Effect of Different Plant Spacing to Weed Composition and Lowland Rice Yield in Sobari and Conventional Irrigation Methods

Merry Antralina[1], Endang Kantikowati[1], YuyunYuwariah[2], & Tualar Simarmata[2]

[1)] Faculty of Agriculture Bale Bandung University, Jalan RAA Wiranatakusumah No. 7 Baleendah Bandung. Telp.(022) 5897702.

[2)] Faculty of Agriculture Padjadjaran University , 45363 Jatinangor, Sumedang
Email :mantralina@yahoo.com

ABSTRACT

The research was aimed to assess the Effect of different plant spacing to weed composition and lowland rice yield in SOBARI and conventional irrigation methods . The experiment has been conducted in Farmers Groups Sadang Mukti, Sadang Sari Village, Bandung District, West Java at 668 m above sea level , from April 2013 to July 2013. It was arranged as split plot design, consist of two factors, : irrigation methods factor (M) was set up as main plot, irrigation methods in SOBARI (m_1) and conventional (m_2). Subplot is plant spacing factor (J), which consists of four levels of factors, namely: (30 x 35) cm, (30 x 25) cm, (35 x 35) cm, and (30 x 30) cm. The results showed that there was interaction between irrigation method and plant spacing on the value of the domination number of weeds, weed dry weight and yield of rice plants , dominant weeds in treatment SOBARI method of irrigation were more than conventional treatment , weed dry weight and yield of rice plants in treatment-SOBARI method of irrigation with spacing of 35 cm x 35 cm had greater than the other treatments.

Keywords: rice,weeds , SOBARI, conventional, plant spacing

INTRODUCTION

Water management in conventional rice cultivation is generally done by continously flooding, it is an effort to control weeds, on the other hand the condition of water resources become more limited so it needs to do various actions to overcome , including water management in rice cultivation, one of the technologies that can be applied is System Organic-Based Aerobic Rice Intensification (SOBARI) technology. SOBARI is a holistic system of rice production based integrated local input (straw compost, bio fertilizers, and other inputs) with the concept of LEISA (low external input sustainable agriculture) water , plant, fertilizers management, to raise the biological power(root system and number of productive tillers) and soil biological power (the abundance of beneficial soil organisms) based technology design and management input to achieve the production target (input-oriented management) (Simarmata (2008).

SOBARI method use wide plant spacing, hence the wider spacing, the more extensive the root zone. Research indicated that minimum spacing was 30 x 30 cm and maximum 50 x 50 cm. On the other hand plant spacing can play an important role in minimize weed suppression on the rice in aerobic soil conditions.

Spacing shows a negative correlation with weed biomass but positively associated with rice yield, because according to Norhidayati Bt. Sunyob, et al. (2012) less plant spacing can be adopted to increase rice yield and better weed suppression in an integrated weed management program for aerobic rice. Water management in SOBARI method require only half to one-third of the conventional way, saturated wetland or flooded. It saves water usage by up to 30%, however, these conditions will stimulate the growth and development of weeds compared to flooded rice field (Simarmata and Yuwariah, 2008).

Water surface elevation in SOBARI method use saturated conditions. Therefore rice plants and rice rhizosphere activity have opportunity to be in alternating aerobic or anaerobic conditions.This will give the roots a chance to get some air so it can grow deeper, prevent iron toxicity, accumulation of organic acids and H_2S gases which inhibit root development (Ihsan, 2011) .

According to Bhagirath S. Chauhan , and David E. Johnson (2011), rice cultivation both in dry or wet season, with wider plant spacing (30 cm x 30 cm) are susceptible to weed competition. Information obtained from this study also showed that aerobic rice yields better obtained at spacing of 15 cm x 15 cm and 10-20-10-cm compared to 30 cm x 30 cm, and if weed control is done after 8 weeks after planting , then less benefit to the decrease in the yield of rice plants. Rice planted at a spacing of 30 cm x 30 cm resulted in greater weed biomass and less rice yield compared to spacing of 15 cm x 15 cm and 10-20-10 cm. Rice production is reduced 94-96% without weed control. Critical period in wet season is 31 days at 10-20-10-cm spacing, 34 days at spacing of 15 cm and 43 days at spacing of 30 cm, while in dry season, the critical period of 43 days at spacing of 10-20 -10-cm, 15 cm 39 days on and 49 days at 30 cm.

Based on the above, then, it is necessary to investigate the effect of different plant spacing on weed composition and rice yield in SOBARI and Conventional method.

