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Performance of Quinclorac+ Fenoxaprop-P-Ethyl+ Pyrazosulfuron-Ethyl 70% WP against Annual Weeds of Transplanted Rice

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Abstract: Weed control is as old practice as agriculture itself. Weeds cause major difficulty in rice production, which do not only try to win with crop yield but also damage quality. Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP is a new post emegence herbicide in Bangladesh. Field trials were conducted at Bangladesh Rice Research Institute (BRRI), Gazipur during Aman, 2016 and Boro, 2016-17 to assess the efficacy of Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP on weed suppression and performance of transplanted rice. Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 150, 175 and 200 g ha^{-1} were applied along with Pyrazosulfuron-ethyl 10 WP @ 125 g ha^{-1}, weed free and unweeded control was used for evaluation. Visual inspection indicated that this herbicide possesses high selectivity and not toxic to rice plants. The results revealed that the major weed flora associated with the transplanted rice was mainly comprised of two grasses, two sedges and four broadleaves in Aman, 2016 and two grasses, two sedge and two broad leaves in Boro, 2016-17. The most dominant weeds were Cyperus difformis, Echinochloa crus-galli, Scirpus maritimus and Monochoria vaginalis in both the growing seasons. Application of Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 175 g ha^{-1} was most effective to suppress weed density and dry masses in both the seasons resulting increased grain yield more than 40% as compared to unweeded control. Therefore, Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 175 g ha^{-1} should apply at two to three leaf stage of weed may be recommended for effectively control weeds in transplanted rice.

Key words: Quinclorac+ Fenoxaprop-P-Ethyl+ Pyrazosulfuron-Ethyl 70% WP · Transplanted Rice · Weed Density · Weed Control Efficiency

INTRODUCTION

Rice (*Oryza sativa* L.) is a principal source of food for more than half of the world's population, especially in Bangladesh. The average yield of rice in Bangladesh is 4.5 tha^{-1} [1]. Rice production needs to be increased by 50% or more above the current production level to meet the rising food demand [2]. Weed infestation and interference is a serious problem in rice fields that significantly decreases yield. In Bangladesh weed infestation reduces rice grain yield by 70-80% in Aus rice, 30-40% in transplanted aman rice and 22-36% for modern boro rice cultivars [3, 4]. According to Willocquet *et al*. [5] and Bari [6] the losses due to infestation of weeds are greater than the combined losses caused by insect, pest and diseases in rice. Weeds not only cause huge reductions in rice yields but also increase cost of cultivation, reduce input efficiency, interfere with agricultural operations, impair quality, act as alternate hosts for several insect pests, diseases, they affect aesthetic look of the ecosystem as well as native biodiversity, affect human and cattle health. Weeds compete for nutrient, space, sunlight and consume the available moisture with crop plant resulting in crop yield reduction [2]. Weed management in rice production is a major constraint and is expensive. Since hand weeding and other weed control methods are difficult, chemicals are the obvious and cost efficient weed control practices [7, 8]. Chemical weed control has become popular in Bangladesh mainly due to scarcity of labour during peak growing season and lower weeding cost. In Bangladesh the annual consumption of herbicides grew over 3420 metric tons in 2014 [9] compared to only 108 tons during 1986-87 [10] and the growth is almost exponential. In Bangladesh the traditional methods of weed control practices include preparatory land tillage, hand weeding by hoe and hand pulling. Mechanical and

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cultural weed control in transplanted rice is an expensive method. Especially at the time of peak period of labor crisis sometimes weeding becomes late causing drastic losses in grain yield [11, 12]. Nowadays use of herbicides is gaining popularity in rice culture due to their rapid effects and less cost involvement compared to traditional methods. Quite a lot of pre and post emergence herbicides such as butachlor, pretilachlor, oxadiazone, pyrazosulfuron ethyl, ethoxysulfuron alone or supplemented with one hand weeding have been found to be useful for weed management in transplanted paddy. Use of single herbicide might be effective for only sedges or only grass or broad leaf weeds. Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP has been recently developed for pre emergence control of weeds in rice field. It is a selective herbicide, absorbed mainly by the shoots of germinating plants. It can effectively control most important perennial and annual species of broad leaf weeds, grasses and sedges in transplanted rice. Furthermore such type of herbicide is almost new perception in Bangladesh for control of weeds. So to give farmers a wider choice of effective herbicide there is a need to develop environmental friendly molecules of newer chemistries with different mode of action. The present study was, therefore, planned to evaluate the efficacy of Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP for annual weed suppression and find out an appropriate dose of the herbicide and its impacts on transplanted rice.

