Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2019 16(4):3927-3936. **OPEN ACCESS**

Crop ecosystem responses and weed population under elevated temperature regimes

Md. Shahidul Haque Bir[1], Most Mohshina Aktar[2], Md. Romij Uddin[3], Botir Khaitov[1], and Kee Woong Park[1*]

[1]Department of crop science, Chungnam National University, Daejeon 34134, **Korea**
[2]Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh- 2202, **Bangladesh**
[3]Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, **Bangladesh**.

***Correspondence:** parkkw@cnu.ac.kr **Received: 04-01-2019, Revised: 13-11-2019, Accepted: 14-11-2019 e-Published: 30-12-2019**

The negative effects of weed infestation in paddy fields and increasing temperature are considered as the main factors of reducing rice grain yield. This study conducted to reveal the competitive interaction between rice (upland rice Dongjin 1) and weeds with different densities at ambient and 0.8℃, 1.9℃, and 3.4℃ above ambient temperature in special phytotrons at Chungnam National University, Daejeon, Korea. The competition between rice and weeds was created in the following three treatments: 1. Natural occurrence of weeds is naturally grown from the soil seed bank, 2. Standard density, the following weeds were grown in the plots: EO (*Echinochl oaoryzicola*) 1g, Mv (*Monochoria vaginalis*) 1 g, Lp (*Ludwigia prostrata*) 1 g, Ek *(Eleocharis kuroguwai)* 15 tuber, Sp (*Scirpus planiculmis)* 15 tuber, SS (*Sagittaria sagittifolia*) 15 tuber, Lpr *(Lindernia procumbens)* naturally occurred, Rp *(Rotala pusilla*) naturally occurred. 3. High density, the following weeds were grown in the plots: EO=2 g, Mv=2 g, Lp=2 g, Ek=30, Sp=30, SS=30, Lpr naturally occurred, Rp naturally occurred. Results presented that rice growth parameters such as height, the number of tillers, and shoot dry weight were increased with the increase of ambient temperature. However, rice yield negatively correlated with the increase of temperature, especially, caused enhancing the panicle senescence at the pollination period and shortening the grain filling period. The lowest rice yield was observed in high weed density treatment followed by standard weed density of weed treatment compared to natural weed occurrence treatment. From the perspective of rice: weed competitions, generally weeds exhibited more competitive ability than rice in this interspecific competition.

Keywords: Density, plant abundance, rice, temperature, weeds

INTRODUCTION

The global changing climate is considered to have the biggest threaten for crop biodiversity and ecosystem. Climate change, due to the onward emissions of greenhouse gases, is probably to affect agro ecosystems in several processes, but the effect like as a change in productivity depends on the associated effects of climate (temperature, precipitation) and various earth environmental change factors. Changes in global temperature can cause significant changes in crop production. Crop ecosystem responses to the impact of abiotic and biotic factors and it is not tough to predict how ecosystems will respond to changing global environment.

In the agricultural sector, especially crop production is a major area which is sensitive to global warming and climate change. Rice is the staple food for more than half of the population in the world. Rice (*Oryza sativa* L.) is the main food source for more than two fifths (2.4 billion) of the world's population (Halder et al., 2016). Asia is the leading continent for the production and consumption of rice in the world. Rice occupies 11% of the world's crop field annually, and it ranks next to wheat (Chakravarthi and Naravaneni, 2006; Won et al., 2017). Rice as a valuable crop in the diet of 3 billion population is Asia provides 30-75% of total calories (Khush, 2004; Von Braun and Bos, 2004). It is predicted that almost 114 million tons of extra milled rice will be tasked to produce by 2035 to fulfill the food security, which requires increasing the production by 26% in the next 23 years. The probability of increasing the area under rice in the coming future is almost impossible. So, this additional rice production has to provide a productivity profit. In Korea, this gain could be achieved by increasing the efficiency of weed management which is still a great challenge in rice production.

Weed plays a significant role in the rice production of Korea. These species of weeds, namely *S. planiculmis, E. kuroguwai, L. procumbens, L. prostrata, E. oryzicola, M. vaginalis, R. pusilla*, and *S. sagittifolia*are dominant weed species in rice fields of Korea. They compete against different factors such as space, fertilizers, water, and sunlight. Yield loss caused by the weed competitions has been estimated up to 15% in rice (Baltazar and De Datta, 1992), reducing the number of fertile tillers/m^2, grains per panicle, and 1000-grain weight. Uncontrolled growth of weeds in paddy reduced the grain yield by 62.6% (Singh et al., 2005) or even 100% (Kropff, 1993) in transplanted rice. In addition, a majority of weeds serve as the harbor for harmful insect pests and pathogens. Therefore, weed management is the main strategy in rice production systems.

