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CHEMICAL CONTROL FOR WEEDY RICE ACCOMPANIED TO THREE RICE CULTIVARS UNDER DRILL-SEEDING CULTIVATION

S. S. M. Abd El-Naby

Rice Dept., Field Crop Research Institute, ARC, Giza, Egypt.

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ABSTRACT: ***Two field experiments were carried out at the Experimental Farm of Sakha Agricultural Research Station, Kafrelsheikh, Egypt during 2017 and 2018 summer seasons to study the impact of rice cultivars and chemical control on weedy rice in drill-seeded rice. Three rice cultivars (Giza 178, Giza 177 and Sakha 101) were used. Fifteen weedy rice chemical control treatments, viz, thiobencarb (3.57 kg ai ha^{-1}) at 4 DAS alone or followed by fenoxaprop-ethyl, bispyribac-sodium and propanil (recommended doses) at 35, 18 and 20 DAS, respectively, pendimethalin (2.023 kg ai ha^{-1}) at 4 DAS alone or followed by fenoxaprop-ethyl, bispyribac-sodium and propanil as recommended, oxadiazon (0.595 kg ai ha^{-1}) at 4 DAS alone or followed by fenoxaprop-ethyl, bispyribac-sodium and propanil by recommended rates, in addition to fenoxaprop-ethyl, bispyribac-sodium and propanil (as post-emergence herbicides) by recommended doses as compared with weedy check and weedy rice free plots were applied. A split-plot design arranged in randomized complete block with three replications was used in both seasons. Main plots were devoted to common rice cultivars while, the sub-plots included weedy rice control treatments in both seasons. The results showed Giza 178 appeared the best competitiveness ability against red rice and significantly reduced dry weight and grain yield of red rice, consequently produced the highest dry weight, yield and yield attributes of cultivated rice as well as reduced yield losses in 2017 and 2018 seasons. Under heavy infestation of weedy rice, oxadiazon at 4 DAS followed by fenoxaprop-ethyl at 35 DAS recorded the lowest dry weight, grain yield ha^{-1} of red rice as well as the highest weedy rice control efficiency percent, moreover the best cultivated rice growth, yield and its attributes as well as minimized yield losses to 27.9% as average in both seasons. It could be concluded that, under heavy infestation of weedy rice, cultivating Giza 178 rice cultivar and the application of oxadiazon at rate of 0.595 kg ai ha^{-1} at 4 DAS followed by fenoxaprop-ethyl under rate of 0.0625 kg ai ha^{-1} applied at 35 DAS can achieve the best weedy rice control, highest cultivated rice growth, yield and yield attributes under drill-seeding conditions.***

Key words: ***Weedy rice, cultivated rice, pre, post-emergence, herbicides, yield, competition, losses, control.***

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important cereal crops in Egypt as well as worldwide. It is also the main dish for most of Egyptians. FAOSTAT (2016) reported that the harvested area in Egypt was 672,582 hectares and total production was 6,300,000 tons of paddy rice by average of 9.367 t ha^{-1}.

Rice crop face many limiting factors for production but weeds are considered the key biotic threat for rice production especially in direct-seeded rice. In this respect, Rao *et al*., (2007) found that weed-induced yield losses can be as high as 100% under direct-seeded rice (DSR) conditions. Weedy rice is the most aggressive and common weed in rice fields, it is define as undesirable plants of genus *Oryza* which have some desirable traits and pose threat to rice production worldwide. Weedy rice is also referred to red rice because it's red pericarp (Nadir *et al.*, 2017).

In Egypt, red rice problem reappear in rice cultivation system in the latest five years especially in direct seeded rice, it compete rice plants on water, macro and micro elements, light, space and other growing demands from the soil and environment and cause weakness for cultivated rice growth, low yield and damage grain quality (Chauhan, 2013) which led to decreasing farmer income from rice production, consequently reduce national income of the country. Moreover, its seed longevity reaches to seven years in the soil.

Weedy rice has a wide variability and high similarity to cultivated rice in morphological and anatomical traits, but there are many differences between cultivated and weedy rice. Red rice is rapidly germinate by 24-48 hours than cultivated rice, seedling vigor and strong vegetative growth, strong root system, high tillering ability with a huge leaf area, tall plants and awned panicles. Moreover, early maturity, seed shattering in short period, seed dormancy and longevity which make weedy rice control too difficult and complex (Esqueda, 2000, Ferrero, 2003 and Karim *et al.*, 2006).

In this concern, Azmi and Karim (2008) cited that weedy rice can cause a yield loss of 60% under moderate infestation (15-20 plants of weedy rice m^{-2}), 80% under high infestation (21-30 plants of weedy rice m^{-2}), and 100% under heavy infestation (more than 30 plants m^{-2}).

Weedy rice control must be a combination of preventive methods, cultural practices, mechanical and chemical control (Fischer and Ramirez, 1993), in addition to increase awareness about morphological, biology, ecology and control of weedy rice. Rice cultivar choice is very important in the infested area by red rice. It must be rapid germination, have strong root and shoot systems, high tillering ability and rapid soil coverage and occupy the spaces in soil surface to maximize crop-competition against weedy rice plants and decrease the undesirable effect of red rice on rice plants, reduce yield losses and improve grain quality of cultivated rice (Azmi and Abdullah, 1998).

The previous studies reported that pre-emergence herbicides can be used to delay or prevent the germination of weedy rice seeds. Red rice has been found to be more sensitive to molinate and thiobencarb applied pre-planting (Baker *et al.*, 1986 and Forner, 1995). Singh *et al.*, (2013) reported that pre-emergence herbicides, such as acetochlor (1.5 kg ai ha^{-1}), metolachlor (2.5 kg ai ha^{-1}), alachlor (2.4 kg ai ha^{-1}), and dimethenamid (1.4 kg ai ha^{-1}), provided 85-92% control of weedy rice with no phytotoxicity on cultivated rice plants. The previous studies also referred to inability to depend on post-emergence herbicides alone in weedy rice management especially in DSR because of the high similarity between cultivated and red rice in vegetative stage in addition to the same age for both.

The main target of this research is how to make a good combination by employing rice cultivars, pre and post-emergence herbicides to increase the productivity of drill-seeded rice under heavy infestation of red rice.

MATERIALS AND METHODS

Two field experiments were carried out during 2017 and 2018 seasons at the Experimental Farm of Sakha Agricultural Research Station, ARC, Egypt to select the best combination from rice cultivars and pre or post-emergence herbicides in controlling weedy rice under drill-seeded rice conditions. Rice cultivars were planted by drilling machine at seed rate of 120 kg ha^{-1} at 15 and 20^{th} of May in both seasons respectively. Red rice infestation was done after cultivated rice drilling before irrigation and fixed at density of 25 plants m^{-2}, red rice seeds were cultivated by hand between cultivated rice rows. Plot size was 14 m^2. A split-plot design arranged in randomized complete block with three replications was used in both seasons. Main plots were devoted to the three rice cultivars while, the sub-plots included weedy rice control treatments in both seasons. The rest rice agricultural practices were applied as recommended for drill-seeded rice.

Studied factors were as follow:

a- Rice cultivars:

1- Giza 178. Giza177. Sakha 101.

The three cultivars were introduced by breeding program at Rice Dept., Field Crops Research Institute (FCRI), ARC, Giza, Egypt.

b-Weedy rice control treatments were as follow:

1- Thiobencarb 50% EC at 3.57 kg ai $ha^{-1.}$
2- Thiobencarb 50% EC followed by fenoxaprop-ethyl 7.5% EW at rate of 0.0625 kg ai ha^{-1}.
3- Thiobencarb 50% EC followed by bispyribac-sodium 2% SL at rate of 0.0381 kg ai ha^{-1}.
4- Thiobencarb 50% EC followed by propanil 36% EC at rate of 3.427 kg ai ha^{-1}.
5- Pendimethalin 50% EC at rate of 2.023 kg ai ha^{-1}.
6- Pendimethalin 50% EC followed by fenoxaprop-ethyl 7.5% EW at rate of 0.0625 kg ai ha^{-1}.
7- Pendimethalin 50% EC followed by bispyribac-sodium 2% SL at rate of 0.0381 kg ai ha^{-1}.
8- Pendimethalin 50% EC followed by propanil 36% EC at rate of 3.427kg ai ha^{-1}.
9- Oxadiazon 25% EC at rate of 0.595 kg ai ha^{-1}.
10- Oxadiazon 25% EC followed by fenoxaprop-ethyl 7.5% EW at rate of 0.0625 kg ai ha^{-1}.
11- Oxadiazon 25% EC followed by bispyribac-sodium 2% SL at rate of 0.0381 kg ai ha^{-1}.
12- Oxadiazon 25% EC followed by propanil 36% EC at rate of 3.427 kg ai ha^{-1}.
13-Fenoxaprop-ethyl 7.5% EW at rate of 0.0625 kg ai ha^{-1}.
14- Bispyribac-sodium 2% SL at rate of 0.0381 kg ai ha^{-1}.
15- Propanil 36% EC at rate of 3.427 kg ai ha^{-1}.
16- Weedy check (un-treated).
17- Free of weedy rice (red rice).

