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The Effect of Plant Density and Propnit Herbicide on the 1-Controlling of Companion Weeds of Sorghum

Areej M.S. AL-Mohammedi[1], Shaker M. Saleh[2], Mohammed R. Ahmed[3]

[1,2,3]*Department of Field Crop, College of Agriculture, Tikrit University, Iraq.*

Email: eng.areej75@gmail.com

Abstract: A field experiment was carried out during the spring season of 2020 in the experimental field of the College of Agricultural Engineering Sciences - University of Baghdad - Abu Ghraib, to knowing the effect of weed control with propnit herbicide and plant density on the companion weeds growth of sorghum (Inqath cultivar).Randomized complete block design (RCBD) according to split plots at three replications was used, the main plots included three weed control treatments (spraying of propnit herbicide at recommended dose 450-500 ml dunum^{-1} and half recommended dose 225-250 ml donum^{-1}) in addition to weedy and free weedy treatments, while the sub plots included three plant density(100000, 150000 and 200000 plants ha^{-1}).The results showed that the spraying of propnit at recommended dose recorded the lowest mean of weed density after 25 and 50 days of spraying the herbicide (12.36 and 11.11 weeds m^{-2}) respectively and at the harvest stage (11.89 weeds m^{-2}), and the highest control percentage after 25 and 50 days of spraying the herbicide and at the harvest stage (78.66, 79.80 and 69.41%) respectively. Also, the results indicated that the plant density of 200000 plants ha^{-1}gave the lowest weed density after 50 days of spraying the herbicide (17.25 plants m^{-2}), and atthe harvest stage (12.08 weeds m^{-2}), and gave the highest control percentage at the harvest stage (60.74%). The different combinations between the two studied factors showed a significant effect on the most of the studied traits, the spraying of propnit at recommended dose and sometimes at half recommended dose with high plant density led to an increasing the competition of the crop to the companion weed and reducing weeds density more than the effect of both factors alone.

Keywords: Sorghum bicolor L., companion weeds, pollution, competition

1. INTRODUCTION

Sorghum (*Sorghum bicolor* L.) is a versatile annual crop. It is animportant cereal crop after wheat, rice, maize and barley in terms of cultivated area and production (FAO, 2018). The importance of the crop came in its use for human and animal nutrition because it contains carbohydrates, protein and fats. It is used to produce starch, glucose, vitamin B, alternative food for diabetics and the manufacture of bread and pastries (Dong et al., 2017). The crop is one of the most abundant renewable resources and in the future can be used as an alternative to petroleum (RFA, 2020).The weeds is one of the main agricultural problems of production when it spreads in the fields of crops, as it acts as a host for diseases and insects, in addition to its negative impact in reducing the quantity and quality of the crop, especially crops

sensitive to the presence of the weeds such as the sorghum (Swanton et al., 2015).Various methods have been used to eliminate the weeds or to reduce its impact, most notably weedherbicides because they are more effective and less expensive compared with other weed control methods, so many researchers have been interested in using herbicides to controlling a companion weeds of sorghum, but some types of herbicides as a result of their continuous use cause pollution of environment, groundwater and the growth of subsequent crops (Taha, 2000), and in order to avoid these damages, herbicidesat different chemical composition and different rates that have high selective efficacy can be used to control companion weeds of sorghum or reduce their impact such as propnit, which is one of the selective herbicides which can be used to control broad and narrow-leaved weeds in their early stages of growth in sorghum fields (EFSA, 2010).Recently, attention has been focused on reducing the use of herbicides by finding alternative techniques for weeds management that include a number of safe strategies and agricultural applications for weeds management in field of crops, including the use of optimal plant densities appropriate to reduce the spread of the weeds and its competition, which gives the highest rate of crop productivity, and can be considered a partial alternative to the chemicals control are safer and less polluting to the environment, as well as preserving the means of production. Therefore, this study was carried out to knowing the effect of weed control with propnit herbicide and evaluating the effectiveness of the best concentration of this herbicide as well as determining the optimum plant density to reduce the effect of the companion weeds of sorghum crop.