The increase of atmospheric temperature due to the climate changes in the ecosystem is expected to have an adverse effect and it requires to understanding the effect of climate change in agriculture, particularly in weed management. According to Chauhan and Ramesh (2015), plant species and growth condition are essential elements of human-engineered agro-ecosystems and crop-weed interactions in this process are expected to be influenced by the increase of atmospheric temperature and CO_2 (Nowak et al., 2004).

In both cultivated and uncultivated fields, weeds exhibit serious threats to the biodiversity of crop production systems, which interfere with the biodiversity of cultivated crop ecosystems. Patterson (1995) noticed that climate change seems to favor for the vigorous growth of weed species such as Jimsonweed (*Daturastramonium* L.), a potential weed in maize which requires high temperature for good performance. Cavero (1999) reported that weeds would be highly competitive under climate-change regimes while higher temperature regimes induced the profusion of orange hawkweed (*Hieracium aurantiacum* L.) in Australia (Brinkley and Bomford, 2002) through accelerating growth, reproduction, and multiplication. As crop density increases, the areas occupied by weeds are lessened and simultaneously the availability of nutrient resources for weeds reduces, and eventually crop yield loss is reduced. Mohler (2001) reported that crop density positively affected crop competition ability against weeds. It was reported that under high crop density, the weed biomass is reduced at the same time crop grain yield is increased (Eslami et al., 2006; Olsen and Weiner, 2005).

However, little information available about the effect of increased plant density on weeds survival under elevated temperatures in rice production systems. Therefore, the goal of this study was to investigate whether increased rice density improves weed control and find out whether there is any relationship between crop density and elevated temperature regimes

MATERIALS AND METHODS

Experimental site and plant growth condition

The field experiment was carried out in 2016 on an upland rice field at Chungnam National University, Daejeon, Korea (127°21′ E, 36°22′ N, alt. 34 m). Seeds of one rice cultivar (Dongjin 1) were sown at one seed per cell in plastic trays filled with upland rice paddy soil. One month after sowing, seedlings (3-4 leaf stage) of rice were transplanted into pre-puddled soils in weeds population (from soil seed bank) plots and the same time sprouting were sown in direct-seeded plots of phytotron. The size of per plot was 2 m × 1 m with three replicates which were arranged randomly with50 cm space among each other. Each plant was arranged with 3 cm and 6 cm planting and row space for investigations 30 days and 60 days after transplanting, respectively. The competition between rice and weeds was created in the following three treatments: 1. Natural occurrence of weeds is naturally grown from the soil seed bank, 2. Standard density, the following weeds were grown in the plots: EO (*E. oryzicola*) 1g, Mv (*M. vaginalis*) 1 g, Lp (*L. prostrata*) 1 g, Ek

(E. kuroguwai) 15 tuber, Sp (*S. planiculmis)* 15 tuber, SS (*S. sagittifolia*) 15 tuber, Lpr *(L. procumbens)* naturally occurred, Rp *(R. pusilla*) naturally occurred. 3. High density, the following weeds were grown in the plots: EO=2 g, Mv=2 g, Lp=2 g, Ek=30, Sp=30, SS=30, Lpr naturally occurred, Rp naturally occurred.

Temperature device installation

A temperature control device was engineered using sensors to automatically open and close the ventilation of plastic windows to pre-calculated variable apertures to allow for an exchange of air which maintained the desired elevated temperatures regimes at ambient and, 0.8℃, 1.9℃, and 3.4℃ above ambient level. Temperatures were measured in every 10 seconds by sensors in the phytotron and values were stored inside a smart cell phone system. The temperature level was continuously monitored using an internet mobile based control system to give elevated temperature on rice and weed species during the experiment period.

Nutrient management

Chemical fertilizers were applied at a rate of 210 kg urea, 170 kg di ammonium phosphate, and 170 kg sulphate of potash ha^{-1}. Except urea, the whole amount of other fertilizer was applied as a basal treatment during the final land preparation. Urea was applied in three installments; the first 30% at 10 days after transplanting (DAT), second 30% at 30 DAT, and the remained 40% of fertilizer was applied at panicle initiation stage. The black plastic film was used on the boundary area of the plots to block the emergence of any other weeds. After transplanting of rice seedlings, water balance was kept up at 2-3 cm on the surface of the plot.

Plant sampling

Plant height and number of tillers were measured at 30-day intervals starting from 30 days to 120 days after transplanting. After harvest, grain yield was separated from panicle and placed in an electric oven dried at 30 ℃ for three days. Weed density from the transplanted and direct–seeded paddy fields was counted inside a quadrate (25 cm × 25 cm) placed at random in one location per plot. In each quadrate individual weed species were recorded. For dry weight assessment, plants were gently pulled out from a plot and excessive soil was removed from roots by gentle rinsing with clean water. Plants were then softly wrapped with clean paper towels and placed in an electric oven drier at 72℃ for three days prior to measuring the dry weight.

