

## Effect of Tillage Technique and Herbicides on Weeds and Yield of Transplanted Rice.

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### ABSTRACT

A field study was carried out at the experimental farm of Rice Department, Sakha, Kafr El-Sheikh, Egypt during 2016 and 2017 seasons to detect the effect of tillage technique and herbicides use on weeds and yield of transplanted rice. A strip plot design with four replicates was applied. Tillage techniques (Zero tillage + puddling, one tillage + puddling, two tillage + puddling and two tillage without puddling) were allocated in horizontal strips. Weed control treatments were weedy check, hand weeding, thiobencarb (Saturn 50 % EC) at recommended dose (2.4 kg ai ha<sup>-1</sup>) and penoxsulam (Granite 24% SC) at recommended dose (0.029 kg ai ha<sup>-1</sup>) were assigned as vertical plots. Weed flora and rice yields were considerably affected by tillage technique and weed control treatments. *Cyperus difformis*, *Ammania* sp., *Scirpus* sp. and total weeds dry weights were noticeably reduced fewer than two tillage + puddling plots than with other tillage technique. But *Echinochloa crus-galli* and *Echinochloa colona* were significantly reduced under zero tillage + puddling plots than under other tillage techniques. The highest values of panicles per unit area, panicle weight (g), filled grains / panicle, biological yield, grain yield (t ha<sup>-1</sup>) and harvest index of rice (%) were recorded under two tillage + puddling plots followed by one tillage + puddling than under other tillage techniques. The application of penoxsulam resulted in the best weed control and best rice grain yield (t ha<sup>-1</sup>) and its components under this study followed by the application of thiobencarb. Untreated (weedy check) plots gave the highest weed presence and the lowest rice yields and its components in 2016 and 2017 seasons under this study. For the interaction, the lowest values of dry weight for *Echinochloa crus-galli*, *Echinochloa colona*, *Cyperus difformis*, *Ammania* sp., *Scirpus* sp. and total weeds, in addition to the highest grain yield of rice was obtained under two tillage + puddling treated by penoxsulam 24% SC as the recommended dose during the two growing seasons.

**Keywords:** Tillage technique, Herbicides, Puddling, Weed control, Total weeds and Rice grain yield

### INTRODUCTION

Rice is one of the most important foods in the world among all staple food crops. 60% or more in the world's population relies on rice for food, protein and calories, especially in developing countries. Rice is considered as other grain crops, suffering from competition of weeds (Rao *et al.* 2007). Uncontrolled weed compete with rice and cause yield losses of up to 50-65% with transplanted rice (Spia and Sridivi 2000) and up to 76% in direct-seeded rice (Singh *et al.*, 2009). Traditional tillage is a soil management system that relies on tillage to control all the weeds and previous crop residues (Stobbe, 1990). Tillage methods are one of the processes affecting the appearance of weeds in most arable land. Also reduced tillage or no-tillage method used widely with many crops in the world wide and this methods has potential to allow saving in labour, time, water and energy during rice season (Piggin *et al.* 2002). It has therefore growing significance due to receding water table and rising labour costs for paddy transplantation (Humphyreys *et al.* 2004) and (Singh *et al.* 2005). A no-till method is a soil management method that increases bulk of soil organic matter, reduces poor soil and can also increase crop yield (Bayer *et al.* 2000, Santos *et al.* 2011, and Crucioli *et al.* 2012). Low tillage and no-till method can gave rice grain yield similar to those produced with classical puddling (Mabbayad and Buencosa 1967, Mittra and Pieris 1968, De Datta *et al.*, 1979 and Rodriguez and Lal 1979). It has been show that in clay soil, low tillage gave similar rice grain yield as puddling (Sharma *et al.* 1988). Conservation tillage recorded better yield than no-tillage method (Bhattacharaya *et al.* 2006). In other research, transplanted rice and direct seeded at no-tillage recorded the same yields (Singh *et al.* 2008).

