INTEGRATING PRE AND POST-EMERGENCE HERBICIDES FOR CONTROLLING WEEDS IN DRILL-SEEDED RICE (*ORYZA SATIVA* L.)

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Abstract

Two field experiments were carried out at the experimental farm of Sakha Agricultural Research Station, Kafrelsheikh, Egypt during the summer seasons of 2015 and 2016 to find out the optimum pre and post-emergence herbicide treatments from the recommended herbicides to control weeds under drill-seeded rice conditions (Giza179 cv). Fourteen weed control treatments included two pre-emergence herbicides i.e. thiobencarb 50% at the rate of 3.57 kg ai ha^{-1} alone and followed by six weed control treatments included; penoxsulam 2.5% at 0.0238 kg ai ha^{-1}, bispyribac-sodium 2% at 0.0381 kg ai ha^{-1} and fenoxaprop-ethyl 7.5% at 0.0625 kg ai ha^{-1} alone and mixed with halosulfuron 75% at 0.0357 kg ai ha^{-1}, also pendimethalin 50% at rate of 2.023 kg ai ha^{-1} alone and followed by the previous six post-emergence weed control treatments as compared to weedy check (untreated). Randomized Complete Block Design (RCBD) with three replications was used. The results revealed that, spraying pendimethalin as pre-emergence herbicides at 4 days after seeding (DAS) recorded the best weed control, highest rice growth characters and grain yields, as compared to thiobencarb. Each of penoxsulam 2.5% or bispyribac-sodium 2% or fenoxaprop-ethyl 7.5% mixed with halosulfuron 75% gave the lowest dry weights of grasses, broadleaves and total weeds in addition to rice dry biomass, grain yield and its studied attributes. Based on obtained results, it can be concluded that pendimethalin as pre-emergence herbicide at 4 DAS followed by spraying any of penoxsulam 2.5% or bispyribac-sodium 2% or fenoxaprop-ethyl 7.5% mixed with halosulfuron 75% at recommended doses applied at 15, 22 and 35 DAS, respectively were the best combinations for controlling weeds and gave the highest grain yield in drill-seeded rice.

Keywords: Rice, drill-seeded, grasses, broadleaves, weeds, herbicide, pre-emergence, post- emergence and weed control.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the main cereal crops in Egypt, in addition, its importance as a main dish for most of Egyptians. It is a stable food for more than half of the world population (FAOSTAT, 2011). In Egypt, rice productivity has been increased from 5.712 tons ha^{-1} in 1984 to 9.50 tons ha^{-1} in 2014 (FAOSTAT, 2014) by releasing high yielding capacity varieties, efficient weed control, optimum cultural practices and integrated pest (diseases and insects) management (IPM).

Direct seeded rice (DSR) cultivation save water, seeds and low production cost as compared with traditional transplanting (Hongyan *et al.*, 2014). Because of water shortage and unwilling rural work in Egypt, scientists must develop strategies to increase sustainability and profitability of direct seeded-rice systems as drill-seeded rice. Moreover effective weed management practices must be established to maximize rice yield per unit area.

Weed control is the most serious problem and challenge force both of drill and broadcast-seeded rice, weeds can directly or indirectly negatively affect rice yield (Mahajan *et al.*, 2009). Weed flora in drill-seeded rice is a complex of mainly grassy weeds (*Echinochloa crus-galli, E. colona* and *Dinebra retroflexa*) and broad leave weeds so that, individual herbicide application through rice growth season in drilling cultivation is not effective. This is because of the ability of some weeds to still life and/or had a quick recovery again after herbicide application in addition to, the new generations of weeds which can be grow during different times in the same season. Moreover, herbicide tolerance can occur because of frequent application for the same herbicide at the same area every year.

In drill-seeded rice, weeds can cause a huge reduction in yield of rice determined by 14-93% as compared to transplanted rice (17-47%) (Ranjit, 1997). In addition, decreasing grain quality and increasing rice production costs. El-Refaee *et al.*, 2006 reported that drill-seeded rice method had four weeks of flush irrigation during the crop establishment period which resulted in large accompanied weed flora. There are few limiting factors associated with DSR that impair yields including crop-weed competition. Therefore, there is a scope to increase yield by adopting integrated weed management approaches including tillage systems, competitive cultivars, use of crop residue as mulch, hand hoeing, and herbicides in DSR (Chauhan, 2012).

