Effect of Organic Matters And Water Stress On Performance of Rice in Vegetative Phase

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Abstract
Drought become a major limiting factor in world cereal production. Various methods are used to solve this problem such as irrigation management by managing the soil moisture effectively for the plants to grow normally. Another way to improve the water holding capacity with the addition of organic matter in soil. Another way by planting drought tolerant rice varieties. Drought-tolerant rice varieties like Inpago 8 with various doses of organic matter and water stress at vegetative phase treatment done to analyze the change of rice plant performance at the vegetative phase of the rice crop due to drought and organic matter dose. At very low water content, which happened repeatedly during the vegetative phase causes the change in root growth, plant height, length and width of rice leaf significantly.
Key words: Organic Matter, water stress, rice, vegetative

Introduction

The effect of global warming need to be addressed urgently to alleviate the negative impacts that could be caused low production of major crops in the world (IPPC, 2007). Cereal crops such as rice are very sensitive to water shortages. Production of rice in dry season in Aceh was 5.4 ton/ha for rice field and 2.4 ton/ha for upland rice field (BPS, 2014). Because this plant is basically a plant that grows in watery conditions. To resolve this issue, water management required to deliver water to the boundary that allows the plant to grow normally (De Datta, 1981).

For a plant to grow normally requires to improve soil moisture in plant rooting medium by adding organic matter to increase the water holding capacity of the soil. The addition of organic matter can provide benefits of improvement in physical, chemical and biological fertility of soil. Physical improvements such as water-holding capacity due to organic matter function in changing the soil structure. Porosity is expected to minimize the effects of drought that happens frequently in the last decade. It is necessary for adaptive cropping patterns to mitigate drought effect in rice cultivation.

Materials and Methods

Procedure

This research was conducted at plastic green house at BPPT Lampineung in Syiah Kuala district with daily temperature of 28°C up to34 ° C , from January to April 2014. The study was conducted in a randomized block design with a 4x4 factorial with 3 replications. The treatment factor were water stress and organic matter consisting of four levels equall to 0, 20, 30, 60 tons per hectare. While water stress consists of four levels which are well watering every day, stop watering until the leaves roll up to form a shallow V, deeply V rolled leaf, and forming a shallow U rolled leaf,and then continue watering. Assessment of rolled leaf based on evaluation score of rolled leaf effect of drought (IRRI, 2002).

Each polybag filled with 10 kg of soil. Organic matter used for the treatment was rice straw compost. urea fertilizer equivalent to 200 kg per hectare, SP36, 150 kg per hectare, KCl 50 kg per hectare. The parameters observed in rice vegetative phase, were plant height, leaf length, leaf width, number of tillers, weight of root and root volume. Plant height is measured from the ground to the tip of the highest leaf clumps of plants. Leaf width measured at the center of the leaves on the same leaves that have been marked. Weight root weighed at the age of 60 days after the roots are washed clean and wipe with a dry tissue. Root volume is measured by water replacement method (IRRI 2012).

Data Analysis

Analysis ovarian used to see the effect of organic matter and water stress (F test). The significance in level of the treatment analyses with this significant difference (LSD 0.05)

Results and Discussion

Dose of organic matter have significant effect on the rice performance at vegetative phase as seen in plant height, leaf length, leaf width, root weight, root volume, as shown in the table 1 below.

Tabel 1. Effect of organic matters on the performance of the rice plants at vegetative phase

No	Parameter	Dose Treatment of Organic matters (T/ha)				
		0	20	30	60	LSD 0.05
1	Plant height 15 DAP (cm)	28,67 b	31,67 c	29,08 b	24,00 a	0,92
2	Plant height 30 DAP (cm)	46,25 b	55,75 c	46,00 b	31,50 a	1,35
3	Plant height 45 DAP (cm)	63,00 c	73,25 d	61,00 b	54,92 a	1,98
4	Plant height 60 DAP (cm)	79,75 b	99,45 c	83,20 b	74,53 a	2,78
5	Number of tillers 15 DAP (perhill)	1,42 a	2,00 c	1,42 a	1,58 b	0,11
6	Number of tillers 30 DAP (perhill)	5,25 a	8,00 c	6,17 b	5,72 a	0,30
7	Number of tillers 45 DAP (perhill)	10,58 b	15,25 b	11,33 c	8,58 a	0,54
8	Number of tillers 60 DAP (perhill)	20,92 b	22,58 c	21,08 b	17,50 a	0,92
9	leaf length 30 DAP (cm)	14,42 c	17,75 d	12,42 b	10,08 a	0,64
10	leaf length 45 DAP (cm)	22,25 c	27,92 d	20,75 b	14,42	1,08
11	leaf length 60 DAP (cm)	34,00 b	43,33 b	36,08 c	25,00 a	1,66
12	leaf length 30 DAP (cm)	0,57 b	0,63 d	0,60 c	0,53 a	0,01
13	leaf width 45 DAP (cm)	0,84 a	1,02 c	0,95 b	0,81 a	0,05
14	leaf width 60 DAP (cm)	1,36 b	1,50 d	1,44 c	1,18 a	0,05
15	Root weight (g)	29,08 a	76,58 d	43,88 b	51,69 c	1,82
16	Root volume (cm^3)	63,33 a	120,83 d	79,17 b	84,17 c	3,40

