{-1}$)	Height plant cm		Number teller m^{-1}		Long spike cm	
		Hollow cone nozzle	Flat fan 11004	Hollow cone nozzle	Flat fan 11004	Hollow cone nozzle	Flat fan 11004
CONTROL	0.0	98.23	96.4	111.4	131.4	8.8	9.1
CLODEX 100EC + SPOTLIGHT WDG 75	60 g. ha^{-1} + 80 g. ha^{-1}	96.5	101.3	191.3	197.3	9.2	8.5
Atlantis WG	80 g. ha^{-1}	92.3	97.3	141.6	139.6	10.5	9.8
Logran extra 64 WG + Topik plus	50 g. ha^{-1} + 65 g. ha^{-1}	101.3	108.6	138.5	140.5	12.1	11.1
Chevalier 15 WG	320 g. ha^{-1}	107.5	108.22	147.8	142.8	10.1	9.9
L.S.D 5%		4.5		6.5		0.6	

Effect of control treatments and type of spray nozzle on grain yield (ton.ha^{-1})

The grain yield is a product of many vital activities in the plant, which may be affected by many factors surrounding the crop growth. Among the most important of these factors is the weed which negatively affects the yield amount. Table 7 showed that there were significant differences between control treatments, as it was observed that there was a significant increase in the grains yield ton.ha^{-1} for the comparison treatment, and the increasing percentage was (10.19, 11.18, 15.97 and 25.11%), respectively. It was also observed that the treatment of Chevalier 15 WG gave the highest yield reached 6.105 ton.ha^{-1}, while the comparison treatment without herbicide gave a yield of 4.71 ton.ha^{-1}, the reason for this superiority is due to the role of chemical control in reducing the weed percentage, which led to an improvement in the characteristics of vegetative growth, and this was reflected on the characteristics of the yield and its components, thus increasing the grains yield per unit area (Chhokar *et al.*, 2007). It was observed from the Table that there were no significant differences between the types of spray nozzle used when adding herbicides in this characteristic. As for the interaction between control treatments and spray nozzle type, it had a positive effect on the total grain yield, where all herbicide treatments with a different spray nozzle gave significant differences from the comparison treatment. Additionally, the Chevalier 15 WG with Hollow cone nozzle achieved the highest yield amounted to 6.13 which did not differ significantly from the flat fan 11004 that gave a yield of 6.08 ton.ha^{-1}, while the comparison treatment gave the lowest yield of 4.61 ton.ha^{-1}. It can be concluded from this that the use of chemical herbicides had a significant effect in reducing the weed numbers per unit area. Therefore, the competition for growth and necessary food decreased, which encouraged the crop to grow well and then increase the efficiency of the crop's physiological processes, which was reflected in increasing the yield compared to the treatment without herbicide. The type of spray nozzle had a clear effect on increasing the efficiency and effectiveness of the used herbicides. Therefore, it can be recommended using the flat fan 11004 because it achieved the best weed control (Soltani *et al.*, 2009).

Table 7 : Effect of control treatments and type of spray nozzle on grain yield (ton.ha^{-1})

Herbicides	Rate (g. ha $^{-1}$)	yield (ton per ha^{-1}).		Effect herbicides
		Hollow cone nozzle	Flat fan 11004	
CONTROL	0.0	c4.81	c4.61	4.71 c
CLODEX 100EC+ SPOTLIGHT WDG 75	60 g. ha $^{-1}$ + 80 g. ha^{-1}	ab5.12	ab5.26	5.19 ab
Atlantis WG	80 g. ha^{-1}	ab5.23	ab5.35	5.29 ab
Logran extra 64 WG+ Topik plus	50 g. ha $^{-1}$ + 65 g. ha^{-1}	ab5.52	ab5.59	5.555 ab
Chevalier 15 WG	320 g. ha^{-1}	a6.13	a6.08	6.105 a
Effect type nozzle		5.362 a	5.378 a	

Means followed by same letter(s) within the same column and treatment group are not significantly different at 5% level of probability using DMRT. ** = significant at 1% level of probability. NS = Not significant.

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