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Growth and Yield of Upland Rice under Rice - Grass Intercropped In Rainfed Area.

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ABSTRACT

Objective of this study was to know growth and yield of upland rice varieties with characters of drought tolerance and high yield under intercrops with grass in rainfed area. The study was carried out in rainfed area of Banjaranyar village, Banyumas District, Central Java, Indonesia during April-August 2012. Main plot of grass viz. no grass, elephant grass and lemon grass with subplot of variety viz. Situ Patenggang, Kalimutu, Danau Gaung, Jatiluhur and Cisokan were tested in split plot design with three replications. Under very low soil water content of less than 12 percent showed the vary results in intercrops rice-grass system. Even there was no effect on plant growth characters, variety of Kalimutu obtained the higher values on plant height (46.27 cm), leaf area (14.63 cm^2) and yield (1.38 t/ha) than others.

Keywords: intercrops, upland rice, grass, growth, yield.

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INTRODUCTION

Improving the potency of land area still has chance for developing upland rice production in Indonesia. Contribution of upland rice to total of rice national production is still low about 5-6 percent. Erratic rainfall during growth period is the main problem as the major resource of water in dry land of rainfed area. This condition causes the unstable and sometime no production. Solution to improve upland rice production in dry land of rainfed areas is possible to enhance through cropping systems, water management, and growing shortage and drought tolerance of upland rice varieties.

Some studies revealed that using the appropriate varieties could gain the highest production under drought condition (Dixit et al., 2014; Guimaraes et al., 2016). Due to the environmental conditions are vary, so selecting varieties which appropriate with a given condition is most important. Therefore, selection the upland rice varieties which suitable grown under rainfed area is a must to explore their tolerance capacity under low soil water condition but still have high yield. This is the point as one solution in order to improve production of rice in rainfed area with the soil characters of acid and high potency to drought.

Another alternative to solve the problem of drought condition is improve soil water content through naturally approach. The biological approace can be applied by using grass. Commonly, grass has high distirbution of root system in soil so its could fill pore with the high capacity (Prihar *et al*., 2000). This condition can improve soil physics condition through high volume of pore and low soil bulk density so in directly increasing the soil water retention. The study of intercropped maize with grass (elephant grass, lemon grass and vetiver) in rainfed area showed there's no competition and no effect on yield (Ahadiyat dan Ranamukhaarhrhachi, 2007). Root horizontal and root biomass increased under intercropped system and no effect on yield (Ahadiyat dan Ranamukhaarhrhachi, 2011).

Based on above explanation that cropping system rice – grass is need to develop to anticipate the low availability of water especially during dry condition. Water conservation through water harvesting during rainy season is must to do by sowing grass to give opportunity grow in fast duration by extending the root systems and finally increasing soil water retetion. Upland rice – grass intercropped is a new model in cropping system and interesting to conduct to find the appropriate solution on drought codition but it still gains the high production.

METHODOLOGY

Potency upland rice varieties with the characters of drought tolerance and high yield obtained based on selection study during 2008-2010 in screen house level. Main plot of grass viz. no grass, elephant grass and lemon grass with subplot of variety viz. Situ Patenggang, Kalimutu, Danau Gaung, Jatiluhur and Cisokan were tested in split plot design with three replications. Growth variables were observed on root systems of total root length and biomass (Bohm, 1979), plant height, leaf area, shoot biomass and number of tiller. Each parameter was taken from three samples in each plot.

Another variable was analyzed on leaf proline content according to Bates et al. (1973) in prior to harvesting time. Yield and yield components were observed on number of panicle per hill, number and weight of grain, and grain weight per plot. Data was analysis by F test and the results of significant effect based on treatment followed by Duncan's Multiple Range Test (p=0.05). Software of IRRIStat ver. 4.3. (2004) was applied to analysis the data.

RESULTS AND DISCUSSION

Growth variables of plant height, leaf area, number of leaf, number of tiller, weight of biomass, total root length, and dry root weight showed insignificant effect due to intercropped rice – grass. But, the significant effect resulted by weight of grain per hill, and grain weight per ha (Table1).

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Table 1. Characters of growth and yield of upland rice under intercrops with grass

Observed variables / Treatment	PH	LA	NL	NT	B	TRL	DRW	PRO	GW/H	GW/HA
Grass										
No grass	40,12	17,01	33,55	8,73	3,42	292,77	1,68	41,57	1,94 a	0,39 a
Elephant grass	37,38	17,22	32,65	7,04	2,94	360,29	1,55	53,73	4,41 c	0,88 c
Lemon grass	39,23	17,74	30,68	8,66	3,37	331,29	1,59	54,87	3,00 b	0,60 b
Variety										
Situ Patenggang	40,19 b	18,99 b	29,56 b	700 b	3,67	433,02 c	1,65 c	57,36	3,17 c	0,63 b
Kalimutu	46,27 c	22,04 c	14,63 a	3,72 a	2,52	214,27 a	0,87 a	36,79	6,92 d	1,38 c
Daun gaung	41,10 b	17,58 b	25,96 b	7,13 b	2,89	232,42 a	1,36 b	42,19	2,06 b	0,41 b
Jatiluhur	38,76 b	18,15 b	32,04 c	8,35 c	3,42	409,60 c	1,70 c	54,22	3,35 c	0,67 b
Cisokan	28,24 a	9,93 a	59,29 d	14,51 d	3,73	351,29 b	2,45 d	59,74	0,10 a	0,02 a

Remarks: PH=plant height (cm); LA=leaf area (cm^2); NL=number of leaf; NT=number of tiller; B=weight of biomass (g); TRL=total root length (cm); DRW=dry root weight (g); PRO=leaf proline content (µM/g); GW/H=grain weight per hill (g); GW/HA=grain weight per ha (ton). Values sharing similar letters do not differ significantly at $p<0.05$, according to Duncan's multiple range test

Under intercropped rice – grass, all growth variables resulted insignificant effect between no grass and with grass on plant height (37,38 – 40,12 cm), leaf area(17,01 – 17,74 cm^2), number of leaf(30,68 – 33,55), number of tiller(7,04 – 8,73), weight of biomass(2,94 – 3,37 g), total root length (292,77 – 360,29 cm) anddry root weight(1,55 – 1,68 g) (Tabel 3). Leaf proline content had values with range of 41,57 – 54,87 µM/g.

