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Response Macronutrient Content of Saline-Resistant Paddy to the Saline Source Distance

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ABSTRACT

The impact of salinity on paddy production in Indonesia was pronounced with an average decline of 6.83% (2015-2019). Salinity interferes with macronutrient absorption into plants, causing stunted growth (salinity contributed to a 42% decrease in paddy production). One solution to solve the salinity problem in paddy is to use saline-resistant varieties. However, very few studies on macronutrient content analysis in resistant varieties responded to the salinity source's distance. Therefore, this research was conducted in the Jabon sub-district, Sidoarjo district, East Java, Indonesia, which aimed to study the macronutrient and plant growth responses to the saline source's distance. This research used two transects with a length of 2 km and 3.4 km, respectively. The distance between the research location and the salinity source was 10.65 km. The survey used a free grid to adjust the paddy field's location and the presence of resistant varieties. The results showed that the closer to the salinity source, the salinity indicators consisting of electrical conductivity, sodium adsorption ratio, exchangeable sodium percentage, and pH (H_2O) would increase. The increase in salinity then decreased macronutrients (N, P, and K) in plants. However, tillers and leaves (length and number) were unaffected by high salinity levels in the soil.

Keywords: Macronutrient, paddy varieties, saline-resistant, salinity

INTRODUCTION

Salinity is a soil condition with dissolved salts accumulation on the soil surface, affecting agricultural production, biodiversity, and sustainable development. Saline soil is usually located on dry and semi-dry land, can be caused by evaporation, an intrusion of seawater, and its parent material (Gopalakrishnan and Kumar 2020). Saline soil is generally found in fluvio-marine and marine landforms and topographically tend to have a sloping slope (Hasmunir 2017). The formation process causes high salt deposits in the marine landform and fluvial-marine. Marine landform comes from seawater activities (Dewadaru and Saputro 2014) and the fluvio-marine landform is formed due to seawater activities and river activities (Wulan *et al*. 2016).

Saline soils are different from sodic and saline-sodic soils. Saline soils have pH < 8.5 with electrical conductivity (EC)> 4 $dS.m^{-1}$, exchangeable sodium percentage (ESP)< 15% and sodium adsorption ratio (SAR)< 13. While sodic soils have EC <4 dSm^{-1}, ESP> 15%, and pH> 8.5. While, saline-sodic soils have EC > 4 dSm^{-1}, ESP > 15%, pH> 8.5. Plant tolerance to salinity is very diverse. The level of salinity based on the EC can be divided into: non-saline (0 – 2 dSm^{-1}), low (2 – 4 dSm^{-1}), medium (4 – 8 dSm^{-1}), high (8 – 16 dSm^{-1}), and very high (>16 dSm^{-1}) (Follett *et al*. 1981; Sipayung 2003). High salinity levels increase the osmotic pressure and ionic toxicity while decreasing nutrient uptake (N, Ca, K, P, Fe, Zn) and cause oxidative stress (Shrivastava and Kumar 2015). The decrease in nutrient uptake resulted from a decrease in tillers, root length, plant height, shoot dry weight, roots, and whole plants. Salinity also affects photosynthesis, primarily through the reduction of leaf area, chlorophyll content, and stomatal conductance (Netondo *et al*. 2004; Shrivastava and Kumar 2015). This condition can reduce paddy productivity (Sitorus 2012).

The most commonly cultivated crop in saline soil was paddy. Paddy can adapt to almost any environment from lowland to highland, from tropical to subtropical, from wetland (swamp) to dry land, from fertile area to marginal area (salinity stress, high metal content, organic acids, drought). In Indonesia, paddy cultivation is carried out in various lands, including wetlands in lowland paddy fields, dry land, upland paddy fields, and peatlands (Utama 2015). Salinity can affect a plant's morphology, physiology, growth, and productivity (Akbarimoghaddam *et al.* 2011; Shrivastava and Kumar 2015).

Indonesia is the world's third-largest paddy producer after China and India (World Agricultural Production 2020). In 2019, Indonesia's paddy production reached 54.60 million tons with a planted area of 10.68 million ha (Central Statistics Agency 2020). Ironically, this production has grown significantly in the last five years (2015-2019) is -6.83% (Kementan 2019). Salinity contributes around 42% of the decline in national paddy production (Ahmed and Haider 2014).

One of the efforts to overcome the decline in paddy production due to salinity stress is by using saline-resistant varieties. Saline-resistant paddy varieties' growth is not disturbed on saline soil (Jalil *et al.* 2016). As a result, saline-resistant paddy varieties have grown and yielded more significantly than saline-sensitive paddy varieties (Habibi 2018). Therefore, it is crucial to study how nutrient content responds in resistant varieties to distance from the source of salinity. This analysis is essential given that the closer to the salinity source, the salinity indicator will also increase. In this study, researchers aimed to determine the response of saline-resistant varieties of paddy to salinity levels based on the distance of saline sources. This research is expected to support the government's food security program (NAWACITA) and Sustainable Development Goals.

MATERIALS AND METHODS

Research Location

The research activity was carried out in paddy fields in Jabon District, Sidoarjo Regency, East Java which is located in the lowlands, with coordinates of 112° 70'36 .17 "- 112° 87'33.13" East Longitude and 7° 49' 40.01" - 7° 57'83.45" South Latitude (Figure 1). Jabon District is located in a lowland coastal area consisting of two alluvial and marine landscapes. Alluvial landforms with alluvial plains and marine sub-landforms with tidal plains sub-landforms. The topography is influenced by fluvio-marine sediments and alluvium material (Marsoedi *et al.* 1997). Types of soil owned are Typic Endoaquents, Typic Fluvaquents, Typic Hydraquents, and Typic Endoaquents (Soil Survey Staff 2014). The paddy field's total area was 1,883.86 ha, or 23.05% (of the total area from the Jabon sub-district).