2. MATERIALS AND METHODS

A field experiment was carried out during the spring season of 2020 in the experimental field of the College of Agricultural Engineering Sciences - University of Baghdad - Abu Ghraib, to knowing the effect of weed control with propnit herbicide and plant density on the companion weeds growth of sorghum (Inqath cultivar). Randomized complete block design (RCBD) according to split plots at three replications was used, the main plots included three weed control treatments: spraying of propnit herbicide at recommended dose 450-500 ml dunum^{-1} (P1) and half recommended dose 225-250 ml donum^{-1} (P½) in addition to weedy and free weedy treatments, while the sub plots included three plant density (100000, 150000 and 200000 plant ha^{-1}).Soil management were carried out as required, and then the experiment land was divided into 27 experimental units, the area of each experimental unit was 6 m^2(2 m x 3 m)**.** Diammonium Phosphate (DAP) fertilizer (18% N and 48% P) was added with an average a436 kg ha^{-1} one dose before planting, urea fertilizer (46% N) was added with an average 696 kg ha^{-1} at two doses, $^1/_3$ at emergence and $^2/_3$after 30 days of the first dose (Cheyad et al., 2014).The required concentrations of propnit herbicide were prepared, as the recommended concentration (720 g L^{-1}) and half of the recommended concentration (360 g L^{-1}) of the active ingredient of the herbicidewas prepared. The herbicideconcentrations were sprayed after planting and before crop emergence using a 16-liter dorsal sprinkler.

Studied traits

1. Weeds density after 25 and 50 days of spraying of the herbicide as well as at harvest stage for an area of 1 m^2 from each experimental unit.
2. The percentage of weeds control (%) was calculated after 25 and 50 days of spraying of the herbicide as well as at harvest stage according to the following equation (Chalabi, 2003):

$$\text{weeds control (\%)} = \frac{\text{W treatment} - \text{W control}}{\text{W control}} \text{ x } 100$$

W control = Number of weeds in the weedy treatment
W treatment = Number of weeds in the other treatments
The data were statistically analyzed by using Gnestat program, and least significant difference (LSD) test at 0.05 probability level was used to compare the treatment means .

3. RESULTS AND DISCUSSION

Weeds density after 25 days of herbicide spraying (weed m^{-2})

The results in Table 1 show that the weedy treatment was significantly superior and gave a highest mean of weeds densityafter 25 days of herbicide spraying (61.33 weeds m^{-2}) compared with spraying of propnit herbicide at recommended dosewhich gave a lowest (12.36 weeds m^{-2}). The reason may be due to the inhibitory effect of propnit herbicide on the seed germination and development of weeds, especially at the early stages of weed seed germination, as a result of its absorption by the embryonic leaves before the weeds reaches to 2-leaf stage. Also, it can be absorbed by the roots of weeds, which leads to rapid death, as the process of the effect is manifested in inhibiting the synthesis of amino acids and proteins in addition to preventing cell division (EFSA, 2010). However, the free weedy treatment gave 0.00 weeds m^{-2}. The results in Table 1 reveal that there are no significant differences between plant densities in the weeds densityafter 25 days of herbicide spraying. In addition to, the interaction between weeds control treatments and plant density didn't significant effect on this trait.

Table (1). Effect of Plant Density and Propnit Herbicide on weeds density after 25 days of herbicide spraying (weed m^{-2})

Weed control treatments	Plant density (plant ha^{-1})			Mean
	100000	150000	200000	
Weedy	61.00	60.67	62.33	61.33
Free weedy	0.00	0.00	0.00	0.00
P½	14.67	14.33	14.67	14.56
P1	12.42	12.17	12.50	12.36
LSD 0.05	N.S			1.18
Mean	22.02	21.79	22.38	
LSD 0.05	N.S			

Weeds density after 50 days of herbicide spraying (weed m^{-2})

The results in Table 2indicate that the weedy treatment was significantly superior and hada highest mean of weeds densityafter 50 days of herbicide spraying(55.22 weeds m^{-2}) compared with spraying of propnit herbicide at recommended dosewhich had a lowest (11.11 weeds m^{-2}).The reason may be that propnit herbicide belongs to the chloro acetanilide group, which prevents the germination of the seeds of the weeds, and then leads to their rapid death because of its direct effect on the development of the weeds seedlings by preventing cell division (EFSA, 2010). However, the free weedy treatment gave 0.00 weeds m^{-2}. The results in Table 2show that there are significant differences between plant densities in the weeds density after 50 days of herbicide spraying, the low plant density (100000 plant ha^{-1})

