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Influence of Nano-Silica on the Growth of Rice Plant (*Oryza sativa* L.)

[1]Amrullah, [2]Didy Sopandie, [2]Sugianta and [2]Ahmad Junaedi
[1]Perum BULOG, Jl. Gatot Subroto Kav. 49, Jakarta, 12950, Indonesia
[2]Program Study Agronomy and Horticulture, Graduate School of Bogor Agriculture Institute, Jl. Raya Dramaga, Bogor, Indonesia

Corresponding Author: Amrullah, Perum BULOG, Jl. Gatot Subroto Kav. 49, Jakarta, 12950, Indonesia

ABSTRACT

Rice is one of the most important food commodities in Indonesia because it is the staple food of most of the population. However, until now the rice crop productivity is low and has not fulfilled the overall needs. Therefore, efforts are needed to increase yields of rice plants. One effort to do this is by providing nutrient silica (Si) on rice cultivation. To reduce costs, given the element Si was isolated from rice husks are made in nano size. This study aims to know the influence of nutrient in the nano-size Si on the growth of rice plants. Treatments include: (1) The type and dose of fertilizer is fertilizer Ordinary Silica (OS) in the form of fertilizer SiP with normal particle size, concentration 0.9, 1.8, 2.7, 3.6 and 4.5 ppm and Nano-Silica (NS) concentration 0.09, 0.23, 0.45, 0.68 and 0.9 ppm and (2) Rice varieties, namely paddy rice IR 64, Ciherang and upland rice Situ Bagendit, Situ Patenggang. Based on the results of the study concluded that the granting of nano-silica treatment gives a better effect than ordinary silica fertilizer application (SiP) and controls at all observation variables such as plant height, root length, leaf length, canopy and root fresh weight and dry weight of canopy and root.

Key words: Rice, paddy, rice husk, nano silica, nutrient solution

INTRODUCTION

One of the nutrients that are currently hardly ever given or added to the soil in the cultivation of rice crops is an element of Si. During this time, the needs of the rice crop will be relying on the element availability in nature. According to Kyuma (2004), every harvest, the rice plants carrying Si between 100-300 kg ha^{-1}. The decrease in availaility of the land, thought to be the main cause of the stagnation of rice production in Java and other areas in Indonesia.

The role of nutrients on the growth and productivity of rice plants is very important. According to Go (1984), Si is an element that is most absorbed by the rice plants. The Si uptake by rice plants about 10 times the N, P 20 times, 6 times and 30 times the K, Ca besides as a stabilizer plant nutrients, Si is also known as a binder influence soil can reduce soil erosion.

However, the provision of Si on rice cultivation will add to the cost and should be sought alternative sources of Si are less costly. One potential source of Si is rice husk. Rice husk is used in a way taken it element Si. Furthermore, to further increase the availability and uptake of Si by the roots and leaves of plants as well as to improve the function and role of Si in rice made efforts to reduce the size of the binding element of Si particles into smaller sizes by using nano technology. The use of nano-sized (10^{-9} m) is expected to have advantages over the usual particle size of Si fertilizer. This is in accordance with the opinion of Ranjbar and Shams (2009) who stated that nano fertilizer is more readily absorbed by plants and more efficient than conventional chemical fertilizers.

This study aims to look at the effect of nanosilika on rice plant growth in nutrient culture media.

MATERIALS AND METHODS

Arranged in a factorial study with two treatments and three replications. The design environment used was split plot design in a randomized block design. The main plot is the type and dose of fertilizer is fertilizer Ordinary Silica (OS) in the form of fertilizer SiP with normal particle size, respectively 100, 200, 300, 400 and 500 kg ha^{-1} (0.9, 1.8, 2.7, 3.6 and 4.5 ppm) and Nano Silica (NS), respectively by 10, 25, 50, 75 and 100 kg ha^{-1} (0.09, 0.23, 0.45, 0.68 and 0.9 ppm) were mixed in Yoshida nutrient solution (Yoshida *et al.*, 1976) and the control treatment, so, of which there are eleven treatment dose. As a subplot is the rice paddy rice variety IR 64, Ciherang and upland rice varieties Situ Bagendit, Situ Patenggang.

Materials used nano silica powder obtained through the isolation process elements in rice husk silica using sol-gel method.

Pithy seed soaked with water for 24 h, then sowing. After the age of 7 days, the seedlings of plants with long roots and the same high cut endospermanya selected and then transferred to the nutrient solution media. Four seeds of each variety were grown in 7 L of nutrient solution were framed Styrofoam.

Variables measured included, plant height (cm), root length (cm), number of leaves ($plant^{-1}$), leaf length (cm $plant^{-1}$), canopy wet weight (g $plant^{-1}$), canopy dry weight (g $plant^{-1}$), root fresh weight (g $plant^{-1}$) and dry weight root (g $plant^{-1}$). Observations for all variables were performed when the plants 1 and 2 Weeks After Planting (WAP) in nutrient culture.

Statistical analysis: Data was analyzed with ANOVA 5% followed by Duncan's test.

