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Effect of Irrigation and Azolla Compost on Rice (Oryza Sativa)

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ABSTRACT

The effects of irrigation and Azolla compost on rice (Oryza sativa. Var. Hashemi) in a field trial at Rice Research Institute located in Rasht, Iran, during 2009 cropping season were studied. The experiment was conducted in split plot arrangement based on randomized complete block design with three replications. In this experiment, three irrigation managements (I1, instance with 100%, I2 and I3, irrigation with 80 and 60% evaporation from pan class A, respectively), known as the main plot and four levels (C1, 4 t\ha; C2, 8 t\ha; C3, 12 t\ha and C4, without using of compost) of the different amounts of Azolla compost known as the sub plot were considered. The results showed that the effect of different irrigation levels on plant height, number of panicles (including hollow panicles), total biomass and yield was significant and the effect of different doses of compost on plant height, tiller number, panicle length, number of both panicles, number of hollow panicles, total biomass, yield and chlorophyll was also significant. Moreover, interaction between the different levels of irrigation and compost on yield was significant. In conclusion, it is suggested that the most effective management of rice in moderate regions can be achieved in irrigating the field in line with 60% evaporation from class A pan and it's utilization by8 t of Azolla compost per hectare.

KEYWORDS: Irrigation, Oryza sativa, pan evaporation, Azolla Compost.

1. INTRODUCTION

Rice is one of the world's oldest crops and after wheat, with the largest amount of land for cultivation in the world. Rice is in the first place in quantity of produced calories in comparison to other cereals (Malakouti and Kavousi, 2004). The agricultural industry in Iran includes the largest water consumer, and rice farming basically has low efficiency of water consumption as more than 50% of water is removed from plant in form of planar drain (Malakouti and Kavousi, 2004). However, due to the advantages of flooding irrigation, farmers prefer to use it. These advantages include the suppression of weed growth, soil temperature setting, leading to better access to some of the essential plant nutrients such as phosphorus, iron, manganese and silicon in the early stages of growth, and allows recovery of photosynthesis in lower leaves and improvement of photosynthesis in underneath leaves because of light reflection from water surface. Overall, considering Iran's position as a region with less water due to the lack of uniformity in distribution of rainfall, even in rainy Northern provinces, there is need to save water (Yazdani and Sharifi, 2003). There is the possibility of saving water in irrigation by more than 50% (Bouman *et al.,* 2002). One of the methods for decreasing consumption of water in irrigation and preventing waste of water in rice cultivation (instead of using flooding system which is customary in Iran's rice growing area) (Guilan Province) is changing from saturated to unsaturated system. Asian farmers who are faced with dry spells or are in areas with high cost of water use irrigation system in which the soil is saturated. They also use alternative method; for example, in China, India and Philippines, there are many farmers who when faced with drought, use pumps for irrigation. They profit from this alternative irrigation method (Bouman, 2001). The effect of reducing soil wetness to 80% saturation in different stages of rice growth not only harms the rice, but also decreases its quality. Rice would get damaged in stages of plant establishment and flowering, but it is not significant. The most sensitive stage of rice growth is dryness stress, flowering stage and plant establishment (Razavipuor *et al.,* 1999). Continuous use of fertilizers increases expenditure and causes biological pollution. In present times, the use of compost with chemical fertilizers is known as an essential factor in sustainable agronomy because it can fulfill the lack of essential and necessary elements in soil such as zinc, nitrogen, phosphorus and potassium (Alam, 2004). Azolla is a kind of aquatic fern found in paddy water, streams and pool (Rehana *et al.*, 2003). On the other hand, compost is a mixture of organic materials, which are corrupted by microorganisms placed in wet, warm and aerobic environments and which have food and materials. The use of compost in management of soil food for farming system is necessary. Compost can acquit some of the problems related to decreasing action in

