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Research Article

Effects of Rainfall on Yield and Seed Quality of Three Local Upland Rice Varieties Produced Under Organic Farming System

Raumjit Nokkoul and Teerayut Wijitparp
King Mongkut's Institute of Technology Ladkrabang, Chumphon Campus, Pathio, Chumphon, 86160, Thailand

Abstract: The effects of rainfall on yield and seed quality of three local upland rice varieties: Lebmeunang, Kemhern and Hammuang produced under organic farming system were done at the experimental plots of the King Mongkut's Institute of Technology Ladkrabang, Chumphon Campus, Thailand during July to November, 2010. The study was conducted in randomized complete block design with four replications. The results showed that at the vegetative, reproductive and seed formation to ripening stage the 3 tested varieties got the rainfall of 59.20, 57.40 and 97.10 mm with 10, 7 and 12 days raining, respectively. All varieties had lower seed yield than when grown at the low level rainfall. Three varieties produced empty seeds per panicle of 36.00, 35.00 and 37.00% with seed yield of 46.88, 46.08 and 23.52 kg/ha, respectively. Incidentally, the seeds had high quality. All varieties had seed germination of 92.00, 89.00 and 88.00% and soil emergence of 90.00, 91.00 and 86.00%, respectively. Speed of germination index of 7.25, 7.13 and 12.07 and seedling dry weight of 68.25, 75.11 and 49.57 mg/seedling, respectively.

Keywords: Local upland rice, organic farming, rainfall, southern of Thailand, yield and seed quality

INTRODUCTION

Rice (*Oryza sativa* L.) is consumed by about 3 billion people and is the most common staple food of a large number of people on earth. In fact, it feeds more people than any other crop (Maclean *et al*., 2002). Ninety percent of the world's rice is produced and consumed in Asia. In Thailand, most upland rice is grown in the northern and southern, where it represents about 10.00% of total rice area. It has been grown almost exclusively by small-household food security. For the southern part of Thailand are the lowland and less area than other sectors and can not produce enough rice for domestic consumption. Upland rice is planted as alternative crops of farmers for household consumption or for sale in local market. However, one of the major problems of upland rice in southern Thailand is a drought that causing lack of rain, specifically during the rainy season when the rainfall is less than 1 mm/day with more than 15 consecutive days. Drought during the rainy season is incidentally caused by climate change, which would seriously affect growth and yield of upland rice (Nokkoul *et al*., 2011).

However, rainfall is a factor that can be considered in addition to the environmental quality of the seed. This is one factor that is an indicator of growth rate and productivity. In particular, organic farming system is the production system which avoids the use of synthetic fertilizers, insecticides and plant growth regulators. The use of high quality seed can increase yields by 5.00 to 20.00%. Thus increase productivity under organic systems can reduce the risk. It also makes it possible to calculate the growth rate accurately. The seedlings are strong with growth rate consistently and quickly (Santipracha, 1997). This research study the effects of rainfall on yield and quality of local upland rice seeds produced under organic farming system during the rainy season in Chumphon of southern Thailand.

MATERIALS AND METHODS

This study was conducted at King Mongkut's Institute of Technology Ladkrabang, Chumphon Campus, Thailand (Latitude 10° 00' 30.05" N Longitude 99° 25' 45" E Altitude 17.84 m above the sea level) from July to November, 2010. Three varieties of upland rice: Lebmeunang, Kemhern and Hammuang seeds were produced via organic farming system. The land was ploughed and disc harrowed and leveled before sowing the seeds. Four seeds of upland rice were sown per hole with spacing of 25 cm. within rows and 30 cm. between rows. The plants were thinned to three plants per hole after 14 days of seedling emergency. The total area of each plot was 10 m^2. The fertilized was applied at the rate of 3.10 kg/plot of manure. Weeds were eliminated by using hoes twice at the age of 20 and 40 days after the seeds germinated. Harvesting was done when all the seeds maturity. The

Corresponding Author: Raumjit Nokkoul, King Mongkut's Institute of Technology Ladkrabang, Chumphon Campus, Pathio, Chumphon, 86160, Thailand

data collected were flowering age at 50%, harvesting age of the seeds, empty seeds per panicle, perfect seeds per panicle, seeds yield. After threshing, the seeds were sun-day, sieved and weighted after the measurement of the moisture content. The seed yields were determined for corresponding weight of standard moisture of 10%. The good seeds were tested for their quality; seed size, 1,000 seed weight, standard germination, soil emergence, speed of germination index, seedling dry weight, root length and shoot length (AOSA, 2002). Data of daily rainfall and daily minimum and maximum temperatures from July to November, 2010 were gathered from the Tha Ta Pao Agrometeorological Station, Muang Chumphon, Chumphon, Thailand. All data were analyzed using the analysis of variance and means separated by Duncan's Multiple Range Test (DMRT) at the 5% level of significance.