Chemical weed control is the key of high yielding under direct-seeded rice (DSR) system, it must be a sequential application of pre and post-emergence herbicides to achieve the best weed control and rice yield as superior grain quality (Chauhan *et al.*, 2015) besides avoiding the appearance of tolerant-herbicide weeds rapidly. Singh *et al.*, 2016 found that the application of pendimethalin *fb* bispyribac-sodium + azimsulfuron achieved the maximum reduction in weed biomass and recorded the best weed control efficiency (WCE) percentages. These results are similar to those obtained by Ganie *et al.*, 2014 and Awan *et al.*, 2015.

The objective of the present study is to investigate the integration between both pre and post-emergence herbicides for wide spectrum of weed management in drill-seeded rice to achieve the best weed control, this will reflect on a good rice growth and better yield.

MATERIALS AND METHODS

Two field experiments were carried out during 2015 and 2016 seasons at Sakha Agricultural Research Station, ARC, Egypt. Giza 179 as a new released rice cultivar was planted using drilling machine at seed rate of 120 kg.ha^{-1} at 20th of May in both seasons of study (the optimum date of sowing as recommended). Plot size was 14 m^2 (4 m x 3.5 m). Randomized Complete Block Design (RCBD) with three replications was used. The normal rice agricultural practices were applied as recommended for drill-seeded rice. Weed control treatments were suggested as follow:

1- Pendimethalin 50% EC (Stomp) at 2.023 kg ai ha^{-1}.

2- Thiobencarb 50% EC (Saturn) at 3.57 kg ai ha^{-1}.

3- Pendimethalin 50% EC followed by penoxsulam 2.5% OD (Rainbow) at rate of 0.0238 kg ai ha^{-1}.

4- Pendimethalin 50% EC followed by bispyribac-sodium 2% SL (Nominee 2%) at rate of 0.0381 kg ai ha^{-1}.

5- Pendimethalin 50% EC followed by fenoxaprop-ethyl 7.5% EW (Whipsuper) at rate of 0.0625 kg ai ha^{-1}.

6- Thiobencarb 50% EC followed by penoxsulam 2.5% OD (Rainbow) at rate of 0.0238 kg ai ha^{-1}.

7- Thiobencarb 50% EC followed by bispyribac-sodium 2% SL (Nominee 2%) at rate of 0.0381 kg ai ha^{-1}.

8- Thiobencarb 50% EC followed by fenoxaprop-ethyl 7.5% EW (Whipsuper) at rate of 0.0625 kg ai ha^{-1}.

9- Pendimethalin 50% EC followed by penoxsulam+ halosulfuron-methyl 75% WG (Inpul) at rate of (0.0238+0.0357 kg ai ha^{-1}).

10- Pendimethalin 50% EC followed by bispyribac + halosulfuron-methyl 75 % WG at rate of (0.0381+0.0357 kg ai ha^{-1}).

11- Pendimethalin 50% EC followed by fenoxaprop + halosulfuron-methyl 75%WG at rate of (0.0625+0.0357 kg ai ha^{-1}).

12- Thiobencarb 50% EC followed by penoxsulam+ halosulfuron-methyl 75% WG (Inpul) at rate of (0.0238+0.0357 kg ai ha^{-1}).

13- Thiobencarb 50% EC followed by bispyribac + halosulfuron-methyl 75 % WG at rate of (0.0381+0.0357 kg ai ha^{-1}).

14- Thiobencarb 50% EC followed by fenoxaprop + halosulfuron-methyl 75%WG at rate of (0.0625+0.0357 kg ai ha^{-1}).

15- Weedy check (untreated).

Thiobencarb and pendimethalin 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.

Penoxsulam alone or mixed with halosulfuron were applied at 15 DAS, while bispyribac-sodium alone or mixed with halosulfuron were sprayed at 22 DAS, then fenoxaprop-ethyl alone or mixed with halosulfuron treatments were applied at 35 DAS. 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.

At 80 DAS, weeds were sampled by area of 50 x 50 cm quadrate replicated four times for each plot, weeds were cleaned then air dried then oven dried to stable weight, dry weights per square meter for each weed species were recorded then total dry weights of total weeds were calculated.

Also, rice dry weight was measured by the same method. 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, the central 5 m^2 from each plot were manually harvested to determine grain yield then recorded rice grain yield at 14% moisture content.

Data analysis: the collected data were subjected to proper statistical analysis of variance according to Snedecor and Cochran (1971). Weed data were statistically analyzed by MSTATC program after transformed according to square-root transformation ($\sqrt{[x + 0.5]}$), while rice collected data were directly analyzed by MSTATC program then the means of both weeds and rice characters were compared by using Duncan´s Multiple Range Test (Duncan, 1955).