RESULTS

Plant height, root length and leaf length: Results of ANOVA showed that the granting of silica treatment and varieties significant effect on plant height, root length and leaf length. As for the interaction between the silica and the granting of rice varieties showed a noticeable effect on the observation variables 2 WAP root length and leaf length.

Table 1 shows that NS75 has an average plant height of the highest compared to other treatment, either at 1 or 2 WAP is 25.38 cm and 36.31 cm but not significantly different from NS100. Treatments NS10, NS25 and NS50 has the same effect on the average plant height but different from the NS75 and NS100. Treatments OS300, OS400 and OS500 has an average plant height greater than the OS100 and OS200. While the OS100 and OS200 has a better effect compared with controls or without silica granting of lowest plant height of rice plants owned by silica is not given a 18.42 cm (1 WAP) and 26.98 cm (2 WAP).

For root length, results showed that NS75 and NS100 had an average root length of the largest compared to the other treatment. Average length of the largest root is the treatment NS75 is 13.25 cm (1 WAP) and 15.45 cm (2 WAP). Treatments NS10, NS25 and NS50 has the same effect on the average length of roots but differ with NS75 and NS100. The OS400 and OS500 treatment had an average root length greater than the OS100, OS200 and OS300 which inter treatment has the same effect on the average length. Average length of the shortest root plants that are not owned by a given silica is 9.79 cm (1 WAP) and 10.98 cm (2 WAP) (Table 1).

Table 1: Average value of plant height, root length and leaf length at each treatment silica

	Plant height (cm)		Root length (cm)		Leaf length (cm)	
Treatments	1 WAP	2 WAP	1 WAP	2 WAP	1 WAP	2 WAP
Control	18.42[e]	26.98[e]	9.79[e]	10.98[e]	12.13[e]	16.13[e]
OS100	20.58[d]	29.51[d]	10.17[d]	12.10[d]	12.65[d]	16.73[d]
OS200	20.58[d]	29.52[d]	10.19[d]	12.11[d]	12.67[d]	16.75[d]
OS300	22.17[c]	31.23[c]	10.20[d]	12.13[d]	12.67[d]	16.76[d]
OS400	22.15[c]	31.21[c]	11.13[c]	13.17[c]	13.50[c]	17.75[c]
OS500	22.17[c]	31.22[c]	11.15[c]	13.19[c]	13.51[c]	17.76[c]
NS10	23.56[b]	34.37[b]	11.78[b]	14.35[b]	15.30[b]	19.33[b]
NS25	23.57[b]	34.40[b]	11.80[b]	14.37[b]	15.31[b]	19.32[b]
NS50	23.58[b]	34.40[b]	11.81[b]	14.38[b]	15.33[b]	19.33[b]
NS75	25.38[a]	36.31[a]	13.25[a]	15.45[a]	16.29[a]	20.42[a]
NS100	25.31[a]	35.25[a]	13.25[a]	15.44[a]	16.27[a]	20.42[a]

The numbers in the column followed by the same letter are not significantly different shows based on Duncan's multiple range test at the 5% level

Table 2: Mean Wet Weight (WW) canopy and root on each silica treatment

	Wet weight canopy (g)		Wet weight root (g)	
Treatments	1 WAP	2 WAP	1 WAP	2 WAP
Control	0.523[e]	0.600[e]	0.147[e]	0.247[e]
OS100	0.610[d]	0.710[d]	0.238[d]	0.360[d]
OS200	0.613[d]	0.710[d]	0.243[d]	0.365[d]
OS300	0.709[c]	0.813[c]	0.248[d]	0.368[d]
OS400	0.713[c]	0.813[c]	0.352[c]	0.480[c]
OS500	0.713[c]	0.813[c]	0.358[c]	0.483[c]
NS10	0.812[b]	0.922[b]	0.452[b]	0.571[b]
NS25	0.815[b]	0.922[b]	0.460[b]	0.581[b]
NS50	0.817[b]	0.922[b]	0.463[b]	0.583[b]
NS75	0.935[a]	1.085[a]	0.593[a]	0.713[a]
NS100	0.931[a]	1.085[a]	0.585[a]	0.709[a]

The numbers in the column followed by the same letter are not significantly different shows based on Duncan's multiple range test at the 5% level

For leaf length, results showed that NS75 has an average length of the largest leaf treatment other than the 16.29 cm (1 WAP) and 20.42 cm (2 WAP) but not significantly different from NS10, NS25 and NS50 has the same effect on the average length of the leaves but differ with NS75 and NS100. Treatments OS100, OS200 and OS300 have the same effect on the average length of the leaves but differ with OS400 and OS500 which have an average length greater leaf (Table 1).

Canopy and root fresh weight: Results of analysis of variance showed that the granting of silica treatment significant effect on canopy and root fresh weight, whereas treatment plant varieties has no significant effect. As for the interaction between the silica and the granting of rice varieties showed that the effect is not real.