MATERIALS AND METHODS

The experiments were conducted at the Bangladesh Rice Research Institute, Gazipur, situated at 23°59′33′′ N and 90°24′19′′ E at an elevation of 8.4 m from the mean sea level and is characterized by sub-tropical climate during Aman, 2016 and Boro, 2016-2017 seasons to evaluate the efficacy of Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP for weed suppression and to find out an appropriate dose of this herbicide by with its impacts on transplanted rice. The soil of the experimental site was non-calcareous dark grey flood plain [13] with pH around 6.2 and low in organic matter (1.2%). The experiment was carried out with six (6) treatments viz. i) T_1= Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 150 gm ha^{-1} (105 g a.i. ha^{-1}), ii) T_2= Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 175 g ha^{-1}(122.5 g a.i. ha^{-1}), iii) T_3= Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 200 g ha^{-1} (140 gm a.i. ha^{-1}), iv) T_4= Pyrazosulfuron-ethyl 10 WP @ 125 ha^{-1} (12.5 g a. i. ha^{-1}), v) T_5= Weed free by hand weeding and vi) T_6=Control (Unwedded). All treatments were laid out in a randomized complete block design with three replications. Twenty five days of BRRI dhan49 for Aman, 2016 and thirty five days old seedlings of BRRI dhan28 for Boro, 2016-17 were transplanted at 20 x 20 cm spacing with 2 seedlings $hill^{-1}$. Fertilizer was applied following BRRI recommended dose Aman: N:P:K:S= 69:10:41:11 kg/ha and Boro; N:P:K:S= 120:19:60:24 kg/ha [14]. Herbicides were sprayed 3 days before transplanting with the help of a knapsack sprayer. In weed free treatment, the plots were kept weed free up to 50 DAT by hand weeding and check herbicide was Pyrazosulfuron-ethyl 10 WP @ 125 ha^{-1}which commercial name is Empty 10 WP. Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP herbicide is innovative in Bangladesh and its phytotoxicity needs to be evaluated on rice crop. The commercial name of Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP is Bicosaf 70 WP. The phytotoxicity of the herbicide to rice plants was determined by visual observations (yellowing leaves, burring leaf tips, stunting growth etc). The degree of toxicity on rice plant was measured by the following scale used by IRRI [15].

- No toxicity
- Slightly toxicity
- Moderate toxicity
- Severe toxicity
- Toxic (plant kill)

The rating of toxicity was done within 7 days after application of herbicides. It was observed three times at 3, 5 and 7 days after application of herbicide and the mean rate was calculated from 10 sample plants of a unit plot.

Data on weed density and dry weight were taken from each plot on 40 DAT. The weeds were identified species-wise. Dry weights of weeds were taken by drying them in electric oven at 60° C for 72 hours followed by weighing by digital balance. Relative weed density (RWD), relative weed biomass (RWB) and weed control efficiency (WCE) of different weed control treatments were calculated with the following formulas [16].

$$RWD\ (\%) = \frac{\text{Density of individual weed species in the community}}{\text{Total density of all weed species in the community}} \times 100$$

$$RWB (\%) = \frac{\text{Dry weight of a given oven dried weed species}}{\text{Dry weight of all oven dried weed species}} \times 100$$

$$SDR (\%) = \frac{RWD (\%) + RWB (\%)}{2}$$

$$WCE (\%) = \frac{\text{(Dry weight of weeds in weedy check plots- Dry weight of weeds in treated plots)}}{\text{Dry weight of weeds in weedy check plots}} \times 100$$

Data on panicle m^{-2}, grains panicle^{-1}, sterility and grain yield were collected. Yield attributes data were analyzed with analysis of variance and also graphical presentation by using STAR 2.0.1 software.

RESULTS AND DISCUSSION

Phytotoxicity of Herbicides on Rice Plant: The degree of toxicity of the herbicide to rice plants and the symptoms produced on plant are presented in Table 1. It is observed that Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 150 gm ha^{-1}showed no toxicity and 175 gm ha^{-1}showed very slight yellowing of leaves while 200 gm ha^{-1}showed temporary yellowing of leaves. It is observed that phytotoxicity symptoms were not more prominent for using this herbicide. Phytotoxicity of rice plant by combined herbicide is less which is similar to the findings of Bhuiyan *et al*. [17].