Tabel 2. Effect of interval watering of the appearance of the rice plants in the vegetative phase

No	Parameter	Water Stress treatment				
		S0	S1	S2	S3	LSD 0,05
1	leaf length 30 DAP (cm)	14,46 c	13,67 b	12,25 a	12,67 a	0,64
2	leaf length 45 DAP (cm)	22,87 c	19,17 a	19,50 a	21,25 b	1,08
3	leaf length 60 DAP (cm)	36,95 b	33,08 a	33,49 a	34,33 a	1,66
4	leaf width 30 DAP	0,59 b	0,64 c	0,55 a	0,56 a	0,01
5	leaf width 45 DAP (cm)	0,93	0,97	0,88	0,88	-
6	leaf width 60 DAP (cm)	1,42	1,45	1,33	1,37	-
7	Root weight 60 DAP (g)	51,06 c	52,23 d	47,66 b	30,78 a	1,82
8	Root volume 60 DAP (cm^3)	89,49 c	88,33 c	82,50 b	70,90 a	3,40

Interaction between doses of organic matter and water stress on the appearance of the rice plants vegetative phase.

Tabel 3. Average length of rice leaf (cm) age 30 DAP due to the dosage of organic matter and water stress.

No	Dose of Organic Matter (T/ha)	Water Stress treatment			
		S_1	S_2	S_3	S_4
1.	0	18,33 Cd	13,33 Bb	10,00 Aa	16,00 Dc
2.	20	24,33 Dc	17,67 Db	17,67 Db	11,33 Ba
3.	30	12,00 Bb	14,00 Cd	10,33 Ba	13,33 Cc
4.	60	9,67 Aa	9,67 Aa	11,00 Cc	10,00 Ab
	$BNT_{0,05}$	0,16			

Description: The numbers followed by the same letters (lowercase and uppercase letters horizontally vertically) not significant at the 5% level LSD opportunities

Tabel 4. Average length of rice leaf (cm) age 45 DAP due to the dosage of organic matter and water stress.

No	Dose of Organic Matter (T/ha)	Water Stress treatment			
		S_1	S_2	S_3	S_4
1.	0	28,67 Cc	16,33 Bb	13,67 Aa	30,33 Dd
2.	20	39,00 Dd	24,33 Db	30,33 Dc	18,00 Ba
3.	30	20,33 Bb	21,67 Cc	19,00 Ca	22,00 Cd
4.	60	13,67 Aa	14,33Ab	15,00 Bd	14,67 Ac
	$LSD_{0,05}$		0,27		

Description: The numbers followed by the same letters (lowercase and uppercase letters horizontally vertically) not significant at the 5% level LSD opportunities

Tabel 5. Average length of rice leaf (cm) age 60 DAP due to the dosage of organic matter and water stress

No	Dose of Organic Matter (T/ha)	Water Stress treatment			
		I_1	I_2	I_3	I_4
1.	0	48,00 Cd	28,67 Bb	22,00 Aa	37,33 Cc
2.	20	56,67 Dd	40,33 Db	48,33 Dc	28,00 Ba
3.	30	32,00 Ba	38,33 Cc	33,33 Cb	40,67 Dd
4.	60	26,67 Ac	25,00 Ab	23,67 Ba	24,67 Ab
	$LSD_{0,05}$		0,27		

Description: The numbers followed by the same letters (lowercase and uppercase letters horizontally vertically) not significant at the 5% level LSP opportunities

Tabel 6. The average root weight (g) of rice due to the dosage of organic matter and water stress.

No	Dose of Organic Matter (T/ha)	Water Stress treatment			
		I_1	I_2	I_3	I_4
1.	0	39,03 Ad	31,33 Ac	22,53 Aa	23,40 Ab
2.	20	97,10 Dc	80,67 Db	101,73 Dd	26,83 Ba
3.	30	58,27 Bd	37,23 Bb	38,93 Cc	33,80 Ca
4.	60	72,87 Cd	60,07 Cc	27,43 Ba	39,10 Db
	$LSD_{0,05}$		0,46		

Description: The numbers followed by the same letters (lowercase and uppercase letters horizontally vertically) not significant at the 5% level LSD opportunities

Tabel 7. The average volume of roots (cm 3) of rice at 60 DAP due to the dosage of organic matter and water stress.

