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Yield and Yield Components of Wheat as Affected by Weed Control of Common Mallow with Apyrus and Othello Herbicides

Apyrus ve Othello Herbisitleri ile Ebegümeci Yabancı Ot Kontrolünden Etkilenen Buğdayın Verim ve Verim Bileşenleri

Fathieh NABHANİ[1], Shapour LORZADEH[2]

[1]Islamic Azad University, Department of Agronomy and Plant Breeding, Shoushtar Branch, Shoushtar, Iran
• **fathiehnabhani@gmail.com** • ORCİD > 0009-0008-0741-7809

[2]Islamic Azad University, Department of Agronomy and Plant Breeding, Shoushtar Branch, Shoushtar, Iran
• **lorzadeh42@gmail.com** • ORCİD > 0000-0002-0075-5417

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Sorumlu Yazar / Corresponding Author: Fathieh NABHANİ

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YIELD AND YIELD COMPONENTS OF WHEAT AS AFFECTED BY WEED CONTROL OF COMMON MALLOW WITH APYRUS AND OTHELLO HERBICIDES

ABSTRACT

This study was conducted to investigate the effect of various concentrations of Apyrus and Othello herbicides on the common mallow weed control and their possible negative effect on wheat yield in 2017-18 in Ahwaz, Iran. The treatments were Othello at concentrations of 1.25, 1.5, and 1.75 L/ha and Apyrus at 24.6, 26.6, and 30.6 g/ha. Results showed that herbicide treatments significantly reduced common mallow weed density and dry weight after spraying (15 and 30 days after application). Best results in reducing the common mallow weed density and dry weight were recorded in 30.6, 26.6 g/ha of Apyrus, and 1.75 and 1.5 L/ha of Othello. The effect of treatments was also significant on wheat plant height, spike number per plant, grain number per spike, 1000-grain weight, biological yield, and grain yield. The highest wheat grain yield (4359 kg/ha) was obtained in no-weed control, and among the herbicide treatments, the highest wheat grain yield (3981 kg/ha) was obtained by 1.75 L/ha of Othello, followed by 26.6 g/ha of Apyrus; while, these yields were not significantly different. Therefore, to control the broadleaf common mallow weed in wheat fields by using Apyrus herbicide, a lower dose of this herbicide (dose of 26.6 g/ha) could be used. Also 1.75 L/ha is a more acceptable application rate for Othello herbicide to control the common mallow weed in wheat fields.

Keywords: Mesosulfuron Methyl, Iodosulfuron Methyl Sodium, Diflufenican, Sulfosulfuron, Wheat Grain Yield, Common Mallow Weed Control.

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APYRUS VE OTHELLO HERBİSİTLER İLE EBEGÜMECİ YABANCIOTUN KONTROLÜNDEN ETKILENEN BUĞDAYIN VERİM VE VERİM BİLEŞENLERİ

ÖZ:

Bu çalışma, Apyrus ve Othello herbisitlerinin çeşitli konsantrasyonlarının yaygın ebegümeci otu kontrolü üzerindeki etkisini ve bunların buğdayın verimi üzerindeki olası olumsuz etkilerini ortaya koymak amacıyla 2017-18 yıllarında İran, Ahwaz'da yürütülmüştür. Othello'da 1.25, 1.5 ve 1.75 L/ha ve Apyrus'da 24.6, 26.6 ve 30.6 g/ha'da konsantrasyonlarında uygulamalar yapıldı. Herbisit uygulamalarının, püskürtmeden sonra (uygulamadan 15 ve 30 gün sonra) yaygın ebegüme-

ci ot yoğunluğunu ve kuru ağırlığı önemli ölçüde azalttığını göstermiştir. Yaygın ebegümeci ot yoğunluğunu ve kuru ağırlığı azaltmada en iyi sonuçlar Apyrus'ta 30.6, 26.6 g/ha ve Othello'da 1.75 ve 1.5 L/ha'da belirlenmiştir. Ayrıca buğday bitki boyu, bitki başına başak sayısı, başaktaki tane sayısı, 1000 tane ağırlığı, biyolojik verim ve tane verimi üzerine uygulamaların etkisinin önemli olduğu saptanmıştır. En yüksek tane verimi (4359 kg/da) yabancı otsuz mücadeleden elde edilirken herbisit uygulamalarında ise aralarında istatistiksel olarak fark olmamakla birlikte en yüksek tane verimi (3981 kg/da) 1,75 L/da ile Othello'dan ardından da 26,6 g/ha ile Apyrus'tan elde edilmiştir. Bu nedenle, buğday tarlalarındaki geniş yapraklı ebegümeci otunu kontrol etmek için Apyrus'un daha düşük bir dozunun (26.6 g/ha doz) kullanılabileceği belirtilmiştir. Ayrıca buğday tarlalarındaki yaygın ebegümeci otunu kontrol etmek için Othello'nun 1,75 L/ha dozunun daha kabul edilebilir bir uygulama oranı olduğu vurgulanmıştır.