- Correlation coefficient:

Phenotypic correlation coefficients between all possible combinations of pair of characters were computed as follows:

$$\mathbf{r} = \frac{\Sigma XY - \Sigma X.\Sigma Y / n}{[\Sigma(X - \bar{X})^2.\Sigma(Y - \bar{Y})^2]^{1/2}}$$

The significance of the (r) values tested by using the (t) test at 0.05 and 0.01 levels of significance by Steel and Torrie (1960) as follows:

Calculated (t) value for (r) = $r\ (n\text{-}2 / l\text{-}r^2)^{1/2}$.

The estimated (t) values for the different correlation coefficients were tested against tabulated (t) values with (n-2) degrees of freedom at 0.05 and 0.01 levels of significance, where (n) is the number of error degrees of freedom.

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
Rainbow 2.5% OD	400 ml.	penoxsulam	0.0238	Triazolopyrimidine	$C_{16}H_{14}F_5N_5O_5S$	Systemic – ALS inhibitors	Grassy + broad leaves + sedges
Nominee 2% SL	800 ml.	bispyribac-sodium	0.0381	Pyrimidinyloxybenzoic acid herbicides	$C_{19}H_{17}N_4NaO_8$	Systemic – ALS 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
Stomp 50% EC	1.7 Lit.	pendimethalin	2.023	Dinitroaniline	$C_{13}H_{19}N_3O_4$	Microtubule assembly inhibitor	Grassy + broad leaves
Inbul 75% WG	20 g.	halosulfuron-methyl	0.0357	pyrimidinylsulfonylurea herbicides	$C_{12}H_{13}ClN_6O_7S$	Systemic – ALS inhibitors	Broad leaves + sedges

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

RESULTS AND DISCUSSION

A- Weeds:

The major weed species associated with rice crop during the two growing seasons were grassy weeds including; *Echinochloa crus-galli* (barnyard grass) and *Echinochloa colona* (jungle rice) and broad leave weeds including (*Ammania baccifera*) and others. Dry weights per square meter for each weed species were recorded then total dry weights of total weeds were calculated and used as reliable indicators for weed distribution in rice plots.

A.1. Effect of pre and post-emergence weed control treatments on dry weights of grassy weeds, broadleaves and total weeds during 2015 and 2016 seasons.

Data on dry weights (g.m^{-2}) of grassy weeds, broadleaves and total weeds as affected by pre and post-emergence weed control treatments in 2015 and 2016 seasons are presented in Table (2). Pendimethalin application (2.023 Kg ai ha^{-1}) at 4 DAS followed by penoxsulam (0.0238 Kg ai ha^{-1}) + halosulfuron (0.0357 Kg ai ha^{-1}) or bispyribac-sodium (0.0381 Kg ai ha^{-1}) + halosulfuron (0.0357 Kg ai ha^{-1}) as well as fenoxaprop (0.0625 Kg ai ha^{-1}) + halosulfuron (0.0357 Kg ai ha^{-1}) treatments achieved the best weed control (lowest values of grasses, broadleaves and total weeds dry weights) for studied traits in the first season without significant differences between thiobencarb at rate of 3.57 Kg ai ha^{-1} at 4 DAS followed by penoxsulam (0.0238 Kg ai ha^{-1}) + halosulfuron (0.0357 Kg ai ha^{-1}) or bispyribac-sodium (0.0381 Kg ai ha^{-1}) + halosulfuron (0.0357 Kg ai ha^{-1}) as well as fenoxaprop (0.0625 Kg ai ha^{-1}) + halosulfuron (0.0357 Kg ai ha^{-1}) through 2016 season. While untreated plots (weedy check) scored the highest values of grasses, broadleaves and total weeds dry weights in the two growing seasons. Previous studies showed that bispyribac-sodium mixed with broadleaves herbicide recorded better weed control than the single application of bispyribac-sodium because of the mixture can be manage both grassy and broadleaves weeds in the same time to reduce weed-competition against rice for water, nutrients and light (Chauhan *et al.*, 2013 and Mahajan and Chauhan, 2015).

Table 2. Dry weight of grassy weeds, broadleaves and total weeds (g m^{-2}) as affected by weed control treatments during 2015 and 2016 seasons. Weed data were subjected to square-root ($\sqrt{[x + 0.5]}$) transformation before analysis; transformed values are shown in parentheses.