Thiobencarb, pendimethalin and oxadiazon as pre-emergence herbicides were sprayed in 300 liter water per hectare on wet land at 4 days after seeding (DAS) by using Knapsack sprayer then the soil was flush irrigated after 24 hours from herbicidal application.

Bispyribac-sodium, propanil and fenoxaprop-ethyl as post-emergence herbicides were sprayed at 18, 20 and 35 DAS, respectively. All post-emergence weed control treatments were sprayed in 300 liter water per hectare on wet land by using Knapsack sprayer then the soil was flush irrigated after 24 hours from herbicidal application. The studied herbicides trade name, rate per feddan, active ingredient, rate Kg ai ha^{-1}, chemical group, molecular formula, site of action and target weeds are presented in Table (1).

At 80 DAS, weedy rice plants were sampled by area of 50 x 50 cm quadrate replicated four times for each plot, weedy rice plants were cleaned then air dried then oven dried to stable weight, dry weight per square meter were recorded. Weedy rice control efficiency (WCE %)

Table (1): Studied herbicides trade name, rate per feddan, active ingredient, rate Kg ai ha^{-1}, chemical group, molecular formula, site of action and target weeds.

Herbicide trade name	Rate fed^{-1}	Active ingredient (ai)	Rate (Kg ai ha^{-1})	Chemical group	Molecular formula	Site of Action	Target weeds
Saturn 50% EC	3 Lit.	thiobencarb	3.57	Thiocarbamate	$C_{12}H_{16}ClNOS$	Systemic – photosynthesis inhibitors	Grassy + sedges
Stomp 50% EC	1.7 Lit.	pendimethalin	2.023	Dinitroaniline	$C_{13}H_{19}N_3O_4$	Microtubule assembly inhibitor	Grassy + broad leaves
Ronstar 25% EC	1 lit.	Oxadiazon	0.595	Oxadiazolone herbicides	$C_{15}H_{18}Cl_2N_2O_3$	Systemic – photosynthesis inhibitors	Grassy + sedges
Whip-super 7.5% EW	350 ml.	fenoxaprop-ethyl	0.0625	Aryloxyphenoxypropionic herbicides	$C_{18}H_{16}ClNO_5$	Systemic –inhibition of acetyl CoA carboxylase (ACCase)	Grassy weeds
Nominee 2% SL	800 ml.	bispyribac-sodium	0.0381	Pyrimidinyloxybenzoic acid herbicides	$C_{19}H_{17}N_4NaO_8$	Systemic – ALS inhibitors	Grassy + sedges
Steam 36% EC	4 lit.	propanil	3.427	Anilide herbicides	$C_9H_9Cl_2NO$	photosynthesis inhibitors- fatty acids inhibitor	Grassy + sedges

Fed. = feddan (4200 m^2), Lit. = litter, ha = hectare (10000 m^2), g = gram, ALS = acetolactate synthase.

was calculated by using the following formula (Drost and Moody, 1982)

$$WCE (\%) = \frac{DMC - DMT}{DMC} \times 100$$

Where: DMC = Weedy rice dry matter in un-treated (weedy check) plots.

DMT = Weedy rice dry matter in a particular treatment.

After weedy rice maturity, the central 5 m^2 from each plot were manually harvested to determine grain yield of red rice then recorded the grain yield ha^{-1} at 14% moisture content as tons ha^{-1}.

Cultivated rice dry weight was estimated with the same method with weedy rice at 80 DAS. Before harvest, panicles were counted in two random quadrates of 50 x 50 cm and number of panicles per square meter was recorded. After rice maturity, panicle weight (g) was estimated by weighing ten random panicles per plot and their average was estimated, while thousand-grain weight (g) was recorded in random samples from 1000-grain weight. The central 5 m^2 from each plot were manually harvested to determine grain yield ha^{-1}then rice grain yield at 14% moisture content was recorded. Yield losses (%) were calculated by the following formula:

$$\text{Yield losses (\%)} = \frac{Y_{\text{weed free}} - Y_{\text{treatment}}}{Y_{\text{weed free}}} \times 100$$

Data analysis: The collected data were subjected to proper statistical analysis of variance according to Snedecor and Cochran (1971). The collected data were analyzed by MSTATC program then the means of both weeds and rice characters were compared by using Duncan´s Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

A. Weedy rice:

Dry weight per square meter for weedy rice was recorded as reliable indicators for weed distribution in rice plots. Weed control efficiency was calculated as indicator for weedy rice (red rice) chemical control. At harvest, weedy rice plants in the 5 central square meters were harvested and grain yield ha^{-1} of red rice was determined and estimated at 14% moisture content.

A-1- Effect of rice cultivars:

Data on dry weight, weed control efficiency and grain yield of weedy rice as affected by rice cultivars in 2017 and 2018 seasons are presented in Table (2).

Regarding dry weight of weedy rice, Giza 178 as Indica-Japonica rice cultivar recorded the lowest dry weight of red rice and the best control as well as the lowest seed production of weedy rice in the two seasons, it may be due to the high competitiveness ability of this cultivar, speed vegetative growth and producing strong canopy. However, the infested plots cultivated with Sakha 101 rice cultivar recorded the highest dry weight of weedy rice, in addition to producing the highest grain yield of this weed in 2017 and 2018 seasons, it may be as a result of slow vegetative growth in the first growth stage, short stem and poor soil coverage which resulted in many spaces in the field and encourage germination and strong growth of weedy rice plants accompanied to Sakha 101 as Japonica rice variety. Similar results were reported by Singh *et al.* (2013).

A-2- Effect of weedy rice control treatments:

For weedy rice control treatments, the results showed that sequential application of pre and post-emergence herbicides exceeded the single application of both pre and post-emergence herbicides in the two seasons of study. The results showed that the sequential application of oxadiazon 25% EC at 4 DAS followed by fenoxaprop-ethyl at 35 DAS recorded the lowest dry weight, the best weedy rice control efficiency (78.5 and 69.66% in the two seasons, respectively) and lowest seed production of red rice in the two seasons of study. The application of pendimethalin 50% EC at 4 DAS followed by fenoxaprop-ethyl at 35 DAS ranked second in this respect and achieved 72 and 64.9% for control efficiency in 2017 and 2018 seasons, respectively under the heavy infestation of red rice. The highest dry weight and seed production of weedy rice as well as zero control efficiency were recorded by un-treated plots in the two seasons of study. These results are confirmed with those obtained by Ferrero, (2001).

Table (2): Weedy rice dry weight, control efficiency percent and grain yield as affected by rice cultivars and weedy rice control treatments in 2017 and 2018 seasons.