Weed Infestation

Aman Season, 2016: In this experiment the rice field was infested with different types of weeds. The relative density of these weed species was also different (Table 2). Eight different weed species were observed in unweeded (Control) plot where most dominating weeds were sedges and broad leaf. Among the infesting different categories of weeds, two were grasses, two sedges and four broadleaves. The weed species were belonging to the families of Poaceae, Cyperaceae, Pontederiaceae, Marsileaceae, Sphenocleaceae and Asteraceae. The broad leaved were: *Monochoria vaginalis, Marsilea minuta*, *Sphenoclea zeylanica* and *Eclipta alba*; grasses were: *Echinochloa crus-galli, Cynodon dactylon*; and sedges were *Cyperus difformis* and *Scirpus maritimus.* Among the weed species maximum relative weed density (RWD) was observed for *Cyperus difformis* (31.50%) followed by *Echinochloa crus-galli* (29.40%) but highest relative weed biomass (RWB) observed for *Echinochloa crus-galli* (32.90%) followed by *Cyperus difformis* (32.80%). Among the weeds *Eclipta alba* was the minor weed with 2.54% RWD and 3.80% RWB. In this study it was also observed that broad leaf were less dominating weed species. Bhuiyan *et al*. [17, 18] revealed that efficacy of combined herbicide reduce the weed infestation.

Boro Season, 2016-17: The number of infesting weed species was slightly different in Boro season than Aman season. These weed flora were ecologically categorized

Table 1: Rating of herbicide toxicity on rice plant under different treatments at BRRI, Gazipur

Treatments	Rating		Symptom observed in rice field
	Aman,2016	Boro,201-17	
Quinclorac+Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 150 g ha^{-1} (11.47 g a.i. ha^{-1})	1.10	1.20	No toxicity
Quinclorac+Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 175 g ha^{-1} (13.77 g a.i. ha^{-1})	1.25	1.40	Sometimes slight yellowing of leaves
Quinclorac+Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 200 g ha^{-1} (16.06 g a.i. ha^{-1})	2.50	2.70	Slight yellowing of leaves
which required 5-7 days to recover Pyrazosulfuron-ethyl 10 WP @125 g ha^{-1} (12.5 g a.i. ha^{-1})	1.10	1.15	No toxicity

Table 2: Weed composition, Relative weed density (RWD) and Relative weed biomass (RWB) in the untreated control plots in Aman, 2016 at BRRI, Gazipur

Name of Weed Species	Family	Class	RWD (%)	RWB (%)
Cynodon dactylon	Poaceae	Grass	8.65	10.63
Echinochloa crus-galli	Poaceae	Grass	29.40	32.90
Cyperus difformis	Cyperaceae	Sedge	31.50	32.80
Scirpus maritimus	Cyperaceae	Sedge	25.65	23.90
Monochoria vaginalis	Pontederiaceae	Broad leaf	22.45	26.50
Marsilea minuta	Marsileaceae	Broad leaf	10.59	12.95
Sphenoclea zeylanica	Sphenocleaceae	Broad leaf	3.51	3.58
Eclipta alba	Asteraceae	Broad leaf	2.54	3.80

Table 3: Weed composition, Relative weed density (RWD) and Relative weed biomass (RWB) in the untreated control plots in Boro, 2016-17 at BRRI, Gazipur

Name of Weed Species	Family	Class	RWD (%)	RWB (%)
Cynodon dactylon	Poaceae	Grass	9.40	10.25
Echinochloa crus-galli	Poaceae	Grass	30.70	33.20
Cyperus difformis	Cyperaceae	Sedge	32.60	34.69
Scirpus maritimus	Cyperaceae	Sedge	27.55	29.66
Monochoria vaginalis	Pontederiaceae	Broad leaf	21.40	25.70
Marsilea minuta	Marsileaceae	Broad leaf	9.70	11.90