The research location was determined based on the initial salinity analysis with the EC value of

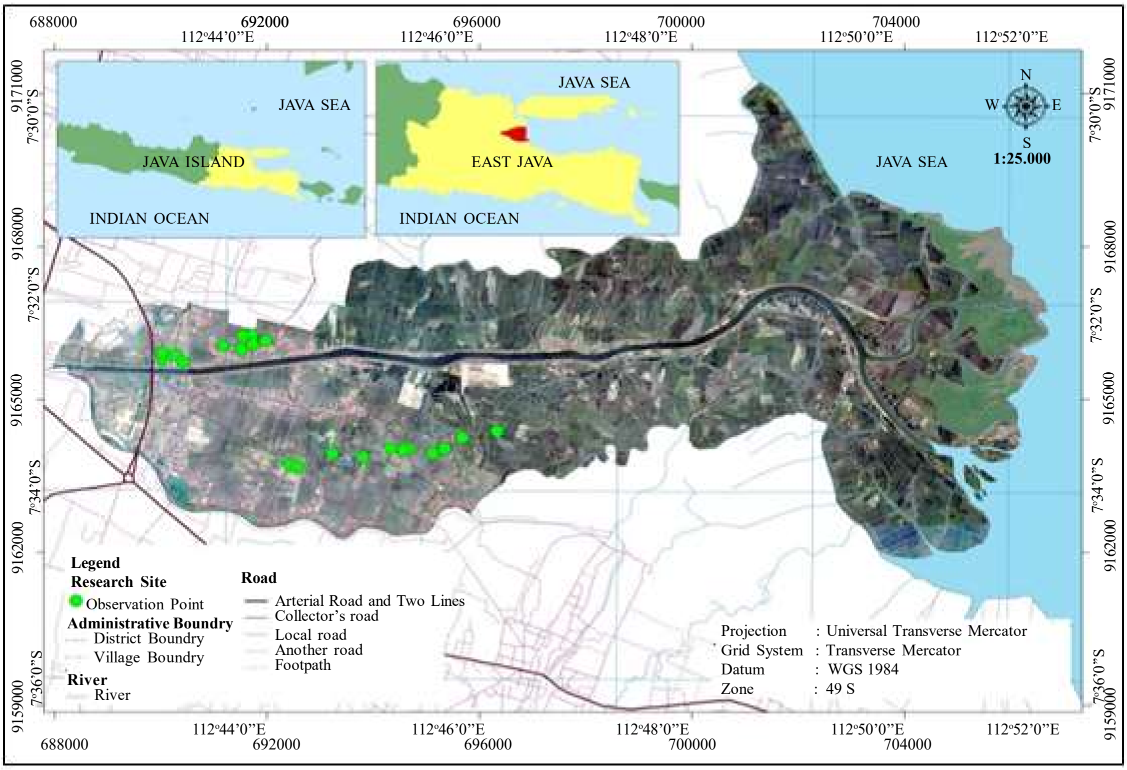

Figure 1. Distribution of research observation points (modification from Putra 2021)

9.6 dSm^{-1} and Na-ex was 1.8 cmol kg^{-1}. This research was located on two transects, the transect one length was ±2 km with the observation point interval 316-814 m, and transect two was ±3.4 km with the observation point interval distance of 104-718 m. Each transect has ten observation points. The distance between the research location and the salinity source was 10.65 km and determined by the free grid (Rayes 2007). The distance between the saline source and observation point uses the ArcGIS 10.3 application with the line measurement tools. The paddy crops in the research area are saline-resistant varieties that have been registered in the Agency for Agricultural Research and Development.

Soil and Plant Sampling

Soil and plant samples were taken at each observation point at different distances from the saline source and composite sampling (Pennock and Yates 2006). The sampling of paddy plants was carried out by taking part in the leaves (Setiawan and Herdianto 2018). Soil samples taken were the layer of paddy root areas, taken from a depth of 0-20 cm (Vadas *et al*. 2006).

Soil and Plant Analysis

Biomass macronutrient analysis was conducted by Nitrogen (Total-N) (Bremner and Mulvaney 1982), Phosphorus (Total-P) (Bray and Kurtz, 1945), Potassium (Total-K) (AOAC 2002). Soil salinity analyses are divided into ESP (Gupta and Sharma 1990), pH H_2O (Amran *et al*. 2015), EC (Rhoades *et al*. 1989), and SAR (Robbins 1984).

Statistical Analysis

Statistical analysis was carried out by data normality test, correlation test, and regression test. The normality test was carried out by Genstat 10.4 with the Shapiro-Wilk method (Royston 1992) to determine data distribution. The average data (> 0.05) will be continued to the correlation test with R software. The correlation coefficient (r) was compared to the r-table. A regression test is then followed by correlating data (Putra and Nita 2020).

RESULTS AND DISCUSSION

Soil Salinity, Macronutrients, and Plant Growth Indicator Analysis

The analysis results show that all salinity indicators fall into the criteria for saline soil. The EC value ranges from 7.35 to 8dS m^{-1}, where the closer to the source of salinity, the value increases. pH H_2O also has the same trend as EC, with a value range of 5.59 to 5.83. The range of ESP values fluctuates concerning the copy source's distance, while the SAR ranges from 0.26 to 0.53 (the value gets higher when it approaches the salinity source) (Table 1).

The number of tillers, length, and the number of leaves of paddy plants in the saline area was found that at the farthest distance of 13.5 km from the salinity source, the number of tillers was 45.7, the length of the crops was 96.7 cm, and the number of leaves was 209.5. Whereas at the closest distance of 10.3 km from the salinity source, the number of tillers value was 25.5, the length of the plant was 80.9 cm, and the number of leaves was 87.8. The distance that has the highest number of tillers was 13.5 km at 45.7, and the lowest was at 10.3 km at 25.5. While, the highest plant length was 10.64 cm at 102.8 cm, and the lowest was at 13.2 km at 57.8 cm. Moreover, the highest number of leaves was 13.5 km at 209.5, and the lowest was 13.2 km at 79.5. The differences in crop age and paddy varieties affected the yields. The varieties used at all observation points were Ciherang, Inpari 32, and Inpari 42 varieties, where the varieties were different for each observation point. In terms of plant age, according to the statement by Banyo *et al*. (2013) that, in the vegetative phase, plants with a longer planting age caused a higher chlorophyll concentration than plants with a faster vegetative phase. According to Pratama and Nikmati (2015), plant age affects chlorophyll's value in leaves. Research by Mardiansyah (2018) stated that the Ciherang variety has moderate salinity tolerant characters. The Inpari 32 variety is an inbred variety from the selection results of the Ciherang variety, and Inpari 42 is a salinity tolerant variety (Agricultural Research and Development Agency 2019). Moreover, Irman *et al*. (2017) mentioned the salinity did not affect plant chlorophyll levels.