Statistical analysis

Four agronomic traits such as plant height, dry weight, tiller numbers, and grain weight were performed by one-way ANOVA using the SPSS software and means were compared by Duncan's Multiple Range Test (Gomez et al., 1984).

RESULTSAND DISCUSSION

Plant heights

Plant height is one of the most significant growth characteristics of rice and has exhibited a wide variation associated with the increase of temperature in the phytotrons. It was detected that plant growth responded positively in rising temperature and the highest increase of plant height, tiller number, and dry weight were obtained at the ambient+3.4℃ followed by at the ambient+1.9℃ at the different rice: weed densities in both direct seeded and transplanted fields (Table 1 and 2). The highest increase of plant height estimated to be 7.9% and 3.5% at the ambient+3.4℃ and ambient+1.9℃, respectively under standard density compared to the respective control in the direct seeded rice field (Table 1). No significant differences in rice height were found between standard and high densities of rice: weeds competitions at all ambient conditions, but rice height was slightly lower at the natural occurrence of weeds.

Among the three regimes of the rice: weed competition, the plant height of rice was 4.3%, 21.1%, and 9% higher under natural occurrence, standard density, and high density conditions, respectively at ambient+3.4℃ compared to the ambient condition under transplanting fields (Table 2). It is notable that rice exhibited the highest increase rates of plant heights under standard density compared to the other plant densities except at the ambient condition (Table 2). This result is a consistency with the finding of Oh-e et al. (2007), who also observed that plant height was increased under elevated temperature than that of ambient temperature condition.

Number of tillers

A number of tillers are the significant traits of yield contributors in rice cultivation. In direct seeding fields, the total number of tillers of rice was 38.6%, 81%, and 84% higher at the ambient+3.4℃ under natural occurrence, standard density, and high density, respectively than it was at the ambient (Table 1).

Table 1:Growth characteristics of direct sowing rice under different temperatures and weed densities.

Process	Temperature (℃)	Plant height (cm)	Tiller number (no/m^2)	Shoot dry weight (g)	Grain yield (g)
Natural occurrence	Ambient	87.7±1.95	11.4±1.14	20.66	24.5±3.72
	Ambient+0.8	88.0±1.19	13.8±0.95	23.373	24.3±3.91
	Ambient+1.9	90.8±1.08	14.4±1.61	25.662	23.3±2.62
	Ambient+3.4	94.6±1.31	15.8±1.29	26.307	15.9±1.67
Standard density	Ambient	89.0±2.55	5.3±0.40	10.863	15.0±1.47
	Ambient+0.8	90.8±1.64	6.0±0.45	12.472	14.3±2.46
	Ambient+1.9	96.8±1.02	9.2±0.90	18.503	8.4±0.74
	Ambient+3.4	97.7±1.59	9.6±0.48	23.151	6.8±0.99
High density	Ambient	90.8±1.07	5.0±0.61	11.678	13.1±1.29
	Ambient+0.8	93.7±1.73	5.8±0.51	12.689	11.8±0.98
	Ambient+1.9	96.4±1.08	8.5±0.43	16.578	4.7±1.04
	Ambient+3.4	97.8±1.90	9.2±0.61	19.674	4.5±0.72

Table 2:Growth characteristics of transplanted rice under different temperatures and weed densities.

Process	Temperature (℃)	Plant height (cm)	Tiller number (no/m^2)	Shoot dry weight (g)	Grain yield (g)
Natural occurrence	Ambient	103.3±2.31	8.9±0.53	22.3±1.71	33.5±3.77
	Ambient+0.8	105.9±2.08	11.2±1.28	29.9±3.13	32.8±3.26
	Ambient+1.9	107.3±1.15	18.0±1.07	37.2±2.61	16.3±1.98
	Ambient+3.4	107.7±1.80	19.3±1.84	38.1±3.51	15.5±0.94
Standard density	Ambient	94.9±2.31	7.2±0.59	16.4±1.81	20.4±1.33
	Ambient+0.8	103.8±1.26	8.7±1.16	19.6±2.23	14.4±2.22
	Ambient+1.9	108.3±2.61	9.2±0.96	20.4±2.71	7.7±1.37
	Ambient+3.4	114.9±0.96	10.8±0.94	25.6±1.84	4.0±0.64
High density	Ambient	102.8±1.96	6.7±0.56	17.7±1.75	21.8±2.89
	Ambient+0.8	104.0±2.36	8.8±0.53	21.3±1.88	19.0±1.87
	Ambient+1.9	111.2±2.76	9.5±0.86	21.4±1.46	7.0±1.00
	Ambient+3.4	112.1±2.37	10.2±1.00	26.8±3.12	3.5±0.22

Especially, the highest enhance in the total number of tillers (15.8) at ambient+3.4℃ was detected under the natural occurrence of weeds compared to other densities (Table 1). Likewise, the tillers number of rice was 96.9%, 50%, and 52.2% greater at the ambient+3.4℃ than it was at the respective ambient under natural occurrence, standard density, and high density, respectively (Table 2). The impact of different weed density regimes on tillers amount at the natural occurrence of weeds was significantly higher than that of standard and high densities in both direct and transplanted rice fields. Whereas, there was is a small or nonexistent difference between standard and high densities in both direct and transplanted rice fields.