Herbicides are considered to be a replacement or complement to hand weeding. Various pre-emergence

herbicides including thiobencarb, butachlor, oxadiazon, oxyfluorfen, pendimethalin and nitrofen alone or with hand weeding achieved the same weed control (Estorninos and Moody 1988, Janiya and Moody 1988, Pellerin and Webster 2004). But, many factors can affect pre-emergence herbicides, like soil moisture at the time of their application and their limited duration of application (0-5 days after sowing). In such case, post-emergence herbicides are superior. Hence, it is needful to evaluate different pre and post-emergence herbicides that are formulated from time to time to provide wider options to farmers for weed control in rice. Limited of water irrigation and high costs for labor has caused farmers to convert from manual transplanting to direct-seeding in many world countries. However, yield losses due to weeds in direct seeding rice higher than in transplanted rice because of simultaneous emergence of weeds and crops and non-attendance of standing water at the early stages of crop to inhibit weed growth. (Tuong *et al.* 2005, Chauhan and Johnson 2010). Hassan *et al.* (2008) demonstrated that, bispyribac mixed with thiobencarb registered the efficient weed biomass inhibition, more effective weed control percentages and higher rice yields. (Singh *et al.* (2009) reported that highest rice yield was acquired with penoxsulam at 22.5 and 20.0 g.ha<sup>-1</sup> at 3 days after translating respectively. penoxsulam at 22.5 and 20.0 g.ha<sup>-1</sup> was found better against weeds than pretilachlor and butachlor. Weed check plot registered 41.0 and 34.0 % lower grain yield as compared to the treatments producing highest grain yield. The main objective of current study was to evaluate the effectiveness of various tillage techniques and herbicides applications on weed control and rice yields.

### MATERIALS AND METHODS

A field study was conducted in 2016 and 2017 seasons at Rice Department, Sakha, Kafer El-sheikh to

study effect of tillage technique and herbicides on weed flora and yields of transplanted rice. The field was ploughed and dry leveled according to the studied treatments in transplanted rice. Sakha 104 cultivar was planting in the prepared nursery at 100 Kg ha<sup>-1</sup>. Under the permanent field, tillage techniques were: Zero tillage + puddling, one tillage + puddling, two tillage + puddling and two tillage without puddling. Weed control treatments were: Weedy check, Manual weeding times at 20 and 40 days after transplanting ( DAT), thiobencarb (Saturn 50 % EC) at 2.4 kg ai ha<sup>-1</sup> and penoxsulam (Granite24% SC) at dose of 0.029 kg ai ha<sup>-1</sup>. All other agronomic, water management and fertilization were applied as recommended for transplanting rice. A strip plot design as four replicates was applied where tillage techniques were assigned in the main strips while weed treatments were allocated in sub-plots.

**Weed flora:**

General presence of weed flora in the field was observed in check plots at 60 DAT, weed flora of the experiment predominantly consisted of grass weeds were *Echinochloa colomum* (20%) and *Echinochloa crus-galli* (33%), broadleaves (*Ammania sp.* 22%), and sedges contained *Scirpus sp* and *Cyperus difformis* (25%).

**Sampling and data were recorded as follows:**

At 60 DAT, weeds in 50 x 50 cm quadrate replicated four times for each plot were pulled out, classified, dried about 24 hour at 70 OC in an oven and dry weight for total weeds was obtained.

For the rice plant, panicles m-2 was recorded at maturity. At harvest, the central 6 m2 of rice were manually harvested, threshed and weight. The yield as t/ha at 14% moisture was recorded.

**Statistical analysis:-**

Analysis of variance was carried out according to Gomez and Gomez (1984) using MSTAT software. Duncan’s Multiple Range Test (DMRT) was used to compare among means of treatments (Duncan, 1955).