The closer the distance to the saline source was, the value of N, P, and K in the biomass decreased. For example, the soil N value at 13.5 km farthest from the salinity source was 0.45%, P was 28.43 mg 100 g^{-1}, and K was 41.7 mg 100 g^{-1}. Whereas at the distance of 10.3 km closest to the salinity source, N values were 0.3%, P was 18.46 mg 100g^{-1}, and K was 31.63 mg 100g^{-1}. Thus, saline soil affects the availability of nutrients in the biomass (Soussi 1998).

Salinity Indicator Content Analysis Based on Salinity Source Distance

The salinity indicators consisting of EC, pH H_2O, ESP, and SAR all show an increase in each indicator's value when the distance to the source of

Table 1. The analysis results of Salinity, Macronutrient, and Plant Growth Indicator.

Distance (km)	Salinity Indicator (Putra 2021)				Tillers	Leaves		N	P	K
	EC (dS m^{-1})	pH H_2O	ESP (%)	SAR		Length (cm)	Amount	-- % --		
13.40	7.35	5.59	7.38	0.26	35.30	96.80	127.60	1.39	0.59	5.11
12.90	7.39	5.64	8.34	0.31	27.10	67.20	103.40	1.31	0.48	3.97
13.20	7.54	5.62	8.99	0.35	28.20	57.80	79.50	1.31	0.48	4.04
13.00	7.65	5.69	10.73	0.48	32.70	64.80	106.00	1.34	0.53	4.49
12.00	7.58	5.72	9.72	0.40	34.10	64.90	125.20	1.33	0.51	4.31
11.69	7.72	5.65	11.05	0.53	25.90	79.70	114.50	1.26	0.41	3.30
11.46	7.61	5.74	9.59	0.41	34.70	86.75	158.80	1.30	0.47	3.87
11.61	7.75	5.82	11.04	0.55	34.50	92.70	148.00	1.27	0.42	3.45
11.43	7.65	5.90	9.80	0.45	37.50	88.70	123.80	1.26	0.42	3.41
11.20	7.84	5.94	10.14	0.51	38.10	85.30	174.20	1.24	0.38	3.06
13.50	7.40	5.52	6.30	0.22	45.70	96.70	209.50	1.38	0.58	4.97
13.43	7.45	5.54	7.34	0.28	30.10	67.50	163.10	1.36	0.55	4.73
12.76	7.62	5.62	8.05	0.33	32.50	72.90	115.80	1.37	0.57	4.84
12.19	7.73	5.70	9.93	0.44	42.30	101.60	175.50	1.29	0.46	3.79
11.65	7.65	5.76	9.87	0.42	32.70	82.80	121.50	1.32	0.50	4.17
11.42	7.79	5.59	11.13	0.55	29.00	92.50	116.40	1.28	0.44	3.62
11.31	7.68	5.64	9.74	0.43	26.10	85.10	102.30	1.29	0.45	3.74
10.87	7.83	5.70	11.13	0.57	39.10	91.60	137.10	1.26	0.41	3.30
10.64	7.73	5.80	9.94	0.47	35.00	102.80	156.90	1.27	0.42	3.42
10.30	7.92	5.83	10.25	0.53	25.50	80.90	87.80	1.25	0.39	3.15

the saline gets closer (Figure 2). The EC value at all observation points increased about 7.4 dSm^{-1} at a distance of 13.5 km and 7.9 dSm^{-1} at 10.5 km. The same increasing pattern also occurred in pH H_2O and SAR. Soil pH H_2O increased from about 5.5 to almost 6.0 as the closest distance from the saline source. Other indicators, namely SAR, increased from 0.2% to 0.6%, and ESP increased from 6 to around 10. The EC had a normality test value of 0.63dS m^{-1} when the pH H_2O was 0.73. ESP and SAR have a normality test value of 0.25% and 0.3, respectively. All parameters data can be expected because the values are more than 0.05. The correlation test showed that all parameters of the saline indicator were correlated with the distance of the saline source. Electrical conductivity has the highest correlation with -0.83, followed by SAR, ESP, and pH H_2O to distance (r-table was 0.36).

The regression analysis showed that the salinity distance influenced the soil salinity indicator. Electrical conductivity has the highest coefficient determination (R^2) for about 0.73, and the other factors were less than 0.7. According to Kolinug (2014), the closest land to the sea has a higher salinity value because seawater supply is more in areas directly adjacent to the sea.

Nitrogen, Phosphorus, and Potassium Biomass Content

Macronutrient (Total-N, Total-P, and Total-K) content decreased when the salinity source's distance is further away (Figure 3). The Total-N value in all observation points decreased from about 1.38% at a distance of 13.5 km to 1.25% at 10.5 km. The same pattern also occurred in Total-P and Total-K. Phosphorus decreased from about 0.58% to 0.39% when the saline source's distance got closer. Other indicators, K, decreased from 4.97% to 3.15% at the same distance. The data were normally distributed with N, P, and K's respective values of 0.34, 0.60, and 0.60 (more than the p-value (0,05)). The regression analysis between the macronutrients (N, P, and K) and the saline source show the N, P, K contents were getting lower when approaching the salinity source.

The low macronutrient contents were due to the low level of saline soil fertility and nutrient deficiencies elements (Dewi and Setiawati 2018).