Shoot dry weight and grain yield

Shoot dry weight and grain yield of direct seeded and transplanted rice was investigated in competition with weeds under different temperatures. Significant differences in rice shoot dry weight and grain yield between the weed infestation and temperature treatments were found with statistical analysis. The estimated maximum shoot dry weight of rice was recorded under natural occurrence followed by standard density and high density of weeds regimes with values of 26.3 g, 23.1 g, and 19.7 g per 10 plants at the ambient+3.4℃ in the direct seeded rice field (Table 1 and Fig. 1 a). Similarly, in transplanted rice, the maximum shoot dry weight of rice was obtained at natural density followed by standard density and high density of weed with values 38.1 g, 25.6 g, and 26.8 g per 10 plants, respectively under the elevated temperature at the ambient+3.4℃ (Table 2). The increase of shoot dry weight positively correlated with the increase of ambient temperature in both direct and transplanted rise. These results are in agreement with the outcomes of Sato and Maruyama (2002), who explained that shoot dry weight was the highest under elevated temperature due to the increase of leaf development and shoot elongation during seedling establishment. Our results confirmed these facts indicating that elevated temperature had a significant effect on shoot dry weight of rice. In contrast to our findings by Mitra and Bhatia (2004) showed the total biomass of rice was reduced under high-temperature regimes.

On the other hand, grain yield of rice was greatly affected by varying weed densities in conjunction of elevated temperatures and it was significantly decreased with the increase of weed populations (Table 1 and Table 2). As the nonlinear regression analysis shows a negative correlation between rice yield and temperature. The maximum grain yield of rice was achieved at the ambient temperature condition and gradually decreased with increasing of temperatures in both direct and transplanted rice (Fig. 2 a, b).

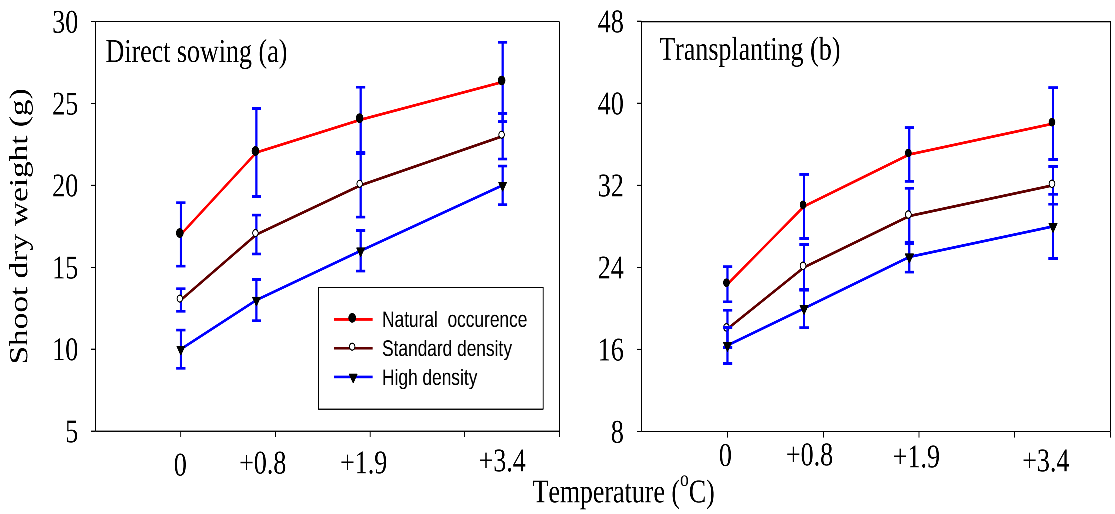

Figure 1:Shoot dry weight of rice under elevated temperatures condition.

