تأثير طرائق مكافحة الأعشاب خلال مراحل النمو في الغلة ومكوناتها لبعض أصناف القمح (*Triticum* spp.)

Effect of Different Methods of Weed Control on Yield and its Components of Some Wheat (*Triticum* spp.) Varieties

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الملخّص

نُفذ البحث في حقول كلية الزراعة بجامعة دمشق/سورية خلال الموسم الزراعي 2013/2012، بهدف دراسة تأثير طرائق مكافحة الأعشاب (T_1: دون تعشيب خلال كامل فترة نمو المحصول، T_2: تعشيب باليد خلال كامل فترة نمو المحصول، T_3: تعشيب لمرتين بالعزاقة وباليد، T_4: تعشيب لمرتين باستخدام مبيد الأعشاب سوبرفيوز قبل الإنبات و U-46 بعد الإنبات) في الغلة ومكوناتها لبعض أصناف القمح (دوما$_1$، شام$_3$، شام$_{10}$ وشام$_4$)، وُضعت التجربة وفق تصميم القطع المنشقة بثلاثة مكررات.

أشارت نتائج التحليل الإحصائي إلى وجود تباين وراثي في استجابة أصناف القمح المدروسة لطرائق مكافحة الأعشاب، إذ سجلت معاملة التعشيب باليد خلال كامل فترة التجربة (T_2) معنوياً أعلى القيم لمؤشرات ارتفاع النبات (113.42 سم)، ودليل المساحة الورقية (4.97)، ومعدل نمو المحصول (286.83 مغ.يوم$^{-1}$)، وعدد السنابل في النبات (10.50)، وعدد الحبوب في النبات (277.79)، ووزن الـ 1000 حبة (34.80 غ)، والغلة الحبية (5689.52 كغ.هكتار$^{-1}$)، ودليل الحصاد (47.78)، تلاها معاملة التعشيب باستخدام مبيدات الأعشاب (T_4). أما بالنسبة لاستجابة أصناف القمح لطرائق مكافحة الأعشاب، فقد سجل الصنف شام$_{10}$ معنوياً أعلى القيم لمؤشرات ارتفاع النبات (89.13 سم)، ودليل المساحة الورقية (3.64)، ومعدل نمو المحصول (225.25 مغ. يوم$^{-1}$)، وعدد السنابل في النبات (9.33)، وعدد الحبوب في النبات (200.81)، والغلة الحبية (4792.85 كغ.هكتار$^{-1}$)، ودليل الحصاد (47.32)، تلاه الصنف شام$_4$.

الكلمات المفتاحية : طرائق مكافحة الأعشاب، الغلة الحبية، مكونات الغلة، أصناف القمح.

Abstract

The research was carried out in the fields of the Faculty of Agriculture, Damascus University during the growing season of 2012 /2013, to study the effect of different methods of weed control (T_1: without weeding during the whole growth period, T_2: hand weeding during the whole growth period, T3: two weedings by cultivator and hand, T_4: two weedings using Superfuse and U-46 herbicides) on yield and its components of some wheat varieties (Douma$_1$, Cham$_3$, Cham$_{10}$

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and $Cham_4$). The experiment was laid in split plot design with three replications.
The statistical analysis results clearly indicated the genetic variation in the response of the studied wheat varieties to weed control methods. Hand weeding during the whole crop growth period (T_2) significantly recorded the highest mean values of the parameters: plant height (113.42 cm), leaf area index (4.97), crop growth rate (286.83 mg.day^{-1}), number of spikes per plant (10.50), number of grains per plant (277.79), 1000-kernel weight (34.80 g), grain yield (5689.52 kg.ha^{-1}) and harvest index (47.78), followed by the weed control treatment using herbicides (T_4). With respect to the response of wheat varieties to weed control methods, the variety $Cham_{10}$ recorded significantly the highest mean values of the parameters: plant height (89.13 cm), leaf area index (3.64), crop growth rate (225.25 mg.day^{-1}), number of spikes per plant (9.33), number of grains per plant (200.81), grain yield (4792.85 kg.ha^{-1}) and harvest index (47.32), followed by the variety $Cham_4$.
Keywords: Weed control methods, Grain yield, Yield components, Wheat varieties.

