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The Effect of Different Concentrations of Major Element's Foliar Application on Resistance to Lodging and Morphological Traits of Rice Varieties

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ABSTRACT

Background: Effects of foliar application of nitrogen and potassium on morphological and physiological traits of two rice varieties, Shiroodi and Hashemi were evaluated at Rice Research Institute of Iran in Mazandaran in 2013. The experiment was conducted in a split-split plot based on a randomized complete block design. Two rice varieties were set as main plot and foliar application times and the concentration of foliar application were assigned as sub- and sub-sub plots, respectively. **Objective:** Using various concentrations and times of foliar application of fertilizers, resistance to lodging and improvement of morphological traits were evaluated in Iranian rice varieties. **Result:** The result of analysis of variance showed that the effect of variety was significant on the traits of plant height, number of tillers and resistance to lodging. Hashemi had the highest plant height both at vegetative and reproductive stage of growth. However, Shiroodi obtained the maximum number of tillers at reproductive stage and higher resistance to lodging. Effect of concentration of foliar application was significant only on plant height at vegetative stage and resistance to lodging. Mean comparison of the yield in varieties showed that Shiroodi had a higher yield (6666.1 Kg.h⁻¹) than Hashemi (3939.4 Kg.h⁻¹). Different concentrations of foliar application affected the plant yield and altered concentration resulted higher yield (5331.2 Kg.h⁻¹) than control (4933.3 Kg.h⁻¹). **Conclusion:** According to the results, two times foliar application with 2% nitrogen and 0.05% potassium at panicle initiation stage for Shiroodi and two times foliar application with 4% nitrogen and 1% potassium for Hashemi, have had a positive impact on the resistance to lodging in comparison with the control with no foliar application. It also increased chlorophyll content, plant height and reduced the percentage of unfilled grains.

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INTRODUCTION

Rice is a second main staple crop after wheat in Iran, cultivated in 570,000 hectares of irrigated area and 2.4 million tons of milled rice is produced. Iran still largely depends on rice imports to the tune of 0.8 million tons each year meet the domestic consumer demand (Cooper *et al.*, 1971). Lodging is a major problem in the production of cereal crops (Lim *et al.* 1997). The lower yield and decreased quality also lead directly to poor profits for farmers. It also causes difficulties in harvesting operations and consequently results in increased production cost (Li *et al.*, 2009). In a high-yielding environment, lodging is the most important constraining factor on yield for most cereals, including rice (Setter *et al.* 1997). Lodging negatively impacts both grain yield and quality (Weibel and Pendleton 1964), in part through a 60%–80% reduction in rice canopy photosynthesis (Setter *et al.*, 1997). More practically, lodging reduces working efficiency by about 25% by making machine harvesting difficult (Lim *et al.*, 1997). Lodging in rice may occur as a result of strong winds, heavy rain, water management, planting density, or an excessive use of fertilizer (Back *et al.*, 1998). Due to the increasing need for rice consumption as a high calorie food source and reducing the cultivated area of this plant in the world, use of the modern methods of farming is important. Foliar application has a great role in absorption efficiency and reducing losses due to leaching. It can increase the yield and reduce the ultimate cost, especially in several times of application and different concentration (Zhang *et al.*, 2005). On the other hand, the capita consumption of main fertilizers (N, P, and K) was about twice in Iran fields than developed countries (agricultural) which itself causes negative impacts on water resources, soil, plants and humans (Lim *et al.* 1997). So, foliar application of basic fertilizers may enhance both the yield and safety of the human food supply while reducing the production cost to attain sustainable agriculture (Longping, 2004). Abou El-Nour reported that foliar application can reduce

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environmental pollution and increase the absorption of nutrients by roots, associated with root growth by improving the nutrient usage and reduction of fertilizer usage (Abou *et al.*, 2002). Soleimani *et al.* (2006) reported that the number of grains per panicle in wheat has increased by foliar application of iron and zinc and foliar application of micronutrients played an important role in increase of corn yield, in the Isfahan region, especially iron + zinc and copper + manganese. Although several research have been performed to study the effect of foliar application, little is known about the effect of foliar application of major elements on rice varieties. In this research we tried to investigate the effect of different concentrations and times of foliar application on yield and yield components of two Iranian rice varieties, Shiroodi and Hashemi.

MATERIALS AND METHODS

In the crop year of 2013, an experiment was conducted at Rice Research Institute of Iran in Mazandaran - Amol, to investigate the foliar application effect of nitrogen and potassium on morphological and physiological traits of two Iranian rice varieties, Shiroodi and Hashemi. The experimental design was split-split plot based on a randomized complete block design with three replications. Two rice varieties were set as main plot and foliar application times (0,1 and 2 times) and the concentration of foliar application (recommended concentration: 2% nitrogen and 0.5% potassium and altered concentration: 4% nitrogen and 1% potassium) were assigned as sub- and sub-sub plots, respectively. Fertilizer concentration and times of application were decided according to the soil test and nutritional principles of rice plant (Malakoti, 2000). The source of the applied nitrogen was from urea (soluble) and for potassium, a commercial liquid fertilizer with 20% potassium was used. The experiment plot size was 5 × 2 m and the distances between and within rows were 20 cm. The traits were plant height, number of tillers, resistance to lodging, percentage of filled and unfilled grains, number of total grains per panicle, panicle length, 1000-grains weight and yield. The average of data from each plot was used for the statistical analysis using SAS software and mean comparison performed using the LSD test.