**RESULTS AND DISCUSSION**

**A- Weeds:**

**Influence of tillage technique on dry weight of weeds:**

Dry weight (g.m-2) of *Echinochloa crus-galli*, *Echinochloa colona*, *Cyperus difformis*, *Ammania sp.*, *Scirpus sp.* and total weeds as influenced by tillage technique in 2016 and 2017 seasons are presented in Table (1). Zero tillage + puddling gave the lowest dry weight of *E. crus-galli* and *E. colona* compared to other tillage technique followed by one tillage + puddling in both seasons. One tillage + puddling and two tillage + puddling gave the lowest dry weight of total weeds compared to other tillage technique in the two seasons. On the other hand two tillage + puddling gave the lowest *C. difformis*, *Ammania sp.*, *Scirpus sp.* dry weight compared to other tillage compared to other tillage. These findings confirmed with these obtained by (Bayer *et al.* 2000), (Bhattacharaya *et al.* 2006) and (Humphreys *et al.* 2004).

**Table 1. Dry weights (g.m<sup>-2</sup>) of *E. crus-galli*, *E. colona*, *C. difformis*, *Ammania sp.*, *Scirpus sp.* and total weeds, as affected by tillage technique during 2016 and 2017 seasons.**

Tillage technique	Dry weight of weeds (g.m <sup>-2</sup> )					Total weeds
	<i>E. crus-galli</i>	<i>E. colona</i>	<i>C. difformis</i>	<i>Ammania sp</i>	<i>Scirpus sp</i>	
2016 season						
Zero tillage+puddling	27.10 d	8.90 d	112.90 b	220.07 a	84.08 a	453.05 b
One tillage+puddling	39.43 c	48.30 c	82.80 b	94.08 b	39.33 b	303.93 c
Two tillage+puddling	72.09 b	120.20 b	16.70 c	14.60 c	14.20 c	237.80 c
Two tillage without puddling	130.11 a	144069 a	197.30 a	23.46 c	35.30 b	530.85 a
2017 season						
Zero tillage+puddling	29.00 d	21.00 d	139.00 b	111.00 a	59.72 a	360.10 b
One tillage+puddling	67.00 c	29.00 c	97.00 c	88.00 b	40.31 b	321.70 c
Two tillage+puddling	106.00 b	63.00 b	69.00 d	72.00 c	19.36 c	341.90 b
Two tillage without puddling	134.00 a	100.00 a	170.00 a	93.00 b	33.20 b	529.00 a

In a column for season, means followed by the same letter are not significantly different at 5% level according to DMRT (in all tables).

**Effect of weed control on dry weight of weeds**

Data on weed dry weight as influenced by weed control (Table 2) revealed that, the applied weed management treatments significantly reduced weed dry weights as compared to weedy check in 2016 and 2017 seasons. Within the treated plots, penoxsulam 24 % SC found to be significantly superior in controlling the weeds and recorded least dry weight of weeds followed by thiobencarb 50%. However, two times hand weeding recorded dry weight of weeds significantly less than the untreated plots in transplanted rice. These results was true during both seasons. Pal *et al.* (2009) found that penoxsulam 24% SC at 0.00225 kg a.i. ha<sup>-1</sup> applied at 8-12 DAT was most effective to check all types of weed

species and their growth. These results are conformed with the findings of (Humphreys *et al.* 2004, Hassan *et al.* 2008 and Hasanuzzaman *et al.* 2009).