Introduction

Wheat crop is considered the most important food crop worldwide; it ranks in the first place among cereal crops in term of cultivated area and production. The world total cultivated area of wheat crop is about 228 m. ha and the production is 663 m. tons with an average yield of 2908 kg. ha^{-1} (FAO, 2012). The total cultivated area of wheat crop in Syria is 1.23 m. ha and the production is 2.78 m.ton with an average yield of 2260 kg. ha^{-1} (Yearly Agricultural Statistics, 2012). Wheat is mainly grown under rainfed conditions especially in the Mediterranean basin which characterized with low and uneven distribution of rainfall.

A better progress has been made in the development of wheat varieties, but still Syria has lower yield as compared to other advanced wheat growing countries of the world. The major yield reducing factors: lack in applying optimum cultural practices, abiotic stresses especially drought and heat, in addition to biotic stresses including disease, insect and weeds. The degree of decreasing wheat grain yield due to weed competition depends on the density of harmful weeds per unit area and weed species, and the efficiency of crop plant for competition and the availability of growth factors during the growing season (Donald and Easten, 1995). Weeds limit wheat yield potential in arid regions because they increase evapo-transpiration rate and compete with wheat plants for limited soil moisture, nutrients and light resulting in grain yield reduction amounting to 7% (Shah *et al*., 2005), 52% (Khan et *al*., 2003), 92% (Tiwari and Parihar, 1997) and in serious cases may lead to complete crop failure (Abdul-Khaliq and Imran, 2003). Use of aggressive cultivars can be effective cultural practice for weed growth suppression (Wicks et *al*., 2004). Hucl (1998) found that the less competitive genotypes suffered a 7-9% greater yield loss than that of the more competitive genotypes. Mason et *al*., (2008) reported that tallness and early heading and maturity were related to an increase in grain yield at the highest weed level. Tallness and early heading were associated with reduced weed biomass depending on weed level. Balyan (1991) declared that the differences in competitive ability among wheat cultivars often correlated with plant height and dry matter. It has been found that taller wheat varieties with high biomass were highly competitive for weeds as compared with shorter one (Williams, 1994).

High wages and scarcity of labours at the right time make hand weeding difficult and uneconomical day by day. Several researchers have shown that application of herbicides can control weeds in wheat (Brzozowska *et al*., 2008).

The response of wheat plants to herbicides also varied among cultivars. Some investigators found positive effect for the interaction between cultivars and weed control treatments on weeds and yield of wheat crop (Abusteit *et al*., 1991). Chemical and hand weeding have often been used as a weed control in wheat. Ahmad *et al*., (1993) observed that herbicides application and hand weeding decreased dry weight of weeds significantly compared to non treated plots. Akhtar *et al*., (1991) found that the application of grassy and broad leaf herbicides increased grain yield and yield components. In a study conducted in Egypt it was found that leaving the harmful weeds in wheat fields caused severe reduction in grain yield up to 42% due to reduction in the number of spikes per plant and per unit area and the number of grains per spike, whereas weed control treatment resulted in increasing grain yield by 52% compared with un-weeded check (Aboziena *et al*., 2007). In a study performed in Pakistan, it was found that weed control treatments have increased significantly the number of spike per plant and the number of grains per spike under weed control treatment during 2-5 leaves stage, while the weight of 1000-kerenel, harvest index and grain yield increased under weed control treatment during the whole crop growth period (Shah *et al*., 2003).

The main objective of this study was to evaluate the effect of some weed control methods on the yield and its components of some wheat varieties.

