Study Of Nutrient Uptake In Some Varieties Of Rice By Foliar Application Of Potassium Phosphate Fertilizer On Saline Soil

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Abstract: The aim of this research was to determine the effect of different levels of Potassium Phosphate (KH_2PO_4) fertilizer on nutrient uptake of rice under saline conditions. This research was arranged in a factorial randomized block design with two factors, i.e.: Variety and KH_2PO_4 fertilizer concentration with 3 replications. Eight rice varieties used were Ciherang, IR 64, Lambur, Batanghari, Banyuasin, IR 42, Inpara 10 and Margasari. Four levels of KH_2PO_4 concentration were 0, 50, 100 and 150 mg/l. Results showed that Potassium Phosphate application was alleviated the stress condition and significantly affected nutrient uptake in rice. Potassium Phosphate fertilizer applications through the leaves with a concentration of 150 mg/l (P_3) gives the best results for all variables observed. Banyuasin had the better growth in saline soil than other varieties.

Keywords : Analysis , Nutrient uptake, Potassium Phosphate, Salinity, Rice

1 INTRODUCTION

Salinity stress can cause nutrient deficiency (specific ion, sitotoxisity and ionic stress), osmotic stress and oxidative stress (Munns et. al., 2006). Ionic stress resulting in inhibition of absorption of nutrients Potassium and Phosphorus. Effect of salinity will result in the lack of availability of nutrients K and P, as well as the ratio of K+/Na+ is low. Soil salinity significantly reduces the absorption of mineral nutrients, especially phosphorus (P), because phosphate ions precipitate with Ca2+, Mg2+ and Zn2+ on saline soil and becomes unavailable to plants. As has been reported by Hussein, Shaaban and Saady (2008), Potassium-Phosphate fertilization through the leaves in the form KH2PO4 can improve the availability of P and K were hampered due to salinity stress in leguminous plants (Wang et.al., 2013). KH2PO4 fertilizer applications were made through the leaves make the plant more tolerant to salinity stress. Potassium (K) is an essential nutrient that affects most of the biochemical and physiological processes that influence plant growth and metabolism (Wang et.al., 2013). Nutrient absorption through the roots in saline soils often experienced problems because of nutrients provided may be bound by other minerals. This results in lower nutrient availability. Low nutrient availability in the soil will hamper the process physiological saline. PK fertilizer applications through the leaves may resolve the issue. Na+ accumulation in roots due to saline soils will reduce the uptake of K+ (Lacerda et.al, 2003). Higher amounts of Na also reduce nutrient uptake (Ashraf, 2004; Flower and Flower, 2005).