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lack of some elements, especially from lack of zinc in soil. It can be a supplier of sources of food and help in the maintenance of water, thereby increasing water efficiency. Compost can also improve soil ventilation and compensate the shortage of humus or soil organic materials. It provides some vitamins, hormones and enzymes, which cannot be added to the soil by chemical fertilizer. In addition, it acts as a buffer in setting the pH of soil. It can wash out some of the diseases, weeds and useless corns in itself. This is done when it (compost) is being made by increasing heat to more than 60°C (Razavipour, 2004). Azolla compost, a mixture of leftover rice and *Azolla CAROLINIANA*, with useful materials and being used as a biological fertilizer in many countries, is searched with its positive effects proven (Mian, 1993). One of the important agricultural objectives in recent years is the use of fertilizers which can fertilize soil the most in a way that it would make farming stable or even look like organic fertilizer. Due to the lack of uniformity in water distribution in regions like northern parts of Iran (Guilan Province), the necessity of careful use of water is so important. This research attempts to identify the usefulness of irrigation and compost ,in integrated manner, on rice cultivation.

2. MATERIALS AND METHODS

For investigating irrigation and Azolla compost on rice (var. Hashemi) agronomic traits, an experiment was laid out in 2009 at Rice Research Institute of Iran (RRI), Rasht district, Iran. Split-plot design test in a randomized complete block design with three replications was performed. In this experiment, three irrigation managements (I_1, instance with 100%; I_2 and I_3, irrigation with 80 and 60% evaporation from class A pan, respectively) were assigned as the main factor and several amount of Azolla compost in four levels (C_1, 4 t\ha; C_2, 8 t\ha; C_3, 12 t\ha and C_4, without using of compost) as sub factor were studied. Phosphorous fertilizer from triple super phosphate of 100 kg (…% P, 100 kg/ha) and potassium from potassium sulfate (…% K, 150 kg/ha) sources were supplied and incorporated within the soil were used. A randomized experimental soil sample along with Azolla compost were analyzed in the laboratory with the results shown in Tables 1 and 2. The land was plowed in late February 2009, and in the second half of May. Then Azolla compost was added in each plot and well incorporated with the soil. The dimensions of each plot were 3×3 m and rice was cultivated in 20×20 cm per four hills. For irrigation of each of them, evaporation from the pan class A for a period of five days was calculated and the amount of irrigation water on the basis of level of plot and the observed evaporation percent was set. The amount of water in each plot was also estimated regularly. The amount of water which entered the plot in the period of I_1 was equal to 297 mm; I_2, 250 mm and I_3, 206 mm during the whole agricultural season. Measured traits are Seed yield, Plant height, the number of tiller per m2, Length of panicle, the number of seed in panicle and hollow seed in panicles, Biological yield

Statistical analysis

Data were analyzed by analysis of variance using statistical software MSTATC, and then mean comparison was done by Duncan’s test with probability level of 5%.

3. RESULTS AND DISCUSSION

Plant height

The analysis of variance (Table 3) showed that the effect of different levels and amounts of irrigation water, Azolla compost and their interaction on plant height at 1% probability was significant. Comparison of results in terms of plant height (Table 4) showed that the highest irrigation with an average height of 140 cm reduced the amount of irrigation water with 80% of class a pan evaporation. Among different applied doses of compost manures, the second level (4 t/ha) could drastically boosted the plant height (139.4 cm) than other levels. Average interaction treatments (Table 5) showed that 80% of the amount of irrigation evaporation without the use of Azolla compost resulted in an average maximum height of 141 cm while 60% of the amount of irrigation evaporation with the use of 12 tons of Azolla compost per hectares led to the lowest average height of 129 cm. Basically, water shortage during plant growth reduces height, but in this case there is more stress (Jayabalan *et al.,* 1995). Increases in plant height might result from the increased levels of nutrients in compost and fertilizers that cause the simplified availability of plant food (Kavitha and Subramanian, 2007). The increase in plant height alongside the application of compost has also been previously reported by other workers (Ibrahim *et al.,* 2008).