RESULTS AND DISCUSSION

The environmental variables: Rainfall, number rainy days, minimum and maximum temperatures of local upland rice including Lebmeunang, Kemhern and Hammuang seed produced using organic farming system were shown in the Fig. 1. The results showed that the rainfall during the July to November, 2010 was found to be deleterious for local upland rice seeds yield (Fig. 1b and 1c). Rice plants received 12.40-97.10 mm of average monthly rainfall; vegetative, reproductive and seed formation to ripening stage the 3 tested varieties got the rainfall of 59.00, 57.40, 97.10 mm with 10, 7, 12 days raining, respectively, 31.40-35.20°C of average monthly temperature (Fig. 1a).

Seed yield: The flowering age at 50% (Table 1) of Lebmeunang variety was the highest number of days

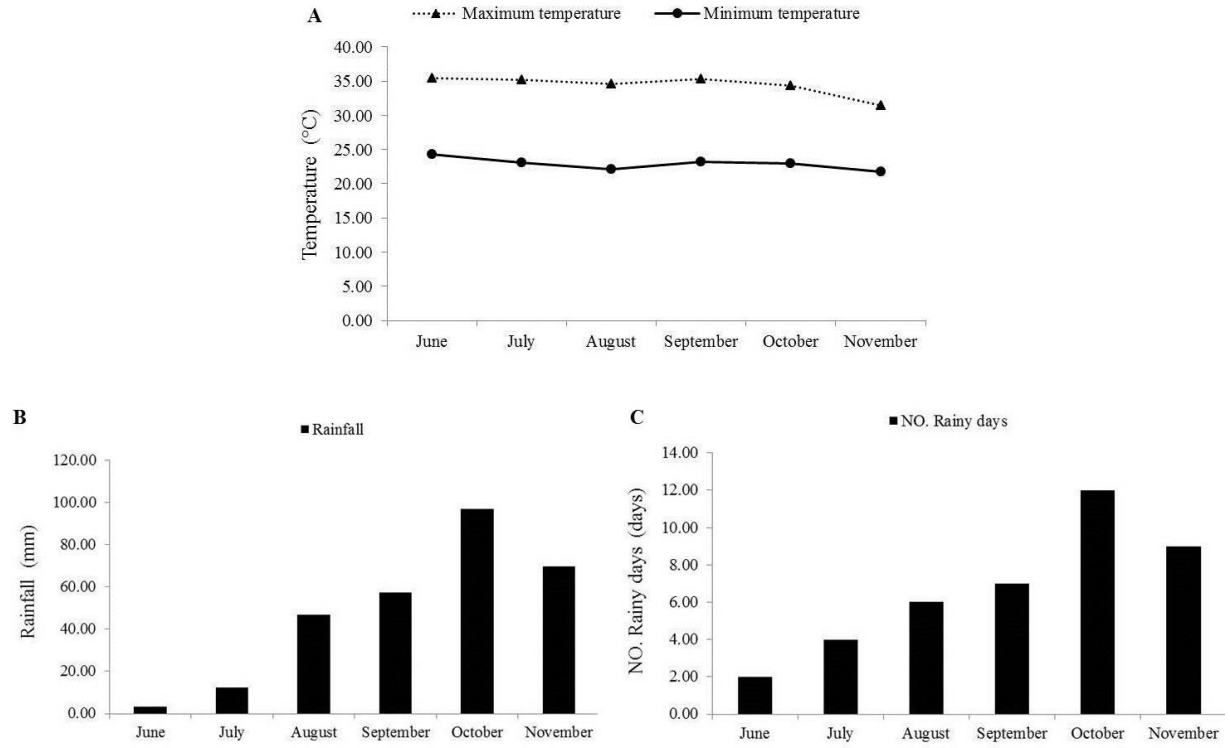

Fig. 1: Data of minimum and maximum temperatures (A), amount of monthly rainfall (B) and number of rainy days (C) in the experiment location, King Mongkut's Institute of Technology Ladkrabang, Chumphon Campus, Thailand during July to November 2010

Table 1: Flowering age at 50%, harvesting age of the seeds, empty seeds per panicle, perfect seeds per panicle and seeds yield of three local upland rice seed produced under organic farming system

Varieties	Flowering age at 50% (days)	Harvesting age of the seeds (days)	Empty seeds per panicle (%)	Perfect seeds per panicle (%)	Seed yield (kg/ha)
Lebmeunang	95.00a	122.00b	36.00	64.00	46.88a
Kemhern	93.00b	125.00a	35.00	65.00	46.08a
Hammuang	76.00c	104.00c	37.00	63.00	23.52b
F-test	*	*	ns	ns	*
C.V.%	1.59	0.98	25.69	14.80	16.59

ns = non-significant * = significant different at $p \leq 0.05$; Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

Table 2: Seed size and 1,000 seed weight, standard germination and soil emergence of three local upland rice seed produced using method organic farming system