Anahtar Kelimeler: Mezosülfüron Metil, İyodosülfuron Metil Sodyum, Diflufenikan, Sülfosülfuron, Buğday Tanesi Verimi, Yaygın Ebegümeci Ot Kontrolü.

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1. INTRODUCTION

Wheat (*Triticum aestivum L.*), the most important crop and human food source, is one of the first plants cultivated by humans (Godarzi and Fathi 2006). Several factors, such as weeds, effectively reduce the yield of agricultural production (Eskandari and Alizadeh-Amraie 2016). Common mallow (*Malva neglecta*) is a winter annual or biennial weed of the Malvaceae family propagated by seeds; the other names of this weed are cheese-weed, cheese-plant, dwarf mallow, button-weed, and round-leaf mallow (Lorzadeh 2009), and in recent years it has spread widely in Khuzestan Province (Iran). It is becoming a problematic weed in this region. There is no registered or recommended herbicide for chemical control of this weed, and there is little information on how herbicides affect this weed. Therefore, in addition to investigating the chemical control of this weed, it is necessary to study the agronomic response of wheat to herbicides.

It seems that one of the most important reasons for the increase in the common mallow population in wheat fields of Khuzestan Province of Iran is the continuous use of herbicides Tribenuron methyl and Clodinofop propargyl, which in many cases has led to herbicide resistance (Makenaly and Minbashi 2013). The alternative herbicide application is one of the proper approaches to reducing herbicide resistance (Hajiabaee et al. 2021). Although there is no report on herbicide resistance in this weed, if there is resistance in this weed, it can be investigated by conducting this study via different doses of herbicides.

In this study, two herbicides, i.e. Apyrus and Othello, were investigated as alternative options provided for farmers, especially in the fields where herbicide resistance could occur in the future. ALS (Acetolactate Synthase) inhibitors, such as Apyrus herbicide (Sulfosulfuron), are the major dual-purpose registered herbicides for wheat fields and are used for the chemical management of herbicide-resistant weeds (Zand et al. 2012). Apyrus is a selective, systemic herbicide belonging to the sulfonylurea group, and it is used as a post-emergence herbicide (Baghestani et al. 2007). Othello (mesosulfuron methyl + iodosulfuron methyl sodium + diflufenican) is a selective, systemic, post-vegetative herbicide and belongs to the sulfonylurea group that controls broadleaf and narrow-leaf weeds. The mode of action for mesosulfuron methyl and iodosulfuron methyl sodium is to prevent the production of the enzyme esthydoxy acetate. Also, diflofenic acid prevents the construction of phytoene dehydrogenase (Ghassam et al. 2017).

This study's objective was to investigate the effect of two herbicides on mallow weed control and their possible side effects on wheat. Dual-purpose herbicide should be used to compare and provide appropriate ways to chemical control wheat weeds while having no adverse effect on wheat yield.

2. MATERIAL AND METHODS

2.1. Location

To study the efficacy of different concentrations of Apyrus and Othello herbicides on common mallow weed control wheat yield under Ahwaz climate conditions (southwest of Iran), an experiment was conducted in the 2017-2018 growing season. With a latitude of 31°20' North and longitude of 48°41' east, Ahvaz city is located about 20 meters above sea level.

2.2. Treatments

A randomized complete block design with eight treatments and three replications was used in the study. The treatments were Othello® (Mesosulfuron methyl (0.75%)+ iodosulfuron methyl sodium (0.25%)+ diflufenican (5%) + mefenpyr-diethyl (2.25%), OD 8.25%, Bayer science, Germany) at concentrations of 1.25, 1.5, and 1.75 L/ha and Apyrus® (Sulfosulfuron, DF 75%, Bayer Company, Germany) (at concentrations of 24.6, 26.6, and 30.6 g/ha); while weed-free control and weed-infested control were included. Doses of herbicides were selected based on the recommended dose so that 25% lower than recommended dose was determined as the first dose, recommended dose as the second dose, and 25% higher than the recommended dose as the third dose of each herbicide. The herbicide application was carried out uniformly using a lanced 16-L MATABI Elegant Sprayer,

with a nozzle 8002, pressure 240 kPa, and also at the common time of herbicide application in the region.