Number of tiller

Effect of different levels of irrigation, with non-significant different amounts of Azolla compost and interaction between compost and irrigation on tiller number at 1% had a significant effect (Table 3). A comparison of results of tillers per square meter (Table 4) in terms of compost manure showed that the maximum number of tillers (m^2\ha) using eight Azolla compost averagely was 325 tillers. Furthermore, interaction between treatments (Table 5) indicates that irrigation with 100% evaporation with the use of 8 tons of Azolla compost per hectare resulted in maximum average number of tillers (m^2) of 351, while 100% irrigation with 12 Azolla compost per hectare resulted in the lowest average number of tillers per square meter, which is 271. Reports ofYazdani and Sharifi, (2003) and Nahvi (2000) had suggested that a significant difference in the effect of irrigation treatments on the number of tillers per square meter did not exist. With the addition of compost treatment, the square meter of tillers will be affected. There is maximum number of tillers when compost treatment is used. The result shows that a significant interaction with nitrogen is stored and accessible (Cassman et al., 1994). Application of compost with nitrogen fertilizer will increase the number of tillers (Adel, 2008).

Panicle length

The analysis of variance (Table 3) showed that the effect of different levels of irrigation water and interactions between irrigation and compost, having long spikes with no significant different values of panicle length using Azolla compost at 5% was not significant. The length of panicles using 8 and 4 tons of Azolla compost per hectare was 28.1 and 27.5 cm, respectively (Table 4). The interaction of treatments showed that 80% of the amount of irrigation evaporation associated with Azolla compost of 8 tons\ha resulted in an average maximum panicle length of 28.67 cm (Table 5).Nitrogen can influence trait of panicles and increase their length performance. The results of Salahshour (2005) suggest that there is no significant difference between irrigation treatments on trait of panicles. Singh (2001) on the same research on panicles realized that panicles significantly increased during the composting of organic material. Compost application increased significantly the panicles which were created (Ibrahim *et al.,* 2008). Manivannan*et al.,* (2009) also reported that compost application increased spike length.

Number of grains per panicle

The analysis of variance (Table 3) showed that the effect of different levels of irrigation water on number of panicle seed, without significant different amounts of Azolla compost and interactions between irrigation and compost on the number of seed per panicle at 1 and 5% had significance. Mean number of seeds of panicle shows that using Azolla compost of 8 tons per hectare (Table 4) resulted in an average maximum number of seeds, which was 76.7. Average interaction treatments (Table 5) showed that 80% of the amount of irrigation evaporation associated with Azolla compost of 8 t/ha resulted in an average maximum number of 81.3 seeds per panicle; and 80% of the amount of irrigation evaporation using alongside Azollacompost of 12 tons per hectare resulted in the lowest average number of 66 seeds per panicle. The results of Nahvi (2000) and Yazdani and Sharifi, (2003) suggest there was no significant difference in the number of grains per panicle using irrigation (4 and 5 grains, respectively), but the number of grains per panicle increased significantly when compost material was used (Singh, 2001). Amanullah*et al.* (2008) found that com-post application increased the number of grains per panicle significantly. Reddyi and Mitra (1984) reported that with increase in the number of tillers per square meter, the total number of grains per panicle increased; and decrease of the number of tiller seeds per square meter resulted in decrease in the number of seeds per panicle. Spanu andPruneddu (1997) reported that increasing nitrogen means increasing grain weight and more number of grains per panicle.

Number of grains per hollow panicle

The analysis of variance (Table 3) showed that the effect of different levels and amounts of irrigation water, Azolla compost on the number of seeds per hollow panicle at 1% and interaction between irrigation and compost on the number of round hollow seeds in a panicle at level 5% is significant. Mean number of seeds in a hollow panicle (Table 4) showed that the number of hollow seeds in a panicle with an average of 15.08 decreases in irrigation number of seeds per hollow panicle shows that the water with 80% of class pan evaporation. The mean number of seeds per hollow panicle shows that the largest number of hollow seeds per panicle was 15.11 using Azolla compost value of 8 tons per hectare. Average interaction treatments (Table 5) showed that 80% of the amount of irrigation evaporation associated with Azolla compost of 8 tons per hectare resulted in the largest number of hollow seeds per panicle, with a mean value of 18.33; and in irrigation of 100% evaporation without the use of Azolla compost, the lowest number of seeds per hollow panicle was a mean of 11. Some reports suggest that it is useful to seek efficient irrigation methods because the percentage of hollow grain yield increases and decreases (Pirmoradian*et al.,* 2004). In this case, most irrigation method is such that during flowering stage, air relative humidity increased and temperature is reduced below the critical level.