MATERIALS AND METHODS

In this experiment, seeds of rice varieties used were Sintanur, where planted on the field, , basic fertilizer used of straw compost, Urea, SP 36 and KCl. To prevent pests and diseases of plants used pesticides.

The experiment has been conducted in Farmers Groups Sadang Mukti, Sadang Sari Village, Bandung District, West Java at 668 m above sea level , from April 2013 to July 2013. It was arranged as split plot design, consist of two factors, : irigation methods (M) was set up as main plot, irigation methode in SOBARI (m_1) and conventional (m_2). Subplot is plant spacing factor (J), which consists of four levels of factors, namely: (30 x 35) cm, (30 x 25) cm, (35 x 35) cm, and (30 x 30) cm, each plot takes an area of 4 x 5 m, at each sample plot were determined for observation weeds whice located in the diagonal direction respectively. Weed control in each treatment was carried out manually by hand.

Seedlings were transferred to the field after reaching the age of 10-15 days after sowing, planting systems using SOBARI-TS (twin seedlings), by as much as 2 seeds planted crops DAPH aged 10-15 with a distance of 5 cm were planted shallow at a depth of about 2- 3 cm. Water conditions at planting time is " saturated" (dump but not waterlogged).

Irrigation methods in the treatment of SOBARI done by inundation (0 cm water height) at first, then the water supply is stopped and the water level allowed to fall naturally. Provision of irrigation water to 0 cm height of water carried back when the ground water level has gone down and reaches a depth limit - 5 cm below the soil surface. Water level management is done since 7-10 day-old plants up to 7 days before harvest, with a record of reproductive to discharge panicle phase (7 days before the flowering period of 100% up to 7 days after flowering) throughout continuously flooded to prevent the plants suffer shortage of water. In the begining of reproductive phase we gave sufficient water. After the grain completetly mature until harvest time the soil allowed to dry for all treatments.

The pest and disease control was done mechanically, physically or using the pesticides in accordance with the target.

The variables collected were dry weight of weeds, species and value total domination of weeds and rice yield. Observations on samples made of 2 samples in each plot by using the square (50 cm x 50 cm) (Tjitrosudirdjo dkk, 1998). Any weeds in the sample plots removed with roots and put into envelopes which have been labeled for easy identification. The collected data was used to calculate of the species dominance ratio (SDR).

RESULTS AND DISCUSSION

Weed Dry Weight

The results of analysis of the weed dry weight can be seen in Table 1.2 and 3 which indicates that there is interaction between irrigation methods and plant spacing on weed dry weight.

Table 1. The effect of Interaction of Irigation Methods and Plant Spacing On Weed Dry Weight (g) at 30 DAT

Treatment	Plant spacing			
Irigation Methods	**j_1**	**j_2**	**j_3**	**j_4**
Sobari	4.61 a A	1.44 a A	2.64 a A	1.92 a A
Conventional	0.00 b A	1.05 a A	0.00 b A	0.00 a A

Note:

- The average number followed by the same letter vertically (lowercase) and horizontal direction (capital letters) are not significantly different according to Duncan's Multiple Range Test at the real level of 5%.
- j_1 = Plant spacing (30 x 35) cm,
- j_2 = Plant spacing (30 x 25) cm,
- j_3 = Plant spacing (35 x 35) cm,
- j_4 = Plant spacing (30 x 30) cm

At 30 days after planting (30 DAP), which is the highest weed dry weight achieved by SOBARI treatment on all plant spacing (Table 1), this occurs because one of the technical culture of weed control in rice fields is to inundate.

Table 2. The effect of Interaction of Irigation Methods and Plant Spacing On Dry Weight of Weeds (g) at 60 DAT

Treatment	**Plant Spacing**			
Irigation Methods	**j_1**	**j_2**	**j_3**	**j_4**
Sobari	5.30 a AB	2.70 a BC	8.83 a A	0.40 a C
Conventional	1.90 a B	0.77 a B	0.20 b B	9.77 b A

Note: The average number followed by the same letter vertically (lowercase) and horizontal direction (capital letters) are not significantly different according to Duncan's Multiple Range Test at the real level of 5%.

Waterlogged soil conditions creates an aerobic atmosphere so that weed seed germination can be inhibited. Inundation also caused inhibition respiration the roots, whereas in SOBARI use saturated conditions, thus allowing dormant weed seeds in the soil to germinate.

At the age of 60 and 90 days after planting, highest weeds dry weight were achieved by SOBARI method with spacing 35 x 35 cm (Tables 2 and 3), this happens due to saturated water conditions , wide plant spacing , allowing dormant weed seeds in the soil to germinate , related to space become wider and more sunlight can be obtained .