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Potassium is one of the important macronutrients required for the growth, development, yield, and quality of plants, and it also plays a key role in the survival of plants under abiotic stress conditions, as stress negatively affects the physiological processes of plants such as root and shoot elongation, enzyme activity, water and assimilate transport, synthesis of protein, photosynthetic transport, and chlorophyll content (Gerardeaux et al., 2010 and Kanai et al., 2011). Under saline field conditions, plants suffer a deficiency of potassium mainly because of the excess of Na+ in the rooting medium, which acts as an antagonist and decreases the availability of potassium ; thus, under salinity stress, plants face the problem of K deficiency. Therefore, under salinity stress, improving the K-nutritional status of plants alleviates the detrimental effects of Na+ by different mechanisms, including K+ = Na+ discrimination (Rubio et al., 2009). However, addition of potassium further enhanced the activities SOD, POD and CAT in both maize hybrids under saline condition. These finding also parallel to the argument that antioxidant activities in plants under salinity stress are improved by potassium application (Zheng et al. 2008; Soleiman et al. 2010; Abbasi et al. 2014). Phosphorus nutrition appeared to modify the effects of salinity upon growth of glycophytic plants. There was a significant increase in the starch content and cob index in maize due to foliar application of P. When initial P deficiency symptoms appeared 25 days after sowing in wheat, higher doses of ammonium phosphate as a foliar spray gave the greatest reduction in P deficiency and highest yields. Phosphorus and salinity act antagonistically. Phosphorus lessens the effects of salinity, and induces salt tolerance in plants (Garg et. al ., 2005). It has been observed that Phosphorus fertilization reduces the concentration of Na+ in shoots and grains. It results in better survival, growth and yield in rice and wheat. By increasing the supply of Phosphorus to a saline medium it tended to decrease the concentration of Na+ in rice, sunflower, spinach (Kaya et al., 2001) and wheat (Abid et al., 2002). Wheat (Triticum aestivum L.) is a major food crop for more than one third of the world population (Shiraz et al., 2001). It is the most important food for two billion people 36% of the world population). Worldwide wheat provides nearly 55% of the carbohydrates, and 20% of food calories consumed globally. The objective of this experiment was to study the effect of foliar application of phosphorus to determine the physiological changes produced in wheat plants exposed to saline conditions. Nutrient availability is an important factor in increasing rice production. In the biochemical reactions of plants, phosphate fertilizer has an important role as a store and transfer energy, osmotic work, the reactions of photosynthesis and glycolysis so that ultimately affect the production of rice (Arifin and Sugiono, 2010). The main role of potassium in plants is an activator of many enzymes. With the available potassium in the soil causes: the hardness of the plants is assured, stimulating root growth, plants are more resistant to pests and diseases, improve the quality of grain, it can reduce the influence of maturity accelerated by phosphorus and able to cope with water shortages at certain levels. Saline soils generally have concentrations of Na+, K+ and Ca2+ is high and this can result in passive accumulation of Na+ on the root. High levels of Na+ can replace Ca2+ from root membranes, changing their integrity and thus affect the selectivity for the absorption of K+ (Tester and Davenport, 2003). In addition, K Uptake also is affected salinity, therefore the application of potassium fertilizers through the leaves will offset the uptake of Na due to salinity, in addition to the potassium fertilizer applications through the leaves in saline soil is the best method (Mohiti et.al., 2011). Xylem loading is governed by the K+. K+ uptake of external solutions. This indicates that the Na+ side salinity stress reduces the uptake rate of K+, is also disturbing to levels greater uptake in K+ translocation from the roots, which produce K+. The inhibitory effect of salinity on the translocation of K+. K resulted in a low nutrient content, thereby reducing dry weight. Inhibition of shoot growth at low levels in the medium root K deficiency caused by the influence of K and / or Na toxicity in plants. Salinity stress causing a leak K out of cells will eventually lead to a decrease in cell growth. Salt tolerance with regard to the Na concentration and selectivity for K higher than Na. One of the reasons of fertilizer nutrients phosphorus and potassium can be done through the leaves was to avoid the possibility of fixation elements in the soil. For example, the element phosphate (P) in acid soil containing Fe and Al will form a complex compound of Fe-Al Phosphate that settles that P can not be absorbed by plant roots. The introduction of potassium nutrients through the leaves will reduce the effects of salinity on the yield of wheat (Khan et al, 2013) and rice (Ebrahimi et. al., 2012).

2 MATERIALS AND METHODS

The study was conducted during 2014 in Paluh Merbau, Tanjung Rejo, Percut Sei Tuan Deli Serdang district, North Sumatra, Indonesia. The experiment was laid down on a randomized block design with two factors factorial arrangement (8 Variety Levels and 4 KH_2PO_4 levels) and three replicates. Levels of KH_2PO_4 applied exogenously as a foliar spray at the vegetative stage of Rice were 0, 50, 100 and 150 mg/L.

3 RESULTS AND DISCUSSIONS

Analysis of variance indicated that foliar application of Potassium Phosphate significantly was affected N uptake, P uptake, K uptake and Na uptake. Nutrient uptake of eight varieties of rice under salt stress by Foliar Application of Potassium Phosphate was showed in Table 1. Based on Table 1, it was shown that application of Potassium Phosphate fertilizer through leaf significantly affected the N uptake and P uptake but not significant in K Uptake and Na uptake. Although base on statistical analyses, application of Potassium Phosphate fertilizer through leaf was not significantly affected K uptake, Na uptake, but there was an increasing trend when compared with application of Potassium Phosphate fertilizer through roots. P and K nutrients in saline soils were more available to plants when applied through leaves. P and K nutrients were essential nutrients needed in large quantities. The presence of salinity stress makes the nutrient unavailable and plant growth disturbed, therefore leaf application of potassium phosphate will increase plant growth. Nutrient uptake was affected by salinity. Nutrient uptake of eight varieties of rice under NaCl stress was showed in Table 1. Base on Table 1, N uptake and P uptake of eight rice varieties on NaCl stress was significantly increasing by KH_2PO_4 foliar application. Although was not significant on K and Na uptake but there was a trend that K uptake was increasing by KH_2PO_4 foliar application but Na uptake was decreasing. the results of this study were in line with what has been reported by Kaya *et.al*. (2011) that supplementary KH_2PO_4 can partly mitigate the adverse effects of high salinity on both fruit yield and whole plant biomass in pepper and cucumber plants. Application of KH_2PO_4 significantly was increasing N and P uptake. Kaya *et.al* (2001) was reported that Foliar KH_2PO_4 sprays ameliorated the negative effects of salinity on plant growth and fruit yield of pepper and cucumber. Water use by plants decreased with elevated NaCl and increased with foliar KH_2PO_4 sprays. According Kaya *et.al* (2011), membrane permeability increased with high NaCl and was reduced by KH_2PO_4 sprays. Sodium concentration in plant tissues increased in both cultivars in the high NaCl treatment. Concentrations of P and K were in the deficient range in plants grown at high NaCl and these deficiencies were corrected by foliar KH_2PO_4. The results of this study are also in line with what has been reported by Lacerda *et al.* (2003) reported that high levels of Na^+ inhibited the K^+ concentration in Sorghum plants. The results of present investigation are in agreement with the findings of many workers in different plant species (Cha-um *et al.*, 2010) who found that nutrients were absorbed by the leaves when applied onto the shoot.