**Effect of the interaction between tillage technique and weed treatments on total dry weight of weeds:**

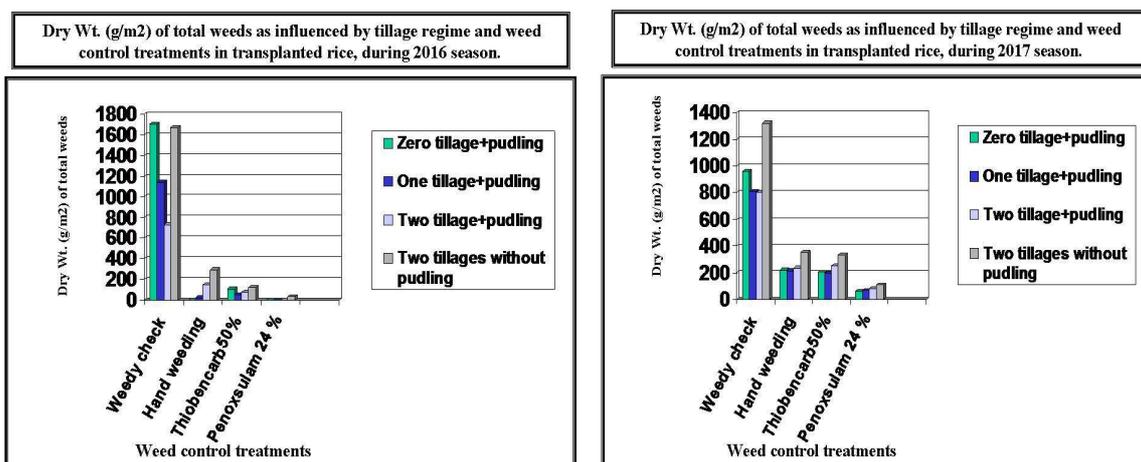
Data in Figure (1) show that tillage technique x weed control significantly affected weed dry weight during seasons of study. The used treatments of weed control reduced total dry weight of weeds under all tested tillage techniques as compared to the un-treated (control) plots during 2016 and 2017seasons. Dry weight of total weeds was significantly inhibited by the application of penoxsulam 24% SC with all tested tillage techniques compared to other weed controlling

treatments. This may be due to increased efficiency of penoxsulam 24% SC more than thiobencarb 50% EC in the effect on weed control. Same results trends were found by (Bhattacharaya *et al.* 2006), (Pellerin and Webster 2004), (Bazaya *et al.* 2009) and (Hassan *et al.* 2008). Bahgat *et al.* (1999) found that, the herbicides levels (half and full doses) integrating tillage were

equally effective and produced statistically similar rice yields. Azmi and Baki (2006) showed that to ensure weeds are suppressed during conventional puddling (CP), pre-emergence herbicides are normally applied before or after rice sowing and these herbicides must have residual activity to control weeds at the critical period of weed competition.

**Table 2. Dry weight (g.m<sup>-2</sup>) of *E. crus-galli*, *E. colona*, *C. difformis*, *Ammania* sp., *Scirpus* sp. and total weeds, as influenced by weed control treatments during 2016 and 2017 seasons.**

Treatments	Dry weight of weeds (g.m <sup>-2</sup> )							
	Rate (kg ai/ha)	Time DAT	<i>E. crus-galli</i>	<i>E. colona</i>	<i>C. difformis</i>	<i>Ammania</i> sp	<i>Scirpus</i> sp	Total weeds
2016 season								
Weedy check	-	-	360.10 a	220.69 a	307.10 a	222.80 a	200.88 a	1311.56 a
Hand weeding	-	20 fb 40	38.09 b	55.95 b	20.64 b	0.02 b	0.02 b	114.63 b
Thiobencarb	2.3	4	35.15 b	40.70 b	24.39 b	24.30 b	0.02 b	90.19 c
Penoxsulam	0.029	10	0.02 c	9.20 c	0.02 b	0.02 b	0.02 b	9.25 d
2017 season								
Weedy check	-	-	206.00 a	119.00 a	286.00 a	210.00 a	152.38 a	973.80 a
Hand weeding	-	20 fb 40	57.00 b	41.00 b	80.00 b	77.00 b	0.10 b	254.70 b
Thiobencarb	2.3	4	56.00 b	40.00 b	74.00 b	66.00 c	0.09 b	254.40 b
Penoxsulam	0.029	10	16.00 c	13.00 c	35.00 c	11.00 d	0.02 b	78.70 c



**Figure 1. Total weeds dry weight (g.m<sup>-2</sup>) as influenced by tillage technique and weed control treatments during 2016 and 2017 seasons.**

**B- Rice:**

**Effect of tillage technique on panicles per square meter, panicle weight (g), number of filled grains / panicle, biological yield, grain yield (t ha<sup>-1</sup>) and harvest index (%) of rice in 2016 and 2017 seasons.**