Factor	Dry weight (g m^{-2})		ncy		Weedy rice grain d yi a^{-1})	
A- Rice cultivars:	2017	2018	2017	2018	2017	2018
1- Giza 178	1258.26 c	1195.57 c	-	-	2.248 c	2.154 c
2- Giza 177	1628.43 b	1468.98 b	-	-	3.489 b	3.114 b
3- Sakha 101	1759.19 a	1654.40 a	-	-	3.745 a	3.427 a
F. test	**	**	-	-	**	**
B- Weedy rice control treatments:						
1- Thiobencarb 50% EC	2016.11 c	1838.22 e	34.36	31.57	3.809 d	3.661 d
2- Thiobencarb *fb* fenoxaprop-ethyl	948.00 g	1131.89 j	69.14	57.86	2.759 j	2.492 i
3- Thiobencarb *fb* bispyribac-sodium	1273.22 f	1336.22 h	58.55	50.26	3.076 hi	3.004 f
4- Thiobencarb *fb* propanil 36% EC	1576.33 e	1530.89 g	48.68	43.01	3.429 ef	3.227 e
5- Pendimethalin 50% EC	1830.22 d	1693.44 f	40.42	36.96	3.512 e	3.250 e
6- Pendimethalin *fb* fenoxaprop-ethyl	860.17 g	943.00 l	72.00	64.90	2.454 k	2.104 j
7- Pendimethalin *fb* bispyribac-sodium	1300.04 f	1163.22 j	57.68	56.70	3.024 i	2.553 hi
8- Pendimethalin *fb* propanil 36% EC	1616.78 e	1240.78 i	47.36	53.81	3.259 g	2.799 fg
9- Oxadiazon 25% EC	1600.00 e	1528.00 g	47.91	43.12	3.301 fg	2.762 gh
10- Oxadiazon *fb* fenoxaprop-ethyl	660.00 h	815.00 m	78.51	69.66	2.289 l	1.696 k
11- Oxadiazon *fb* bispyribac-sodium	1261.69 f	1047.22 k	58.92	61.02	2.850 j	2.039 j
12- Oxadiazon *fb* propanil 36% EC	1515.78 e	1323.56 h	50.65	50.73	3.198 gh	2.334 i
13- Fenoxaprop-ethyl 7.5% EW	2102.89 c	1966.44 d	31.54	26.80	3.944 cd	3.906 c
14- Bispyribac-sodium 2% SL	2310.00 b	2052.00 c	24.80	23.61	4.050 bc	4.122 b
15- Propanil 36% EC	2383.78 b	2178.00 b	22.39	18.92	4.167 b	4.294 b
16- Un-treated (control)	3071.67 a	2686.33 a	0.00	0.00	4.612 a	5.029 a
17- Free of weedy rice	0.00 j	0.00 n	100.0	100.00	0.000 m	0.000 l
F. test	**	**	-	-	**	**
Interaction:						
A x B	**	**	-	-	**	**

** indicates P< 0.01. Means followed by the same letter in the same column are not significantly different at 5% level, using Duncan's Multiple Range Test.

In this respect, Kuk *et al.* (1997) reported that weedy rice was completely controlled by thiobencarb at 2.1 kg ha^{-1} and oxadiazon at 0.24 kg ha^{-1}. Molinate (6.5 kg ha^{-1}), however, gave 26–67% control when applied 6 days before rice seeding. Duong *et al.,* 2007 found that imidazolinone – herbicide treatments caused the reduction in weedy rice dry weight (0.0 g m^{-2}) statistically as compared to untreated check (269 g m^{-2}) and minimized weedy rice-competition and improved cultivated rice grain yield.

A-3- Effect of the interaction between rice cultivars and weedy rice control treatments:

It is obviously from data in Figures (1 and 2) that the interaction between studied factors was significantly affected dry weight and grain yield ha^{-1} of weedy rice in 2017 and 2018 seasons.

Giza 178 rice cultivar treated with sequential application of oxadiazon 25% EC at 4 DAS at the rate of 0.595 Kg ai ha^{-1} *fb* fenoxaprop-ethyl 7.5% EW at the rate of 0.0625 Kg ai ha^{-1} at 35 DAS gave the lowest values of dry weight and grain yield of weedy rice in both seasons of study under the infestation of red rice. The same cultivar treated with pendimethalin 50% EC by rate of 2.023 Kg ai ha^{-1} at 4 DAS *fb* fenoxaprop-ethyl 7.5% EW at the rate of 0.0625 Kg ai ha^{-1} at 35 DAS ranked second in this respect under heavy infestation of red rice through 2017 and 2018 seasons. Un-treated plots cultivated with Sakha 101 rice cultivar scored the highest dry weight and seed production of weedy rice in the two seasons of study. The superiority of Giza 178 rice cultivar treated with oxadiazon 25% EC at 4 DAS *fb* fenoxaprop-ethyl 7.5% EW at 35 DAS might be due to the high efficiency of oxadiazon as pre-emergence herbicide which prevent or delay germination and keep the field free of weedy rice plants for the early period which led to differences in age between cultivated and weedy rice age resulting in rapid and strong vegetative growth and producing more tillers which help Giza 178 rice plants to tolerate the toxic effect of fenoxaprop-ethyl when applied at 35 DAS, while it may killed weedy rice young seedlings and reduced weed biomass and seed yield of weedy rice. Chauhan (2013) noticed that cultivars that have early vigor and quick canopy closure may help suppress weedy rice growth, he also found that oxadiazon and metolachlor herbicides use at high rates may also provide effective control of weedy rice. Saha *et al*., (2014) reported that single management technique cannot effectively control red rice, but, best weedy rice control can be achieved as a combination of preventive, cultural, mechanical and chemical control.

B- Rice measurements:

Rice dry weight (g m^{-2}), number of panicles per unit area, panicle weight (g), 1000-grain weight (g) and grain yield (t ha^{-1}) were determined for rice, in addition to estimating yield losses percentage to reflect the effect of studied factors on rice growth and yield. Results will be presented as follow:

B.1. Effect of rice cultivars:

Data in Table (3) showed the significant effect of rice cultivars and weedy rice control treatments on dry weight, number of panicles per unit area and thousand grain weight of cultivated rice in 2017 and 2018 seasons.

Giza 178 rice cultivar exceeded both of Giza 177 and Sakha 101 in dry weight, number of panicles per square meter in both seasons, while the lowest dry weight and number of panicles per unit area of cultivated rice were obtained by Sakha 101 in the two seasons of study. It

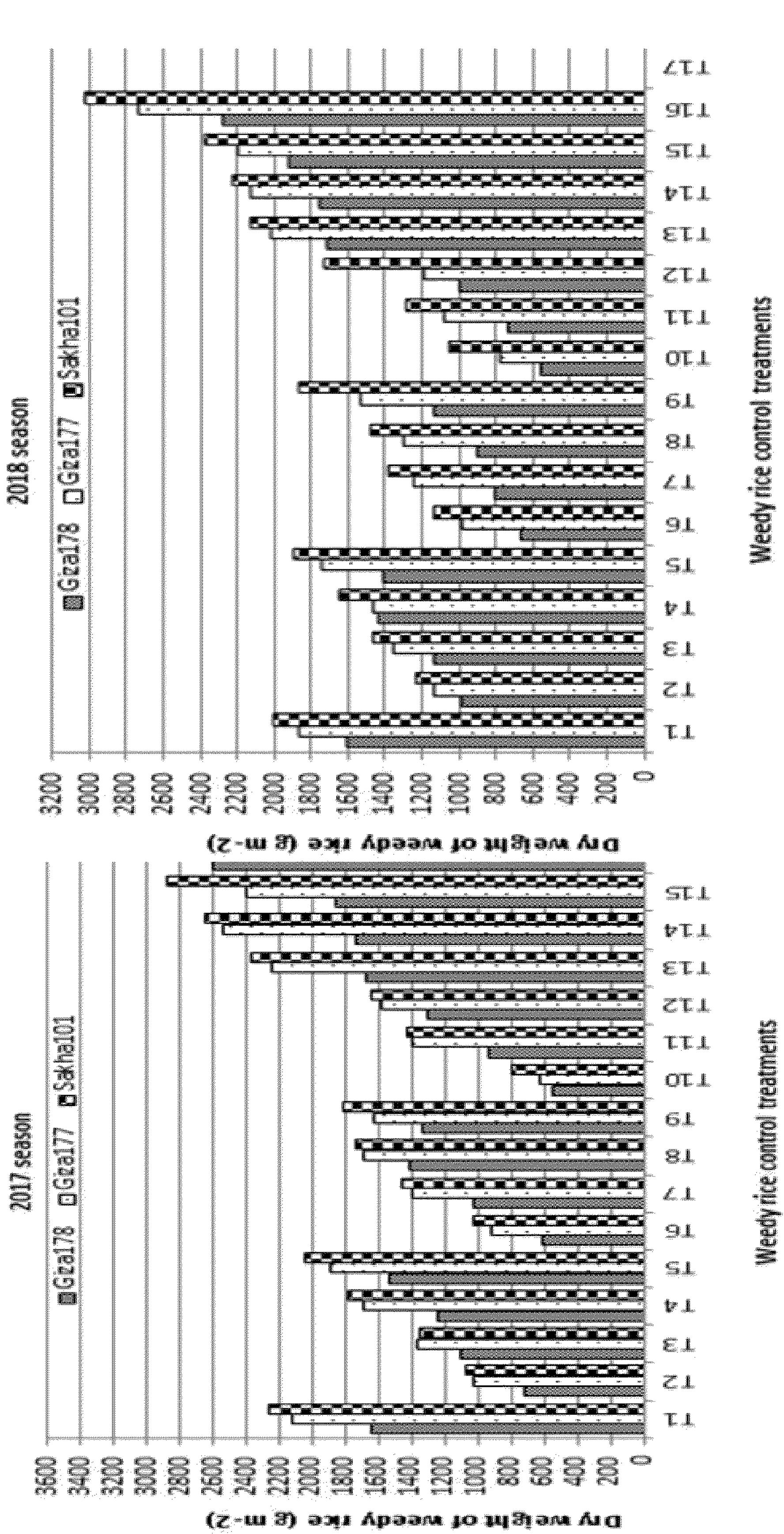

Figure (1): Effect of the interaction between rice cultivars and weedy rice control treatments on dry weight of weedy rice (g m^{-2}) in 2017 and 2018 seasons.