2.3. Field Operations

Spring wheat local cultivar called Chamran (Attila) was the selected cultivar for the experiment. Before planting, the base fertilizing included: 130 kg/ha Azot (46% Nitrogen), 200 kg/h triple superphosphate fertilizer (43-44% P2O5), and 80 kg/h potassium sulfate (53% K2SO4) was applied according to the soil test results (Table 1). The first irrigation was done after planting, and the next irrigations were based on the plant's water needs.

Table 1. Soil characteristics in 0-30 cm depth of field soil and fertilizer application details in experiment.

Texture	pH	E.C.	Organic C	Total N	P	Total K	Fe	Mn	Zn	B
		(dS m^{-2})	(%)	(%)	mg kg^{-1}					
Silty-loam	7.7	0.71	1.01	0.16	12.92	222	5.18	4.31	0.61	3.24

2.4. Sampling

Sampling and evaluation of mallow weed were before herbicide application, 15 days, and 30 days after herbicide application. Weed counting and sampling were performed in the middle of the each plot in an area of one square meter using a 50 x 50 cm quadrat. The weed samples were placed in an oven at 70 °C in the laboratory for 48 hours, and after drying, all samples were weighed with a digital scale. Evaluated factors for wheat were the weight of the aerial part, yield and yield components, grain number per spikelet, 1000-grain weight, grain yield, biological yield, and harvest index. Wheat grain yield, biological yield, and harvest index were calculated by following formulas:

$$\text{Grain yield (kg ha}^{-1}) = \frac{\text{Grain yield (kg) subplot}^{-1}}{\text{Area sub plot}^{-1}} \times 1000$$

$$\text{Biological yield (kg ha}^{-1}) = \frac{\text{Biological yield (kg) subplot}^{-1}}{\text{Area sub plot}^{-1}} \times 1000$$

$$\text{Harvest index (H.I)} = \text{Grain yield/Biological yield}^{-1} \times 100$$

2.5. Data Analysis

Data were analyzed using SAS software Ver. 9.3 (SAS, 2008) and variance analysis and mean comparison were performed. Then, the Duncan method was used as a post hoc test at a 99% confidence level. Microsoft Excel (2010) software was used for graph drawing.

3. RESULTS AND DISCUSSION

3.1. Mallow Weed

Obtained results showed that the effect of herbicide treatments on the density of mallow weed was significantly reduced after 15 and 30 days. Also, the herbicides' effect on the weed dry weight was significant after 15 and 30 days.

3.1.1. Mallow Weed Density

The mean comparison for the effect of experimental treatments on mallow density, 15 and 30 days after herbicides application, showed that the best treatment was Apyrus herbicide at the dose of 30.6 gr/ha with a 62.8% weed reduction. Application the 1.75 and 1.5 L/ha of Othello reduced weed percentages to 60.2% and 59.8%. Also, obtained results showed no significant differences between herbicides in three doses. The lowest effect was obtained at 1.25 L/ha of Othello herbicide (19% reduction), which was not significantly different from 24.6 g/ha of Apyrus (26.5% reduction) (Figure 1).

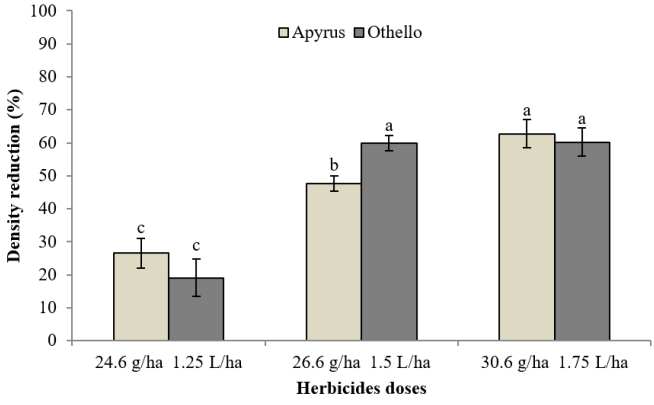

Figure 1. The effect of Apyrus and Othello herbicides on mallow weed density 15 days after spraying

After 30 days, Apyrus in 30.6 g/ha concentration was the most effective treatment, reducing the weed density by 99%. However, it has no significant difference with Othello in 1.5 and 1.75 L/ha and Apyrus itself at 26.6 g/ha, leading to 92.8, 94.2, and 93.4 percent of reduction. After 30 days, 1.25 L/ha of Othello was the least effective against the weed and reduced its density by 39% (Figure 2).