Seed yield

The analysis of variance indicated that different levels of irrigation water, different amounts of Azolla compost and interaction between compost and irrigation on grain yield at 1% was significant (Table 3). A comparison of per-

formance results showed that irrigation with 60% evaporation (that is reduction in the amount of irrigation water) resulted in the highest average yield of 3541 kg (Table 4). The results show that water loss leads to reduced grain yield of rice and so 30% of irrigation water needs to be increased. Comparison of performance in terms of manure compost showed the highest yield of 3505 kg using Azolla compost of 8 tons/ha (Table 4). Average interaction treatments showed that 60% of the amount of evaporation associated with Azolla compost of 8 tons per hectare resulted in the grain yield of 3683 kgper hectare, which is the highest; and irrigation of 80% evaporation using alongside Azolla compost of 12 tons per hectare resulted in yield of 3224 kg per hectare, which is the lowest performance (Table 5) (Fig. 1). Treatment of Azolla compost of eight tons per acre resulted in increase in grain yield, number of tillers per square meter, total number of panicles; and the panicle is chlorophyll.
Boumanand Tuong (2001) results on this research are similar to the result of this study. General lack of significant difference in yield can be due to enough water supplies in all irrigation treatments. There are no regimes in the plant that have not been stressed; therefore, functional decline has not been observed. Kavitha and Subramanian (2007) also reported a significant effect of compost application on yield in different treatments; compost application increased rice yield. Specific breakdown of compost on rice yield and readily available food plants are potassium and phosphorus and micronutrients like zinc, iron, manganese and copper. Compost has positive effects on plant growth and performance, raising the capacity of organic matter and physical properties. Chemical and biological compost makes more nutrient elements available (Gupta and Potalia, 1990), and increasing amount of organic fertilizer will increase yield (Akanbi *et al.,* 2000).

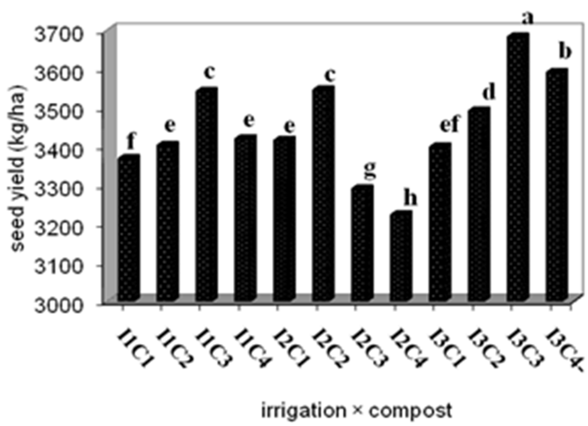

Fig. 1. Interaction between irrigation and Azolla compost on yield.

Biological yield

The analysis of variance (Table 3) showed that biological functions were affected by different levels of irrigation and different amounts of Azolla compost at 5% level and the interaction between irrigation and compost at 1% was significant. Comparison of results in terms of biological yield (Table 4) showed that maximum biological yield of an average of 8602 kg per hectare was obtained in irrigation (reduced evaporation from the pan) with 60% grade; and a maximum biological yield was obtained in compost C_2, C_3 and C_4 levels in that order. The lowest average biological yield (7597 kg) was found in the treatment without compost, and this was because of the lack of the amount of nitrogen supply required for plant growth. This also led to reduced photosynthesis and dry matter accumulation decline in production unit areas. So compost should be used in order to increase grain yield and biological yield (Table 4).