Materials and methods

The study was conducted in the fields of the Faculty of Agriculture, Damascus University during the growing season of 2012-2013, The experiment was laid in a split plot design with three replications, to evaluate the response of four wheat varieties (Douma$_1$, Cham$_3$, Cham$_{10}$ and Cham$_{4)}$ to four weed control methods (T_1: without weeding during the whole crop growth period as control, T_2: hand weeding during the whole crop growth period, T_3: one weeding by cultivator after 20 days from crop germination and one weeding by hand after 45 days from crop germination, T_4: one weeding using non-selective herbicide Superfuse before crop germination and one weeding using selective herbicide U-46 after crop germination). The soil was ploughed three times before growing wheat crop to prepare the seedbed. The land was divided into main plots allocated to wheat varieties and subplots allocated to weed control treatments. Recommended dose of fertilizers under rainfed conditions (100 : 60 : 60 kg NPK. ha^{-1}) were added and seeds of wheat varieties were sown during last week of November in lines, with a spacing of 20 cm between lines and 5 cm between plants, each subplot contained eight lines and every line maintained 40 plants, therefore the size of subplot was (2m × 1.6 m). The soil of the experimental site (Table 1) was loamy, slightly alkaline in reaction (pH 8.6), low in available nitrogen (186.43 kg.ha^{-1}) and medium in available phosphorus (32.55 kg.ha^{-1}) and available potassium (193.25 kg.ha^{-1}), and medium in organic matter content (2.30%). The total rainfall received during the growing season of 2012-2013 was 183.30 mm only; therefore field capacity of the soil was maintained through irrigation water with a rate of 6 irrigations during the whole crop growth period.

Table 1. Physical and chemical properties of the soil in the experimental site.

Indicator	Physical properties			Chemical properties				
	Sand (%)	Silt (%)	Clay (%)	N (kg.ha^{-1})	P_2O_5 (kg.ha^{-1})	K_2O (kg.ha^{-1})	PH	OM (%)
Value	43.28	32.50	23.62	186.43	32.55	193.25	8.6	2.30

Source: Department of soil sciences, Faculty of Agriculture, Damascus University.

Investigated traits: the following traits were studied:

1. **Plant height (cm):** measured during flowering stage using scale from the ground level up to the top of the spike except the awns (IPGRI, 1994).
2. **Leaf area index (LAI):** calculated during flowering stage using the following formula suggested by Watson (1947).

$$LAI = \frac{\text{Leaf area of the plants per } m^2}{\text{Ground area } (1\ m^2)}$$

3. **Crop growth rate (mg.day^{-1}):** calculated during flowering stage using the following formula suggested by Watson (1947).

$$CGR = \frac{w_2 - w_1}{t_2 - t_1}$$

Where: W_2 and W_1 are the dry weight of the plant at the time t_2 and t_1 respectively.

4. **Number of spikes per plant:** represent the mean value of the number of spikes in ten plants selected randomly from each subplot and each replication.

5. Number of grains per plant: represent the mean value of the grains in ten plants selected randomly from each subplot and each replication.

6. 1000-kernel weight (g): calculated by weighing 250 grains from each subplot and each replication and multiplying the result by 4 to get weight of 1000 kernels.

7. Grain yield (kg.ha^{-1}): represent the weight of grains (g) in each subplot and each replication then converting the result into (kg.ha^{-1}).

8. Harvest index (%): calculated using the following formula:

$$\text{Harvest Index} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

The data of the experiment were subjected to statistical analysis using SAS-9 programme at 5% level of significance.

Results and discussion

1- Plant height (cm): The results in Table 2 clearly indicated to significant differences in plant height among weeding treatments and studied varieties. The highest plant height (113.42 cm) was recorded in T_2: hand weeding during the whole crop growth period and was closely followed by T_4: one weeding using Superfuse herbicide before crop germination and one weeding using U-46 herbicide after crop germination. This was due to absence of weeds competition with wheat crop. Whereas the lowest plant height (61.69 cm) was recorded in T_1: without weeding during the whole crop growth period. With respect to wheat varieties (Table 2) the highest plant height (89.13 cm) was significantly recorded with the variety $Cham_{10}$ and was closely followed by the variety $Cham_4$, whereas the variety $Cham_3$ and $Douma_1$ recorded the lowest plant height (79.01 and 80.87 cm respectively). This may be attributed to the differences in competitive ability of the studied varieties. Similar results were also reported by Wicks et *al*. (2004) and Mason et *al*. (2008). The interaction among varieties and weeding treatments was not significant indicating to consistent behaviour of wheat varieties across weed control treatments.

Table 2. Effect of weed control methods on plant height of the studied wheat varieties.