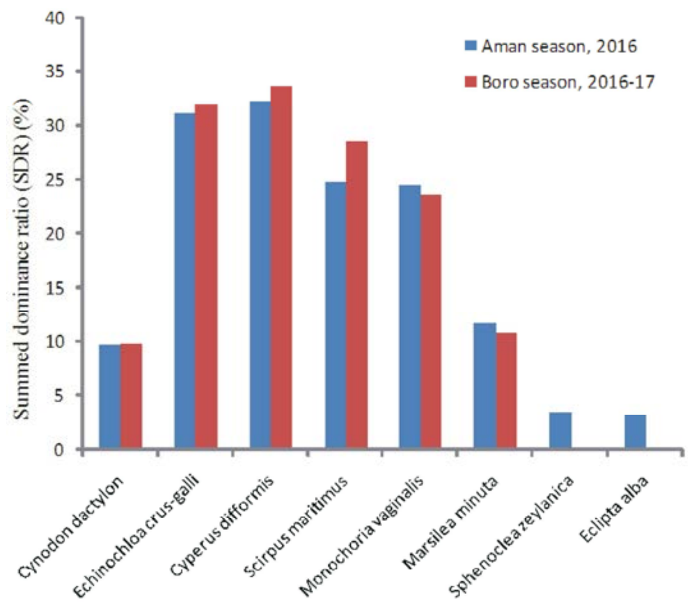

Fig. 1: Summed dominance ratio (SDR) of infesting weeds in transplanted rice

into two broad leaved species, two sedge and two grasses (Table 3). The major weed was *Cyperus difformis* which relative weed density (RWD) and relative weed biomass (RWB) was 32.60% and 34.69%, respectively. The second top weed was *Echinochloa crus-galli* which RWD was 30.70% and relative weed biomass (RWB) was 33.20%. So in Boro season broad leaf weeds were less dominating than Aman season. Combination of different herbicides effectively controls *Echinochola* and *Cyperus* sp. which found by Mahbub *et al*. [19].

Weed Ranking: The summed dominance ratio (SDR) is an important pointer of showing ranking of weeds. The most dominant weeds in Aman season, 2016 were *Cyperus difformis, Echinochloa crus-galli, Scirpus maritimus and Monochoria vaginalis* (Figure 1). *Cyperus difformis*, *Echinochloa crus-galli, Scirpus maritimus and Monochoria vaginalis* were also the most dominant weeds in Boro saeson, 2016-17. Bhuiyan *et al*. [20] showed that SDR of a weed against same herbicide is more or less similar in different seasons.

Weed Control Efficiency (WCE): Lower weed biomass as well as higher weed control efficiency in all the growing seasons exhibited by Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP. Weed control efficiency improved with increases of herbicide dose irrespective of weed species. Treatment, T_1 controls all the weeds less than 80% due to lower dose of application, whereas T_2, T_3 and T_4 (check) control *Echinochloa crus-galli, Cyperus difformis, Scripus maritimus* and *Marsilea minuta* more than 80% in Aman season (Table 4). The trend of weed control efficiency in Boro, 2016-17 was almost similar as Aman, 2016. All treatment controls most of the weeds more than 80% except T_1. Treatment, $T_{2,}$ T_3 and T_4 controls *Echinochloa crus-galli, Cyperus difformis, Scripus maritimus* and *Marsilea minuta* more than 80% (Table 5). It was evident from the study that the post emergence herbicide Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 175 gm ha^{-1} and 200 gm ha^{-1} was effective for controlling weed than other doses of that herbicide. Mahbub *et al*., [21] reported that the mixture of herbicides gave 80% control of annual and perennial weeds.

Table 4: Effect of Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP on weed control efficiency in transplanted rice in Aman, 2016 at BRRI, Gazipur

	Weed control efficiency (%)			
Name of weeds	T_1	T_2	T_3	T_4
Cynodon dactylon	32.65	47.30	52.75	44.50
Echinochloa crus-galli	60.40	82.10	85.20	83.61
Cyperus difformis	67.55	80.95	83.60	81.60
Scripus maritimus	70.45	83.30	85.35	83.25
Monochoria vaginalis	62.80	69.50	74.60	80.95
Marsilea minuta	51.80	81.55	81.65	82.78
Sphenoclea zeylanica	47.60	70.45	75.60	71.60
Eclipta alba	51.70	58.70	69.50	61.70
CV (%)	8.95	4.68	6.03	6.52
$LSD_{0.05}$	1.24	1.05	0.84	0.72

