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Phenological Traits and Grain Yield of Rice Genotypes in Three Cropping Systems

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Abstract: In order to investigate response of phonological traits and grain yield of rice genotypes under three cropping systems, an experiment was carried out as split plot in randomized complete blocks design based four replications at Neka, Mazandaran, Iran in 2011 and 2012. Planting systems were chosen as main plots (Conventional, Improved and SRI or System of Rice Intensification) and genotypes as sub plots (Tall plant: Sang Tarom and Hashemi Tarom; Short plant: Neda and Shiroodi).

Key words: Growth period, SRI, cropping system, grain yield, rice

INTRODUCTION

Rice is one the most important crops in developing countries and a main food stuff for about 35% of the whole world population (Becker and Asch, 2005). Rice plants require large amounts of mineral nutrients including N for their growth, development and grain production (Ma, 2004). Rice continuous cultivation in the north of Iran has recently decreased rice production and farmers for increasing yield used nitrogen application resulting in coast increasing and production decreasing duo to highland sensitive to disease especially blast and lodging, where disease and lodging have caused major yield losses. Rice production in much of the world increasingly focuses on optimizing grain yield, reducing production costs and minimizing pollution risks to the environment (Koutroubas and Ntanos, 2003)http://agron.scijournals.org/cgi/content/full/98/1/168?maxtoshow=&HITS=10&hits=10&RESULTFORMAT andandorexactfulltext=and&searchid=1&FIRSTINDEX=0&sortspec=relevance&volume=98&firstpage=168&resourcetype=HWCIT - BIB11. The System of Rice Intensification (SRI) is a method of increasing the yield of rice produced and decrease of water using in farming. It was developed in 1983 by the French Jesuit Father Henri de Laulanie in Madagascar. Planting with wider spacing in a square pattern, rather than randomly or in rows, followed as did controlling weed growth by use of a soil-aerating push-weeder (Stoop and Kassam, 2006; Uphoff, 2005). The ability to provide nutrients and their absorption in the SRI system is more common methods of planting. The use of compost and organic fertilizers for gradual and steady share of nutrients, especially during the grain filling period associated with the increased volume of roots and soil to absorb more nutrients due to periodic irrigation increased grain yield. The use of compost and periodic irrigation under SRI system increased 3 tons per hectare yield compared to the conventional system of planting and this was for increase of panicle number per m^2 and filled spikelet per panicle (Barison, 2003). Styger stated plants in SRI were ripped two weeks sooner than control and the net investment return was 108 % more than conventional system. Plants grown in SRI method have more root activity in flowering time and have more resistance to drought and lodging (Stoop and Kassam, 2006). Alagesan and Budhar reported that use of weed rotary in SRI caused to increase in soil aerobic conditions, composition of soil with organic matter, tiller and panicle number. Grain yield decreased with SRI in salinity soil compare to conventional system because of periodic irrigation method (Menete *et al*., 2008). Uptake of soil minerals decreased by permanent flooding and 78 % of rice roots in flowering time are dead in flooding conditions (Barison, 2003). SRI system increased grain yield because of additive effects, periodic irrigation management, use of 3-3.5 leaves seedling, use of one seedling per hill with more space, square planting pattern and fertilization with the use of organic sources (Stoop and Kassam, 2006; Uphoff, 2005). Essential of agricultural sector are sustainable development of rice cultivation for yield increasing and optimal use of production inputs, protect the environment and production resources. Sustainable product depends on decrease of product cost and increase of production efficiency. Comprehensive system and holistic in planting method and rice field management are necessary and unavoidable for increase of yield and protect inputs.

MATERIAL AND METHODS

In order to investigate response of phenological tratits and grain yield of rice genotypes under three

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Table 1: Selected soil properties for composite samples at experimental site in 2011

Soil texture	K (ppm)	P (ppm)	N (%)	OM (%)	pH	EC (μmohs/cm)	Depth (cm)
Clay-loam	220	12	0.18	1.58	7.81	0.22	0-30

Table 1: Selected soil properties for composite samples at experimental site in 2012.