Treatment	Rate (Kg ai ha^{-1})	Time of Application (DAS)	2015 season			2016 season		
			Grassy weeds dry weight (g m^{-2})	Broadleaves dry weight (g m^{-2})	Total weeds dry weight (g m^{-2})	Grassy weeds dry weight (g m^{-2})	Broadleaves dry weight (g m^{-2})	Total weeds dry weight (g m^{-2})
1- Pendimethalin 50% EC	2.023	4	104.67 (10.25 c)	27.33 (5.27 c)	132.00 (11.53 c)	48.10 (6.96 c)	22.57 (4.74 cd)	70.67 (8.47 c)
2- Thiobencarb 50% EC	3.57	4	304.00 (17.45 b)	124.00 (11.15 b)	428.00 (20.70 b)	342.00 (18.51 b)	192.00 (13.87 b)	534.00 (23.13 b)
3- Pendimethalin *fb* penoxsulam	2.023 *fb* 0.0238	15	60.33 (7.80 e)	9.33 (3.11 fg)	69.67 (8.40 ef)	28.07 (5.33 d)	12.86 (3.62 e)	40.93 (6.40 f)
4- Pendimethalin *fb* bispyribac-sodium	2.023 *fb* 0.0381	22	58.40 (7.67 e)	8.73 (3.02 fg)	67.13 (8.23 f)	21.53 (4.67 e)	15.45 (3.99 de)	36.98 (6.10 f)
5- Pendimethalin *fb* fenoxaprop-ethyl	2.023 *fb* 0.0625	35	58.00 (7.64 e)	16.33 (4.09 def)	74.33 (8.70 e)	20.80 (4.60 e)	19.43 (4.46 de	40.23 (6.37 f)
6- Thiobencarb *fb* penoxsulam	3.57 *fb* 0.0238	15	77.67 (8.83 d)	19.67 (4.49 cde)	97.33 (9.87 d)	42.67 (6.54 c)	13.18 (3.64 e)	55.84 (7.50 d)
7- Thiobencarb *fb* bispyribac-sodium	3.57 *fb* 0.0381	22	102.67 (10.15 c)	25.33 (5.07 cd)	128.00 (11.37 c)	28.20 (5.35 d)	17.89 (4.27 de)	46.08 (6.83 e)
8- Thiobencarb *fb* fenoxaprop-ethyl	3.57 *fb* 0.0625	35	78.00 (8.83 d)	24.67 (5.01 cd)	102.67 (10.13 d)	25.40 (5.09 de)	29.51 (5.47 c)	54.91 (7.43 d)
Pendimethalin *fb* penoxsulam + halosulfuron	2.023 *fb* 0.0238+0.0357	15	4.67 (2.27 g)	2.33 (1.65 hi)	7.00 (2.80 i)	4.27 (2.17 f)	1.13 (1.23 g)	5.40 (2.53 g)
Pendimethalin *fb* bispyribac-sodium + halosulfuron	2.023 *fb* 0.0381+0.0357	22	3.67 (2.04 g)	1.33 (1.27 i)	5.00 (2.40 i)	3.73 (2.05 f)	2.20 (1.63 fg)	5.93 (2.63 g)
- Pendimethalin *fb* fenoxaprop-ethyl + alosulfuron	2.023 *fb* 0.0625+0.0357	35	3.33 (1.95 g)	2.00 (1.56 hi)	5.33 (2.47 i)	2.40 (1.69 f)	3.83 (2.08 f)	6.23 (2.67 g)
- Thiobencarb *fb* penoxsulam + halosulfuron	3.57 *fb* 0.0238+0.0357	15	21.87 (4.73 f)	5.63 (2.46 gh)	27.50 (5.33 gh)	4.27 (2.17 f)	1.87 (1.53 fg)	6.13 (2.70 g)
Thiobencarb *fb* bispyribac-sodium + halosulfuron	3.57 *fb* 0.0381+0.0357	22	20.60 (4.59 f)	6.07 (2.55 gh)	26.67 (5.27 h)	4.27 (2.17 f)	2.60 (1.74 fg)	6.87 (2.80 fg)
Thiobencarb *fb* fenoxaprop-ethyl + halosulfuron	3.57 *fb* 0.0625+0.0357	35	19.96 (4.52 f)	11.34 (3.44 efg)	31.33 (5.70 g)	3.73 (2.05 f)	4.63 (2.27 f)	8.37 (3.07 fg)
15- Weedy check (untreated)	--	--	1273.33 (35.68 a)	523.99 (22.85 a)	1797.330 (42.43 a)	1168.00 (34.18 a)	808.67 (28.43 a)	1976.67 (44.50 a)
LSD $_{0.05}$	-	-	0.643	1.067	0.402	0.567	0.761	0.377

Means of transformed data followed by the same letter are not significantly different at 5% level, using Duncan's Multiple Range Test. ai = active ingredient. DAS= days after seeding.