Tillage technique showed high considerable effect on number of panicles per square meter, panicle weight (g), number of filled grains / panicle, biological yield, grain yield (t ha<sup>-1</sup>) and harvest index (%) of rice in the two seasons of study (Table 3). The largest number of panicles per unit area, panicle weight (g), filled grains / panicle, biological yield, grain yield (t ha<sup>-1</sup>) and harvest index (%) of rice were obtained from two tillage + puddling followed by one tillage + puddling compared to other tillage technique in this study. On the other side, the lowest figures of these characters of rice were recorded from zero tillage + puddling in 2016 and 2017 seasons. These obtains are conformity with the findings of (Bayer *et al.* 2000), (Bahgat *et al.* 1999), (Piggin *et al.* 2002) and

(Humphreys *et al.* 2004). The increase of rice yield attributes under tow tillages + puddling may be related the enhancement of rice growing conditions under such conditions referred to more root system growth and nutrients uptake by rice as mentioned by (Bhattacharaya *et al.* 2006).

**Effect of weed control treatments on number of panicles/m<sup>2</sup>, panicle weight (g), filled grains / panicle, biological yield, grain yield (t ha<sup>-1</sup>) and harvest index (%) of rice in 2016 and 2017 seasons.**

Number of panicles/m<sup>2</sup>, panicle weight (g), filled grain/panicle, biological , grain yield (t ha<sup>-1</sup>) and harvest index of rice as influenced by weed control treatments in 2016 and 2017 seasons are presented in Table (4). Generally, all chemical and manual weed control treatments significantly increased panicle weight, filled grains/panicle, biological, grain yield (t ha<sup>-1</sup>) and harvest index of rice than untreated check plots. Rice plots treated by penoxsulam 24% SC at rate of 0.029 kg ai. ha<sup>-1</sup> produced the highest panicle weight,

number of filled grain panicle-1, biological , grain yield (t ha<sup>-1</sup>) and harvest index of rice followed by thiobencarb 50% and hand weeding. The same trend was true during 2016 and 2017 seasons. This efficient weed control, reduce competition and allocate more resources for intact grain production and panicle weight (g), in addition to biological yield (t ha<sup>-1</sup>), harvest index and rice grain yield (Hassan *et al.* 2008) and (Yaaghoubi, 2010). Yield improvement of intact grain in the cluster can be due to appropriate weed control by the application of penoxsulam 24 % SC attributed. While a number of weeds in hand weeding twice control after the tillering stage and crop canopy development, growth, have a low competitiveness compared to untreated plots, where rice plants are suffering high weed competition all season of weed with the crop as reported in the study of Hassanuzzaman (2009) belongs to the "weed infest"

control and treatment penoxsulam 24% SC had the highest number of grain clusters probably, panicle weight (g), in addition to biological yield (t ha<sup>-1</sup>), harvest index and grain yield (t ha<sup>-1</sup>) because the treatment was weed-free conditions. Alam *et al.* (2002) reported that rice traits such as panicle weight (g), filled grain/ panicle and grain yield (t ha<sup>-1</sup>) of rice were significantly affected by different weed control treatments. Number of panicles/m<sup>2</sup>, panicle weight (g), filled grains/panicle, biological and grain yields and harvest index were maximized by using the recommended rate of herbicide followed by hand weeding. Pal *et al.* (2009) found that penoxsulam 24% SC at 0.00225 kg a.i. ha<sup>-1</sup> applied at 8-12 DAT gave the highest grain yield (3.53 t. ha<sup>-1</sup>) and straw yield (4.73 t. ha<sup>-1</sup>) for rice resulting in lowest weed index (5.61 %). In our study, the results were similar to them results.

**Table 3. Number of panicles/m<sup>-2</sup>, panicle weight (g), filled grains / panicle, biological yield, grain yield (t ha<sup>-1</sup>) and harvest index (%) of rice as influenced by tillage techniques during 2016 and 2017 seasons.**