T_1= Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 150 g ha^{-1}, T_2= Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 175 g ha^{-1}, T_3= Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 200 g ha^{-1}and T_4= Pyrazosulfuron-ethyl 10 WP @ 125 g ha^{-1}

Table 5: Effect of Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP on weed control efficiency in transplanted rice in Boro, 2016-17 at BRRI, Gazipur

	Weed control efficiency (%)			
Name of weeds	T_1	T_2	T_3	T_4
Cynodon dactylon	33.60	52.40	58.70	51.45
Echinochloa crus-galli	63.80	82.70	83.60	83.35
Cyperus difformis	65.80	81.50	86.10	84.60
Scripus maritimus	60.70	81.55	84.20	82.60
Monochoria vaginalis	59.40	72.60	77.20	78.40
Marsilea minuta	51.65	80.40	81.750	82.35
CV (%)	9.35	6.72	6.95	7.58
$LSD_{0.05}$	2.15	1.45	1.13	0.91

T_1= Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 150 g ha^{-1}, T_2= Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 175 g ha^{-1}, T_3= Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 200 g ha^{-1}and T_4= Pyrazosulfuron-ethyl 10 WP @ 125 g ha^{-1}

Table 6: Effect of Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP on yield attributes of transplanted rice at BRRI, Gazipur

	Panicles m^{-2}		Grains panicle^{-1}		Sterility (%)		Grain yield (t ha^{-1})	
Treatments	Aman, 2016	Boro, 2016-17	Aman, 2016	Boro, 2016-17	Aman, 2016	Boro, 2016-17	Aman, 2016	Boro, 2016-17
T_1	204	263	99	103	17.73	15.33	3.93	4.78
T_2	211	291	102	116	17.47	17.10	4.25	5.45
T_3	197	249	98	101	17.41	16.50	3.96	4.76
T_4	210	288	104	113	17.23	15.93	4.38	5.52
T_5	216	298	103	113	16.20	15.17	4.31	5.58
T_6	177	199	79	90	20.23	20.03	2.69	3.17
CV (%)	3.97	4.07	3.90	4.09	5.40	6.26	5.00	4.12
$LSD_{0.05}$	14.66	19.64	6.91	7.87	1.74	1.89	0.35	0.36

T_1= Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 150 g ha^{-1}, T_2= Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 175 g ha^{-1}, T_3= Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 200 g ha^{-1}, T_4= Pyrazosulfuron-ethyl 10 WP @ 125 g ha^{-1} and T_5= Weed free and T_6= control (unweeded)

Yield and Yield Attributes: Grain yield is the function of an interaction among various yield components, which are affected differentially by the growing conditions and crop management practices. From Table 6 it was found that all the treatments significantly increased rice grain yield over unweeded control plot. During Aman season, 2016, the highest grain yield (4.38 t ha^{-1}) was recorded in the T_4 treatment which was statistically similar to treatments T_2 and T_5 producing grain yields of 4.18 and 4.31 tha^{-1}, respectively. Minimum grain yield (2.69 t ha^{-1}) was found in weedy check plots as compared to weed free treatment due to high weed density which resulted less number of panicle m^{-2}, grains panicle^{-1} and high sterility. Treatment wise boxplot of yield attributes in Aman season, 2016 confirm that most of the yield contributing characters are showed similar range in T_2, T_4 (Check) and T_5 (Weed free) treatments; whereas T_6 was outside of the normal range and its data was also in disperse condition than other treatments due to severe weed infestation (Figure 2).