B- Rice studied traits:

Rice dry weight (g. m^{-2}), number of panicles per unit area and grain yield (ton ha^{-1}) were determined for rice to reflect the effect of tested factors on rice growth and yield. Results will be presented as follow:

B.1. Effect of pre and post-emergence weed control treatments on dry weight, number of panicles per unit area and rice grain yield during 2015 and 2016 seasons.

Table 3. Dry weight, number of panicles m^{-2} and grain yield of rice as affected by weed control treatments during 2015 and 2016 seasons.

Treatment	2015 season			2016 season		
	Rice dry weight (g m^{-2})	No. of panicles (m^{-2})	Rice grain yield (ton ha^{-1})	Rice dry weight (g m^{-2})	No. of panicles (m^{-2})	Rice grain yield (ton ha^{-1})
1- Pendimethalin 50% EC	1020.00 h	220.0 g	5.003 e	1056.00 d	272.0 g	5.437 g
2- Thiobencarb 50% EC	640.0 i	144.0 h	1.467 f	713.67 e	205.3 h	2.303 h
3- Pendimethalin *fb* penoxsulam	1373.31 de	440.7 e	6.869 d	1369.33 bc	502.7 d	8.340 cd
4- Pendimethalin *fb* bispyribac-sodium	1300.0 ef	476.6 d	7.952 bc	1346.00 bc	510.6 d	8.538 c
5- Pendimethalin *fb* fenoxaprop-ethyl	1353.33 e	492.0 d	7.915 c	1306.67 bc	517.3 d	7.646 e
Thiobencarb *fb* penoxsulam	1213.33 fg	418.7 f	6.380 d	1269.33 c	416.0 f	7.029 f
7- Thiobencarb *fb* bispyribac-sodium	1293.33 ef	443.3 e	6.527 d	1326.67 bc	420.7 f	6.835 f
8- Thiobencarb *fb* fenoxaprop-ethyl	1173.32 g	437.3 e	6.417 d	1265.33 c	473.7 e	6.744 f
9- Pendimethalin *fb* penoxsulam + halosulfuron	1753.33 a	576.0 a	9.371 a	1656.67 a	624.7 a	9.255 ab
10- Pendimethalin *fb* bispyribac-sodium + halosulfuron	1660.0 b	594.7 a	9.296 a	1541.33 a	642.0 a	9.449 a
11- Pendimethalin *fb* fenoxaprop-ethyl + halosulfuron	1660.0 b	586.7 a	9.147 a	1618.67 a	636.67 a	9.221 ab
12- Thiobencarb *fb* penoxsulam + halosulfuron	1453.31 cd	528.0 bc	8.470 b	1368.67 bc	561.3 c	8.287 cd
13- Thiobencarb *fb* bispyribac-sodium + halosulfuron	1513.33 c	541.3 b	8.470 b	1361.33 bc	560.0 c	8.125 d
14- Thiobencarb *fb* fenoxaprop-ethyl + halosulfuron	1513.22 c	520.0 c	8.177 bc	1407.33 b	589.3 b	9.002 b
15- Weedy check (untreated)	420.00 j	85.3 i	1.063 f	377.33 f	114.7 i	0.587 i
$LSD_{0.05}$	90.07	18.65	0.481	113.7	25.26	0.308

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

It is clear from data in Table (3) that chemical weed control by both pre and post-emergence herbicides significantly increased rice dry weight as compared to un-treated plots. The application of pendimethalin herbicide at 4 DAS recorded the highest dry weight of rice in the two seasons of study followed by thiobencarb 50% EC, while the lowest dry weight of rice plants was scored under un-treated plots (control) in 2015 and 2016 seasons. The highest dry weight of rice was obtained by spraying pendimethalin herbicide at 4 DAS followed by penoxsulam +halosulfuron treatment in 2015 and 2016 seasons without significant differences between pendimethalin *fb* bispyribac-sodium +halosulfuron and pendimethalin *fb* fenoxaprop +halosulfuron in 2016 season. On the other side, weedy check plots recorded the lowest dry weight of rice (g m^{-2}) over the two seasons. These results are in conformity with the findings obtained by Walia *et al.* (2008) and Anwar *et al.* (2013).

In respect to number of panicles per unit area and rice grain yield, it is evident from data in Table (3) that number of panicles per unit area and rice grain was significantly affected by weed control treatments over the two seasons of study. Using pendimethalin as a pre-emergence herbicide followed by any of penoxsulam 2.5% or bispyribac-sodium 2% or fenoxaprop-ethyl 7.5% mixed with halosulfuron 75% as post-emergence weed control treatments scored the highest values of number of panicles m^{-2} and grain yield of rice during 2015 and 2016 seasons.