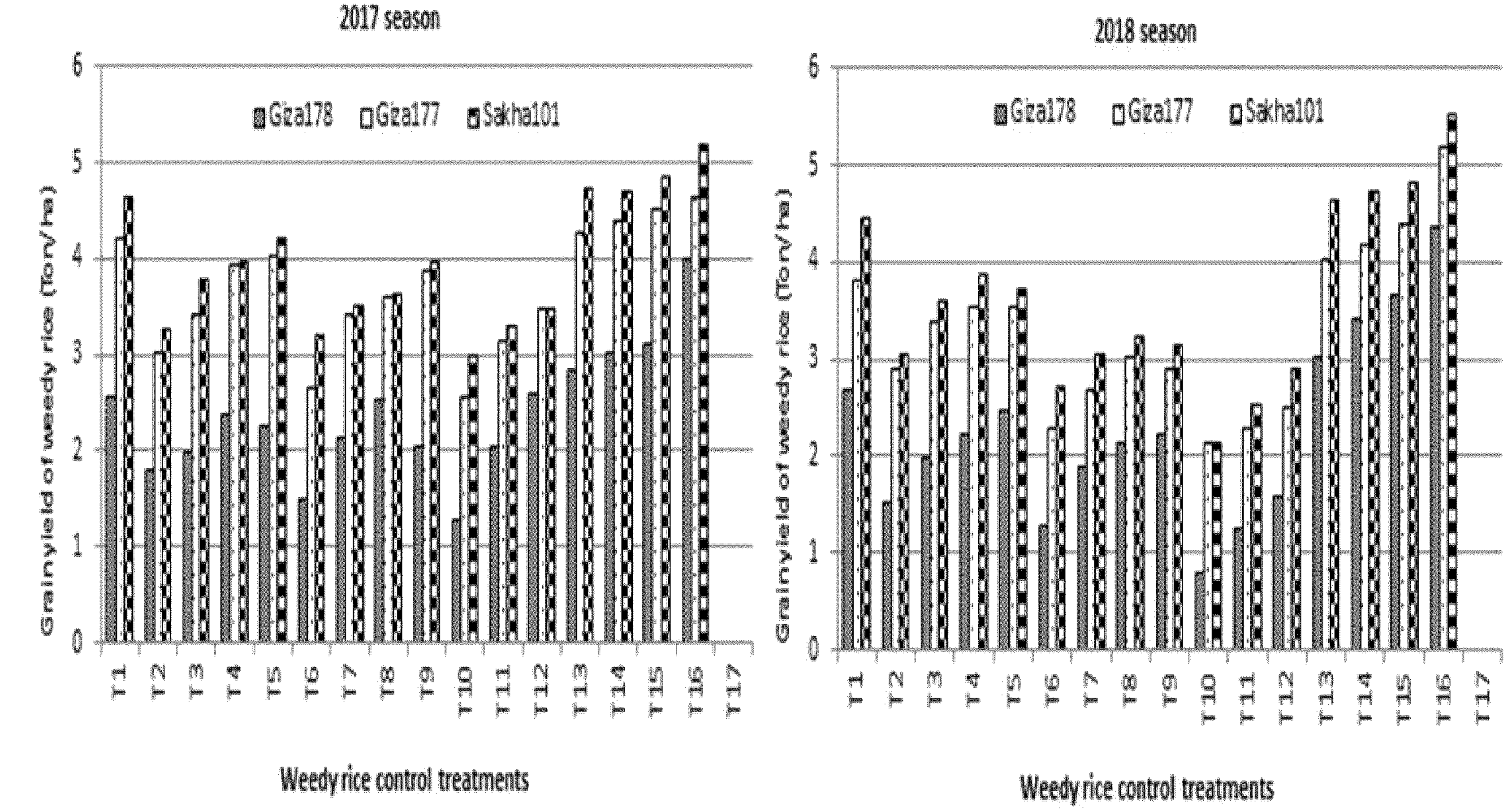

Figure (2): Effect of the interaction between rice cultivars and weedy rice control treatments on grain yield (ton ha^{-1}) of weedy rice in 2017 and 2018 seasons.

T1= thiobencarb, T2= thiobencarb fb fenoxaprop-ethyl, T3= thiobencarb fb bispyribac-sodium, T4= thiobencarb fb propanil, T5= pendimethalin, T6= pendimethalin fb fenoxaprop-ethyl, T7= pendimethalin fb bispyribac-sodium, T8= pendimethalin fb propanil, T9= oxadiazon, T10= oxadiazon fb fenoxaprop-ethyl, T11= oxadiazon fb bispyribac-sodium, T12= oxadiazon fb propanil T13= fenoxaprop-ethyl, T14= bispyribac-sodium, T15= propanil, T16= un-treated (control) and T17= free of weedy rice.

Table (3): Cultivated rice dry weight, number of panicles m^{-2} and 1000-grain weight as affected by rice cultivars and weedy rice control treatments in 2017 and 2018 seasons.

Factor	Dry weight (g m^{-2})		of s		1000-grain weight (g m^{-2})	
A- Rice cultivars:	2017	2018	2017	2018	2017	2018
1- Giza 178	638.71 a	726.80 a	305.9 a	352.8 a	19.23 c	20.80 c
2- Giza 177	532.23 b	567.90 b	254.6 b	256.8 b	24.46 a	25.57 a
3- Sakha 101	424.76 c	464.43 c	197.5 c	217.8 c	23.24 b	24.57 b
F. test	**	**	**	**	**	**
B- Weedy rice control treatments:						
1- Thiobencarb 50% EC	230.67 j	302.22 j	126.0 k	108.0 j	19.78 i	21.76 i
2- Thiobencarb *fb* fenoxaprop-ethyl	726.11 e	838.00 d	312.9 e	389.3 e	24.44 de	25.32 d
3- Thiobencarb *fb* bispyribac-sodium	580.22 g	649.56 f	269.3 g	377.9 e	23.50 f	24.36 f
4- Thiobencarb *fb* propanil 36% EC	453.78 h	493.44 h	218.9 h	274.2 g	22.03 g	23.51 g
5- Pendimethalin 50% C	273.33 i	354.78 i	160.4 j	150.9 i	21.22 h	22.97 h
6- Pendimethalin *fb* fenoxaprop-ethyl	820.11 c	893.89 c	396.0 c	434.4 c	25.22 c	25.77 c
7- Pendimethalin *fb* bispyribac-sodium	680.56 f	698.00ef	318.9 e	402.2 d	24.83 cd	24.93 e
8- Pendimethalin *fb* propanil 36% EC	545.67 g	545.22 g	287.6 f	309.6 f	23.37 f	24.41 f
9- Oxadiazon 25% EC	295.80 i	476.89 h	179.1 i	173.3 h	21.78 gh	23.63 g
10- Oxadiazon *fb* fenoxaprop-ethyl	951.67 b	1067.44b	448.9 b	451.0 b	26.22 b	26.71 b
11- Oxadiazon *fb* bispyribac-sodium	778.00 d	816.89 d	350.2 d	407.6 d	24.89 cd	25.70 c
12- Oxadiazon *fb* propanil 36% EC	547.67 g	701.89 e	312.7 e	307.3 f	23.89 ef	24.80 e
13- Fenoxaprop-ethyl 7.5 % EW	208.02jk	251.11 k	106.4 L	107.3 j	19.06 j	21.49 i
14- Bispyribac-sodium 2% SL	193.97jk	193.33 L	99.3 lm	94.2 k	18.20 k	20.70 j
15- Propanil 36% EC	180.60 k	181.78 L	93.1 lm	81.1 L	17.72 k	19.98 k
16- Un-treated (control)	123.89 L	95.33 m	84.4 m	41.3 m	15.89 l	18.28 l
17- Free of weedy rice	1452.22a	1408.67a	530.7 a	578.9 a	27.22 a	27.66 a
F. test	**	**	**	**	**	**
Interaction:						
A x B	**	**	**	**	**	**