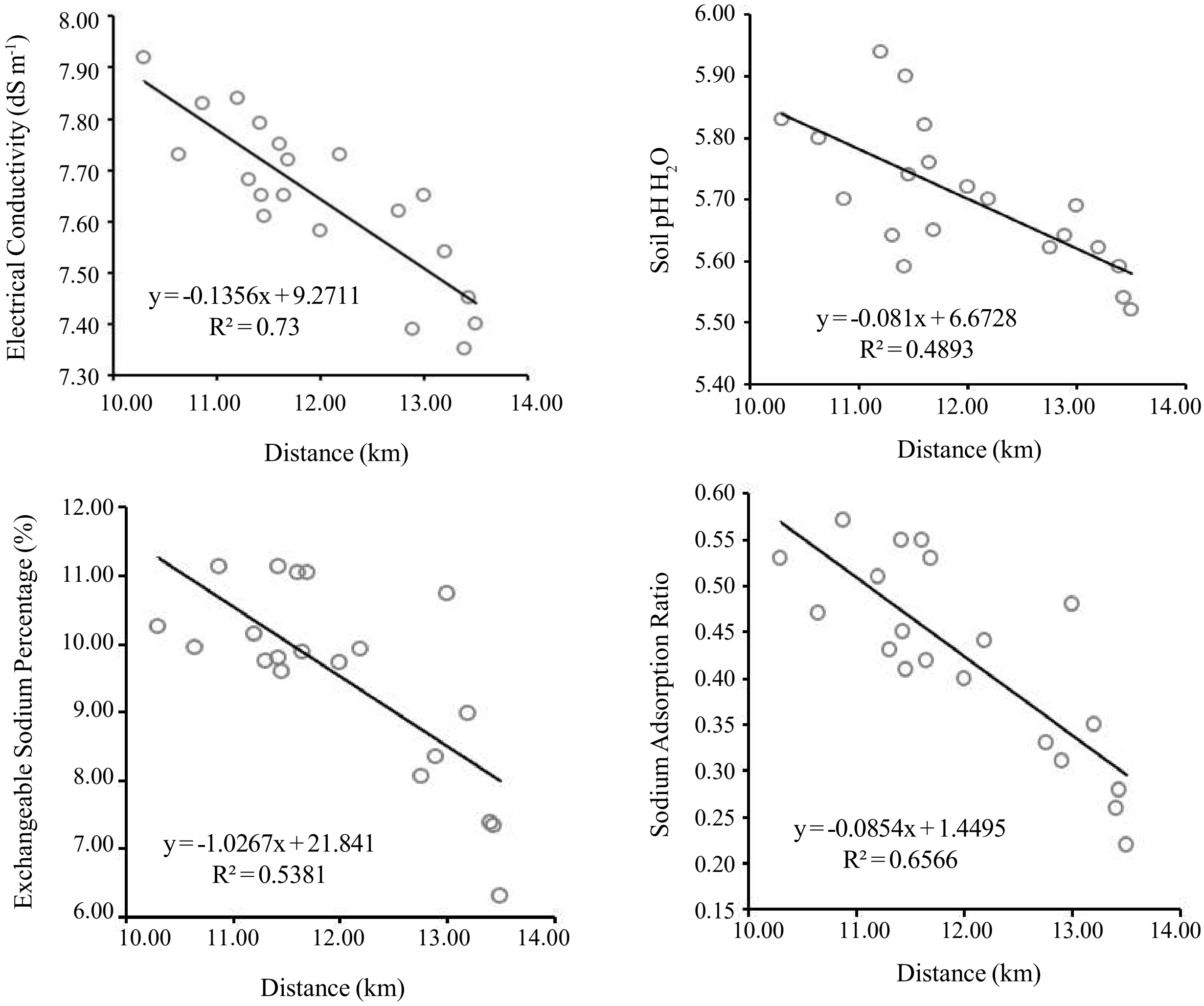

Figure 2. A correlation analysis show the increasing value of the salinity Indicators with the closer salinity source.

A large number of Na ions in the soil causes a decrease in the Ca-exc, Mg-exc, and K-exc ions (Muliawan *et al*. 2016). In addition, saline soil contains high salt, which causes the absorption of nutrients and water into the plants to be inhibited (Nasrudin and Kurniasih 2018). Research Kolinug (2014), the closest land to the sea has a higher salinity value because the supply of seawater is more in areas directly adjacent to the coast.

Salinity Effect on the Macronutrient Content

In general, all macronutrients have a close relationship with electrical conductivity. This result was illustrated from the adjacent data distribution on the line with a negative y value. The relationship between EC and $_{Total}$-N in the form of linear lines is y = -0.2361x + 3.1089 (R^2 = 0.67). The $_{Total}$-P content in the soil and EC also has a close relationship and negative correlation. Intended with the values y = -0.335x + 3.0337 and R^2 = 0.6603. The relationship indicates that the higher the EC, the soil's P content will decrease (Figure 4).

The value of K content also negatively affects EC, meaning that it is inversely proportional. This is indicated by the value y= -3.2652x + 28.896 and R^2 = 0.66. Electrical conductivity is the ability to conduct electrical currents affected by dissolved salts that can be ionized. Electrical conductivity is affected by ions, valence, and concentration. Electrical conductivity is related to the movement of ions. The easier the ions move, the larger the EC (Muliawan *et al*. 2016). According to (Sipayung 2003), plants can be disturbed by the EC value of more than 2 mmhos. The higher the EC value, the more disturbed the plant growth. Some problems are caused, so soil copy is rarely used for plant cultivation, including low osmotic pressure. The adverse influence of salinity on plants is related to the high osmotic pressure of water, an imbalance between ions Na, K, Ca, Mg related to decreased