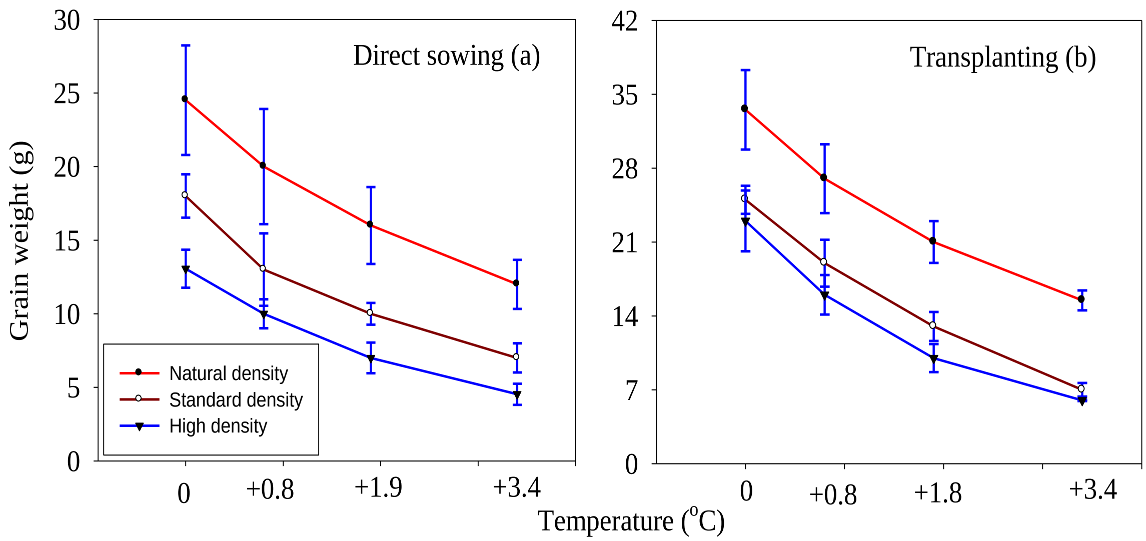

Figure 2:Grain yield of rice under elevated temperatures condition.

Rice yield was significantly reduced from 24.5 to 15.9, from 15.0 to 6.8, and from 13.1 to 4.5 g per 10 plants in natural occurrence, standard and high density of weed treatments, respectively in direct seeded rice. Similar trend of yield reducing against the increase of temperature was observed for transplanted rice, also.

The increase in temperature favored the growth of weeds more compared to rice and weeds were more competitive for available resources. The increase of weed density resulted in the decrease in grain weight and quality of rice, furthermore, reduced of the overall crop yields. The lowest rice yield was observed in high weed density treatment followed by standard weed density compared to natural weed occurrence treatment. Higher weed density indicates higher competition between weed and rice for mineral nutrients, water, and light. But, generally, weeds are more competitive in this interspecific competition. Differential influence of elevated temperature on weeds and crops was also highlighted on the studies of Ramesh et al., (2017).

Also, grain yield was significantly lower at elevated temperatures compared to the ambient temperature condition due to the negative impact of increased temperature during pollination and grain filling period. Kim et al., (2011) declared that the grain yield of rice was reduced by enhancing the panicle senescence and shortening the grain filling period under elevated temperature. Furthermore, Ruiz-Vera et al., (2015) reported that elevated temperature reduced rice yield, and increased ovule failure due to the detrimental impact of higher temperature on the pollination period. Similar results were obtained by Akita (1989), who noticed that elevated temperature can enhance the grain growth rate, reduce grain filling period, and lead to a decrease in the yield of rice. Moreover, the increase of temperature results the negative effects on cooking and eating quality of rice grain (Krishnan et al., 2011).

Abundances of weed population

According to the occurrence frequency, the dominant weed species were *Echinochloaoryzicola*, *Monochoria vaginalis*, *Ludwigia prostrata*, *Eleocharis kuroguwai*, *Scirpus planiculmis*, *Sagittaria sagittifolia*, *Lindernia procumbens and Rotala pusilla* (Hwang et al., 2017). The naturally occurring weed from soil seed bank consists of total 8 annual and perennial grass and broadleaf species. The weed *E. kuroguwai* showed the highest abundance and dominant point (Braun Blanquet) under standard density followed by the natural occurrence and high density under an elevated temperaturewhich was shown in Table 3 and Table 4. But, a number of weeds were the lowest under natural occurrence in all temperature conditions (Table 3 and Table 4). Especially, the highest abundance and density (1680 plants/m^2) of *E. kuroguwai* was found under standard density under elevated temperatures at ambient+3.4℃. Above results are similar to the study of Kent and Coker (1992), who reported that plant abundance signifies a vital characteristic of the composition of plant communities. The previous study indicated that elevated temperature by 2℃ during the seedling promoted the emergence of *E. kuroguwai* up to 1-2 days earlier and occurrence of 5 leaf stage 2-3 days earlier (Kim et al., 2010).

The increase of temperature favored the growth of weeds more compared to rice and weeds were found more competitive for available resources. Some researchers declared that climate change may advance of growth and enlarge distribution area of weed species, also cause promotion of some weeds to become dominant in weed populations and highly competitive in crop-weed interactions (Martinez-Ghersa et al., 2000). On the other hand, weed species emerged from soil seed bank at rice transplantation fields. All occurrences showed the tendency of abundance to increase with increasing temperatures in the phytotron. It was observed that dominance of weed density and the number of overgrowth weeds was higher under standard density and high density compared to the natural occurrence (Table 5 and Table 6). The weed *E. kuroguwai* was the most abundant species, density, and dominant point (Braun Blanquet, 1964) under standard density which was occurred in 1868 plants/m^2 followed by the natural occurrence and high density at ambient+3.4℃ than that of ambient temperature condition. The most abundant species were those flowering in pre-spring and early spring, having adaptability of low temperature, with relatively shade tolerant and high nutrient requirements. The high regional abundance of these species positively correlated with their broad geographical distribution and broad habitat ranges.