On the opposite, the lowest values of number of panicles m^{-2} and grain yield were recorded under un-treated plots in both seasons of study. The high yield may be due to high efficiency of pendimethalin as pre-emergence herbicide in suppress weed seed germination then reducing weed competition resulting in better growth conditions for rice such as water, macro and micro elements uptake and light which reflex on the high grain yield of rice. Similar results were obtained by Mahajan and Chauhan, 2015. Singh *et al*., 2006 and Chauhan *et al*., 2013 reported that the mixture application of herbicides significantly reduced weed biomass and save the best rice growth demands to gain the highest yield of rice than the single application of herbicides.

B.2. Effect of pre and post-emergence weed control treatments on dry weight, number of panicles per unit area and rice grain yield during 2015 and 2016 seasons.

Data on panicle weight, number of filled grain / panicle and 1000-grain weight of rice as affected by pre and post-emergence weed control treatments during 2015 and 2016 seasons are presented in Figures 1, 2 and 3.

All herbicides (pre and post-emergence) treatments significantly increased panicle weight, 1000-grain weight and number of filled grain / panicle of rice as compared to weedy check (untreated plots) during the two seasons of study. The highest values of these characters were recorded with pre-emergence herbicide application of pendimethalin at 2.023 kg ai ha^{-1} followed by post-emergence application of penoxsulam or bispyribac-sodium or fenoxaprop at the recommended dose in mixture with halosulfuron at the recommended dose, while thiobencarb application at 4 DAS followed by applying the same abovementioned post-emergence weed control treatments ranked second. On the other hand, weedy check plots recorded the lowest values of panicle weight, 1000-grain weight and number of filled grain per panicle of rice during 2015 and 2016 seasons. The increasing in these characters due to reduced completion as a results of effective weed control by herbicides. Similar results were obtained by Walia *et al.* (2012).

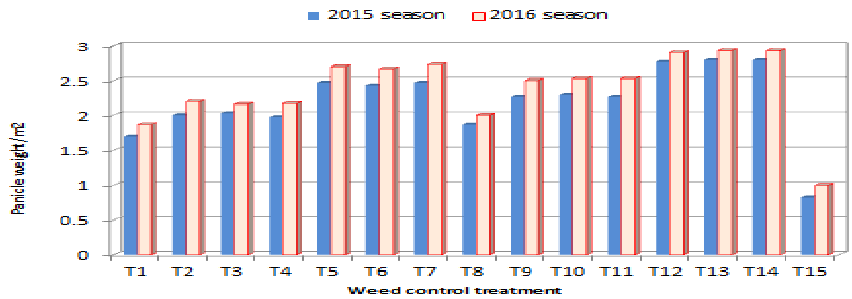

Fig. 1. Panicle weight of rice as affected by weed control treatments in 2015 and 2016 seasons

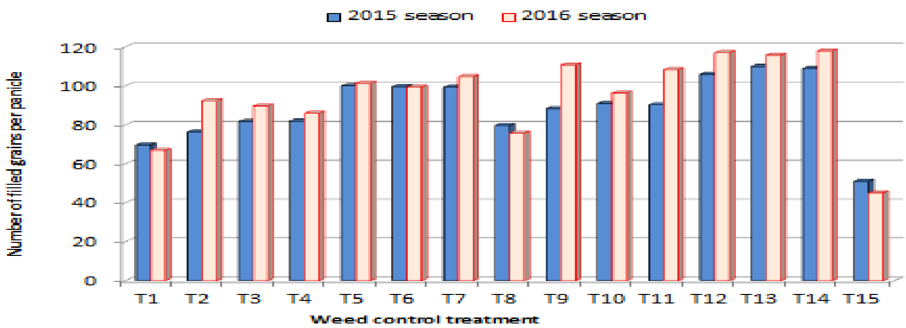

Fig. 2. Number of filled grains per panicle of rice as affected by weed control in treatments in 2015 and 2016 seasons