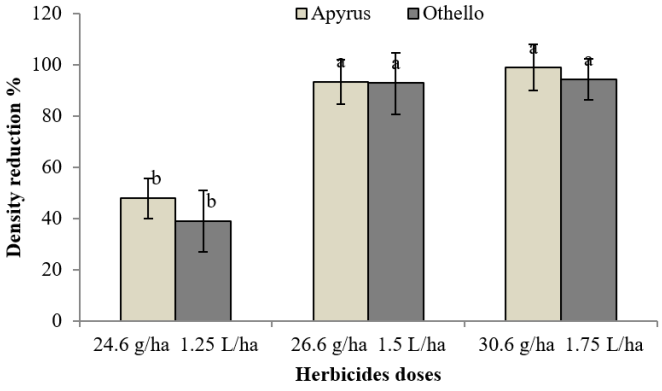

Figure 2. The effect of Apyrus and Othello herbicides on mallow weed density 30 days after spraying

In a study by Lotfi Mavi et al. (2015), found out that 1.6 L/ha of Othello herbicide, in 30 days after spraying, reduced the density of wild oat (Avena iudoviciana) by over 85%; however, at the doses of 2 and 1.2 L/ha, this herbicide had no statistically significant difference with 1.6 L/ha. It seems that the non-significant effect of this herbicide was due to the inadequate time length of investigation since this investigation could be 60 to 90 days after herbicide application. In an experiment, the 1.6 and 2 L/ha doses of Othello reduced wild oat density by 90% (Sharifi Ziwe et al. 2016). According to another study, Apyrus in doses of 26.6 and 33.2 g/ha controlled wild mustard (Sinapis arvensis) in wheat fields at Moghan, Iran (Karbalaei Khiavi and Baghestani, 2014). The study by Hesami et al. (2007) found that Apyrus controlled the wheat weeds in the 30 gr/ha dose application.

3.1.2. Mallow Weed Dry Weight

The effect of herbicide treatments on the dry weight of mallow weed 15 days after spraying showed that Apyrus at 30.6 g/ha had a significant effect on this trait, reducing it by 72.3%. There was no significant difference between 26.6 g Apyrus and 1.5 and 1.75 L/ha of Othello. The lowest dry weight reduction of this weed (25.5%) was obtained in Othello herbicide at 1.25 L/ha (Figure 3).

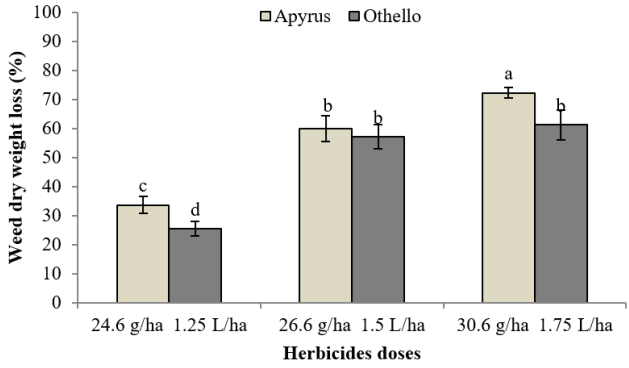

Figure 3. The effect of Apyrus and Othello herbicides on the dry weight of mallow weed, 15 days after spraying

The mean comparison for the effect of different herbicides on the dry weight of mallow weed 30 days after spraying showed that Apyrus herbicide at 30.6 g/ha reduced the dry weight of this weed by more than 98%. After that, Othello (1.75 L/ha) and Apyrus (26.6 g/h) and again Othello (1.5 L/ha) reduced the dry weight of mallow weed by 91.8%, 90.7%, and 88.6%, respectively. Post hoc tests showed that these doses were significantly different. By decreasing both herbicides' doses, their effectiveness was also reduced so that the lowest percentage of dry weight loss of mallow weed (44.4%) was observed in Othello at 1.25 L/ha (Figure 4).

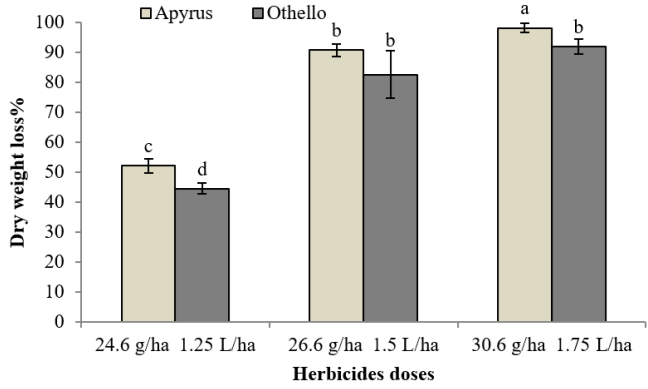

Figure 4. The effect of Apyrus and Othello herbicides on the dry weight of mallow weed 30 days after spraying