Soil texture	K (ppm)	P (ppm)	N (%)	OM (%)	pH	EC (μmohs/cm)	Depth (cm)
Clay-loam	216	11.42	0.22	1.61	7.52	0.68	0-30

cropping systems, an experiment was carried out as split plot in randomized complete blocks design based four replications at Neka, Mazandaran, Iran in 2011 and 2012. The experimental farm is geographically situated at 43°, 36′ N latitude and 13°, 53′ E longitude at an altitude of 15 m above mean sea level. The soil was analysed and the soil of field was clay-loam (Table 1 and 2).

This experiment was conducted as split plot in randomized complete blocks design based four replications. Planting system was chosen as main plots (Conventional system, improved system and SRI or System of Rice Intensification) and genotypes as sub plots (Tall plant: Sang Tarom and Hashemi Tarom; Short plant: Neda and Shiroodi).

Conventional system: Conventional planting (rill and stack), mature seedling (35 days after sowing), >3 seedlings per hill, random planting arrangement, permanent flooding and keep water in all vegetation period in field, without drainage, use of chemical fertilizers (200 kg h^{-1} N, 100 kg h^{-1} P and 100 kg h^{-1} K) which P and K fertilizers were applied before transplanting and 75 % N was used before transplanting and the rest of that was used 30 days after transplanting as top dressing fertilizer. Weeds control had done 28 and 40 day after transplanting by hand.

Improved system: Planting (rill and stack), semi-mature seedling (25 days after sowing), two seedlings per hill with 20×20 cm^2 planting arrangement, permanent flooding and keep water in all vegetation period in field except one time drainage in tillering time, use of chemical fertilizers (200 kg h^{-1} N, 100 kg h^{-1} P and 100 kg h^{-1} K) which P fertilizer was applied before transplanting and 25% N and 50 % K were used before transplanting and 25% N and 50 % K were used 30 days after transplanting as top dressing fertilizers and the rest of N fertilizer was applied in heading time. Weeds control had done one time by herbicide and three times (28, 40 and 50 day) after transplanting by hand.

System of Rice Intensification (SRI): Young seedling (20 days after sowing), one seedling per hill with 10×30 cm^2 planting arrangement, two weeks use flooding system then periodic irrigation system, use of 10 ton h^{-1} compost (cow and sheep manures) before transplanting and nitrogen fertilizer application (46 kg h^{-1}) was applied 50% before transplanting and the rest of that was in heading time. Weeds control had done by rotary weeder (2-4 times) and be used within two to seven days. During the growth time, following characteristics was measured randomly from each plot. Grain yield was harvested from 4 m^2 from the middle of the sub plots with 12 % humidity (Yoshida, 1981). Data analyzed by SAS statistical software and Averages comparison were calculated by Duncan's multiple range tests in a 5% probability level.

RESULTS AND DISCUSSION

Results in Table 3 showed that days number from transplanting to start of tillering, days number to initial heading, days number to 50% flowering, days number to full heading, days number to physiological maturity and grain yield were significant in 1% probability level on cropping system and genotype. As days number to start of tillering, days number to full heading days number to physiological maturity and grain yield were significant in 5% probability level under interaction of planting system and genotypes (Table 3). The most number of days to start of tillering (15.13 day), day number to initial heading (54.69 day), days number to 50% flowering (64.75 day), days number to full heading (89.89 day) and days number to physiological maturity (105.7 days) were observed in conventional system, but the least number of days to start of tillering (11.44 and 11.74 day), day number to initial heading (51.47 and 51.78 day), days number to 50% flowering (61.5 and 61.75 day), days number to full heading (86.5 and 86.5 day) and days number to physiological maturity (101.6 and 101.5 day) were obtained in SRI and improved system. Therefore, the highest grain yield 6412 kg ha^{-1} was produced in SRI and the least grain yield 5692 kg ha^{-1} was produced in conventional system and this parameters in improved system was 6081 kg ha^{-1}. The maximum number of days to start of tillering (15.75 day), day number to initial heading (55.67 day), days number to 50% flowering (65.75 day), days number to full heading (90.38 day) and days number to physiological maturity (106.3 day) were obtained for var. Neda and the minimum number of days to start of tillering (9.94 days), day number to initial heading (49.9 day), days number to 50% flowering (59.94 day), days number to full heading (84.6 day) and days number to physiological maturity (99.73 day) were obtained for var. Tarom Hashemi. The highest grain yield equivalent to 7272 and 7315 kg ha^{-1} because of dwarf plant and short of source and sink distance was observed for var. Neda and Shiroodi and the least grain yield 4641 kg ha^{-1} was produced for var. Tarom Hashemi