Treatment	Number of panicles m <sup>-2</sup>	Panicle weight (g)	Number of filled grain panicle <sup>-1</sup>	Biological yield (t ha <sup>-1</sup> )	Grain yield (t h <sup>-1</sup> )	Harvest index (%)
2016 season						
Zero tillage+puddling	375.5 d	2.18 d	81.00 d	19.73 b	7.89 b	40.07 c
One tillage+puddling	470.3 b	2.76 b	104.00 b	20.88 a	8.56 a	40.76 b
Two tillage+puddling	500.0 a	2.83 a	112.00 a	20.68 a	8.63 a	41.81 a
Two tillage without puddling	410.0 c	2.39 c	94.00 c	19.73 b	8.09 b	41.70 a
2017 season						
Zero tillage+puddling	391.3 d	2.25 d	83.00 d	19.69 c	8.43 c	42.18 b
One tillage+puddling	498.0 b	2.58 b	99.00 b	21.19 a	9.03 b	42.61 b
Two tillage+puddling	521.3 a	2.79 a	107.00 a	20.79 b	9.49 a	45.65 a
Two tillage without puddling	438.8 c	2.46 c	92.00 c	20.56 b	8.68 c	42.22 b

**Table 4. panicle weight (g), filled grain/panicle, biological, grain yields (t ha<sup>-1</sup>) and harvest index of rice as influenced by weed control treatments during 2016 and 2017 seasons.**

Treatments	Number of panicles (m <sup>-2</sup> )	Panicle weight (g)	Filled grains /panicle	Biological yield (t ha <sup>-1</sup> )	Grain yield (t/ha)	Harvest index (%)
2016 season						
Weedy check	207.5 c	1.86 c	76.0 c	17.60 c	3.65 c	20.2 c
Hand weeding	500.0 b	2.58 b	101.0 b	20.15 b	9.30 b	46.2 b
Thiobencarb	505.0 b	2.69 b	106.0 a	20.80 b	9.56 b	46.0 b
Penoxsulam	545.0 a	3.03 a	108.0 a	22.50 a	10.67 a	47.4 a
2017 season						
Weedy check	242.5 c	1.92 c	74.0 c	16.61 c	3.83 c	23.1 c
Hand weeding	520.0 b	2.53 b	97.0 b	21.18 b	9.94 b	46.9 b
Thiobencarb	532.8 b	2.59 b	104.0 a	21.48 b	10.22 b	47.6 b
Penoxsulam	555.0 a	3.05 a	106.0 a	22.96 a	11.15 a	48.6 a

**Effect of interaction between tillage technique and treatments of weed control on grain yield (t ha<sup>-1</sup>):**

Data in Figure (2) show that the effect of interaction between tillage techniques and treatments of weed control significantly affected grain yield of rice (t ha<sup>-1</sup>) in the two seasons of study. Herbicides and hand weeding have increased grain yield under all tillage techniques as compared to weed check during 2016 and 2017 seasons. The grain yield was significantly

increasing by application of penoxsulam 24% SC with each tillage system compared to other weed treatments. Similar results were found by (Bhattacharaya *et al.* 2006), (Pellerin and Webster 2004) and (Bazaya *et al.* 2009). The superiority of penoxsulam application for weed control in rice for higher grain yield may referred to the high weed suppression and more favorable growth conditions for yield attributes of rice as reported by (Pal *et al.* 2009) and (Alam *et al.* 2002).