In summary,the regional abundance of weeds partially can be represented by their attributes. The most important attributes are marked by the ability of the growth of weeds and their reproduction in the cool season at the time of limited competition with crop plants.

Table 3:Number of weed occurrence under different temperature on direct seeding plot.

Process	Temperature (℃)	Sp	Ek	Lpr	Lp	Ec	Mv	Rp	Ss
Natural occurrence	Ambient	10	-	16	-	1	2	-	-
	Ambient+0.8	13	4	-	-	1	9	10	-
	Ambient+1.9	28	-	-	2	1	7	-	-
	Ambient+3.4	29	4	-	-	1	11	5	-
Standard density	Ambient	2	218	-	-	1	3	-	-
	Ambient+0.8	12	273	-	-	1	2	-	
	Ambient+1.9	18	310	-	-	-	1	-	2
	Ambient+3.4	28	420	-	-	1	-	1	1
High density	Ambient	9	213	-	-	-	1	2	-
	Ambient+0.8	23	255	-	-	1	2	-	-
	Ambient+1.9	23	285	11	2	1	5	-	1
	Ambient+3.4	29	312	-	1	1	2	1	2

Sp: *Scirpus planiculmis*; Ek: *Eleocharis kuroguwai*; Lpr: *Lindernia procumbens*; Lp: *Ludwigia prostrata*; Ec: *Echinochloa oryzicola*; Mv: *Monochoria vaginalis*; Rp: *Rotala pusilla*; Ss: *Sagittaria sagittifolia*

Table 4:Dominant point due to temperature difference at direct seeding plot (Braun- Blanquet method).

Process	Temperature (℃)	Sp	Ek	Lpr	Lp	Ec	Mv	Rp	Ss
Natural occurrence	Ambient	1	-	2	-	1	1	-	-
	Ambient+0.8	2	1	-	-	1	2	1	-
	Ambient+1.9	3	-	-	2	1	2	-	-
	Ambient+3.4	3	1	-	-	1	3	1	-
Standard density	Ambient	+	5	-	-	r	+	-	-
	Ambient+0.8	1	5	-	-	r	+	-	r
	Ambient+1.9	1	5	-	-	-	r	-	+
	Ambient+3.4	1	5	-	-	r	-	r	r
High density	Ambient	1	4	-	-	-	r	+	-
	Ambient+0.8	1	5	-	-	r	+	-	-

	Ambient+1.9	1	5	1	+	r	1	-	r
	Ambient+3.4	1	5	-	r	r	+	r	r

Sp: *Scirpus planiculmis*; Ek: *Eleocharis kuroguwai*; Lpr: *Lindernia procumbens*; Lp: *Ludwigia prostrata*; Ec: *Echinochloa oryzicola*; Mv: *Monochoria vaginalis*; Rp: *Rotala pusilla*; Ss: *Sagittaria sagittifolia*

Table 5:Number of weed occurrence under different temperature on transplanting plot.

Process	Temperature (℃)	Sp	Ek	Lpr	Lp	Ec	Mv	Rp	Ss
Natural occurrence	Ambient	-	-	-	-	2	1	2	-
	Ambient+0.8	-	-	-	1	8	5	1	-
	Ambient+1.9	-	-	8	1	2	10	2	-
	Ambient+3.4	31	-	19	1	2	1	-	-
Standard density	Ambient		61	-	-	2	-	2	-
	Ambient+0.8	-	277		1	2			2
	Ambient+1.9	29	351	5	-	2	2	-	-
	Ambient+3.4	45	467				1		1
High density	Ambient	-	258	2	1	1	1	-	-
	Ambient+0.8	7	295	-	-	-	-	-	2
	Ambient+1.9	13	395	2	2	2	3	-	-
	Ambient+3.4	22	398	-	1	1	1	-	2

Sp: *Scirpus planiculmis*; Ek: *Eleocharis kuroguwai*; Lpr: *Lindernia procumbens*; Lp:*Ludwigia prostrata*; Ec:*Echinochloa oryzicola*; Mv:*Monochoria vaginalis*; Rp: *Rotala pusilla*; Ss:*Sagittaria sagittifolia*

Table 6:Dominant point due to temperature difference at transplanting plot (Braun- Blanquet method).