Table 3. The effect of Interaction of Irigation Methods and Plant Spacing On Weeds Dry Weight (g) at 90 DAT

Treatment	**Plant Spacing**			
Irigation Methods	**j_1**	**j_2**	**j_3**	**j_4**
Sobari	4.69 b B	12.89 a A	13.33 a A	13.61 a A

Conventional	14.67 a A	8.43 a BC	0.00 b C	0.00 b C

Note: The average number followed by the same letter vertically (lowercase) and horizontal direction (capital letters) are not significantly different according to Duncan's Multiple Range Test at the real level of 5%.

According to Bhagirath S Chauhan and David E.Johnson (2011) stated that in the dry season or wet season, wider spacing (30 cm x 30 cm) are susceptible to weed competition, produced more weeds biomass compared to plant spacing 15 cm x 15 cm and 10-20-10 cm

Weed composition

The results of the analysis Sum dominance ratio (SDR) of weeds at 30 DAT (Table 4), indicated that in SOBARI irigations method the trial field was infested with seven weed species. Weed species consisted of two sedges , four broadleaf weeds and one grases . The dominan weeds were *Fimbristylis miliacea, Ludwigia octovalvis, Cyperus iria*, *Echicocloa Cruss-galli, Portulaca oleracea*, *Alternanthera sessilis* (L), and *Monochoria vaginalis*

Table 4 also shows that the four types of different spacing on IPAT-BO treatment have values of coefficient community above 75%, meaning there's not much difference in the state of vegetation on the fourth spacing.

In the conventional treatment, weeds only grow at a spacing of 30 cm x 25 cm, where the trial field was infested with three weed species, two from the broadleaf weeds, and one from sedge. The dominant weeds were *Portulaca oleracea*, *Ludwigia octovalvis*, and *Fimbristylis miliacea*. Acording to Mabbayad *in* Moody (1992) stated that water inundation lowering weeds weight and a number of species. While the spacing in this case is less affects the amount of weed dominance, because the spacing used in this study is relatively wide, so that there is avaliable space for growing weeds and rice.

Table 4. Species of Weeds and Sum Dominance Ratio (SDR) in the Irigation Methods Treatment and Plant Spacing at 30 Day After Treatment (DAT)

Species of Weeds	**Sum Dominance Rtaio (SDR) in the Plant Spacing**			
	j_1	j_2	j_3	j_4
SOBARI				
Echicocloa cruss-galli	10.92	4.30	14.70	-
Cyperus iria	13.33	9.43	7.05	-
Fimbristylis miliacea	45.80	38.74	27.12	46.13
Monochoria vaginalis	-	-	-	11.31
Ludwigia octovalvis	29.94	33.81	37.65	25.30
Alternanthera sessilis (L)	-	13.72	-	-
Portulaca oleracea	-		13.48	17.26

Coefisien of Comunity j_1 dan j_2		82.41		
Coefisien of Comunity j_1 dan j_3			75.03	
Coefisien of Comunity j_1 dan j_4				84.58
CONVENTIONAL				
Fimbristylis miliacea	-	24.62	-	-
Ludwigia octovalvis	-	26.18	-	-
Portulaca oleracea	-	49.20	-	-

Note:
- = not found these kinds of weeds
j_1 = Plant spacing (30 x 35) cm,
j_2 = Plant spacing (30 x 25) cm,
j_3 = Plant spacing (35 x 35) cm,
j_4 = Plant spacing (30 x 30) cm

At the age 60 DAP (Table 5) in the treatment of SOBARI the trial field was infested with five species, two from the sedges weed, three from the broadleaf weeds. The dominant weeds were *Fimbristylis miliacea*, *Cyperus iria*, *Ludwigia octovalvis*, *Alternanthera sessilis* (L) and *Portulaca oleracea*, in addition to the value of the coefficient community of the fourth plant spacing is less than 75%, it shows that there are differences in the state of vegetation in the fourth spacing used.

In the conventional treatment the trial field was infested wit four species, two from the broadleaf weeds, two from the sedged weed. The dominant weeds were *Alternanthera sessilis* (L), *Ludwigia octovalvis*, *Fimbristylis miliacea,* and *Cyperus Iria*, values of coefficient communities between at a spacing of 30 cm x 25 cm and 30 cm x 30 cm is no different, which is 85.91 %, whereas value of the coefficient communities another treatment is different one each other even at a plant spacing of 35 cm x 35 cm no weeds growing.