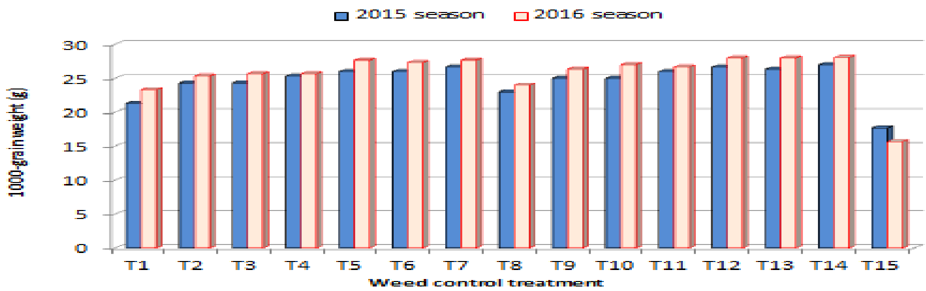

Fig. 3. 1000-grain weight (g) of rice as affected by weed control in treatments in 2015 and 2016 seasons

T_1= thiobencarb, **T_2**= thiobencarb ***fb*** penoxsulam, **T_3**= thiobencarb ***fb*** bispyribac, **T_4**= thiobencarb ***fb*** fenoxaprop, **T_5**= thiobencarb ***fb*** penoxsulam + halosulfuron**, T_6**= thiobencarb ***fb*** bispyribac + halosulfuron**, T_7**= thiobencarb ***fb*** fenoxaprop + halosulfuron**, T_8**= pendimethalin, **T_9**= pendimethalin ***fb*** penoxsulam, **T_{10}**= pendimethalin ***fb*** bispyribac**, T_{11}**= pendimethalin ***fb*** fenoxaprop, **T_{12}**= pendimethalin ***fb*** penoxsulam + halosulfuron**, T_{13}**= pendimethalin ***fb*** bispyribac + halosulfuron**, T_{14}**= pendimethalin ***fb*** fenoxaprop + halosulfuron**,** and **T_{15}**= Weedy check (control).

C- Correlation coefficients among studied traits of weeds and rice) in 2015 and 2016 seasons.

Data in Table (4) are showed the correlation among studied traits of weeds and rice growth, yield and some yield attributes in the two seasons of study.

Table 4. Correlation coefficients among studied traits of weeds and rice in 2015 and 2016 seasons.

	Total weeds dry weight	Total weeds fresh weight	Rice dry weight	Number of panicle/m^2	Panicle weight	Filled grains / panicle	1000-grain weight	Grain yield
	2015 season							
Total weeds dry weight	1	0.962**	-0.788**	-0.749**	-0.834**	-0.768**	-0.946**	-0.771**
Total weeds fresh weight	0.962**	1	-0.910**	-0.879**	-0.933**	-0.898**	-0.982**	-0.897**
Rice dry weight	-0.788**	-0.910**	1	0.956**	0.926**	0.947**	0.898**	0.968**
Number of panicle/m^2	-0.749**	-0.879**	0.956**	1	0.913**	0.914**	0.880**	0.973**
Panicle weight	-0.834**	-0.933**	0.926**	0.913**	1	0.956**	0.928**	0.916**
Filled grains per panicle	-0.768**	-0.898**	0.947**	0.914**	0.956**	1	0.896**	0.925**
1000-grain weight	-0.946**	-0.982**	0.898**	0.880**	0.928**	0.896**	1	0.882**
Grain yield	-0.771**	-0.897**	0.968**	0.973**	0.916**	0.925**	0.882**	1
	2016 season							
Total weeds dry weight	1	0.987**	-0.847**	-0.743**	-0.813**	-0.755**	-0.846**	-0.837**
Total weeds fresh weight	0.987**	1	-0.906	-0.826**	-0.867**	-0.813**	-0.893**	-0.905
Rice dry weight	-0.847**	-0.906**	1	0.930**	0.915**	0.913**	0.907**	0.963**
Number of panicle/m^2	-0.743**	-0.826**	0.930**	1	0.944**	0.917**	0.905**	0.961**
Panicle weight	-0.813**	-0.867**	0.915**	0.944**	1	0.922**	0.892**	0.933**
Filled grains per panicle	-0.755**	-0.813**	0.913**	0.917**	0.922**	1	0.867**	0.916**
1000-grain weight	-0.846**	-0.893**	0.907**	0.905**	0.892**	0.867**	1	0.911**
Grain yield	-0.837**	-0.905**	0.963**	0.961**	0.933**	0.916**	0.911**	1

** indicated highly significant at 0.05 and 0.01 level of probability.

It is obvious from the obtained data that fresh and dry weights of total weeds were highly significantly positively correlated in 2015 and 2016 seasons. On the other hand, there were highly significantly negative correlations between both traits and rice dry weight, yield and yield attributes in both seasons of study. All rice studied traits showed highly significantly positively correlation between each other, while appeared highly significant negative correlations with total weeds fresh and dry weights in 2015 and 2016 seasons.