In addition, the average interaction treatments showed that the maximum biological performance in irrigation with 60% evaporation with the use of 4 and 12 tons of Azolla compost per acre resulted in the highest average biological yield; and irrigation with 60% pan evaporation, without the use of Azolla compost resulted in an average of 7491 kg of biological yield per hectare, which is the minimal number (Table 5) (Fig. 2). Composting has positive effects on plant growth and biological functions, thereby raising the capacity of organic material and making more nutrient elements to be available (Gupta And Potalia, 1990).

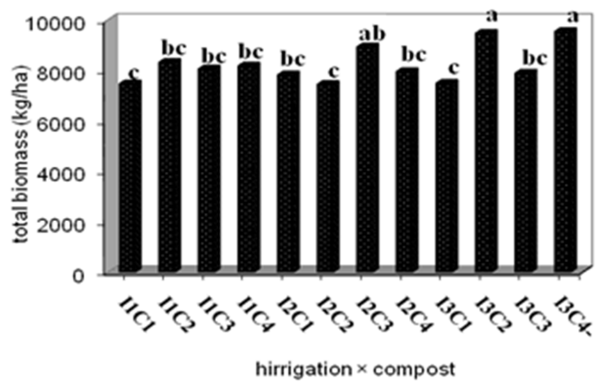

Fig. 2. Interaction between irrigation and Azolla compost of the total biomass.

Chlorophyll

The analysis of variance (Table 3) showed that the effect of different levels of irrigation water on chlorophyll content, without significant different amounts of Azolla compost and interaction between compost and irrigation on the amount of chlorophyll was significant. A comparison of compost manure indicated that the maximum average amount of 40.38 chlorophyll was obtained by using 8 tons of Azolla compost per hectare. Interaction between treatments (Table 5) indicated that 100% of irrigation evaporation associated with Azolla compost of 8 tons per hectare resulted in an average maximum amount of 41.66 and 80 chlorophyll; and 60% of irrigation evaporation with the use of 12 tons of Azolla compost per hectare has the lowest average levels of chlorophyll, which are 36.63 and 36.76, respectively.

4. CONCLUSION

In general, the results obtained herein show that irrigation with 60% evaporation rate from evaporation pan and also 8 tons of compost per hectare should be considered as optimum levels. Due to the balanced performance seed, less water consumption, as well as the prevention of environmental problems, as the best treatment for cultivation in areas with water shortages and drought conditions were recommended. This study showed that the most important achievement was the creation of irrigated rice in the rotation instead of conventional systems in the region (permanent flooding) also found that the decrease in performance, while leading to a saving of water.

Table 1. Analysis of field soil testing before implementation.

Soil texture	clay (%)	Silt (%)	Sand (%)	K (ppm)	P (ppm)	Total N (%)	O.C (%)	pH	EC × 10^3
clay	50	26	24	191	9	0.197	1.7	6.85	1.99

Table 2. Analysis of Azolla compost.

CEC (Meq/100g)	K (ppm)	P (ppm)	Total N (%)	O.C (%)	pH	EC × 10^3
55	0.93	0.22	2.827	33.5	6.02	10.8

Table 3.means of squares of tested treatments effects on agronomical traits.

Source of variance	df	Plant height	Number of tiller	Panicle length	Number of grains per panicle	Number of grains per hollow panicle	Biological yield	Seed Yield	Chlorophyll
Replication	2	0.22^{ns}	1267.19^{ns}	4.70^{ns}	33.44^{ns}	6.02^{ns}	43063.69^{ns}	1196.6^{ns}	8.35^{ns}
Irrigation(I)	2	143.26**	550.86^{ns}	4.91^{ns}	14.77^{ns}	40.52**	1333810.52*	90845.4**	3.29^{ns}
Error	4	0.96	216.98	2.09	31.61	1.4	155567.4	565.2	3.34
compost (c)	3	67.78**	1903.43**	4.62*	137.66**	14.99**	1649357.18*	25665.8**	11.79**
I×C	6	33.42**	1152.04**	2.58^{ns}	44.55*	5.38*	1679780.49**	48670.03**	4.56**
Error	18	1.35	181.64	0.99	12.03	1.5	394699.4	360.9	1.02
Coefficient Variation%	-	0.86	4.33	3.65	4.88	9.05	7.64	4.8	2.61

ns, *, ** are the concepts of non-significance and significance at 0.05 and0.01 respectively.