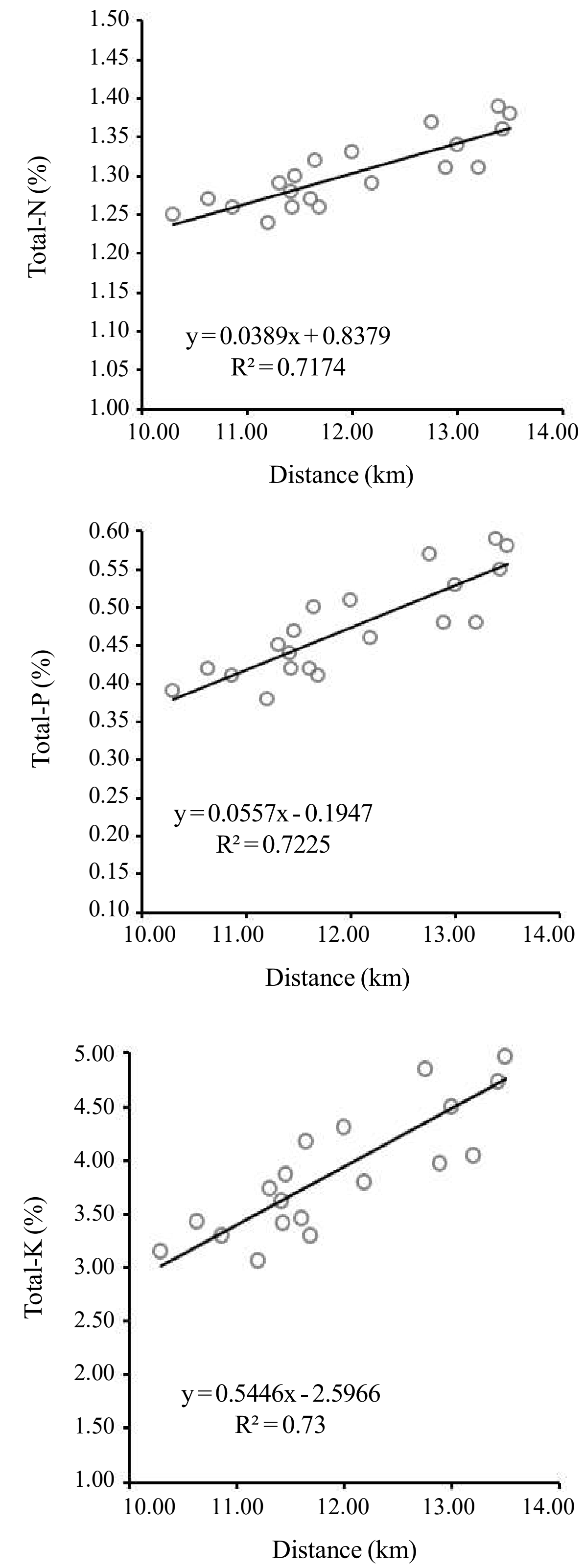

Figure 3. A correlation between Macronutrient content (a) Total-N (%), (b) Total-P (%), (c) Total-K (%), and the distance from the salinity source.

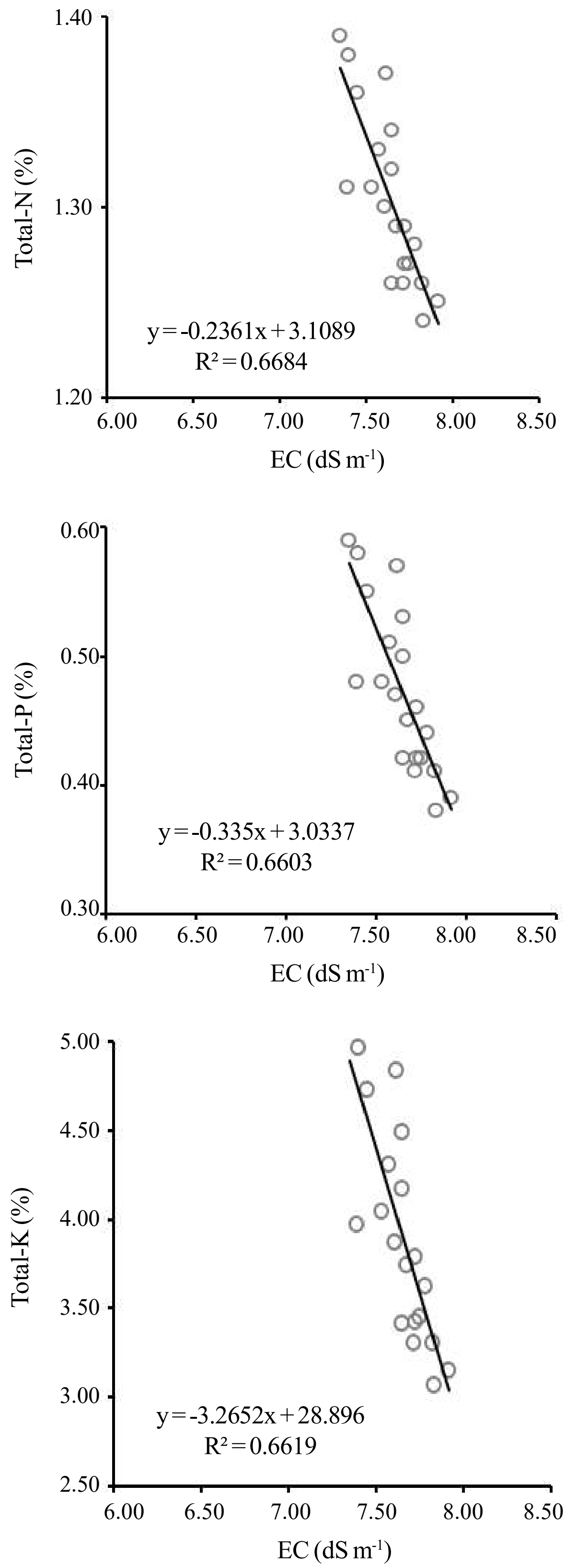

Figure 4. A Regression Analysis between electrical conductivity (EC) and macronutrients

absorption of N and P. Concentrations of Na/Ca^2z or extreme Naz /Kz can interfere with the absorption of Ca and K ions (Wahyuningsih and Kristiono 2017).

Similarly, all macronutrients N, P, and K have a close relationship with inversely proportional with pH H_2O. For example, the relationship between pH H_2O and soil Total-N in linear lines was y = -0.2818x

+ 2.9101, with x is pH H_2O and y is soil Total-N (R^2 = 0.51) Figure 5.