** indicates P< 0.01. In a column, means followed by the same letter are not significantly different at 5% level, using Duncan's Multiple Range Test.

may be due to the strong vegetative growth of Indica-Japonica rice cultivar (Giza 178) as compared with Japonica rice cultivars (Giza 177 and Sakha 101). Moreover, the high competitiveness ability of Giza 178 and speed coverage for the soil and occupation of land spaces in rice field may reduce nutrients and water depletion by weedy rice. Similar results were obtained by Ferrero and Vidotto (1999) and Singh *et al.* (2013). For thousand grain weight, Giza 177 scored the heaviest thousand grain weight followed by Sakha 101 as japonica rice cultivars. On the other hand, Giza 178 recorded the lowest weight of thousand grains in 2017 and 2018 seasons. It may be due to the genetic background which refers to higher thousand grain weight of Japonica rice cultivars than Indica-Japonica rice cultivars (Hassan *et al.*, 2013 and Abd El-Megeed *et al.*, 2016).

B.2. Effect of weedy rice control treatments:

Regarding weedy rice control treatments, data in Table (3) also showed that there were high variation among tested treatments contained pre, post-emergence herbicides and sequential application of pre and post-emergence as compared to untreated plots. The results showed that pre-emergence herbicides application achieved more effective weedy rice management than post-emergence herbicides, while the highest values of dry weight, panicles m^{-2} and 1000-grain weight of cultivated rice were obtained by sequential application of oxadiazon 25% EC at 4 DAS as pre-emergence herbicide fb fenoxaprop-ethyl 7.5% EW at 35 DAS as a post-emergence herbicide under heavy infestation of weedy rice in drill-seeded rice through 2017 and 2018 seasons. While the absolutely higher values of abovementioned traits were recorded by weedy rice free plots in the two seasons of study. On the opposite, un-treated plots gave the lowest values of cultivated rice dry weight, number of panicles and thousand grain weight in 2017 and 2018 seasons. Singh *et al.*, (2013) reported that pre-emergence herbicides, such as acetochlor (1.5 kg ai ha^{-1}), metolachlor (2.5 kg ai ha^{-1}), alachlor (2.4 kg ai ha^{-1}), and dimethenamid (1.4 kg ai ha^{-1}), provided 85-92% control of weedy rice and increase grain yield of common rice.

B-3- Effect of the interaction between rice cultivars and weedy rice control treatments:

As shown in Figures (3 and 4) the interaction between studied factors markedly affected dry weigh, panicles per square meter and 1000-grain weight of cultivated rice in 2017 and 2018 seasons.

Under weedy rice infestation the highest values of both dry weight and number of panicles m^{-2} of cultivated rice were achieved by Giza 178 rice cultivar treated with oxadiazon 25% EC at the rate of 0.595 Kg ai ha^{-1} at 4 DAS *fb* fenoxaprop-ethyl 7.5% EW at the rate 0.0625 Kg ai ha^{-1} of at 35 DAS in both seasons followed by the same cultivar treated with sequential application of pendimethalin 50% EC at the rate of 0.595 Kg ai ha^{-1} at 4 DAS *fb* fenoxaprop-ethyl 7.5% EW by rate 0.0625 Kg ai ha^{-1} of at 35 DAS in 2017 and 2018 seasons. The lowest values of abovementioned traits were obtained from un-treated plots cultivated by Sakha 101 rice cultivar in both seasons of study. These results may be due to the high efficiency of sequential application of oxadiazon as pre-emergence herbicide in suppressing weedy rice germination and minimizing weedy rice plants which help Giza 178 plants for speed vegetative growth and producing more tillers and strong

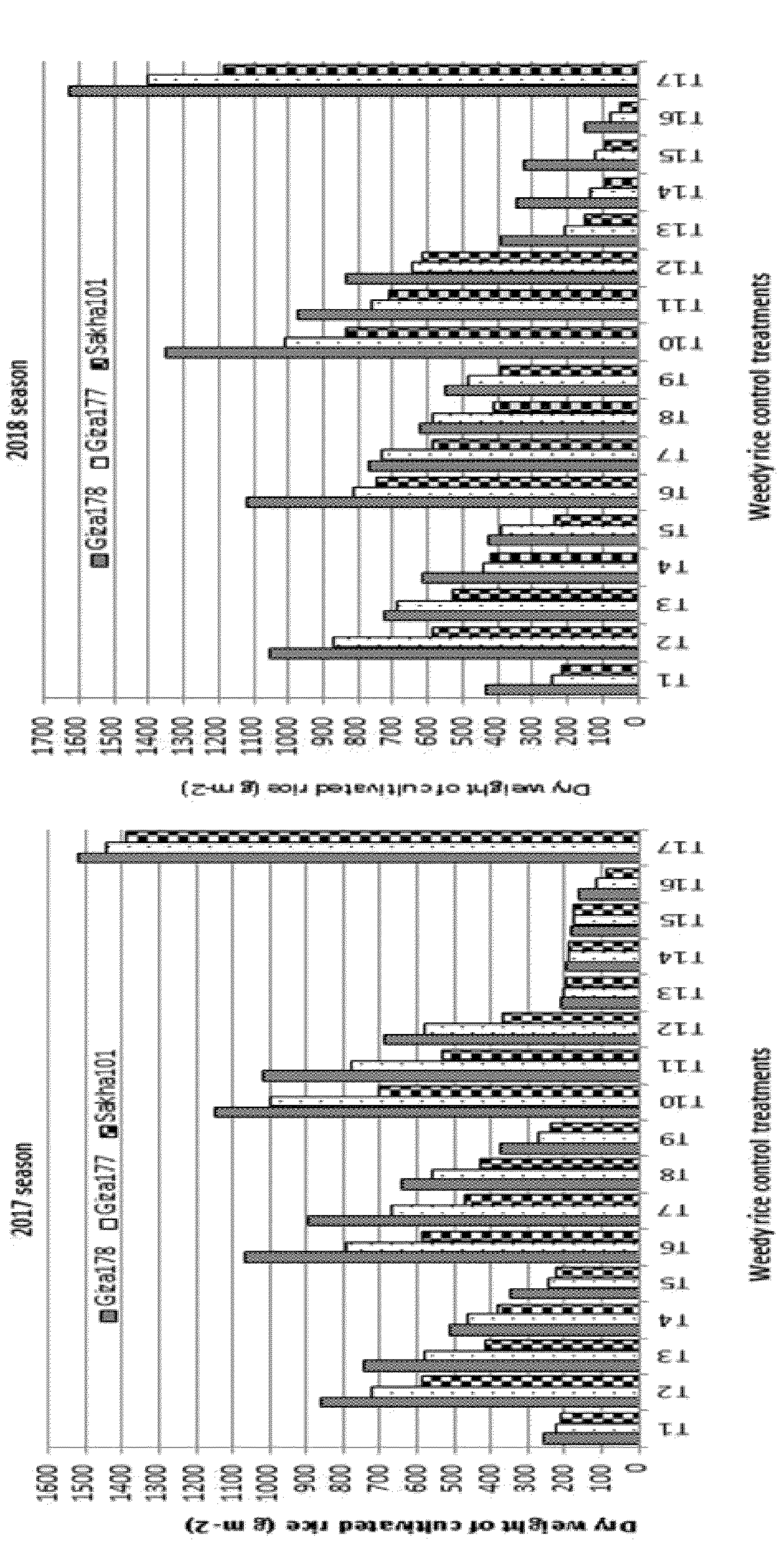

Figure (3): Effect of the interaction between rice cultivars and weedy rice control treatments on dry weight of cultivated rice (g m-2) in 2017 and 2018 seasons.