A study showed that Apyrus at 24, 27, and 30 g/ha reduced the weeds' dry weight by 78.1%, 80.6%, and 84.5%, respectively, after two weeks of spraying. There was no significant difference between 27 and 30 gr/ha doses (Malekian and Ghadiri 2016). Their study's result does not agree with the results of the present study since, in this study, 24.6 and 26.6 g/ha of Apyrus did not show a significant difference. This mismatch could be because of the weed species. In the study by Malekian and Ghadiri (2016), weeds were included Hordeum spontaneum, Setaria viridis, and Descurainia sophia. Also, the climate differences should not be omitted.

Bazoo et al. (2007) reported that Apyrus at a 30 g/ha dose caused a significant reduction in the dry weight of Sinapis arvensis, which was similar to the results of this study. They investigated the effect of broadleaf herbicides on the wild mustard control in the wheat field, and the results confirmed the current study.

3.2. Wheat Traits

Based on obtained results, the effect of herbicide treatments on the weed plant height reduction was significant. Also, herbicides' effect on the number of fertile spikes was significant. The effect of herbicides on the grain number per spike was significant.

Obtained results showed that the herbicides' effect was significant on wheat 1000-grain weight and biological yield. Finally, herbicides reduced wheat grain yield and harvest index significantly.

3.2.1. Wheat Plant Height

Mean comparisons showed that although the highest wheat plant height (94 cm) was obtained in the weed-free control treatment; however, Othello at 1.5 and 1.75 L/ha and Apyrus at 26.6 and 30.6 g/ha (with a wheat plant height of 93.2, 90.3, 92.9, and 88.8 cm, respectively) showed non-significant difference with the recorded maximum. Obtained wheat plant heights in Apyrus 24.6 g/ha (81.9 cm) and Othello 1.25 L/ha (79.3 cm) were not significantly different from weed-infested control (76.1 cm) (Figure 5).

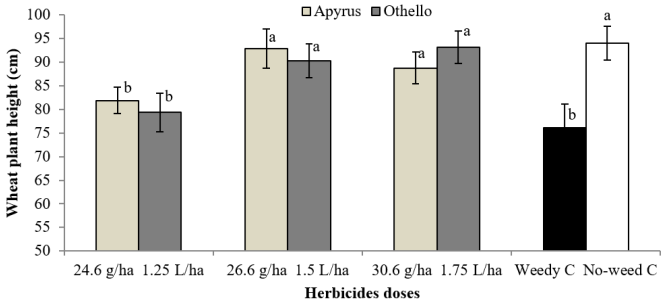

Figure 5. The effect of Apyrus and Othello herbicides on wheat plant height

Hesami et al. (2007) stated that herbicide application increases the efficiency of nutrient consumption in wheat and, consequently, the wheat plants' height the also grows by decreasing the competition between weeds and wheat plants for nutrients, light, water, and space. Our study showed similar results and confirmed their idea. Control of mallow weed can eliminate the competition between wheat and this weed, and it creates suitable conditions for the growth of the wheat stalk. Despite this, weed competition with wheat reduced its growth in the control (without weeding). Sulfonylurea herbicides provide various herbicides for wheat fields, but the rapid resistance of weeds to these herbicides (after five years of repeated use) should be in herbicidal rotation (Zand et al. 2007). In this experiment, Othello herbicide in doses of 1.5 and 1.75 L/ha significantly decreased the mallow weed dry weight and density. Accordingly, this herbicide can be used alternately with other herbicides with a different site of action and in replacement with the same family's herbicides, including Apyrus. Also, the dose of 26.6 g/ha of Apyrus herbicide has been able to control the density and dry weight of cheese weed favorably, and the consumption of this herbicide can be reduced from 30.6 to 26.6 g/ha.

3.2.2. Number of Fertile Wheat Spike

The number of fertile wheat spikes in the no-weed control was 398.9, which was 1.75 L/ha with Othello, and there was no significant difference between this treatment and 26.6 g/ha in the case of the number of fertile wheat spikes. Doses of 1.25 L/ha of Othello and 24.6 g/ha of Apyrus caused 304.7 and 316.7 fertile spikes/m2, respectively. It was 286.2 spikes/m2 in weed control (Figure 6).