No	Dose of Organic Matter (T/ha)	Water Stress treatment			
		I_1	I_2	I_3	I_4
1.	0	86,67 Ad	63,33 Ac	50,00 Aa	53,33 Ab
2.	20	143,33 Dc	130,00 Dd	146,67 Dd	63,33 Ba
3.	30	96,67 Bb	73,33 Ba	73,33 Ca	73,33 Ca
4.	60	110,00 Cd	86,67 Cc	60,00 Ba	80,00 Db
	$LSD_{0,05}$		0,46		

Description: The numbers followed by the same letters (lowercase and uppercase letters horizontally vertically) not significant at the 5% level LSD opportunities

Table 1 shows the changes on plant height from age 15 to 60 DAP. In general there is an increase in plant height with increased doses of organic matter compare with treatment no organic matter increase. Dose of organic matter equals to 20 ton/hectare increased not only in plant height but also

on the number of tillers at the age of 15, 30, 45, 60 days after planting (DAP), leaf length, leaf width, weight of roots and root volume. But increasing organic matter from 20 to 30 tons per hectare decreased plant height, number of tillers, leaf length, leaf width, root weight and volume of roots that are generally lower and significantly different with all average value of parameter in the treatment of 20 tons per hectare. But higher and significantly different with treatment without the addition of organic matter.

The addition of organic matter equivalent to 60 ton/hectare decrease plant height, number of tillers, leaf length, length width. But for root weight and root volume was higher and significantly different compared to the weight of the root and root volume without organic matter treatment. This showed that organic matter up to 20 tons/hectare gives a better effect on the performance of rice plants at the vegetative phase. This is because the nature of organic matters that can affect the availability of water during the dry season but in excessive doses, it will adversely affect the physical properties of the soil, especially lack of oxygen which causes low activity of roots.

Table 2 shows the changes in the performance of the rice plants in the vegetative phase due to water stress which is done by stopping the water until the plants show symptoms of water shortage with changes in leaf form in the shallow V, deeply V rolled leaf and u rolled leaf form. Treatment of water stress causes a decrease in leaf length, leaf width, root weight and root volume significantly. This is because the water stress causing various disturbances in the metabolism of plants that cause changes in the formation and partition fotosintat (Taiz and Zeiger, 2002).similarly reported by Lisar et al (2014) in water stress condition plant cell produce varios compatible compound to keep homeostasis in plant cell.

Tables 3, 4.5, 6, 7 shows the interaction between doses of organic matter in the planting medium with water stress on leaf length ages 30, 45, 60 days after planting and root weight and volume of rice root age 60 DAP. Increase in organic matter up to 20 tons per hectare increase the length of leaves compared to treatment without water stress. But the dose of organic matter 30 to 60 tonnes / hectare decline in leaf length of rice plants than well watered.

Organic matter equals to 20 tons / ha increase the length of the leaf at the age of 30.45, 60 DAP compared with the length of the leaves on the same water stress but without the organic matter treatment. Whereas if water stress improved by stopping watering until leaf rolled forming deep V has longer leaf at age of 30, 45, 60 DAP at 20 tons of organic matter per hectare. It compared to average value of length leaf without increasing organic matter. Similarly, the increase in stress if followed by an increase to 60 tons of organic matter per hectare leaf length longer than the length of the leaves without the addition of organic matter. Similar result were observed Rajasekaran et al., (2015) by observing Organic matter affecting the root length, shoot length, weight wet and dry weight rice seedlings. And also observed by Bagayoko (2012) by observing the addition of organic matter to the soil up to 15 ton/ha can increase the number of seedlings of rice plant height

Increased water stress can reduced with increasing doses organic matter the growing medium. This is due to the high levels of organic matter in the root zone is still more moisturized than without organic matter. The highes of Root volume and root weight is in the treatment of organic matter of 20 tons/hectare with water stress treatment by stopping watering until the leaves roll forming deeply v. This is because the soil moisture were better with the addition of 20 tons of organic matter per hectare whereas if organic matter increased 30 to 60 tons/ hectare decrease in volume and weight of rice root. Similarly reported by Suardi (2002) in water stress condition rice root weight is higher in drought tolerant variety. This is because when the water deficit occur also make imbalance of water in plant cells (Taiz and Zeiger, 2002). Water stress in plant change biochemistry properties of the plant (Zhou and Yu, 2010).many compatible compounds are synthesized by enzymes in wáter stress conidition (Lambers et al., 2008).similarly reported by Reddilas (2011) in water stress condition the rice plant produce more trihalosa as osmoprotectant. Physiological disorder that occur when the rice plants in water stress, also decreased relative water content in leafs (Sikuku et al, 2012).

Decrease in leaf length, leaf width, root weight and root volume due to reduction of water levels decline turgidities cause inhibits the elongation and widening of the cells thereby low elongation and widening of the leaves. when the rice crop in water deficit decreased relative water content in leaves significantly. Similarly reported by Farooq et al. (2009) water stress at vegetative phase significantly reduced plant height. water deficit leads to a reduction in the size of the leaf stems, and roots of plants.

Conclusions

There is change of performance at vegetative phase of rice plants under water stress conditions which can be reduced by increasing dose of organic matter in the planting medium. The addition of organic matter equivalent to 20 tonhectare gives a better performance of rice plant at vegetative phase.

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