Genotypes	Treatments				Mean
	T_1	T_2	T_3	T_4	
$Douma_1$	59.35	108.30	68.44	87.38	**80.87**
$Cham_3$	56.25	111.35	66.00	82.43	**79.01**
$Cham_4$	64.83	115.83	74.83	87.83	**85.83**
$Cham_{10}$	66.33	118.20	76.33	95.67	**89.13**
Mean	**61.69**	**113.42**	**71.40**	**88.33**	

Variable	Treatments (T)	Varieties (V)	T×V
$L.S.D_{0.05}$	10.85	3.55	NS

NS: Non Significant

2- Leaf area index (LAI): The results in Table 3 clearly indicated to significant differences in leaf area index among weeding treatments. The highest leaf area index was recorded in T_2: hand weeding during the whole crop growth period (4.97) and was closely followed by T_4: one weeding using Superfuse herbicide before crop germination and one weeding using U-46 herbicide after crop germination (4.53). Eradication the weeds from the field by applying many hand weeding during the whole crop growth period was better than chemical control of the weeds for two times only, therefore wheat crop might invest photosynthates in attaining the vegetative superiority and higher leaf area index.

The lowest leaf area index was recorded in T_1: without weeding during the whole crop growth period. The highest leaf area index was higher in the variety $Cham_{10}$ (3.64) followed by the variety $Cham_4$ (3.42) and $Cham_3$ (3.37).
The interaction among varieties and weeding treatments was significant indicating to differences in competitive ability among varieties. Similar results were also reported by Balyan (1991).

Table 3. Effect of weed control methods on leaf area index of the studied wheat varieties.

Genotypes	Treatments				Mean
	T_1	T_2	T_3	T_4	
$Douma_1$	1.30	4.42	1.59	4.14	**2.86**
$Cham_3$	1.50	5.34	2.17	4.45	**3.37**
$Cham_4$	1.79	4.97	2.29	4.62	**3.42**
$Cham_{10}$	1.90	5.13	2.59	4.92	**3.64**
Mean	**1.62**	**4.97**	**2.16**	**4.53**	
Variable	**Treatments (T)**	**Varieties (V)**	**T×V**		
$L.S.D_{0.05}$	0.86	0.61	1.49		

3- Crop growth rate (mg.day^{-1}): The results in Table 4 clearly indicated to significant differences in crop growth rate among weeding treatments. The highest crop growth rate was recorded in T_2: hand weeding during the whole crop growth period (286.83 mg.day^{-1}) and was closely followed by T_4: one weeding using Superfuse herbicide before crop germination and one weeding using U-46 herbicide after crop germination (270.58 mg.day^{-1}). Eradication the weeds from the field by applying many hand weeding during the whole crop growth period was better than chemical control of the weeds for two times only, so wheat crop achieved higher dry matter accumulation and crop growth rate due to absence of weed competition. The lowest crop growth rate was recorded in T_1: without weeding during the whole crop growth period (122.43 mg.day^{-1}) due to weed competition on growth factors. With respect to wheat varieties (Table 4) the highest crop growth rate was recorded with the variety Cham10 (225.25 mg.day^{-1}) followed by the variety $Cham_4$ (214.70 mg.day^{-1}) without significant differences among them, whereas the variety $Douma_1$ recorded the lowest crop growth rate (178.25 mg.day^{-1}). The interaction among varieties and weeding treatments was significant indicating the differences in competitive ability among wheat varieties. Similar results were also reported by Williams (1994).

Table 4. Effect of weed control methods on crop growth rate (mg.day^{-1}) of the studied wheat varieties.

Genotypes	Treatments				Mean
	T_1	T_2	T_3	T_4	
$Douma_1$	116.50	240.4	135.60	220.50	**178.25**
$Cham_3$	123.30	290.9	144.20	270.80	**207.30**
$Cham_4$	119.40	300.4	148.50	290.50	**214.70**
$Cham_{10}$	130.50	315.6	154.40	300.50	**225.25**
Mean	**122.43**	**286.83**	**145.68**	**270.58**	
Variable	**Treatments (T)**	**Varieties (V)**	**T×V**		
$L.S.D_{0.05}$	20.22	36.20	57.12		

4- Number of spikes per plant: The results in Table 5 clearly indicated to significant differences in number of spikes per plant among weeding treatments. The highest number of spikes per plant was recorded in T_2: hand weeding during the whole crop growth period (10.50) and was closely followed by T_4: one weeding using Superfuse herbicide before crop germination and one weeding using U-46 herbicide after crop germination (9.29). Whereas the lowest number of spikes per plant was recorded in T_1: without weeding during the whole crop growth period (4.08). With respect to wheat varieties (Table 5) the highest number of spikes per plant was recorded significantly with the variety Cham10 (9.33) and was closely followed by the variety $Cham_4$ (7.94), whereas the variety $Douma_1$ recorded the lowest number of spikes per plant. The interaction among varieties and weeding treatments was significant. Similar results reported by Shah *et al*. (2003).