Table 2 showed that at 1 WAP and 2 WAP, NS75 and NS100 has an average wet weight of the largest canopy compared to other treatment. While the average weight of a wet canopy was lowest

Table 3: Mean Dry Weight (DW) canopy and root on each silica treatment

	DW canopy (g)		DW root (g)	
Treatments	1 WAP	2 WAP	1 WAP	2 WAP
Control	0.0663[e]	0.0936[e]	0.0195[e]	0.0315[e]
OS100	0.0753[d]	0.1086[d]	0.0343[d]	0.0471[d]
OS200	0.0753[d]	0.1086[d]	0.0346[d]	0.0471[d]
OS300	0.0874[c]	0.1239[c]	0.0343[d]	0.0471[d]
OS400	0.0876[c]	0.1236[c]	0.0488[c]	0.0621[c]
OS500	0.0874[c]	0.1234[c]	0.0486[c]	0.0621[c]
NS10	0.1007[b]	0.1412[b]	0.0646[b]	0.0758[b]
NS25	0.1007[b]	0.1412[b]	0.0646[b]	0.0761[b]
NS50	0.1007[b]	0.1412[b]	0.0648[b]	0.0761[b]
NS75	0.1137[a]	0.1642[a]	0.0804[a]	0.0907[a]
NS100	0.1139[a]	0.1639[a]	0.0807[a]	0.0907[a]

The numbers in the column followed by the same letter are not significantly different shows based on Duncan's multiple range test at the 5% level

for the control treatment. Treatments NS10, NS25 and NS50 has the same effect on the average wet weight of the canopy but still lower than the average wet weight of the canopy NS75 and NS100. Treatments OS300, OS400 and OS500 have an average weight of wet canopy greater than the OS100 and OS200 which has the same effect on the average weight of a wet canopy.

For root fresh weight, Table 2 indicate that NS75 and NS100 had an average wet weight of the largest root treatment than others. While the average wet weight of roots was lowest for the control treatment. The NS10, NS25 and NS50 have the same effect on the average weight of wet roots but differ with NS75 and NS100. The OS400 and OS500 had an average wet weight of roots greater than the OS100, OS200 and OS300 which has the same effect on the average wet weight of roots.

Canopy and root dry weight: Results of analysis of variance showed that the granting of silica treatment significant effect on canopy and root dry weight, whereas treatment plant varieties no significant effect. As for the interaction between the silica and the granting of rice varieties showed that the effect is not real.

For the dry weight of the canopy, the test results in Table 3 show that treatment NS75 and NS100 has an average dry weight of the largest canopy compared to other treatment. While the average dry weight of the canopy was lowest for the control treatment. Treatments NS10, NS25 and NS50 has the same effect on the average dry weight of the plant canopy but different from the NS75 and NS100. Treatments OS300, OS400 and OS500 has an average dry weight of the plant canopy greater than the OS100 and OS200, each of which has the same effect on the average dry weight of the plant canopy.

Meanwhile, root dry weight in Table 3 shows that the results of Duncan's test showed that the average root dry weight was lowest for the control treatment, while the average dry weight of roots terbesar.terdapat on treatments NS75 and NS100. Treatments NS10, NS25 and NS50 has the same effect on the average root dry weight but different from the NS75 and NS100. The OS400 and OS500 treatment had an average root dry weight greater than the OS100, OS200 and OS300.

DISCUSSION

Based on the research results that NS treatment gives a better effect than the OS and the application of fertilizer treatments without silica fertilizer application at all observation variables such as plant height, root length, leaf length, canopy fresh weight and dry weight of roots and crowns and roots. This suggests that the effect of NS on the growth of rice plants is better than giving the OS and the control treatment without fertilizer application or silica.

By using nano-sized Si, then the equity in the spread of Si into the ground more secure because of their small size. Besides, with the very small size of the rice plant's ability to absorb Si through the roots or the leaves will be even greater, so that more Si is absorbed. This is in accordance with the opinion Ranjbar and Shams (2009) who stated that nano fertilizer is more readily absorbed by plants and more efficient than conventional chemical fertilizers. Based on the research results (Mazaherinia *et al.*, 2009) use of nanoscale iron oxide iron oxide is more effective than normal in an increased concentration of Fe in the wheat crop. This is probably due to the nature of the nano particles are more soluble and more contact with plant roots than normal particles of iron oxide.

Besides, the element that changes the size of the particle size of the nano-size generally used to be not only changed the size but also experience other changes. According to Uyeda (1991), changes in the shape of a material into the nano size will change the characteristics of the physical, chemical, biological and catalytic activity of the material. Specific surface area of most of the material at the nano size will increase the chemical activity and biology. Because according to the theory of reaction kinetics, the surface area, the faster the reaction will take place. Furthermore, it would appear that the new properties on the nanoscale particles such as higher solubility, increased chemical activity and increased ability to penetrate into cells membram (Ranjbar and Shams, 2009).

CONCLUSION

Based on the results of the present study on nutrient culture medium that has been done, can be seen that the granting of Treatment Nano Silica (NS) gives a better effect than ordinary silica fertilizer application (OS) and controls at all observation variables such as plant height, root length, leaf length, weight wet canopy and root and the crown and root dry weight.

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