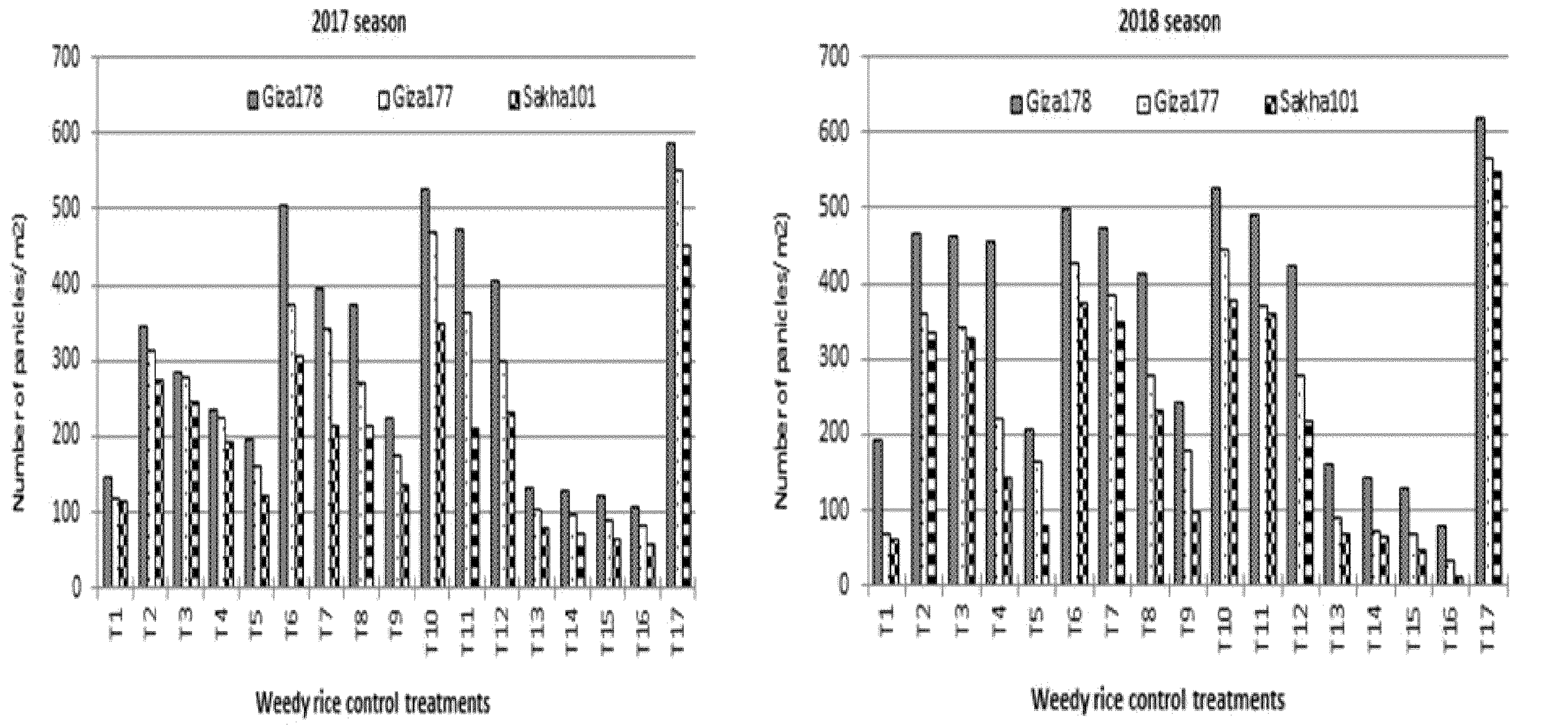

Figure (4): Effect of the interaction between rice cultivars and weedy rice control treatments on number of panicles m-2 of cultivated rice in 2017 and 2018 seasons.

T1= thiobencarb, T2= thiobencarb fb fenoxaprop-ethyl, T3= thiobencarb fb bispyribac-sodium, T4= thiobencarb fb propanil, T5= pendimethalin, T6= pendimethalin fb fenoxaprop-ethyl, T7= pendimethalin fb bispyribac-sodium, T8= pendimethalin fb propanil, T9= oxadiazon, T10= oxadiazon fb fenoxaprop-ethyl, T11= oxadiazon fb bispyribac-sodium, T12= oxadiazon fb propanil T13= fenoxaprop-ethyl, T14= bispyribac-sodium, T15= propanil, T16= un-treated (control) and T17= free of weedy rice.

canopy, moreover the difference in age between cultivated and weedy rice seedlings during applying fenoxaprop-ethyl at 35 DAS made red rice seedling more sensitive to phytotoxicity of fenoxaprop-ethyl and minimized the harmful effect on cultivated rice plants. Similar results were reported by Singh *et al*., (2013) and Olajumoke *et al*., (2016)

B.4. Effect of rice cultivars:

As shown from data in Table (4) that rice cultivars significantly varied in panicle weight, grain yield ha^{-1} and yield losses % in 2017 and 2018 seasons.

Table (4): Panicle weight, grain yield and yield losses percent of cultivated rice as affected by rice cultivars and weedy rice control treatments in 2017 and 2018 seasons.

Factor	Panicle weight (g)				losses %)	
A- Rice cultivars:	2017	2018	2017	2018	2017	2018
1- Giza 178	1.926 a	1.955 a	4.821 a	5.649 a	54.9	47.1
2- Giza 177	1.743 b	1.855 b	3.445 b	4.437 b	66.6	58.0
3- Sakha 101	1.649 c	1.704 c	3.091 c	3.999 c	69.9	61.5
F. test	**	**	**	**	-	-
B- Weedy rice control treatments:						
1- Thiobencarb 50% EC	1.306 j	1.628 gh	2.318 h	2.334 j	75.4	76.2
2- Thiobencarb *fb* fenoxaprop-ethyl	2.131 de	2.088 bcd	4.364 d	6.356 d	53.6	35.1
3- Thiobencarb *fb* bispyribac-sodium	1.934 fg	1.977 e	3.942 e	5.300 f	58.1	45.9
4- Thiobencarb *fb* propanil 36% EC	1.717 h	1.862 f	3.434 f	4.966 g	63.5	49.3
5- Pendimethalin 50% EC	1.520 i	1.683 g	2.476 h	2.722 i	73.7	72.2
6- Pendimethalin *fb* fenoxaprop-ethyl	2.283 c	2.180 b	5.217 c	7.078 c	44.6	27.8
7- Pendimethalin *fb* bispyribac-sodium	2.106 e	2.077 cd	4.318 d	5.817 e	54.1	40.6
8- Pendimethalin *fb* propanil 36% EC	1.866 g	1.881 f	3.521 f	5.239 f	62.6	46.5
9- Oxadiazon 25% EC	1.690 h	1.653 g	2.956 g	3.083 h	68.6	68.5
10- Oxadiazon *fb* fenoxaprop-ethyl	2.380 b	2.126 bc	6.529 b	7.344 b	30.7	25.1
11- Oxadiazon *fb* bispyribac-sodium	2.213 cd	2.007 de	5.109 c	6.458 d	45.7	34.1
12- Oxadiazon *fb* propanil 36% EC	2.002 f	1.799 f	4.440 d	5.943 e	52.8	39.4
13- Fenoxaprop-ethyl 7.5% EW	1.198 k	1.552 hi	1.833 i	2.234 j	80.5	77.2
14- Bispyribac-sodium 2% SL	1.128 kl	1.480 ij	1.686 ij	1.992 k	82.1	79.7
15- Propanil 36% EC	1.056 L	1.427 j	1.540 j	1.760 L	83.6	82.0
16- Un-treated (control)	0.873 m	1.258 k	1.264 k	1.392 m	86.6	85.8
17- Free of weedy rice	2.734 a	2.572 a	9.415 a	9.801 a	0.0	0.0
F. test	**	**	**	**	**	**
Interaction:						
A x B	**	**	**	**	**	**

** indicates P< 0.01. Means followed by the same letter in the same column are not significantly different at 5% level, using Duncan's Multiple Range Test.