Table 5. Effect of weed control methods on number of spikes per plant of the studied wheat varieties.

Genotypes	Treatments				Mean
	T_1	T_2	T_3	T_4	
$Douma_1$	3.22	8.00	4.56	7.33	**5.78**
$Cham_3$	3.56	9.67	4.22	8.50	**6.49**
$Cham_4$	4.44	11.11	6.11	10.11	**7.94**
$Cham_{10}$	5.11	13.22	7.78	11.22	**9.33**
Mean	**4.08**	**10.50**	**5.67**	**9.29**	
Variable	**Treatments (T)**	**Varieties (V)**	**T×V**		
$L.S.D_{0.05}$	1.00	1.83	2.85		

5- Number of grains per plant: The results in Table 6 clearly indicated to significant differences in number of grains per plant among weeding treatments. The highest number of grains per plant was recorded in T_2: hand weeding during the whole crop growth period (277.79) and was closely followed by T_4: one weeding using Superfuse herbicide before crop germination and one weeding using U-46 herbicide after crop germination (247.71). Whereas the lowest number of grains per plant was recorded in T_1: without weeding during the whole crop growth period. There was no significant differences among wheat varieties in the number of grains per plant. However, the highest number of grains per plant was recorded with the variety $Cham_{10}$ (200.81) followed by the variety Cham4 (183.27).

Table 6. Effect of weed control methods on number of grains per plant of the studied wheat varieties.

Genotypes	Treatments				Mean
	T_1	T_2	T_3	T_4	
$Douma_1$	62.68	250.00	92.78	220.20	**156.42**
$Cham_3$	80.85	267.67	110.95	237.60	**174.24**
$Cham_4$	86.40	282.50	113.44	252.55	**183.75**
$Cham_{10}$	91.36	311.00	120.39	280.50	**200.81**
Mean	**80.32**	**277.79**	**109.39**	**247.71**	
Variable	**Treatments (T)**	**Varieties (V)**	**T×V**		
$L.S.D_{0.05}$	31.54	NS	98.73		

NS: Non Significant

The increase of the number of spikes per plant in the variety $Cham_{10}$ and $Cham_4$ resulted in increasing the number of grains per plant in both varieties, whereas the lowest number of grains per plant (156.42) has been recorded in the variety $Douma_1$. The interaction among varieties and weeding treatments was significant indicating the differences in competitive ability among wheat varieties. Similar results were also reported by Shah *et al*. (2003).

6- 1000-Kernel weight (g): The results in Table 7 showed that there was significant differences in 1000-Kernel weight among weeding treatments. The highest 1000-kernel weight was recorded in T_2: hand weeding during the whole crop growth period (34.80 g) and was closely followed by T_4: one weeding using Superfuse herbicide before crop germination and one weeding using U-46 herbicide after crop germination (31.72 g). Whereas the lowest 1000-kernel weight was recorded in T_1: without weeding during the whole crop growth period (26.18 g). With respect to wheat varieties (Table7) the highest 1000-kernel weight was recorded with the variety Douma1 (33.65 g) followed by the variety Cham3 (30.38 g) without significant differences among them. The interaction among varieties and weeding treatments was significant. Similar results were also reported by Akhtar *et al*. (1991)

Table 7. Effect of weed control methods on 1000-kernel weight of the studied wheat varieties.

Genotypes	Treatments				Mean
	T_1	T_2	T_3	T_4	
$Douma_1$	29.60	35.71	37.93	31.37	**33.65**
$Cham_3$	28.00	35.76	26.33	31.43	**30.38**
$Cham_4$	23.10	33.04	27.43	31.71	**28.82**
$Cham_{10}$	24.03	34.69	21.37	32.36	**28.11**
Mean	**26.18**	**34.80**	**28.27**	**31.72**	
Variable	**Treatments (T)**	**Varieties (V)**	**T×V**		
$L.S.D_{0.05}$	2.40	5.36	7.81		

7- Grain yield ($kg.ha^{-1}$): The results in Table 8 clearly indicated to significant differences in grain yield among weeding treatments. The highest grain yield was significantly recorded in T_3: hand weeding during the whole crop growth period (5689.52 $kg.ha^{-1}$) followed by T_4: one weeding using Superfuse herbicide before crop germination and one weeding using U-46 herbicide after crop germination (4850.48 $kg.ha^{-1}$).