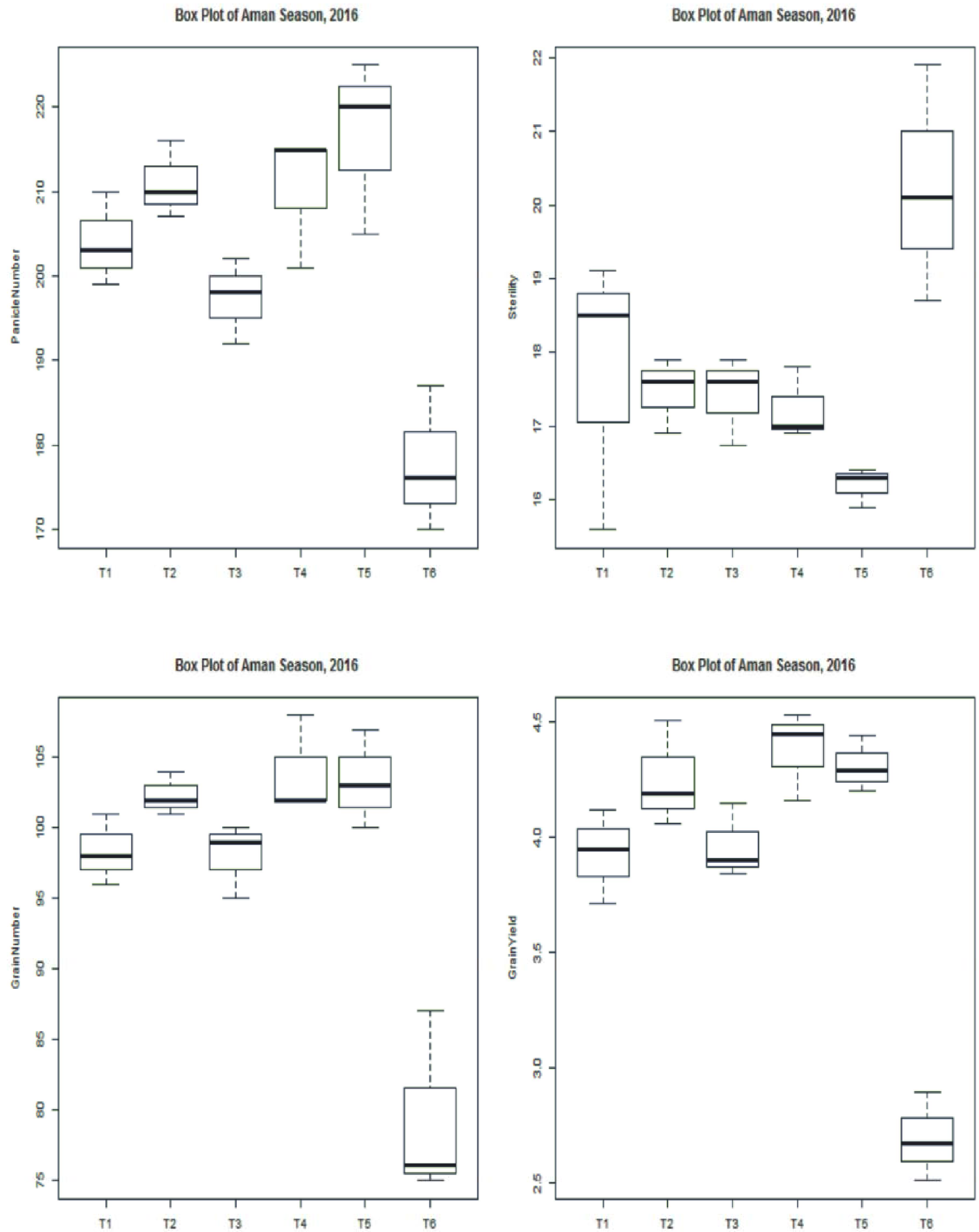

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Fig. 2: Boxplot of yield attributes in Aman season, 2016 at BRRI, Gazipur