Process	Temperature (℃)	Sp	Ek	Lpr	Lp	Ec	Mv	Rp	Ss
Natural occurrence	Ambient	-	-	-	-	1	1	1	-
	Ambient+0.8	-	-	-	1	2	2	1	-
	Ambient+1.9	-	-	2	1	1	2	1	-
	Ambient+3.4	4	-	4	1	1	1	-	-
Standard density	Ambient	r	2	-	-	1	r	1	+
	Ambient+0.8	-	4	r	r	+	+	r	-
	Ambient+1.9	1	5	1	-	+	r	-	r
	Ambient+3.4	2	5	r	r	r	-	r	-
High density	Ambient	-	5	+	r	r	r	-	-
	Ambient+0.8	1	5	-	-	-	-	-	+
	Ambient+1.9	1	5	+	+	+	+	-	-
	Ambient+3.4	1	5	-	r	r	r	-	+

Sp: *Scirpus planiculmis*; Ek: *Eleocharis kuroguwai*; Lpr: *Lindernia procumbens*; Lp: *Ludwigia prostrata*; Ec: *Echinochloa oryzicola*; Mv:*Monochoria vaginalis*; Rp: *Rotala pusilla*; Ss:*Sagittaria sagittifolia*

Apart from that, other attributes include those that show the adaptations to growth in dense vegetation stands and highly productive habitats. Harper (1977) published the population biology of plants and suggested to count the individual plant parts, such as stocks, stems, leaves, and seeds, to collect information about plant populations. In the plant community, it is hard to measure the number of individuals for plant species. Only examples were observed for the number of individuals of annual (Marshal, 1988) and perennial weed species. The difference in diversity of weeds influenced by the agricultural environment that could be used as a base data to control the occurrence of weed species in the paddy fields (Hwang et al., 2017).

CONCLUSION

The present study indicated that increasing plant density of weeds will definitely influence to decrease in individual grain weight, size and grain filling of rice resulting in the reduction of the percent of crop yields. Higher plant density indicates higher competition among the plants for mineral nutrients, water, and light. Plant growth, light interception, yield components, and grain yield changed to a great extent owing to the interactions between plant density and temperature elevation. Therefore, further studies for agronomic management should be conducted to improve the production of rice yield under high plant density.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEDGEMENT

This study was financially supported by research fund of Chungnam National University in 2018.

AUTHOR CONTRIBUTIONS

Bir, M.S.H. designed and performed the experiments and wrote the manuscript. Aktar, M.M. and Uddin, M.R. perform the experimental treatments, data collection and analysis. Khaitov, B. and Park, K.W. designed the experiments and reviewed the manuscript. All authors read and approved the final version.

REFERENCES

Akita, S. 1989. Improving yield potential in tropical rice. "Progress in Irrigated Rice Research", 971-104-184-7, pp. 41–73. International Rice Research Institute, Los Banos, Philippines.

Baltazar, A. M. and DeDatta, S. K. 1992.Weed management in rice*.* Weed Abstracts. 41(11): 495-507.

Braun-Blanquet, J. 1964.Pflansensoziologie, grundzfige der vegetationskunde, 3rd ed. p. 865.Springer, Wien-New York.

Brinkley, T. R. and Bomford, M. 2002. 'Agricultural sleeper weeds: what is the potential threat?' (Australia, Bureau of Rural Sciences, Canberra). www.southwestnrm.org.au/.../brinkleytr-bomford-m-2002-agricultural

Cavero, J., Zaragoza, C., Suso, M. L. and Pard, A. 1999. Competition between maize and *Daturastramonium*in an irrigated field under semi-arid conditions.Weed Research. 39: 225–40.

Chauhan, B. and Ramesh, K. 2015. Weed regimes in agro-ecosystems in the changing Chakravarthi BK, Naravaneni R, 2006. SSR marker based DNA fingerprinting and diversity study in rice (Oryza sativa. L). African J. Biotech. 5: 684-688.climate scenario—a review. Indian J. Agron, 60: 479-84.

Eslami, S. V., Gill, G. S., Bellotti, B. and Mc Donald, G. 2006. Wild radish *(Raphanus raphanistrum)* interference in wheat. Weed Science. 54: 749-756.

Gomez, K. A. and Gomez, A. A. 1984.Statistical Procedures for Agricultural Procedures for Agricultural Research, 2nd.Edn.John Willeyand Sons, New York. p. 68.

Halder, T., Hoque, M. E., Islam, M. M., Ali, L. and Chowdhury, A. K. 2016.Morphomolecular Characterization of Local Boro Rice (*Oryza Sativa* L.) Germplasm. Bangladesh Journal of Plant Breeding and Genetics. 29 (2): 01-09.

Harper, J. L. 1977. Substitutive experiments. In Population Biology of Plants. New York: Academic Press, pp. 255-267.