***Table 1.** Nutrient Uptake of Eight Varieties of Rice Under NaCl Stress*

Variety	KH_2PO_4	N Uptake (meq/100mg)		P Uptake (meq/100mg)		K Uptake (meq/100mg)	Na Uptake (meq/100mg)
V_1	P_0	0,57	ijk	0,045	jkl	0,55	0,19
Ciherang	P_1	0,54	i-l	0,045	ijk	0,52	0,20
	P_2	0,51	k-n	0,047	hij	0,56	0,18
	P_3	0,60	hij	0,053	def	0,57	0,19
V_2	P_0	0,45	mn	0,033	p	0,35	0,26
IR 64	P_1	0,50	k-n	0,037	no	0,36	0,27
	P_2	0,52	j-m	0,041	lm	0,35	0,26
	P_3	0,57	ijk	0,043	klm	0,36	0,27
V_4	P_0	0,55	i-l	0,043	klm	0,39	0,20
Lambur	P_1	0,65	fgh	0,045	ijk	0,40	0,20
	P_2	0,66	e-h	0,047	hijk	0,40	0,19
	P_3	0,68	d-g	0,052	defg	0,38	0,20
V_5	P_0	0,69	d-g	0,050	fgh	0,51	0,15
Batanghari	P_1	0,73	b-f	0,051	efgh	0,53	0,15
	P_2	0,74	b-e	0,055	de	0,54	0,15
	P_3	0,79	b	0,059	bc	0,55	0,15
V_6	P_0	0,75	bcd	0,055	cd	0,58	0,15
Banyuasin	P_1	0,77	bc	0,055	cd	0,59	0,09
	P_2	0,80	ab	0,059	b	0,59	0,09
	P_3	0,88	a	0,065	a	0,60	0,09
V_8	P_0	0,44	n	0,036	op	0,44	0,20
IR 42	P_1	0,49	lmn	0,039	mn	0,44	0,19
	P_2	0,50	k-n	0,044	jkl	0,45	0,19
	P_3	0,56	i-l	0,045	jkl	0,45	0,19
V_9	P_0	0,53	jkl	0,046	ijk	0,43	0,15
Inpara 10	P_1	0,66	e-h	0,047	hij	0,43	0,15
	P_2	0,68	d-g	0,049	fghi	0,43	0,15
	P_3	0,73	b-e	0,055	de	0,43	0,15
V_{10}	P_0	0,55	i-l	0,046	ijk	0,43	0,15
Margasari	P_1	0,62	ghi	0,046	ijk	0,43	0,14
	P_2	0,71	c-f	0,049	ghi	0,43	0,14
	P_3	0,71	c-f	0,053	defg	0,43	0,14

Description : The Number Followed by The Same letter in the column The same is not significant at the 5% level by the Duncan Distance Test

Treated leaves contained higher element concentration compared to non sprayed plants even under saline condition. In present investigation salt stressed resulted an increase in Cl^- concentration, about 72% increase was recorded in leaves of both the plants at the highest salinity level (i.e. EC : 9.9 dS/m) in comparison with their non saline control and a decrease of NO^{3-} concentration in leaves of both sunflower and safflower plants.

4 CONCLUSION
Application of Potassium Phosphate fertilizer through leaves affected the nutrient uptake of some varieties of rice were N uptake, P uptake, K uptake and Na uptake. The most adaptive variety was Banyuasin and the most optimum concentration of Potassium Phosphate fertilizer which contribute to physiological character increase was 150 mg/l.

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