Phosphorus total content value also has a negative effect with pH H_2O, meaning it is inversely proportional. This is indicated by the values y= -0.396x + 2.7306 and R^2 = 0.49. If pH H_2O has a higher value, then total-P will decrease. The content

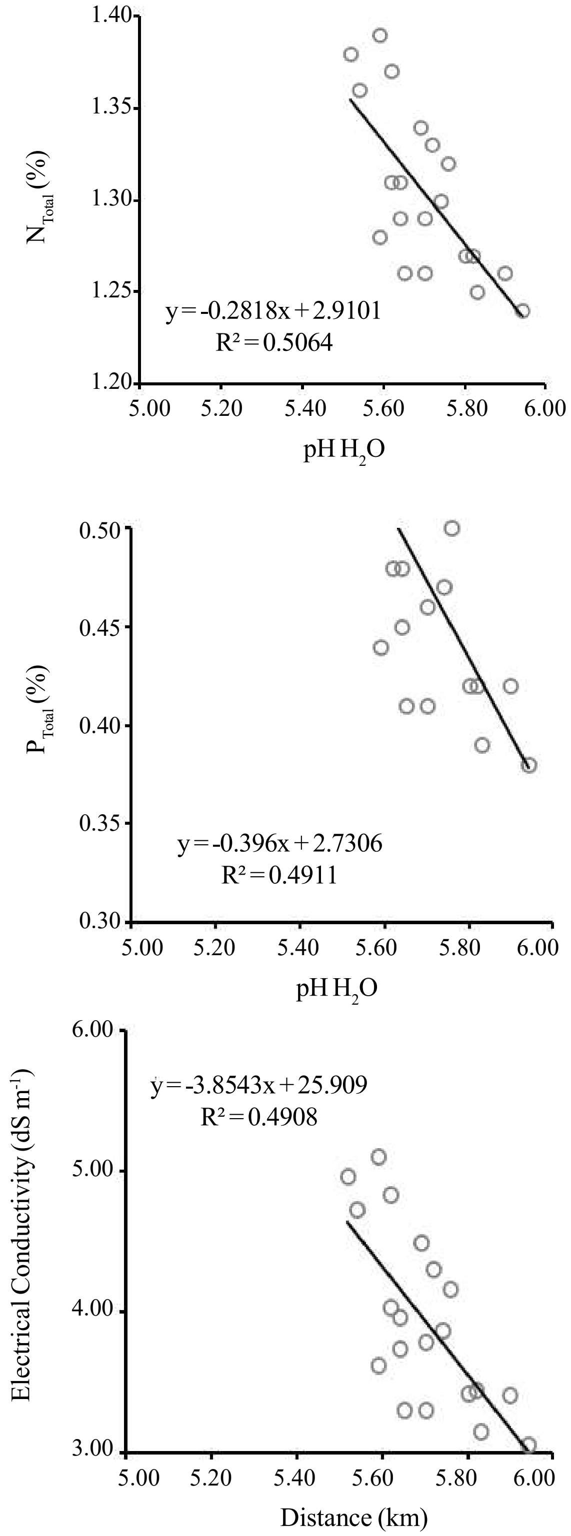

Figure 5. A regression analysis between pH H_2O and macronutrients.

of K in the soil and pH H_2O also has a closely related but inversely proportional. Intended with the values y = -3.8543x + 25, 909 and R^2 = 0.49 with 'X was pH H_2O, and 'y' was total-K.

The influence of water sources containing high salts causes a pH increase (Awatt Project 2009). Soil pH is related to the availability of nutrients in the soil. Soil pH is low (acidic), the soil is dominated by positive content, while the soil pH is high (alkaline soil), the soil is dominated by negative content. The high salt content in saline soil causes soil structure damage, so its aeration and permeability become very low. In addition, a large number of Na ions in the soil causes reduced ions of Ca, Mg, and K that can be exchanged so that the availability of nutrients for plants decreases (Hardjowigeno 2010).

The relationship between ESP and all macronutrients N, P, and K is closely related but negative. The correlation between ESP and the Total-N content value in the soil is indicated by the value y= -0.026x + 1.5518 and R^2 = 0.6307 with x was ESP and y is Total-N.

The relationship between ESP and total-P in the ground is a linear line with y = - 0.0365x + 0.8208 where x is ESP and y is Total-P (R^2 = 0.61). The linkage shows a negative tendency that the higher ESP makes Total-P has a lower value. The soil Total-K content in the soil and ESP also has a closely related but inversely proportional. Indicated by the value y = -0.3573x + 7.3398 and R^2 = 0.6157 (Figure 6).

The exchangeable sodium percentage is a Na-ex salt percentage. Exchangeable sodium percentage is formulated as the Na rate of Cation Exchange Capacity x 100% (Awatt Project 2009). However, there are also direct effects of ESP on soil solution chemistry, a necessary result of the chemical equilibrium developed between the exchangeable and solution ions. One explanation is that low plant P and K concentrations result from poor soil structure, which impedes root growth, increases waterlogging, and restricts access to soil water and nutrients. An alternative explanation is that P and K uptake are directly affected by the chemical composition of the soil solution that is developed in response to the high ESP, for example, by competition between ions for uptake (Dodd *et al*. 2010).

All macronutrient Total-N, Total-P, and Total-K have a close relationship with SAR but inversely proportional (Figure 7). The relationship between SAR and N total land in linear lines is y = -0.3693x + 1.4608, with x is SAR and y is Total-N and (R^2 = 0.72). The relationship shows a negative tendency that the higher the SAR, the Total-N will be decreased.

The sodium adsorption ratio is the ratio between the levels of Na to the amount of Ca and Mg, expressed in $SAR = [Na^+]/([Ca^{2+}+Mg^{2+}/2]^{1/2}$ (Awatt Project 2009). Robbins (1984) concluded that higher K was held in the soil while Na leached down, reducing SAR and ESP. Potassium competes with other cations such as Ca and Mg for retention on soil exchange sites, and high K levels may lead to increased leaching of Na and associated anions such as SO_4^- and Cl^-. A slight increase in Ca was observed