Giza 178 rice cultivar exceeded both Giza 177 and Sakha 101 and gave the highest panicle weight and grain yield as well as lowest yield loss percent caused by weedy rice (1.926 g, 4.821 tons and 54.9% and 1.955 g, 5.649 tons and 47.1%) in 2017 and 2018 seasons, respectively. On the opposite, the lowest values of panicle weight and grain yield as well as yield losses of cultivated rice were scored by Sakha 101 rice cultivar in both seasons. The superiority of Giza 178 as Indica-Japonica rice cultivar may be as a result of good germination, speed vegetative growth, producing more tillers, huge canopy, coverage soil and high competitiveness ability against weedy rice which reflected on producing more panicles, heavy panicles and the highest grain yield, moreover minimum yield losses caused by red rice under drilling system. Leon (2005) found that Cultivars that are tall, tiller vigorously, and is mature later were more favorable with respect to minimizing red rice interference and producing higher grain yield. Similar results were obtained by Azmi and Abdullah (1998), Singh *et al.* (2013) and Olajumoke (2016).

B.5. Effect of weedy rice control treatments on panicle weight, grain yield and yield losses percent in 2017 and 2018 seasons.

Regarding weedy rice control treatments, data in Table (4) revealed that sequential application of pre-emergence followed by post-emergence herbicides was better than single application of pre or post-emergence herbicides to control red rice and produce higher grain yield and attributes of cultivated rice in 2017 and 2018 seasons. Under weedy rice infestation, oxadiazon application at 4 DAS *fb* fenoxaprop-ethyl at 35 DAS recorded the highest panicle weight and grain yield of cultivated rice in both season with no significant differences between the application of pendimethalin at 4 DAS *fb* fenoxaprop-ethyl at 35 DAS in panicle weight through the second season. Moreover, T_{10} reduced yield losses to (30.7 and 25.1%) in 2017 and 2018 seasons, respectively as compared with un-treated plots which recorded yield losses reached 86.6 and 85.89 % in both seasons, respectively. These results reflect the high efficiency of pre-emergence herbicide *fb* post-emergence herbicide in the same field in inhibition weedy rice germination and minimize red rice growth which may cause minimum red rice plants, reduced competition and nutrients depletion, helps cultivated rice plants on optimum vegetative growth and produced more grain yield. Similar results were obtained by Ferrero *et al.* (1999), Eleftherohorinos and Dhima (2002) and Singh *et al.* (2013).

B-6- Effect of the interaction between rice cultivars and weedy rice control treatments on panicle weight and grain yield of cultivated rice in 2017 and 2018 seasons.

Influence of the interaction between rice cultivars and weedy rice control treatments on panicle weight and grain yield of cultivated rice in 2017 and 2018 seasons is shown in Figures (5 and 6). Under weedy rice infestation, Giza 178 rice cultivar treated with the sequential application of oxadiazon 25% EC at the rate of 0.595 Kg ai ha^{-1} at 4 DAS *fb* fenoxaprop-ethyl 7.5% EW at the rate 0.0625 Kg ai ha^{-1} of at 35 DAS recorded the highest values of panicle weight and grain yield in 2017 and 2018 seasons. On the other hand, Sakha 101 rice cultivar in un-treated plots gave the lowest panicle weight and grain yield in both seasons. Under weedy rice free plots, Giza 177 registered the highest panicle weight

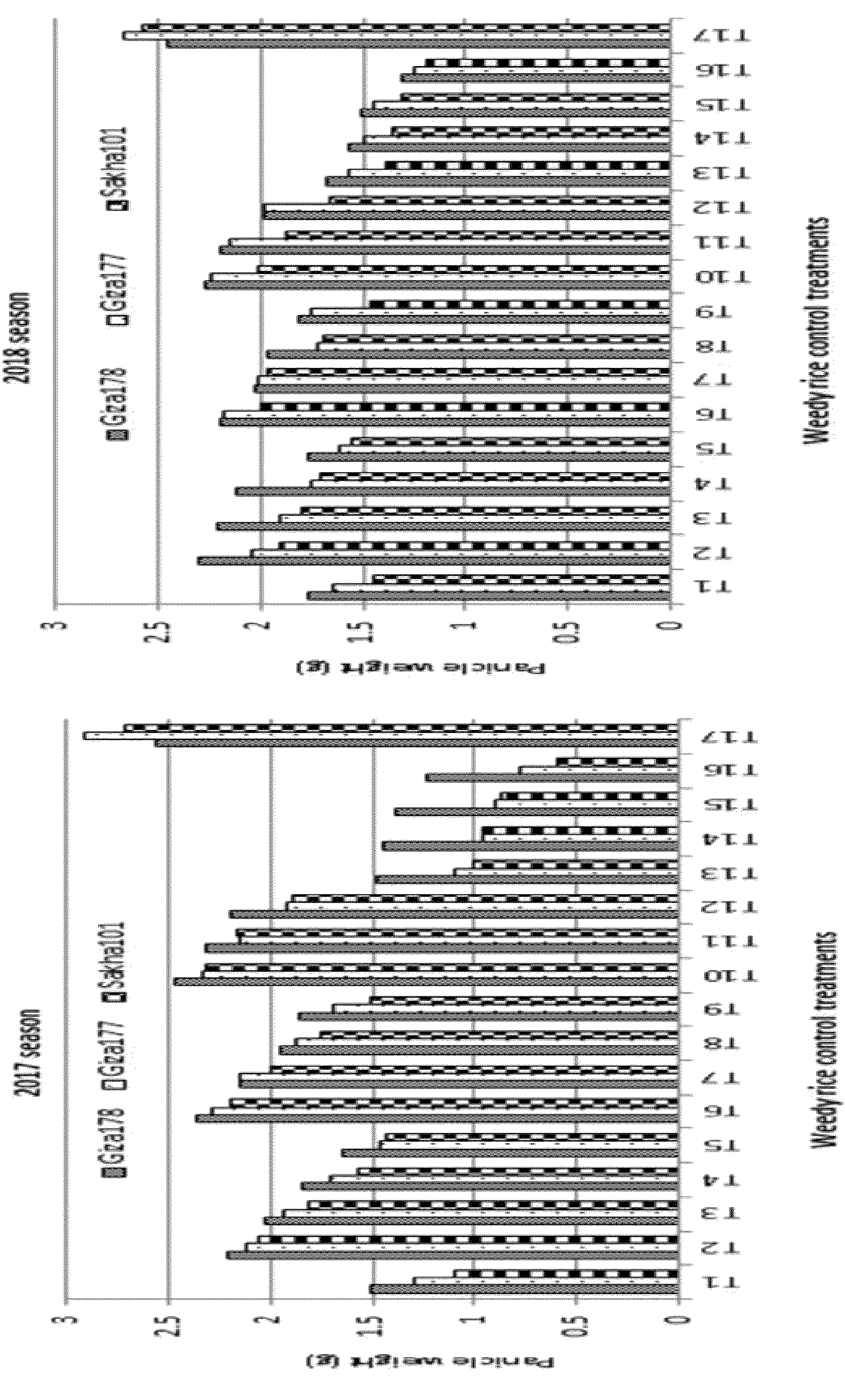

Figure (5): Effect of the interaction between rice cultivars and weedy rice control treatments on panicle weight (g) of cultivated rice in 2017 and 2018 seasons.