Hwang, J. B., Park, T. S., Park, H. K., Kim, H. S., Choi, I. B., Koo, B. I and Bae, H. S. 2017. Characteristics of cultural practice and weed community in adzuki bean fields in the south-west districts of Korea. Korean Journal of Agricultural Science 44:040-049. DOI: https://doi.org/10.7744/kjoas.20170005

Hwang, K. S., Jung, S., Kim, S. C., Chung, D. Y and Park, K. W. 2017. Occurrence and distribution characteristics of weed species in organic paddy fields. Korean Journal of Agricultural Science 44:325-331. DOI: https://doi.org/10.7744/kjoas. 20170048

Kent, A. and Coker, P. 1992. Vegetation Description and Analysis – A Practical Approach John Wiley & Sons, New York.

Khush, G. S. 2004. Harnessing science and technology for sustainable rice-based cropping systems. Proc. FAO Rice Conf. "Rice is Life". Int. Rice Comm. News. 53: 17-23.

Kim, J. H., Shon, J. Y., Lee, C. K., Yang, W. H., Yoon, Y. W., Yanga, W. H., Kim, Y. G. and Lee, B. W. 2011. Relationship between grain filling duration and leaf senescence of temperature rice under high temperature. Field Crops Res. 122: 207-213.

Kim, J. W, Moon, B. C., Lim, S. H., Chung, J. H. and Kim, D. S. 2010. Prediction of seedling

emergence and early growth of *Eleocharis kuroguwai* Ohwi under elevated temperature. Kor. J. Weed Sci. 30: 94-102.
Krishnan, P., Ramakrishnan, B., Reddy, K. R., and Reddy, V. 2011. High temperature effects on rice growth, yield, and grain quality. Advances in 480 Agronomy. 111: 87-206.
Kropff, M. J. 1993. Eco-Physiological models for crop-weed competition. In: Kropff, M. J., Van Laar, H. H. (eds), Modelling Crop-Weed Interactions: 25-32.
Marshal, E. J. P. 1988. Field-scale estimates of grass weed populations in arable land. Weed Res. 28: 191–198.
Martinez-Ghersa, M. A., Ghersa, C. M. and Satorre, E. H. 2000. Coevolution of agricultural systems and their weed companions: implications for research. Field Crops Research. 67: 181–90.
Mitra, R. and Bhatia, C. R. 2004.Bioenergetic cost of heat tolerance in wheat crop. Curr. Sci. 94: 1049-1053.
Mohler, C. L. 2001. Enhancing the competitive ability of crops. In: Liebman, M., Mohler, C. L., Staver, C. P. (eds), Ecological Management of Agricultural Weeds, Cambridge University Press, Cambridge, UK. 269-321.
Nowak, R. S., Ellsworth, D. S. and Smith, S. D. 2004. Functional responses of plants to elevated atmospheric CO_2–do photosynthetic and productivity data from FACE experiments support early predictions? New Phytologist. 162: 253–80.
Oh-e, I., Saitoh, K., and Kuroda, T. 2007. Effects of high temperature on growth, yield and dry-matter production of rice grown in the paddy field. Plant Prod. Sci. 10: 412–422.
Olsen, J. and Weiner, J. 2005. Effects of density and spatial pattern of winter wheat on suppression of different weed species. Weed Science, 53: 690-694.
Patterson, D. T. 1995. Weeds in a changing climate. Weed Sci. 43(1): 685-701.
Ramesh, K., Matloob, A., Aslam, F., Florentine, S.K. and Chauhan, B.S., 2017. Weeds in a changing climate: vulnerabilities, consequences, and implications for future weed management. Frontiers in plant science.8: 95.
Ruiz-Vera, U., Siebers, M. H., Drag, D. W., Ort, D. R. and Bernacchi, C. J. 2015. Canopy warming caused photosynthetic acclimation and reduced seed yield in maize grown at ambient and elevated [CO_2]. Glob.Chang. Biol. 21: 4237–4249.
Sato, T. and Maruyama, S. 2002. Seedling emergence and establishment under drained conditions in rice direct sown into puddled and leveled soil. Effect of calcium peroxide seed coating and sowing depth. Plant Prod. Sci. 5: 71-76.
Singh, S., Singh, G., Singh, V. P. and Singh, A. P. 2005.Effect of establishment methods and weed management practices on weeds and rice in rice wheat cropping system.Indian Journal of Weed Science. 37: 51-57.
Von Braun, J. and Bos, M.S. 2004. The changing economics and politics of rice: Implication for food security, globalization and environmental sustainability. IRRI and Japan Int. Res. Centre for Agri, Sci. pp. 7-20.
Won, O. J., Eom, M. Y., Kim, Y. T., Bir, M. S. H., Park, T. S., Uddin, M. R., Oh, T. K., Shinogi, Y. and Park, K. W. 2017. Growth response of rice and paddy weeds under elevated temperatures. Journal of the Faculty of Agriculture, Kyushu University. 62(1): 63-67.