Table 3: Mean square of planting system on main crop phonological traits and grain yield in rice genotypes.

S.O.V.	df	Days number to start of tillering	Days number to initial heading	Days number to 50% flowering	Days number to full heading	Days number to physiological maturity	Grain yield
Year	1	0.26	3.38	2.67	6.25	1.63	124344.01
RY	6	1.02	2.83	2.79	3.96	2.94	421824.91
System (A)	2	132.78**	100.82**	104.67**	122.63**	184.33**	4154555.47**
Y×A	2	0.198	3.41	2.67	2.78	4.36	124344.01
Error	12	0.715	1.87	2.09	2.03	2.35	205480.64
Genotype (B)	3	176.98**	165.44**	168.73**	173.95**	227.70**	4913723.76**
Y×B	3	0.142	1.69	1.87	1.58	3.55	45517.62
A×B	6	1.87*	0.84	0.83	7.12*	5.98*	246005.47*
Y×A×B	6	0.122	1.34	1.51	2.57	2.68	45517.62
Error	54	0.689	1.62	1.58	2.40	1.47	109706.97
CV (%)	-	6.490	2.41	2.01	1.77	1.43	5.46

**, * respectively significant in 1 and 5% level

Table 4: Mean comparison of planting system on main crop phonological traits and grain yield in rice genotypes

Treatment	Days number to start of tillering	Days number to initial heading	Days number to 50% flowering	Days number to full heading	Days number to physiological maturity	Grain yield (kg ha^{-1})
Cropping system						
SRI	11.44^{b}	51.47^{b}	61.50^{b}	86.50^{b}	101.60^{b}	6412^{a}
Improved	11.74^{b}	51.78^{b}	61.75^{b}	86.50^{b}	101.50^{b}	6081^{b}
Conventional	15.13^{a}	54.69^{a}	64.75^{a}	89.89^{a}	105.70^{a}	5692^{c}
Genotypes						
Sang tarom	11.10^{c}	51.50^{c}	61.04^{c}	86.19^{c}	101.00^{c}	5019^{b}
Tarom hashemi	9.94^{d}	49.90^{d}	59.94^{d}	84.60^{d}	99.73^{d}	4641^{c}
Neda	15.75^{a}	55.67^{a}	65.75^{a}	90.38^{a}	106.30^{a}	7272^{a}
Shiroodi	14.33^{b}	53.92^{b}	63.92^{b}	89.35^{b}	104.80^{b}	7315^{a}

Values within a column followed by same letter are not significantly different at Duncan (p = 0.05)