Grain weight per hill and per ha had significant effect due to intercropped rice grass. Availability of grass of elephant grass or lemon grass improved yield rather than no grass (Table 3). Intercropped rice – elephant grass gained the highest yield on grain weights per hill (4.41 g/ha) and per ha (0.88 t/ha). Sole crop of rice gained the lowest yield on grain weights per hill (1.94 g/ha) and per ha (0.39 t/ha)(Tabel 1).

Among varieties had the vary results on plant growth and yield (Tabel 1). Weight of biomass resulted no significant effect with the values of 2,52 – 3,73 g. Plant height and leaf area was highest in Kalimutu variety of 46,27 cm and 22,04 $cm^2$and the lowest resulted by Cisokan variety of 28,24 cm dan 9,93 cm^2. Highest number of leaf and tiller resulted by Cisokan of 59.29 and 14.51, and the lowest obtained by Kalimutu variety of 14,63 dan 3,72. Total root length of Situ patenggang and Jatiluhur varieties obtained the highest result of 433,02 and 409,60 cm. Highest grain weight per hill and per ha gained by Kalimutu variety of 6,92 g and 1,38 t/ha. The lowest yield gained by Cisokan variety of 0,10 g and 0,02 t/ha.Cisokan variety accumulate leaf prolinecontent higher of 59,74 µM/g than other. Kalimutu accumulate leaf proline low of 36,79 µM/g and other varieties accumulate leaf proline with range of 42,19 – 57,36µM/g.

Intercropped rice – grass had the vary results in plant growth and yield variables. Even though availability of both grass had no improve the performance of plant growth i.e. plant height, number and area of leaf, number of tiller, total root length and root dry weight but there was no competition among them.Moreover, availability of grass improved the yield rather than sole crop of rice. Intercropped rice with elephant grass and lemon grass improve yield 56% and35%, respectively, compared to sole crop of rice. This is indicated that availability of grass in rice cropping system had no effect negatively on plant growth and yield. Wawo *et al.* (1993) revealed that rice could possible grown with grass due to availability of grass would cover the upper soil of land under drought condition (Wawo and Wirdateti,1998).

The previous study of maize – grass intercropped resulted no effect on maize yield due to availability of grass (Ahadiyat dan Ranamukhaarhrhachi, 2007). Therefore, the study of rice grown with grass is interesting to conduct. Even, low rice grain yield of< 1 t/ha under intercopped due to low availability of water (<12%), but improvement of yield under intercropped rather than sole crop is a notice.Low grain yield is a common under low soil water condition as mentioned by Varadan (2002) that water constraint is possible to decrease yield of crops. In general, availability of grass get better availability of water (>10%) compared to no grass (<10%) during phase of blooming – seed filling.Higher soil water content could support plant growth as mentioned by (Prihar *et al*., 2000). Leaf proline content in rice – grass intercropped tent higher than sole crop of rice but it did not decrease the yield. (Tabel 3). Even rice had stress under intercropped with grass due to higher content

of leaf proline content but it had no effect on yield. Availability of grass protects upper soil layer so it improved soil water conservation (Unger *et al*., 1998; Allmaras *et al*., 1998)

In environmental conditions of high temperature and, low in relative humidity and soil water content was effect plant stress. Characters of high in plant height and leaf area in Kalimutu variety gave positive effect on yield compared to other variables. Thus, low accumulation of leaf proline content in Kallimutu variety occupied in position no stress. Meanwhile, low in plant height and leaf area even high in other variables and high leaf proline content was in plant stress condition and directly decrease yield.

Ahadiyat and Ranamukhaarhrhachi (2007, 2011) mentioned that there has improvement in root systems and biomass in maize – grass intercropping system and no effect on yield. Suardi (2001; 2002) in laboratory research level revealed that strong root systems could intercept the deeper soil layer and it effect on crop yield. Other studies by Hidayat (2001) and Ogbonnaya *et al.*, (2003) stated that in legume crops to adaptation in drought condition could improve through physiological approach by decrease the growth of leaf area.Moreover, high total root length could improve adaptation of crops under drought condition (Kasper *et al.*, 1984; Hamim *et al.*, 1996). Based on this study, high accumulation of leaf proline content indicated plant under stress as the same study by Ahadiyat and Hidayat, (2010).

Different results in plant growth and yield showed that each variety has different response on drought condition adaptation. In rice plant showed that plant height and leaf area is most important to improve yield compared to other variables (Tabel 3). Harahap and Silitonga (1989) mentioned that ideotype of rich with high yield character commonly related to low plant height, narrow and stand up leaf, large and strong root systems, high number of tiller and tolerance to pest and disease. However, this condition will be happened under normal condition so it will be different If the plant grown under stress condition.

CONCLUSION

Intercropped rice – grass has no effect to stress and it gained the highest yield of rice under intercropped with elephant grass than others. Variety of Kalimutu obtained the highest yield than others. This study indicated that cropping system rice – grass could possible to develop as a new system of upland rice production under low water content condition especially during dry season.

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