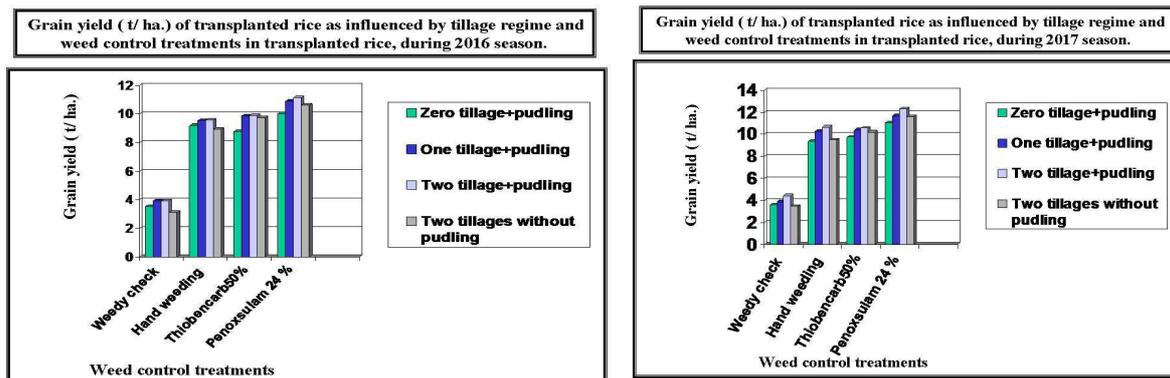


Figure 2. Grain yield (t ha<sup>-1</sup>) of transplanted rice as influenced by tillage techniques and treatments of weed control during 2016 and 2017 seasons.

### CONCLUSION

Generally, tillage methods are one of the processes affecting the appearance of weeds in most arable land and integration with herbicides.

**Based on the obtained results, it could be concluded that:**

- 1- Different tillage technique exhibited different performance against weeds and yield, and its components. (Two tillage + puddling followed by one tillage + puddling).
- 2- Penoxsulam (Granite24% SC) at dose of 0.029 kg ai ha<sup>-1</sup>. achieved the highest grain yield of rice followed by thiobencarb (Saturn 50 % EC) at 2.4 kg ai ha<sup>-1</sup>.
- 3- The best integration for highest grain yield of rice and weed control was two tillage + puddling with Penoxsulam (Granite24% SC) at dose of 0.029 kg ai ha<sup>-1</sup>.

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## تأثير نظم الخدمة ومبيدات الحشائش على الحشائش و محصول الأرز الشتل.

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أقيمت دراسة حقلية بالمزرعة البحثية لقسم بحوث الأرز - سخا- كفر الشيخ- مصر، لدراسة تأثير نظم الخدمة ومبيدات الحشائش على الحشائش ومحصول الأرز الشتل خلال موسم الزراعة 2016، 2017. استخدم تصميم الشرائح المتعمدة ذو أربعة مكررات في تنفيذ التجربة خلال موسم الدراسة حيث وزعت معاملات الخدمة (بدون خدمة+ تلويط و حرث مرة واحدة + تلويط و حرث مرتين + تلويط و حرث مرتين بدون تلويط) في الشرائح الأفقية بينما وزعت معاملات مكافحة الحشائش (غير المعامل، نقاوة يدوية مرتين، ثيوبينكارب (ساتيرن 50%) بمعدل 2.4 كجم مادة فعالة/ هكتار، بينوكسولام (جرانيت 24%) بمعدل 0.029 كجم مادة فعالة / هكتار) في الشرائح المتعمدة. أظهرت النتائج تأثيراً معنوياً على الوزن الجاف لحشيشة الدنيبة وأبوركيه والعجيرة و رجل الحمامة والسويده والوزن الجاف الكلي للحشائش، وكذلك على عدد الداليات / م<sup>2</sup>، وزن الدالية، وعدد الحبوب الممتلئة/ دالية، المحصول البيولوجي ومحصول الحبوب ودليل الحصاد حيث تأثرت هذه الصفات معنوياً بمعاملات الخدمة حيث أعطت معاملة الخدمة مرتين مع التلويط أفضل النتائج من حيث مكافحة الحشائش والمحصول ومكوناته يليها معاملة الخدمة مرة واحدة مع التلويط مقارنة بباقي معاملات الخدمة. وأعطت طريقة الزراعة بدون خدمة أقل وزن جاف لحشيشة الدنيبة وأبوركيه مقارنة بباقي معاملات الخدمة تحت الدراسة. وأظهرت المعاملة بمبيد بينوكسولام أفضل مكافحة للحشائش وأعلى محصول حبوب للأرز ومكوناته. كما كان للتفاعل بين معاملات الخدمة ومعاملات مكافحة الحشائش تأثيراً معنوياً علي الصفات المدروسة للحشائش والأرز، حيث كانت أفضل معاملة هي معاملة مبيد البينوكسولام مع معاملة الخدمة مرتين ثم التلويط في مكافحة الحشائش ومحصول الأرز ومكوناته خلال موسم الدراسة.