achieved a highest mean (22.83 weeds m^{-2}) compared with high plant density (200000 plant ha^{-1}) which achieved a lowest (17.25 weeds m^{-2}).The reason of decrease of weeds density when planting with a high plant density may be attributed to an increase in competition between the weeds and sorghum, which has a large vegetative growth and a large leaf area, which enables it to compete with most types of weed and greatly affects their numerical density. These results agree with Al-Jumaily et al., (2013) and Salman (2016) who indicated the positive role of increasing the plant density in reducing the weeds density. The interaction between weeds control treatments and plant density had a significant effect on this trait (Table 2), the weedy treatment with 100000 plant ha^{-1} treatment had a highest value (63.67 weed m^{-2}),whereas the spraying of propnit herbicide at recommended dose with 200000 plant ha^{-1} treatment had a lowest (10.00 weeds m^{-2}) with non-significant difference with spraying of propnit herbicide at recommended dose with 150000 plant ha^{-1} treatment (11.00 weeds m^{-2}) and spraying of propnit herbicide at half recommended dose with 200000 plant ha^{-1} treatment (11.33 weed m^{-2}).This result indicates the possibility of using propnit herbicide at half recommended dose when increasing the plant density of the sorghum up to 200000 plants ha^{-1}.

Table (2). Effect of Plant Density and Propnit Herbicide on weeds density after 50 days of herbicide spraying (weed m^{-2})

Weed control treatments	**Plant density (plant ha^{-1})**			**Mean**
	100000	**150000**	**200000**	
Weedy	**63.67**	**54.33**	**47.67**	**55.22**
Free weedy	**0.00**	**0.00**	**0.00**	**0.00**
P½	**15.33**	**13.33**	**11.33**	**13.33**
P1	**12.33**	**11.00**	**10.00**	**11.11**
LSD 0.05	**2.88**			
Mean	**22.83**	**19.67**	**17.25**	
LSD 0.05	**1.59**			

Weeds density at harvest stage (weed m^{-2})

The results in Table 3show that the weedy treatment was significantly superior and gavea highest mean of weeds densityat harvest stage(39.89 weeds m^{-2}) compared with spraying of propnit herbicide at recommended dosewhich gave a lowest (11.89 weeds m^{-2}) with non-significant difference with spraying of propnit herbicide at half recommended dose (13.11 weeds m^{-2}).The reason may be that the spraying of propnit after planting and before the emergence of the main crop prevented the seeds germination of narrow and broad-leaved weeds and disability the development of weeds seedlings and rapidly death due to the direct effect of this group of herbicide in preventing cell division (EFSA, 2010). However, the free weedy treatment gave 0.00 weeds m^{-2}. Also, the results in Table 3reveal that there are significant differences between plant densities in the weeds densityat harvest stage, the low plant density (100000 plant ha^{-1}) had a highest mean (20.40 weeds m^{-2}) compared with high plant density (200000 plant ha^{-1}) which had a lowest (12.08 weeds m^{-2}).The reason of decrease of weeds density when planting with a high plant density may be attributed to an increase in competition between the weeds and sorghum, which greatly affects their numerical density (Al-Jumaily et al., 2013). The interaction between weeds control treatments and plant density had a significant effect on this trait, the weedy treatment with 100000 plant ha^{-1} treatment had a highest value (52.00 weed m^{-2}),while the spraying of

propnit herbicide at recommended dose with 200000 plant ha^{-1} treatment had a lowest (9.67 weeds m^{-2}) with non-significant difference with spraying of propnit herbicide at half recommended dose with 200000 plant ha^{-1} treatment (10.33 weeds m^{-2}).This result indicates the possibility of using propnit herbicide at half recommended dose when increasing the plant density of the sorghum up to 200000 plants ha^{-1}.

Table (3). Effect of plant density and propnit herbicide on weeds density at harvest stage (weed m^{-2})

Weed control treatments	Plant density (plant ha^{-1})			Mean
	100000	150000	200000	
Weedy	52.00	39.33	28.33	39.89
Free weedy	0.00	0.00	0.00	0.00
P½	16.00	13.00	10.33	13.11
P1	13.67	12.33	9.67	11.89
LSD 0.05	2.20			1.75
Mean	20.42	16.17	12.08	
LSD 0.05				

Weeds control percentage after 25 days of herbicide spraying (%)

The results in Table 4reveal that the spraying of propnit herbicide at recommended dosewas significantly superior and recorded a highest percentage of weed control after 25 days of herbicide spraying (82.23%) compared with weedy treatment whichrecorded 0.00%.The reason of an increase the percentage of weeds control may be attributed to the role of the propnit herbicide in reducing the weeds density based on the mechanism of action of the herbicide that depends on inhibiting the seeds germination and eliminating of weeds seedlings at early stages of growth, which led to a reduction their density (Table 1) and an increase the control percentage.These results agree with Ahmed (2017) who reported that the spraying of proponit herbicide gave the highest percentage of weed control.However, the free weedy treatment gave 100.00%. Also, the results in Table 4show that there are no significant differences between plant densities in the weeds control percentage after 25 days of herbicide spraying. In addition to, the interaction between two factors didn't significant effect on this trait.