Grain yield of rice was highly significantly negatively correlated with both fresh and dry weights of total weeds in the two seasons of study. But highly significantly positively correlated with rice dry weight and panicles number per square meter (r = 0.968**, 0.963** and 0.973** and 0.961**) in 2015 and 2016 seasons, respectively. In addition the positive correlation with other yield components in the two seasons of study. Previous studies also revealed a negative correlation between rice yield and weed biomass in DSR (Chauhan *et al.*, 2011). Rice grain yield was negatively and linearly associated with weed density and weed biomass. (Abdul Khaliq and Chauhan, 2014).

CONCLUSION

Based on the obtained results under study, it can be concluded that weed management in drill-seeded rice must be a sequential application of herbicides. Moreover, the application of herbicide mixtures as a post-emergence was more effective than single application. The maximum rice grain yield and best weed control were achieved by the application of pendimethalin 50% EC at rate of 2.023 Kg ai ha^{-1} at 4 DAS as pre-emergence herbicide followed by adding any of penoxsulam 2.5% OD or bispyribac-sodium 2% SL or fenoxaprop-ethyl 7.5% EW mixed with halosulfuron 75% WG at recommended doses as post-emergence herbicides at 15, 22 and 35 DAS, respectively.

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التكامل بين مبيدات قبل وبعد الإنبثاق في مكافحة حشائش الأرز التسطير

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قسم بحوث الأرز– معهد بحوث المحاصيل الحقلية– مركز البحوث الزراعية– الجيزة – جمهورية مصر العربية

أجريت تجربتان حقليتان خلال موسمي ٢٠١٥ و ٢٠١٦ بالمزرعة البحثية لمحطة البحوث الزراعية بسخا–كفرالشيخ–جمهورية مصر العربية للوصول لأفضل معاملات قبل وبعد الانبثاق من المبيدات الموصى بها في مكافحة الحشائش تحت ظروف الأرز التسطير (صنف جيزة ١٧٩). وكانت معاملات مكافحة الحشائش المدروسة كالاتي: مبيد ثيوبينكارب ٥٠% بمعدل ٣,٥٧ كجم مادة فعالة للهكتار كمبيد قبل الإنبثاق منفرد، بالإضافة لنفس المبيد متبوعاً باضافة ست معاملات بعد الإنبثاق وهي: بينوكسولام ٢,٥% بمعدل ٠,٠٢٣٨ كجم للهكتار، بيسبيرباك صوديوم ٢% بمعدل ٠,٠٣٨١كجم مادة فعالة للهكتار، فينوكسابروب إيثيل ٧,٥% بمعدل٠,٠٦٢٥ كجم مادة فعالة للهكتار منفردة ونفس المبيدات مخلوطة بمبيد هالوسلفوران ٧٥% بمعدل ٠,٠٣٥٧ كجم مادة فعالة للهكتارن، ومبيد بنداميثيللين ٥٠% بمعدل ٢,٠٢٣ كجم مادة فعالة للهكتار كمبيد يضاف قبل الإنبثاق منفرداً، ومتبوعاً بنفس الست معاملات السابقة بعد الإنبثاق مقارنة بالقطع غير المعاملة بالمبيد (الكنترول). وكان التصميم الإحصائي المستخدم هو القطاعات كاملة العشوائية ذو ثلاث مكررات. وكانت أهم النتائج المتحصل عليها أن إضافة مبيد البينداميثيللين بعد الزراعة بـ ٤ أيام كمبيد قبل الانبثاق متبوعاً باضافة أي من مبيدات بينوكسولام أو بيسبيرباك صوديوم أو فينوكسابروب إيثيل مخلوط مع مبيد هالوسلفوران بالمعدلات الموصى بها حققت أقل وزن جاف للحشائش النجيلية، عريضة الأوراق والحشائش الكلية وكذلك أعلى مادة جافة وصفات المحصول ومكوناته للأرز خلال موسمي الزراعة. بناءً على النتائج المتحصل عليها يمكن استخلاص أنه بإضافة مبيد بنداميثيللين بعد الزراعة بـ ٤ أيام متبوعة بإضافة أي من مبيدات بينوكسولام ٢,٥% ، بيسبيرباك صوديوم ٢% أو فينوكسابروب إيثيل ٧,٥% مخلوط بمبيد هالوسلفوران ٧٥% بعد ١٥، ٢٢ و٣٥ يوم من الزراعة على التوالي بالمعدلات الموصى بها يمكن الحصول على أفضل مكافحة للحشائش الكلية وأعلى محصول حبوب للأرز التسطير.