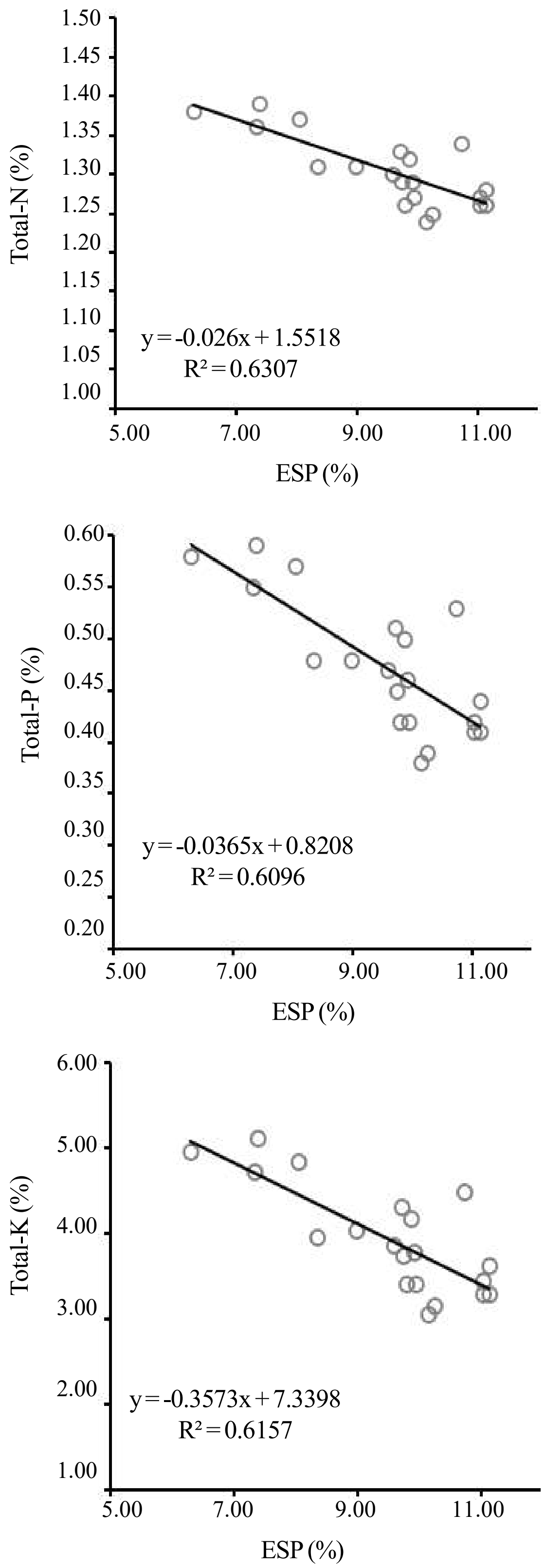

Figure 6. A regression analysis between ESP and macronutrients.

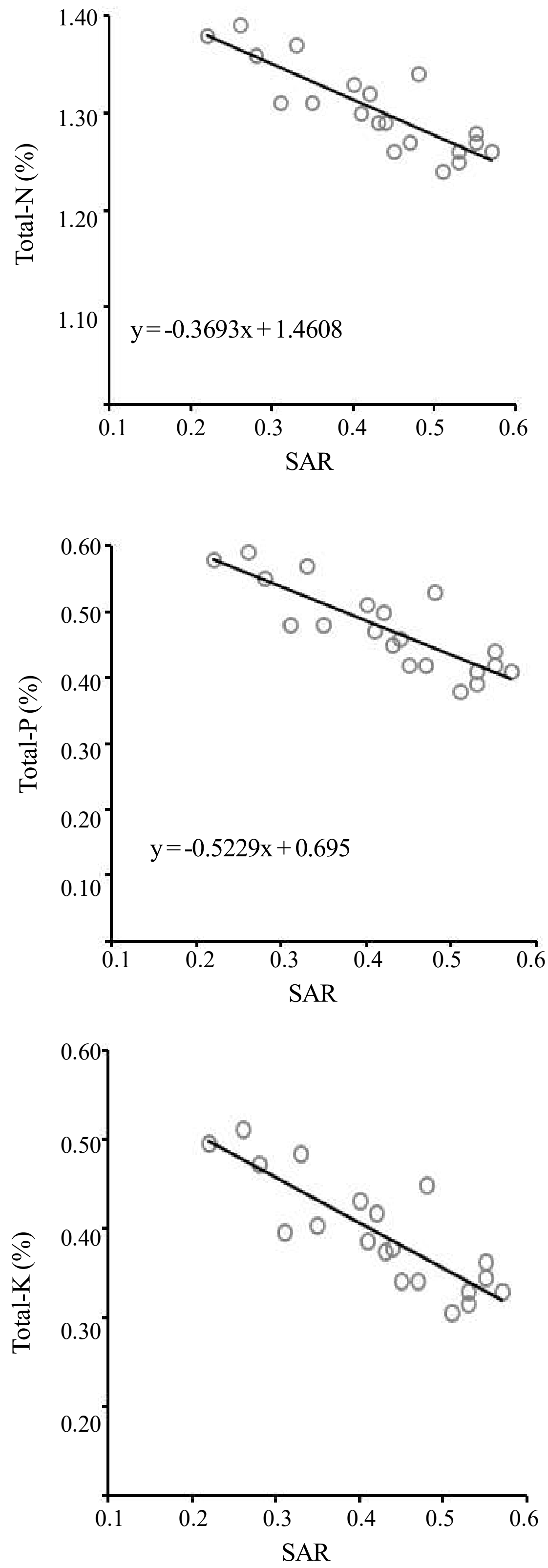

Figure 7. A regression analysis between SAR and macronutrients.

with K under both irrigations. Hence, the Ca: K ratio slightly decreased with K and increased with P. The leaching of Mg increased with P and K treatments alone or combined with saline irrigation. The Ca and Mg in leachates suggested that K application resulted in more Ca than Mg leaching (Morton *et al*. 2004). The Na, Ca and Mg were responsible for the variations in SAR of the leachates. Also, saline water in saline-sodic soil increased soil SAR due to Na's leaching from surface layers (Akhtar *et al*. 2003).

DISCUSSION

Soil salinity variability is influenced by the influence of the source of soil salinity, namely seawater in coastal areas. Thus, the observation points from the farthest distance to the closest to the salinity source illustrate the variability of low to high salinity. The landform in Jabon District is fluvio-marine, formed by a mixture of river sediment (alluvium) and sea sediment (marine), which was previously an ocean that has become land area still contains salt deposits in the lower underground. The area near the coast is still affected by tides. Thus the salt content in the area is higher than in areas further from the coast. Marwanto, Rachman, and Erfandi (2009) explain that the closer to the saline source (beach), the more salinity increases. Increased salinity in paddy fields occurs near the coast or paddy fields with water channels directly connected to seawater. The increase in salt concentration in the soil is an environmental stress factor that many rice fields suffer, especially those close to the coast (Rachman *et al*. 2018).