Varieties	Seed size (mm) Width	Length	Thick	1,000 seed weight)g(	Standard germination (%)	Soil emergence (%)
Lebmeunang	0.21c	0.98a	0.18b	25.47a	92.00	90.00
Kemhern	0.22b	0.93ab	0.18b	22.37b	89.00	91.00
Hammuang	0.25a	0.86c	0.28a	23.90ab	88.00	86.00
F-test	*	*	*	*	ns	ns
C.V. (%)	5.80	5.19	4.40	3.94	5.10	3.22

ns = non-significant * = significant different at p≤0.05; Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

Table 3: Speed of germination, seedling dry weight, shoot length and root length of three local upland rice seed produced using method organic farming system

Varieties	Speed of germination index	Seedling dry weight (mg/seedling)	Shoot length (cm/seedling)	Root length (cm/seedling)
Lebmeunang	7.25b	68.25	2.44	10.32b
Kemhern	7.13c	75.11	2.10	11.89a
Hammuang	12.07a	49.57	1.94	7.67c
F-test	*	ns	ns	*
C.V.%	4.73	24.08	15.59	21.32

ns = non-significant * = significant different at p≤0.05; Within each column, means not followed by the same letter are significantly different at the 5% level of probability as determined by DMRT

(95 days), which was not significantly different from those of Kemhern (93 days) and Hammuang (76 days). The Kemhern variety had the highest harvesting age of 125 days, which was significantly different from the Lebmeunang and Hammuang varieties (122 and 76 days, respectively). All varieties had the highest empty and perfect seeds per panicle of between 35.00 to 37.00% and 63.00 to 65.00%, respectively, which were not significantly different among the varieties. The Lebmeunang and Kemhern varieties had similar seed yields between 46.08 to 46.88 kg/ha, which were not significantly different from the Hammuang variety which gave the seed yield 23.52 kg/ha. However, the three local upland rice varieties had lower seed yields when they were grown at the low level monthly rainfall between 12.40-97.10 mm during these periods. At the vegetative, reproductive and seed formation to ripening stages the 3 tested varieties got the rainfall of 59.00, 57.40, 97.10 mm with 10, 7, 12 days raining, respectively, average monthly temperature 31.40-35.2°C. (Fig. 1a). Such environment could reduce the seed yield. If total rainfall during vegetative and early reproductive stages was less than 610.00 mm, seeds yield averaged low (Saito *et al*., 2006). Whereas when drought occurred during vegetative stages, it had only a small effect on subsequent development and grain yield. The reduction in yield of up to 30.00% was due to reduced panicle number per unit area in one trial and reduced number of spikelets per panicle in another (Boonjung and Fukai, 1996).

Seed quality: Seed sizes (Table 2) of the 3 varieties were measured in width, length and thick. It was found that Lebmeunang, Kemhern and Hammuang varieties were significantly different among the treatments. Hammuang variety had seed width of 0.25 0.21 and 0.22 mm, respectively. Lebmeunang variety had the longest seed length of 0.98 mm, which was significantly different from Kemhern and Hammuang (0.93 and 0.86 mm, respectively). As for the of 1,000 seeds weight, Lebmeunang and Hammuang varieties had 1,000 seeds weight of 25.47 and 23.90 g, respectively, which were significantly different from Kemhern variety (22.37 g). All varieties had seed germination of 92.00, 89.00 and 88.00%, respectively, soil emergence of 90.00, 91.00 and 86.00%, respectively, speed of germination index (Table 3) of 7.25, 7.13 and 12.07, respectively and seedling dry weight of 68.25, 75.11 and 49.57 mg/seedling, respectively. Lebmeunang variety had the longest shoot length of 2.44 cm/seedling, not statistically different from Kemhern and Hammuang (2.10 and 1.94 cm/seedling, respectively). Kemhern variety had the longest root length of 11.89 cm/seedling, statistically different from Lebmeunang and Hammuang (10.32 and 7.67 cm./seedling, respectively). This is similar to Nokkoul and Wijitparp's study (Nokkoul and Wijitparp, 2009) which found that the quality of local upland rice seeds production under organic farming system give the percentage of germination, lower than those grow by using chemicals. This was probably due to the severe draught at vegetative, reproductive and seed formation to ripening stage that had no rainfall more than 20 days with the temperature as high as 39°C. In addition, environment conditions during crop growth and development can strongly impact subsequent seeds yield, germination ability and vigor. While environmental stresses, such as temperature and moisture extremes, are known to reduce seed viability and vigor, whereas the physiological causes of seed quality loss are unclear (McDonald and Copeland, 1997).

CONCLUSION

The study the effects of rainfall on yield and quality of three local upland rice seeds produced under organic farming system during the rainy season in Chumphon, southern Thailand. The results show that rainfall is the important limiting factor for local upland rice cultivation. Three local upland rice varieties: Lebmeunang, Kemhern and Hammuang had lower seeds yield and quality when they were grown at the low level rainfall. However, the cause of declining upland rice seeds yield and quality is a complex issue and is most likely a combination of a number of factors rather than any single factor. Certainly, further research is needed to fully understand these factors and interactions between them. However it is clear that the long-term productivity of upland rice in Thailand can not be sustained. Improved crop and resource management technologies are necessary for sustainable production.

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