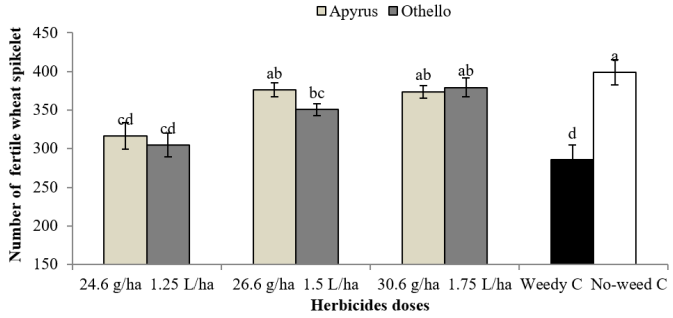

Figure 6. The effect of Apyrus and Othello herbicides on the number of fertile wheat spikelet

Jafar-Nejad and Rahimian (2003) showed that wheat competition with weeds reduced the number of fertile wheat spikes. According to Noroouzi et al. (2003), Avena iudoviciana, Salsola kali, and Rapistrum rugosum weeds significantly reduced the number of fertile wheat tillers. Reducing interspecific competition and reducing plant losses increase the fertility percentage of tillers, and as a result, the number of fertile spikes/m2 increases (Seyed-Masoom et al. 2012).

In a report by Ariannia et al. (2010), weeds' chemical control increased the number of fertile spikes in wheat compared to weed control. In this experiment, the application of Othello and Apyrus herbicides' effective doses caused optimal weed control and consequently reduced competition between weeds and wheat plants, which also positively affected the number of fertile wheat spikes.

3.2.3. Seed Number Per Spikelet

Studying the effect of applying different levels of herbicide on wheat showed that the highest grain number per spikelet was obtained in the no-weed control (38.4), followed by Othello at 1.75 (35.9), Apyrus at 26.6 (34.8), Othello at 1.5 L/ha (33.2), and Apyrus at 30.6 g/ha (33.1), respectively. There was no significant difference between them (Figure 7).

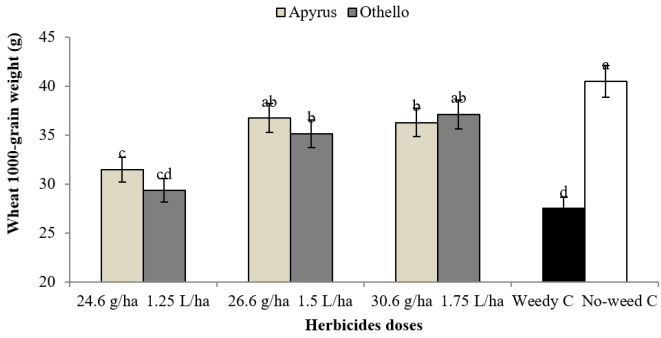

Figure 7. The effect of Apyrus and Othello herbicides on the grain number per spikelet

Weeds presence limits available nutrient resources for wheat; therefore, in conditions where moisture, nutrients, and other growth factors are limited for wheat, a small number of tillers will develop (Thiry et al. 2002). Accordingly, the number of grains on wheat spikes decreases significantly. Our results showed that eliminating these restrictions through Othello and Apyrus played an essential role in improving fertile spike production and the grain number per spike of wheat.

3.2.4. 1000-Grain Weight Of Wheat

The mean comparison for the effect of experimental treatments on the 1000-grain weight of wheat showed that the highest amount (38.37 g) was obtained in no-weed control. It was not significantly different from Othello in 1.75 L/ha (35.97 g) and Apyrus in 26.6 (34.84 g) and 30.6 g/ha (33.14 g), respectively. The lowest 1000-grain weight (20.43 g) was in weed control (Figure 8).

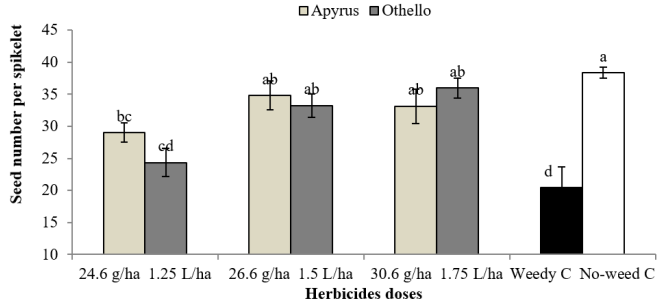

Figure 8. The effect of Apyrus and Othello herbicides on the 1000-grains of wheat

Reducing the application dose of Apyrus and Othello herbicides to 24.6 g/ha and 1.25 L/ha have reduced the ability of these herbicides to improve the wheat's 1000-grains weight; while other doses of these herbicides by eliminating the effects of mallow weed competition with wheat plants have increased the wheat 1000-grain weight compared to no-weed control.