Salinity significantly affects the N, P, and K contents. The higher the salinity value, the lower the plant N, P, and K values. This result was due to the growing substrate's reduced water potential (growing media) and the increased absorption of Na, Cl, or both. In addition, high salinity levels (the number of Na ions) cause a reduction in the Ca-exc, Mg-exc, and K-exc ions, which means a decrease in soil nutrients uptake (Suhartini and Zulchi 2018).

Saline soil affects the absorption of N, P, and K nutrients in plants. The specific effect of soil saline on plant metabolism, especially on leaf aging, is associated with the accumulation of toxic Na^+ and Cl^- ions and decreased K^+. Salinity associated with excess NaCl affects plant growth and yield by suppressing water and mineral absorption and normal metabolism (Al-Karaki 2000).

According to (Sipayung 2003), salinity inhibits the growth of roots, stems, and leaf area, and there is a metabolic imbalance caused by ionic poisoning (Na^+) and nutrient deficiency (N, P, and K). The P concentration in agronomic plants grown in the field decreases with increasing salinity. Salinity decreases the P concentration in plant tissue; elsewhere, salinity increases P or does not affect it. It is not surprising that differences between studies occur because P concentrations vary widely in different experiments, and other nutrient interactions can coincide (Grattan and Grieve1999). Several studies have shown that the concentration of K^+ in plant tissue decreases with the increasing salinity of NaCl. The reduction of K^+ uptake in plants by Na^+ is a competitive process. Salinity decreases the K^+ accumulation in leaves (Machanda and Garg 2008). The destructive effect of salinity on plants is related to the high osmotic pressure of water, an imbalance between Na and K, Ca, Mg ions, and the N and P uptake.

Salinity increases as the land become closer to the source of salinity. This increase has an effect on barriers to nutrient uptake by plants. Increased salinity in paddy fields occurs near the coast or paddy fields with water channels directly connected to seawater. The higher the NaCl concentration in the soil, the higher the osmotic pressure and the soil's EC (Sipayung 2003). The harmful effects of high-salt water affect plant height, fresh weight, and leaf area. In addition, the absorption of saltwater by plant roots can cause a decrease in water content in plant tissues, which will affect metabolic processes in cells (Salama *et al*. 2012).

The number of leaves, the number of tillers, and leaf length have a normality test at a rate of 0.61, 0.60, 0.51, and 0.46. The correlation between paddy performance and the saline indicator is very low, and the r-value is smaller than the r-table. The value of the r-table is 0.4438. The correlation values (r-value) between tillers and salinity indicators (pH H_2O, EC, ESP, SAR) are only 0.13, -0.08, -0.20, -0.14, respectively. The correlation values between the length of leaves and salinity indicator are only 0.21, 0.27, 0.13, 0.24, respectively. The correlation values between amounts of leaves and salinity indicator are only 0.01, -0.12, -0.31, -0.20, respectively. So, it can be interpreted that the saline indicator does not influence paddy performance. The paddy's growth performance (tiller, leaves amount, and leaves length) was stuck because of the paddy plant's lack of macronutrients. Macronutrients as an intake will be distributed to other organs like a stem, tiller, leaves, and others. Nitrogen is the essential intake for accelerating the paddy plant's growth (Leghari *et al*. 2016). However, the result was the opposite because various paddy plant varieties were resistant to salinity, such as Ciherang, Inpari 32, and Inpari 42. It can override the impact of salinity that degrade the macronutrient of paddy plants. Moreover, this condition is supported by the research of Jalil *et al*. (2016). Salinity had no significant effect on the number of leaves, plant length, and tillers' number on salinity-resistant varieties.

The closest distance of saline source increases the salinity that affects the macronutrient degradation of plants, and the opposite does. However, in this research, distance from the saline source has no impact on tillers. The correlation value is shallow, only 0.12; it is smaller than the r-table. So, the saline source does not have an impact on the tillers of the paddy plant. Although salinity impacts macronutrients like N were lacked, according to Leghari *et al*. (2016), it will degrade the plant's growth performance, just like the tillers. Then it will not be applicable if the paddy plant was resistant to variety. The variety used in this research are Ciherang, Inpari 32, and Inpari 42, all of them, based on Suhartini and Zulchi (2018) statement, are resistant varieties in salinity conditions. Therefore, salinity has no impact on the tiller because of resistant variety.

In this study, the results showed that plant performance was not affected by salinity levels. This result was evidenced by the correlation between plant performance and the salinity indicator, which has a low value. The use of saline-resistant varieties means that plant performance is not affected by differences in salinity levels. So, it can be said that the use of saline-resistant varieties is efficient in overcoming salinity problems. Therefore, the use of tolerant varieties is the most effective way to exploit the potential of saline soil to increase national paddy production (Jalil *et al*. 2016).

According to Firmansyah *et al*. (2016), saline-resistant paddy plants have one or more prevention toxicity mechanisms. Adaptive paddy mechanism to salinity is synthesized secondary metabolites for osmotic adjustment—organic metabolite known as osmoregulators because of its characteristics. The osmotic adjustment refers to the accumulation of dissolved substances in cells as a plant response to decrease potential water. It can maintain osmotic potential and cell turgor pressure. So, this mechanism can maintain the rate of water and nutrient absorption in osmotic conditions. Moreover, plasmolysis in plant cells can be prevented, so organic metabolite is known as osmoprotectants.

CONCLUSIONS

The salinity distance affects the level of soil salinity in the Jabon sub-district, Sidoarjo District, which EC, pH H_2O, ESP, and SAR will increase when the salinity source's distance gets closer. The increase in salinity levels causes the plant biomass, macronutrient content (Total-N, Total-P, and Total-K) reduced. So, it can be explained that the saline source's distance affects the decrease in macronutrients. Although the macronutrient content decreased, the use of resistant varieties was proven to withstand salinity stress. In addition, tillers and leaves (length and number) were unaffected by high salinity levels in the soil.

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