RESULTS AND DISCUSSION

The results of the analysis of variance showed that the effect of variety was significant in the traits of height at both growth stages and tiller number at reproductive stage as well as resistance to lodging. The plant height of Hashemi was higher than Shiroodi both at vegetative and reproductive stages (129.1 and 159.5 cm, respectively). The maximum number of tillers at reproductive stage (16.86) and higher resistance to lodging (25.60 N) was obtained in Shiroodi. Effect of concentration was significant in plant height at vegetative stage and resistance to lodging. The highest plant height (112.43 cm) was obtained at vegetative stage for recommended concentration of foliar application and the lowest plant height (75.18 cm) was belonged to the control (No application). In the case of resistance to lodging, the treatment of altered concentration showed higher (26.18 N) than the control (20.12 N). Means of agronomic and morphological traits for variety×concentration, variety× application times and concentration× application times were not significantly different. The effect of interactions of variety× application times× concentration was significant in unfilled grains at 5% probability level. The trait of unfilled grains is negatively related to the yield, so that reducing unfilled grains means an increase in fertile grains which directly increase plant yield.

Table 1: Analysis of variance for morphological traits.

S.O.V	df	Height ^S	Tiller ^S	Height [#]	Tiller [#]	Filled grains	Unfilled grains	Panicle L.	1000-grain W.	Yield	Resistance to Lodging
Block	2	1	0.6	34.42	2.02	28.27	2.22	0.686	3.71	15234.3	9.50
Variety	1	21.98**	45.37	15130.28**	45.37**	256.58	1022.5	31.44	123.1	44609970.8	47.09*
Error (a)	1	11.44	0.72	32.46	0.19	231.46	13.41	2.307	1.80	455614.05	0.092
Application times	1	0.201	0.28	18.37	0.2	558.4	13.21	0.226	2.01	386492.98	6.51
Variety× Application times	1	0.06	0.0001	63.37	1.04	230.52	77.43	0.258	0.55	29531.39	10.34
Error(b)	4	15.61	3.6	49.77	6.91	202.57	34.41	0.659	0.87	872654.41	5.56
Concentration	1	36.01**	0.0001	303.88	8.88	514.53	1.46	0.573	0.58	19337.56	94.01**
Variety × Concentration	1	19.8	0.37	75.61	0.37	344.1	0.840	0.0057	3.29	411798.50	28.86
Application times × Concentration	1	23.6	0.041	23.60	0.041	398.40	1.20	0.964	0.0001	135939.12	5.41
Variety × Application times × Concentration	1	29.48	0.135	39.01	7.48	300.13	28.84*	0.459	2.130	169806.31	28.03
Error (c)	8	17.28	2.02	42.04	3.23	192.21	4.84	0.779	3.42	561360.25	2.71
C.V. (%)		3.8	11.6	4.8	11.6	12.2	13.2	3.2	7.27	14.12	6.81

* and **: Significant at the 5% and 1% probability levels, respectively.

S: Vegetative stage; #: reproductive stage

Table 2: Comparing the average of morphological traits in different Concentration of foliar application.

Concentration	Height ^S (cm)	Tiller ^S	Height [#] (cm)	Tiller [#]	Filled grains (%)	Unfilled grains (%)	Panicle length (cm)	1000- grain weight (gr)	Chlorophyll amount (spad)	Yield (Kg.ha ⁻¹)	Resistance to Lodging (Newton)
Control (No application)	75.18 b	12.83 a	130.33 a	14.31 a	83.16 a	16.88 a	27.83 a	24.83 a	26.99 c	4933.33 a	20.12 b
Recommended	112.43a	12.36 a	133.16 a	14.88 a	83.57 a	16.42 a	27.42 a	25.27 a	37.39 b	5274.4 a	22.22 ab
Altered	105.3 a	12.83 a	135.61 a	16.10 a	89.95 a	6.33 b	27.73 a	25.59 a	38.55 a	5231.2 a	26.18 a

Means with similar letter were not significant at the 5% probability level.

S: Vegetative stage; #: reproductive stage

Conclusion:

Overall, the results of this study showed that nitrogen and potassium foliar application has a positive impacts on plant resistance to lodging, chlorophyll content and plant height. The recommended and altered concentrations had various effects on morphological traits of rice varieties in comparison with control with no foliar application. Further experiments may need to know the physiological effects of foliar application on rice varieties.

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