3.2.5. Biological Yield

Comparing various treatments showed that the highest wheat biological yield was in no-weed control (13158 kg/ha), which was not significantly different from the Apyrus in 26.6 and 30.6 g/ha (12750, 12203 kg/ha, respectively) and Othello at a rate of 1.75 L/ha (12433 kg/ha). The lowest wheat biological yield (7049 kg/ha) was observed in weed control (Figure 9).

In weedy control, mallow competition with wheat reduced its vegetative growth and reduced wheat's dry matter. By shading, weeds prevent light radiation from entering the crop's canopy and reduce biomass (Ebrahimpour et al. 2006). Spraying with herbicides and appropriate doses suppresses weeds, thus providing favorable conditions for crop growth and increasing its competitiveness and utilization of available resources, which ultimately causes decreased dry weight and weed height and increased dry matter production of the crop (Baghestani et al. 2007).

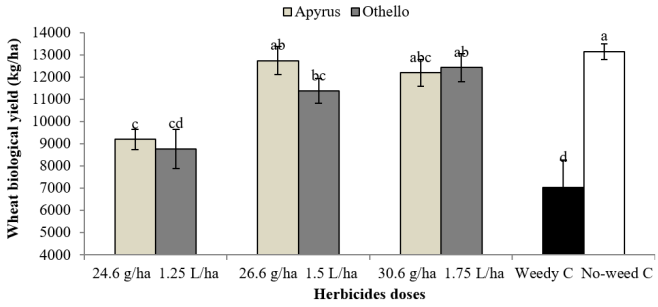

Figure 9. The effect of Apyrus and Othello herbicides on the biological yield

It is noteworthy that although Apyrus in 30.6 g/ha was able to reduce the density and dry weight of mallow weed more than 26.6 g/ha; however, it did not show this effect in increasing the biological yield of wheat. It can be said that the use of 26.6 g/ha has ultimately played a more influential role in increasing wheat biomass.

3.2.6. Grain Yield

Mean comparisons for various herbicides on wheat showed that wheat's highest grain yield was in the no-weed control (4359 kg/ha). After that, there were Othello in 1.75 L/ha (3981 kg/ha) and Apyrus in 26.6 (3959 kg/ha), and 30.6 gr/ha (3866 kg/ha) respectively. The lowest grain yield of wheat was 1881 kg/ha observed in weed control, while it was not significantly different from Othello in 1.25 L/ha (Figure 10).

In Esmaili et al. (2011), Apyrus caused optimal control of wild oat weed and increased wheat yield by more than 30% compared to the control. Ariannia et al. (2011) also reported an increase in wheat yield in herbicide treatment compared to the control treatment. In the study by Hesami et al. (2007), the highest grain yield in wheat was obtained in Apyrus treatment, and there was a significant difference with other herbicides used. Bazoo et al. (2007) reported that Apyrus 30 g/ha significantly increased wheat yield compared to the control. Although, in Karbalaei Khiavi and Baghestani's (2014) experiment, 33.2 and 26.6 g/ha of Apyrus controlled the wild mustard broad-leaved weed of wild mustard (S. arvensis) in wheat fields; however, the dose of 26.6 g/ha of this herbicide was the most appropriate dose to control this broadleaf weed.

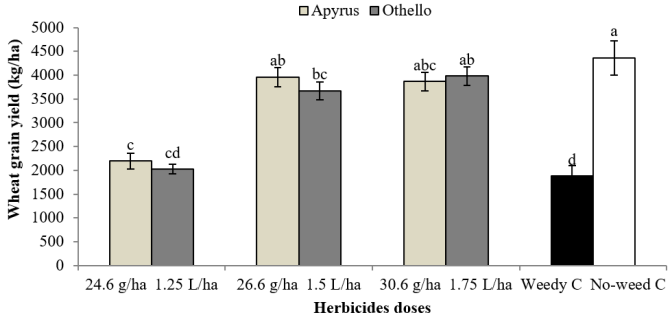

Figure 10. The effect of Apyrus and Othello herbicides on the grain yield

According to Birgani et al. (2007), the application of Apyrus in 26.6 g/ha in the early stages of wheat tillering increased wheat yield by 22%, while no vegetation effects were observed on wheat. In the study conducted by Kelley et al. (2003), 35, 70, and 140 g/ha Apyrus showed that it reduces the yield by 6, 18, and 24%, respectively. Application of selective herbicides in the early stages of weeds and crop growth by eliminating weeds is a good stimulant for wheat growth because the ability of weeds to absorb nutrients is often more significant than that of crops, in which case the weeds are not able to use the fertilizer used, and the competitive advantage to crop profits will change (Rahsepar et al. 2011).