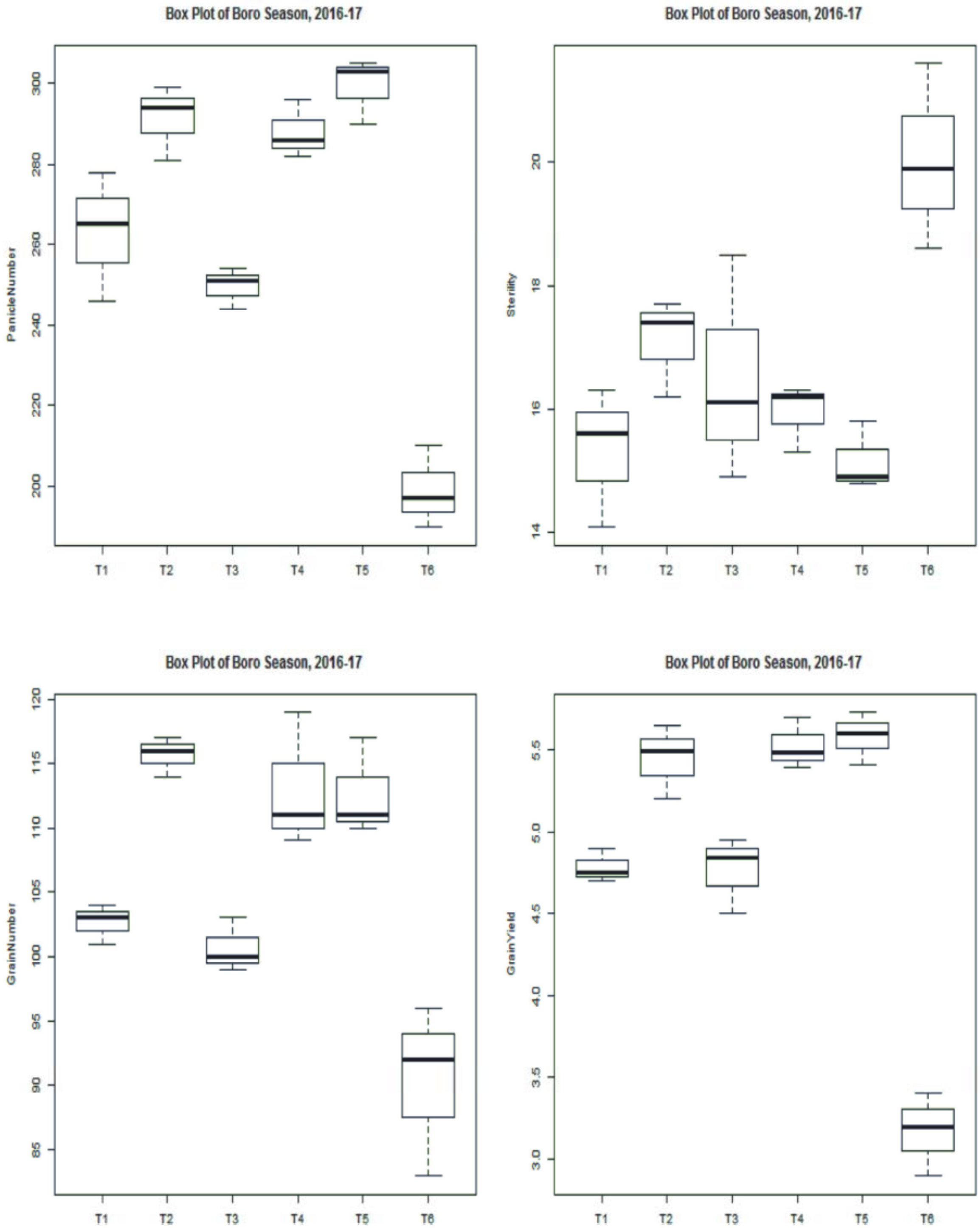

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Fig 3. Boxplot of yield attributes in Boro season, 20116-17 at BRRI, Gazipur

Similar trend of results was observed during the Boro, 2016-17 where unweeded control (T_6) produced minimum number of panicles m^{-2}, grains $panicle^{-1}$ and high sterility which resulting lowest grain yield (3.17 t ha^{-1}). The minimum number of panicles m^{-2} in the control plot was the result of higher competition for nutrient, air space, light and water between crop plants and weeds. Hasanuzzaman *et al.* [22] reported similar results. Maximum grain yield of 5.58 t ha^{-1} that was recorded with T_5 treatment could be due to lower weed-crop competition at crop growth stages. In Boro season, 2016-17; T_2, T_4 (check) and T_5 (Weed free) treatments are in similar range in boxplot of yield attributes (Figure 3). Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 175, 200 gm ha^{-1} gave effective control of grass, sedge and broad leaf weeds lead to increased grain yield. Herbicide treatments contributed to higher yield performance compared to control in all the growing seasons [6].

CONCLUSION

Based on the results, yield and yield attributing parameters and weed dynamics were greatly influenced by different weed management practice. Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 200 g ha^{-1} showed a good weed control efficiency but slightly phytotoxity found in this dose. So it may be suggested from this study that Quinclorac+ Fenoxaprop-p-ethyl+ Pyrazosulfuron-ethyl 70% WP @ 175 g ha^{-1}applied at two to three leaf stage of weed may be effective for annual weed control option instead of hand weeding at peak period of labor to increase yield in transplanted rice.

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