Table 8. Effect of weed control methods on grain yield ($kg.ha^{-1}$) of the studied wheat varieties.

Genotypes	Treatments				Mean
	T_1	T_2	T_3	T_4	
$Douma_1$	2040.23	4543.35	3045.23	4096.28	**3431.27**
$Cham_3$	2542.44	5615.56	3440.92	4549.47	**4037.10**
$Cham_4$	2719.25	6184.54	3749.48	5168.62	**4455.47**
$Cham_{10}$	3184.36	6414.63	3984.84	5587.55	**4792.85**
Mean	**2621.57**	**5689.52**	**3555.12**	**4850.48**	
Variable	**Treatments (T)**	**Varieties (V)**	**T×V**		
$L.S.D_{0.05}$	202.93	462.81	NS		

NS: Non Significant.

Eradication the weeds from the field by applying many hand weeding during the whole crop growth period was better than chemical control of the weeds for two times only. The lowest grain yield was recorded in T_1: without weeding during the whole crop growth period (2621.57 kg.ha^{-1}), the harmful effect of weeds may be attributed to competition and allelopathic effect of weeds on wheat plants. With respect to wheat varieties (Table 8) the highest grain yield was recorded with the variety $Cham_{10}$ (4792.85 kg.ha^{-1}) followed by the variety Cham4 (4455.47 kg.ha^{-1}) without significant differences among them, whereas the variety $Douma_1$ recorded the lowest grain yield (3431.27 kg.ha^{-1}). Differences in competitive ability appear to be related to various attributes including rate of establishment, vegetative growth, tillering and plant height. The interaction among varieties and weeding treatments was not significant. Similar results were also reported by Aboziena *et al*., (2007).

8- Harvest index (%): The results in Table 9 clearly indicated to significant differences in harvest index among weeding treatments. The highest harvest index was recorded in T_2: hand weeding during the whole crop growth period (47.78%) and was closely followed by T_4: one weeding using Superfuse herbicide before crop germination and one weeding using U-46 herbicide after crop germination (46.87%). Whereas the lowest harvest index was recorded in T_3: one weeding by harrow after 20 days from weed germination and one weeding by hand after 45 days from weed germination (42.65%). With respect to wheat varieties (Table 9) the highest harvest index was recorded with the variety Cham10 (47.32%) followed by the variety Cham4 (46.42%) without significant differences among them, whereas the variety $Douma_1$ recorded the lowest harvest index (42.61%). The interaction among varieties and weeding treatments was not significant. Similar results were also reported by Mason *et al*. (2008).

Table 9. Effect of weed control methods on harvest index (%)of the studied wheat varieties.

Genotypes	Treatments				Mean
	T_1	T_2	T_3	T_4	
$Douma_1$	41.48	42.07	41.92	44.98	**42.61**
$Cham_3$	42.95	47.48	42.60	46.32	**44.84**
$Cham_4$	44.17	50.56	43.72	47.21	**46.42**
$Cham_{10}$	46.94	51.00	42.37	48.98	**47.32**
Mean	**43.89**	**47.78**	**42.65**	**46.87**	

Variable	Treatments (T)	Varieties (V)	T×V
$L.S.D_{0.05}$	1.04	2.09	NS

NS: Non Significant

Conclusion

Weeds limit wheat yield potential because they compete with wheat plants for limited growth factors. We can conclude from this study that hand weeding during the whole crop growth period or chemical control using Superfuse and U-46 herbicides are recommended to manage weeds and to get higher values of number of spikes and grains per plant, 1000-kernel weight and grain yield of wheat crop. Growing competitive varieties for weeds like $Cham_{10}$ or $Cham_4$ can be recommended to obtain higher grain yield and its components of wheat crop under rainfed conditions.

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