3.2.7. Harvest Index

Results showed that the highest harvest index of wheat (33.1%) was achieved in no-weed control. There was no significant difference between Apyrus herbicide at doses of 26.6 and 30.6 g/ha and Othello at doses of 1.75 and 1.5 L/ha (31.1, 31.4, 32, and 32.3%, respectively). The lowest harvest index of wheat was obtained in Othello herbicide treatment at a dose of 1.25 L/ha (23.14%), which was not significantly different from Apyrus 24.6 g/ha (23.91%) (Figure 11).

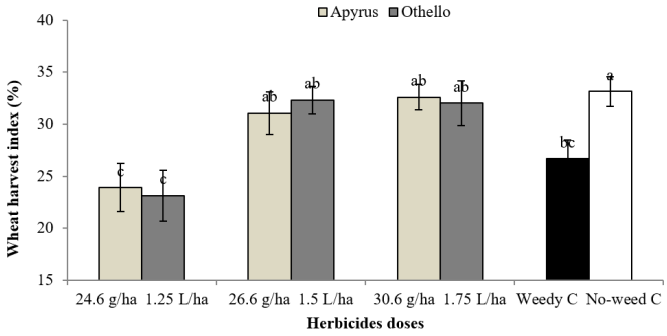

Figure 11. The effect of Apyrus and Othello herbicides on the harvest index

4. CONCLUSION

The results showed that the effect of treatments was significant on wheat plant height, spike number per plant and grain number per spike, 1000-grain weight, biological yield and grain yield of wheat. The highest grain yield of wheat was obtained in no-weed control (4359 kg/ha), and in herbicide treatments (3981 kg/ha) was obtained in 1.75 L/ha of Othello, followed by 26.6 g/ha of Apyrus; while these yields were not significantly different. Othello herbicide at the dose of 1.75 compared to the dose of 1.5 L/ha, although it was superior in reducing the dry weight of common mallow and was in a higher statistical group, in reducing the density of this weed, there was no statistical difference. Compared to the dose of 1.25 L/ha in reducing common mallow weed density and dry weight, this herbicide was more than 50% superior. Therefore, increasing the dose of Othello herbicide from 1.5 to 1.75 L/ha does not cause significant control of this weed, but reducing the dose of this herbicide from 1.5 to 1.25 L/ha significantly reduces the effectiveness. This is also true for different doses of the herbicide Apyrus in the experiment, as increasing the dose from 26.6 g/ha to 30.6 g/ha gives the herbicide a 6 to 7% advantage in controlling the common mallow weed. However, reducing its application to the dose of 24.6 g/ha reduces the efficiency of this herbicide in controlling common mallow by more than 40%. Chemical control of common mallow weed by these

herbicides removes the limited access to growth resources for wheat created by competition with the weed and creates the conditions for the production and development of tiller, fertile spike, and grain increase in wheat spike.

In general, it could be stated that when common mallow weed is not controlled in wheat fields (weed infested control) compared to when complete weed control is done during the season (weed-free control), wheat grain yield has decreased by 56.9%. The application of adequate doses of Othello and Apyrus herbicides and reasonable control of common mallow weed also significantly increased the final yield of wheat.

In this study, Othello herbicide at doses of 1.75 and 1.5 L/ha, although they were able to control the density and dry weight of common mallow weed properly, the dose of 1.75 L/ha increased wheat grain yield to a greater extent than the increase resulted by the dose of 1.5 L/ha. Therefore, 1.75 L/ha is a more acceptable application rate for Othello herbicide to control the common mallow weed in wheat fields. On the other hand, the dose of 30.6 g/ha of Apyrus herbicide had a slight advantage in controlling common mallow weed compared to the dose of 26.6 g/ha of this herbicide, but 26.6 g/ha was more successful in increasing wheat grain yield. However, they did not have a statistically significant difference. Therefore, to control the broadleaf common mallow weed in wheat fields by using Apyrus herbicide, a lower dose of this herbicide (dose of 26.6 g/ha) could be used.

Conflict of Interest:

The authors declare that there is no conflict of interest.

Ethics:

This study does not require ethics committee approval.

Author Contribution Rates :

Design of Study: FN (%50), SL (%50)

Data Acquisition: FN (%100), SL (%0)

Data Analysis: FN (%90), SL (%10)

Writing up: FN (%95), SL (%5)

Submission and Revision: FN (%95), SL (%5)

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