Table 4. Comparison of traits in different conditions of irrigation water and Azolla compost by Duncan's test at 5%.

Treatment	Plant height (cm)	Number of tiller (m^2)	Panicle length (cm)	Number of grains per panicle	Number of grains per hollow panicle	Biological yield (kg/ha)	Seed yield (kg/ha)	Chlorophyll (mg/g fw)
Irrigation(%)								
100	133.5[c]	314.6[a]	26.6[a]	69.8[a]	11.5[b]	8010[b]	3433[b]	39.3[a]
80	140.0[a]	303.3[a]	27.4[a]	71.3[a]	15.08[a]	8042[b]	3369[c]	38.9[a]
60	134.8[b]	315.5[a]	27.9[a]	72.00[a]	14.00[a]	8603[a]	3541[a]	38.3[a]
Azolla compost(ton/ha)								
0	134.4[c]	310.9[b]	27.1[ab]	69.1[b]	13.2[b]	7597[b]	3394[c]	39.08[b]
4	139.4[a]	317.6[ab]	27.5[a]	70.2[b]	13.7[b]	8417[a]	3481[b]	38.4[bc]
8	137.2[b]	325.0[a]	28.1[a]	76.7[a]	15.1[a]	8296[a]	3505[a]	40.3[a]
12	133.3[c]	291.1[c]	26.4[b]	68.1[b]	12.00[c]	8563[a]	3412[c]	37.6[c]

Surfaces treated with at least one common letter are significantly different at 5%.

Table 5. Comparison of interactions between different irrigation regimes and different levels of Azolla compost for the traits using Duncan test at 5%.

Treatment	Plant height (cm)	Number of tiller (m^2)	Panicle length (cm)	Number of grains per panicle	Number of grains per panicle hollow	Chlorophyll (mg/g fw)
I_1C_1	130.7 [e]	323.3 [b]	25.7 [d]	67.00 [cde]	11.00 [e]	38.4 [cd]
I_1C_2	139.1 [bc]	311.7 [bcd]	26.5 [bcd]	66.3 [de]	11.6 [de]	37.8 [cd]
I_1C_3	133.3 [d]	351.7 [a]	28.4 [ab]	75.3 [b]	12.6 [cde]	41.6 [a]
I_1C_4	130.8 [e]	271.7 [e]	25.9 [cd]	70.6 [bcd]e	10.6 [e]	39.6 [bc]
I_2C_1	141.6 [a]	295.0 [cde]	27.5 [abcd]	66.6 [de]	13.3 [bcd]	39.4 [bc]
I_2C_2	140.7 [ab]	326.7 [b]	27.8 [ab]	71.3 [bcde]	15.00 [bc]	39.3 [bc]
I_2C_3	138.2 [c]	305.0 [bcd]	28.6 [a]	81.3 [a]	18.3 [a]	40.4 [ab]
I_2C_4	139.5 [abc]	286.7 [de]	25.7 [d]	66.00 [e]	13.6 [bcd]	36.6 [d]
I_3C_1	130.9 [e]	314.3 [bc]	28.2 [ab]	73.6 [bc]	15.3 b	39.4 [bc]
I_3C_2	138.5 [bc]	314.3 [bc]	28.3 [ab]	73.00 [bcd]	14.6 [bc]	38.1 [cd]
I_3C_3	140.0 [abc]	318.3 [bc]	27.4 [abcd]	73.6 [bc]	14.3 [bc]	39.03 [bc]
I_3C_4	129.7 [e]	315.0 [bc]	27.7 [abc]	67.6 [cde]	11.6 [de]	36.7 [d]

Surfaces treated with at least one common letter are significantly different at 5%. I_1, I_2 and I_3, respectively, are based on irrigation of 100, 80 and 60% of Class A pan evaporation. C_1, C_2, C_3 and C_4, respectively are without the use of Azolla compost, and using compost Azolla levels of 4, 8 and 12 tons/ha.

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