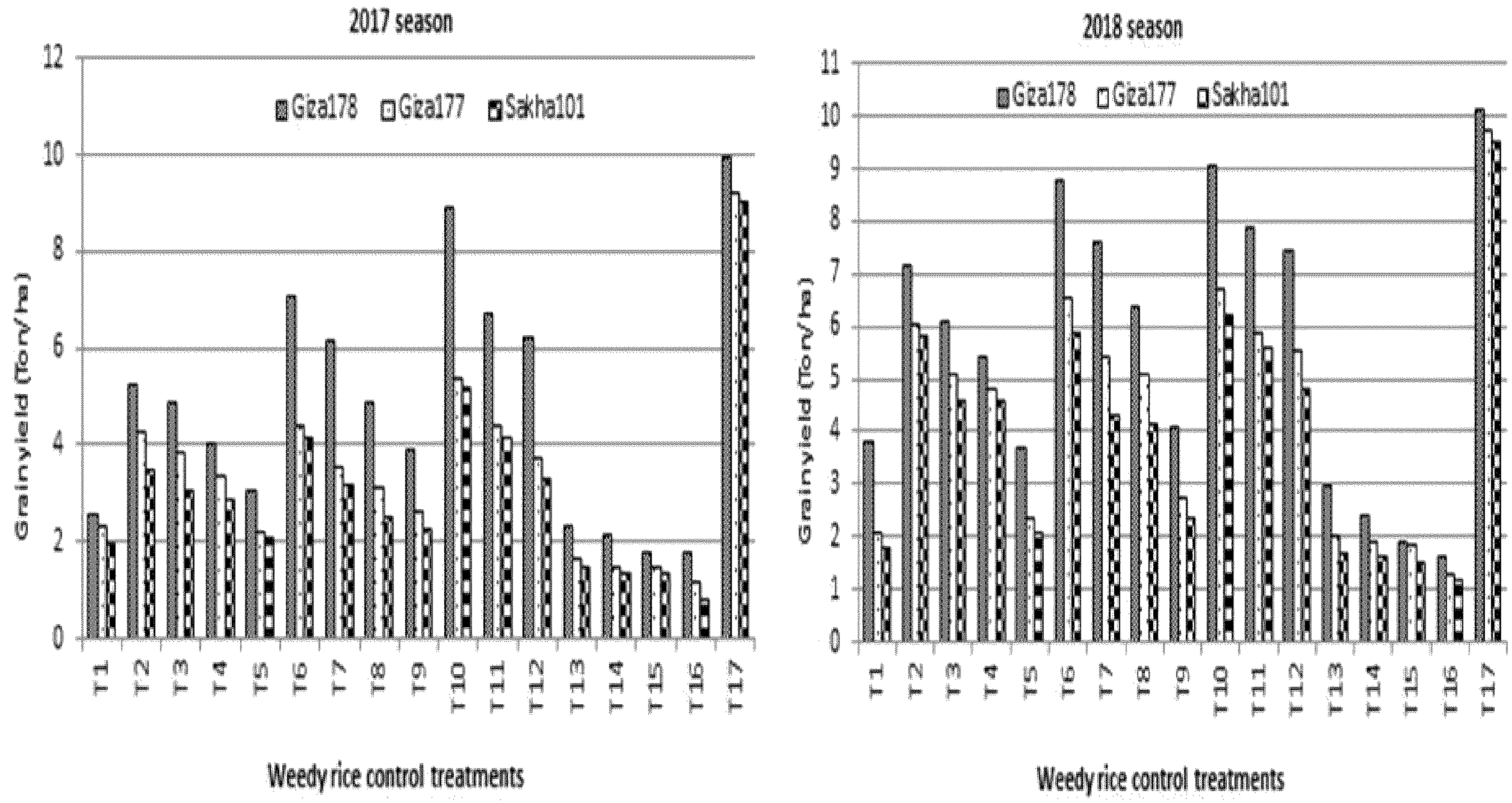

Figure (6): Effect of the interaction between rice cultivars and weedy rice control treatments on grain yield (ton ha-1) of cultivated rice in 2017 and 2018 seasons.

T1= thiobencarb, T2= thiobencarb fb fenoxaprop-ethyl, T3= thiobencarb fb bispyribac-sodium, T4= thiobencarb fb propanil, T5= pendimethalin, T6= pendimethalin fb fenoxaprop-ethyl, T7= pendimethalin fb bispyribac-sodium, T8= pendimethalin fb propanil, T9= oxadiazon, T10= oxadiazon fb fenoxaprop-ethyl, T11= oxadiazon fb bispyribac-sodium, T12= oxadiazon fb propanil, T13= fenoxaprop-ethyl, T14= bispyribac-sodium, T15= propanil, T16= un-treated (control) and T17= free of weedy rice.

through both seasons of study, while Giza 178 was the best in grain yield under drilling method in 2017 and 2018 seasons. The distinction of Giza 178 rice cultivar in drill-seeded rice under weedy rice infestation or in free fields of red rice may be due to its ability to adapt in aerobic condition, rapidly grow, produce great canopy, speed soil coverage and compete weedy rice plants than both Giza 177 and Sakha 101 rice cultivars. Leon (2005) found that cultivars that are tall, tiller vigorously, and is mature later were more favorable with respect to minimizing red rice interference. Singh *et al*. (2013) reported that to achieve best weedy rice control and obtain maximize grain yield it must be choose strong rice cultivar, rapidly germinate and grow and high competitiveness ability then apply pre-emergence herbicide to inhibit or delay red rice germination then can use post-emergence herbicide to kill weedy rice young seedlings without any toxicity on cultivated rice plants. Similar findings were observed by Eleftherohorinos and Dhima (2002).

Conclusion:

Under heavy infestation of red rice, Giza 178 is the most suitable rice cultivar competed against weedy rice and reduced dry weight and grain yield of weedy rice as well as produced the highest dry matter, yield and its components when treated with oxadiazon (0.595 kg ai ha^{-1}) at 4 DAS followed by fenoxaprop-ethyl (0.0625 kg ai ha^{-1}) at 35 DAS in drill-seeded rice

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المكافحة الكيماوية للأرز الأحمر المصاحب لثلاث أصناف من الأرز المنزرع بطريقة التسطير

صبري صبحي محمد عبدالنبي
قسم بحوث الأرز– معهد بحوث المحاصيل الحقلية- مركز البحوث الزراعية- الجيزة – مصر.

الملخص العربي

أجريت تجربتان حقليتان في المزرعة البحثية لمحطة البحوث الزراعية بسخا، كفرالشيخ – مصر خلال الموسم الصيفي لعامي 2017 و 2018 لدراسة تأثير أصناف الأرز المنزرع و المكافحة الكيماوية على الأرز الأحمر في الأرز التسطير . تم استخدام تصميم القطع المنشقة في توزيع القطاعات الكاملة العشوائية ذو ثلاث مكررات، حيث وزعت أصناف الأرز (جيزة 178، جيزة 177و سخا 101) فى القطع الرئيسية ، بينما معاملات مكافحة الأرز الأحمر والتي تضمنت خمسة عشر معاملة كيماوية (ثيوبينكارب بمعدل 3.57 كجم مادة فعالة للهكتار منفرداً أومتبوعاً بـ فينوكسابروب إيثيل، بيسبيرباك صوديوم، بروبانيل بعد 30، 18 و 20 يوم من الزراعة على التوالي بالمعدلات الموصى بها في زراعات الأرز، ومبيد بنديميثالين بمعدل 2.023 كجم مادة فعالة للهكتار منفرداً أومتبوعاً بـ فينوكسابروب إيثيل، بيسبيرباك صوديوم، بروبانيل طبقاً للتوصيات، مبيد أوكساديازون بمعدل 0.595 كجم مادة فعالة للهكتار منفرداً أومتبوعاً بـ فينوكسابروب إيثيل، بيسبيرباك صوديوم، بروبانيل حسب التوصيات) مقارنة بغير المعامل (كنترول) والقطع الخالية من الأرز الأحمر قد وزعت عشوائياً فى القطع المنشقة.

أظهرت النتائج أن صنف الأرز جيزة 178 أفضل الأصناف المدروسة منافسة لحشيشة الأرز الأحمر حيث قلل الوزن الجاف ومحصول الحبوب للأرز الأحمر معنوياً أكثر من صنفي جيزة 177 وسخا 101، بالإضافة لانتاج أعلى وزن جاف ومحصول الحبوب ومكوناته وأقل انخفاض في المحصول الإقتصادي خلال موسمي الزراعة. حققت معاملة أوكساديازون (0.595 كجم مادة فعالة للهكتار) بعد 4 أيام من الزراعة متبوعاً بـ فينوكسابروب إيثيل بالمعدل الموصى به بعد 35 يوم من الزراعة أفضل مكافحة وأقل وزن جاف ومحصول حبوب لحشيشة الأرز الأحمر في كلا الموسمين، كما أعطت أعلى وزن جاف ومحصول حبوب ومكوناته للأرز المنزرع بالإضافة لأقل فقد في المحصول (27.9%) كمتوسط لموسمي الدراسة. يمكن استنتاج أنه تحت ظروف العدوى الكثيفة بحشيشة الأرز الأحمر يفضل زراعة صنف الأرز جيزة 178 ومعاملة الحقل بمبيد أوكساديازون (0.595 كجم مادة فعالة للهكتار) بعد 4 أيام من الزراعة متبوعاً بـ فينوكسابروب إيثيل (0.0625 كجم مادة فعالة للهكتار) بعد 35 يوم من الزراعة لتحقيق أفضل مكافحة للأرز الأحمر وأفضل نمو ومحصول حبوب ومكوناته للأرز المنزرع بطريقة التسطير.

أسماء السادة المحكمين
أ.د/ سعد محمـــــــــــد شبـــــل مركز بحوث الأرز – كفر الشيخ
أ.د/ محمود الدسوقى إبراهيم كلية الزراعة - جامعة المنوفية