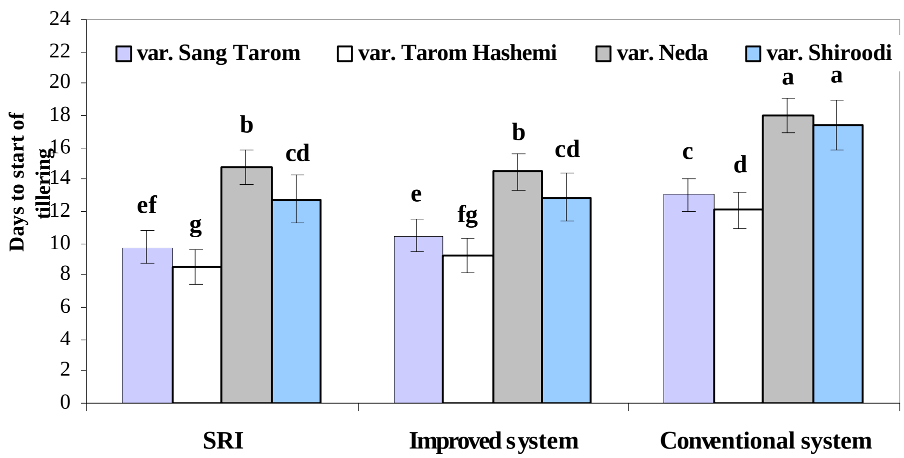

Fig. 1: Interaction of cropping system and genotype on Days number from transplanting to start of tillering

Table 4). With attention to interaction of cropping system and genotypes we can found the most number of days to of tillering (18 and 17.38 day), days number to full heading (93.13 and 92.56 day) and days number to physiological maturity (109.4 and 108.7 day) was observd at interaction of conventional system with var. Neda and Shiroodi and the least days number to start of tillering (8.5 day), days number to full heading (83.75 day) was obtained at interaction of SRI and var. Tarom Hashemi and the minimum days number to physiological maturity (98.5 and 98.63 days was observed at interaction of SRI and improved system with var. Tarom Hashemi (Fig. 1-3). The highest grain yield 7770 kg ha^{-1} was produced at interaction of SRI with var. Neda and the least grain yield 4277 kg ha^{-1} was observed at interaction of conventional system with var. Tarom Hashemi (Fig. 4). Alagesan and Budhar, (2009) reported that use of weed rotary in SRI caused to increase in soil aerobic conditions, composition of soil with organic matter, tiller number and panicle number. Grain yield decreased with SRI in salinity soil compare to conventional system because of periodic irrigation method. Plants grown in SRI have more root activity in flowering time and have more resistance to drought and lodging (Stoop and Kassam, 2006). SRI increased grain yield because of additive effects, periodic irrigation management, use of 3-3.5 leaves seedling, use of one seedling per hill with more space, square planting pattern and fertilization with the use of organic sources (Stoop and Kassam, 2006; Uphoff, 2005). The use of compost and periodic irrigation under SRI system

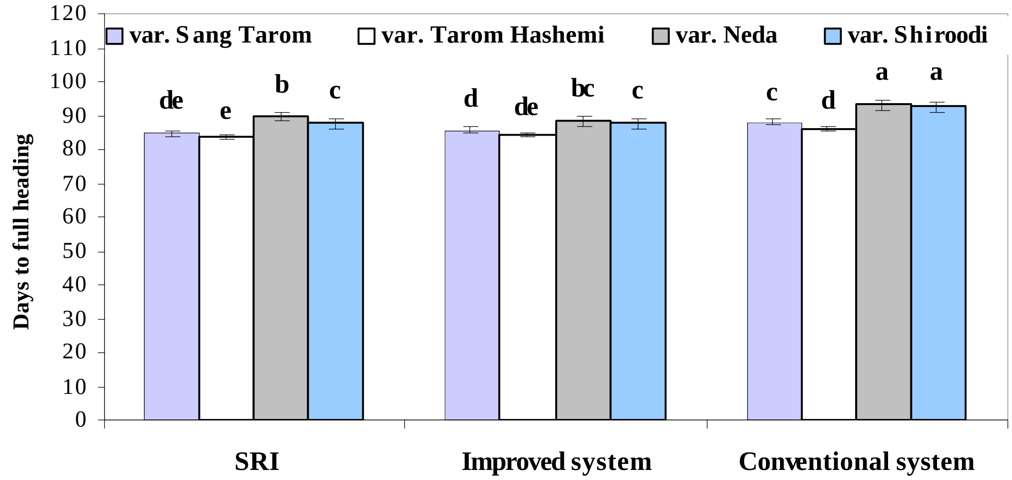

Fig. 2: Interaction of cropping system and genotype on Days number from transplanting to full heading