Table (4). Effect of plant density and propnit herbicide on weeds control percentage after 25 days of herbicide spraying (%)

Weed control treatments	Plant density (plant ha^{-1})			Mean
	100000	150000	200000	
Weedy	0.00	0.00	0.00	0.00
Free weedy	100.00	100.00	100.00	100.00
P½	78.02	78.74	80.72	79.16
P1	80.77	82.18	83.73	82.23
LSD 0.05	N.S			1.09
Mean	64.70	65.23	66.11	
LSD 0.05	N.S			

Weeds control percentage after 50 days of herbicide spraying (%)

The results in Table 5 indicate that the spraying of propnit herbicide at recommended dosewas significantly superior and gave a highest percentage of weed control after 50 days of herbicide spraying (79.80%) compared with weedy treatment which gave 0.00%.The reason of an increase the percentage of weeds control could be due to the positive role of propnit in reducing the weeds density after 50 days of herbicide spraying (Table 4). These results agree with Ahmed (2017). However, the free weedy treatment gave 100.00%. Also, the results in Table 5show that there are no significant differences between plant densities in the weeds control percentage after 25 days of herbicide spraying. In addition to, the interaction between two factors didn't significant effect on this trait.

Table (5). Effect of plant density and propnit herbicide on weeds control percentage after 50 days of herbicide spraying (%)

Weed control treatments	Plant density (plant ha^{-1})			Mean
	100000	150000	200000	
Weedy	0.00	0.00	0.00	0.00
Free weedy	100.00	100.00	100.00	100.00
P½	75.92	75.46	76.23	75.87
P1	80.63	79.75	79.02	79.80
LSD 0.05	N.S			2.31
Mean	64.14	63.80	63.81	
LSD 0.05	N.S			

Weeds control percentage at harvest stage (%)

The results in Table 6show that the spraying of propnit herbicide at recommended dosewas significantly superior and achieved a highest percentage of weed control at harvest stage (69.41%) compared with weedy treatment whichachieved0.00%.The reason of an increase the weeds control percentage may be due to the role of the propnit herbicide in inhibiting the seeds germination of weeds impeding the growth of seedlings by preventing the synthesis of amino acids and proteins, and then reducing the weeds density at harvest stage (Table 3). These results agree with what Kandasamy (2017) who indicated that herbicides affect the vital activities in the weeds, which leads to reducing their numbers and increasing the percentage of their control. However, the free weedy treatment gave 100.00%. Also, the results in Table 6reveal that there are significant differences between plant densities in the weeds control percentage at harvest stage, the high plant density (200000 plant ha^{-1}) had a highest percentage (60.74%) compared with low plant density (100000 plant ha^{-1}) which had a lowest (57.35%).The reason of an increase the weeds control percentage when planting at a high plant density may be due to an increase the number of sorghum crop plants per unit area and thus the increase in competition that led to a decrease the density of the accompanying weeds (Table 3). The interaction between two factors didn't significant effect on this trait (Table 6).

Table (6). Effect of plant density and propnit herbicide on weeds control percentage at harvest stage (%)

Weed control treatments	Plant density (plant ha^{-1})			Mean
	100000	150000	200000	
Weedy	0.00	0.00	0.00	0.00
Free weedy	100.00	100.00	100.00	100.00

P½	**63.53**	**66.95**	**69.23**	**66.57**
P1	**65.88**	**68.64**	**73.72**	**69.41**
LSD 0.05		**N.S**		**1.41**
Mean	**57.35**	**58.90**	**60.74**	
LSD 0.05		**1.91**		

4. CONCLUSIONS

We conclude that spraying propnit at recommended dose had a high efficiency in decreasing theweeds density and reducing their competition for sorghum crop. Also, The spraying the propnit at half recommended dose achieved similar results to spraying of propnit at recommended dose, despite the significant differences between them in most of the studied traits, and this is a positive indication for reducing the amount of pesticides used in weeds control operations. On the other hand, the increasingplant density led to a decrease the number of weeds, which indicates the ability of sorghum plants to compete with the companion weeds, especially after the stage of rapid growth and stems elongation, and this would reduce the use of herbicide in the controlling the weeds.

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