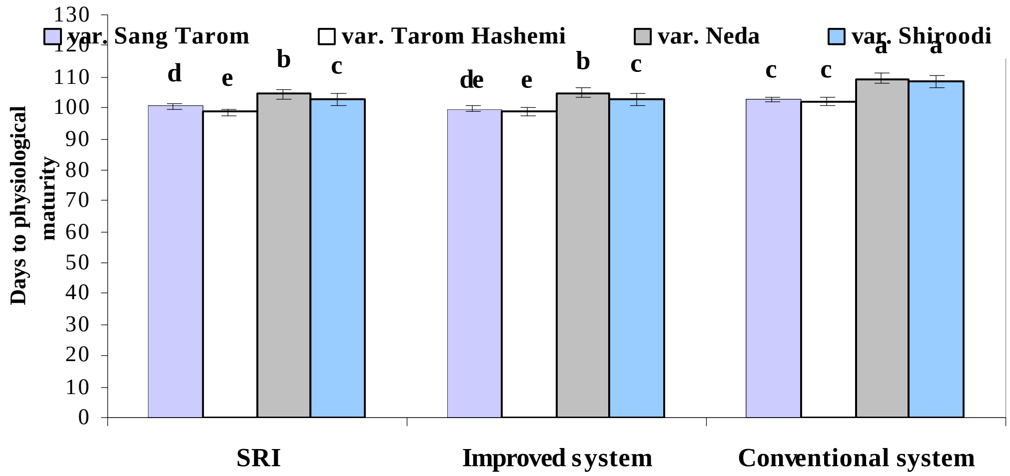

Fig. 3: Interaction of cropping system and genotype on day's number from transplanting to physiological maturity

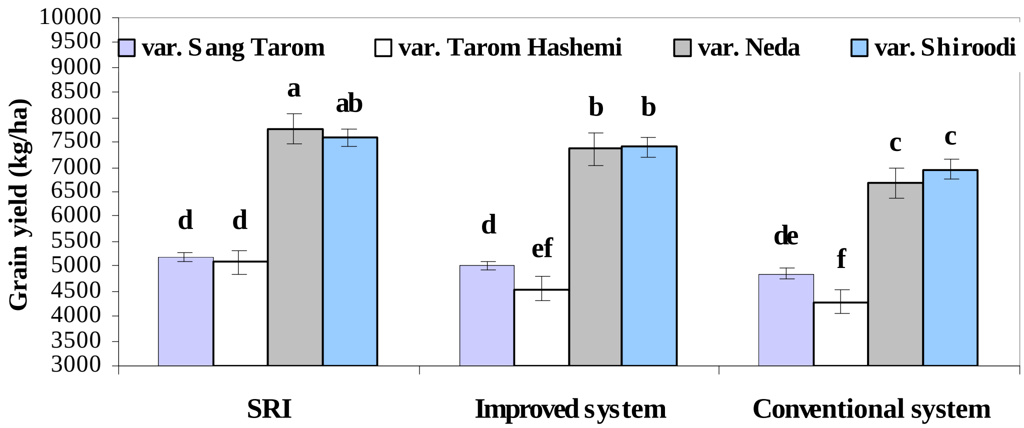

Fig. 4: Interaction of cropping system and genotype on grain yield

increased 3 tons per hectare yield compared to the conventional system of planting and this was for increase of panicle number per m^2 and filled spikelet per panicle, also uptake of soil minerals decreased by permanent flooding and 78 % of rice roots in flowering time are dead in flooding conditions (Barison, 2003).

CONCLUSION

The results showed the least number of days to start of tillering, day number to initial heading, days number to 50% flowering, days number to full heading and days number to physiological maturity were obtained in SRI and improved system. Therefore, the highest grain yield 6412 kg ha^{-1} was produced in SRI. The highest grain yield equivalent to 7272 and 7315 kg ha^{-1} because of dwarf plant and short of source and sink distance was observed for var. Neda and Shiroodi. The minimum days number to physiological maturity days was observed at interaction of SRI and improved system with var. Tarom Hashemi. The highest grain was produced at interaction of SRI with var. Neda. Therfore, SRI was the soutable for rice genotypes in this location.

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