Age 90 HST (Table 6) in the treatment of SOBARI the trial field was infested with three species of weeds, one from grases weeds, two from broadleaf weeds. The dominant weeds were *Echicocloa Cruss-galli, Alternanthera sessilis* (L), and *Ludwigia octovalvis*, coefficient of community among treatments spacing shows values smaller than 75%, meaning that the state of the vegetation is different.

Table 5. Species of Weeds and Sum Dominance Ratio (SDR) in the Irigation Methods Treatment and Plant Spacing at 60 Day After Treatment (DAT)

Species of Weeds	Sum Dominance Rtaio (SDR) in the Plant Spacing			
	j_1	j_2	j_3	j_4
SOBARI				
Cyperus iria	61.84	-	34.31	-
Fimbristylis miliacea	38.16	46.99	-	100.00
Ludwigia octovalvis	-	20.94	36.73	-
Alternanthera sessilis (L)	-	17.02	28.95	-
Portulaca oleracea	-	15.06		-
Coefisien of Comunity j_1 dan j_2		46.99		
Coefisien of Comunity j_1 dan j_3			34.31	
Coefisien of Comunity j_1 dan j_4				38.16
CONVENTIONAL				
Cyperus iria	-	-	-	58.52
Fimbristylis miliacea	48.53	34.44	-	-
Ludwigia octovalvis	-	-	-	14.50
Alternanthera sessilis (L)	51.47	65.56	-	26.98
Coefisien of Comunity j_1 dan j_2		85.91		
Coefisien of Comunity j_1 dan j_3			0	
Coefisien of Comunity j_1 dan j_4				26.98

In the conventional treatment the trial field was infested with one species of weeds from grase is *Echicocloa Cruss-galli* were grown at a spacing of 30 cm x 25 cm and 30 cm x 30 cm. Acording to Mabbayad in Moody (1992) which states that the puddle of water weeds lose weight and number of weed species. While the spacing in this case is less affects the amount of weed dominance, because the spacing used in this study is relatively wide, so that there is ample scope to grow weeds and rice plants are planted. As the weed seeds will germinate in the soil deposits at any time if the environment is favorable.

The number of seeds in the soil are very much as a source of weed infestation which will cause problems continuously for seeds still viable. Seed that is located a few centimeters in the soil seed was collected in the existing deposits, at a time will be lifted from the ground as a result of processing, extracting or contact with animal activity digger (Radovich and Holt, 1984; Aldrich, 1984).

Table 6. Species of Weeds and Sum Dominance Ratio (SDR) in the Irigation Methods Treatment and Plant Spacing at 90 Day After Treatment (DAT)

Species of Weeds	Sum Dominance Rtaio (SDR) in the Plant Spacing			
	j_1	j_2	j_3	j_4
SOBARI				
Echicocloa cruss-galli	46.99	100.00	100.00	100.00
Ludwigia octovalvis	16.94	-	-	-
Alternanthera sessilis (L)	36.07	-	-	-
Coefisien of Comunity j_1 dan j_2		46.99		
Coefisien of Comunity j_1 dan j_3			23.49	
Coefisien of Comunity j_1 dan j_4				46.99
CONVENTIONAL				
Echicocloa cruss-galli	100.00	100.00	-	-

Weed seeds in the soil will germinate at any time if the environment is favorable. The number of seeds in the soil are source of weed infestation which will cause continuously problems if seeds still viable. Seed that is located a few centimeters in the ground at any time will be lifted from the ground as a result of soil tillage or animal activity (Radovich and Holt, 1984; Aldrich, 1984).

At the time of tillage weed seeds in the soil will be lifted to the surface and develop into new plants (Pons et al., 1997), except after manually weeding or with herbicides usually weeds are dead buried in the soil as a mulch so that it still has a piece of weed opportunity to breed again, because weeds quickly adapt to the environment and has high competitiveness, weeds can also grow well on waterlogged state. The dominance of weeds in each experimental plot would affect control recommendations are implemented. This situation has implications for the control of different ways.

The Yield of Rice

In Table 7 it can be seen that rice yield in SOBARI method at spacing 35 cm x 35 cm gave the best results compared to other treatments. This happens because SOBARI Method resulted abiotic factors (**i.e** nutrients, aeration, water and soil structure) to be more optimal to support plant growth therefore plant potential genetic can be more expressed throught growth,development, and rice yield . In such circumstances, weeds are also growing well, so competition always occurs between weeds and rice plants, but because the spacing used is relatively wide, the first third of the life cycle of the rice plant becomes critical period of weed interference can be bypassed with a good rice crop , rice plants pertumbuhannnya be faster than the growth of weeds, thus can control rice plants growing space, and

win the competition, both the nutrients or sunlight. After the rice crop canopy covers the soil surface, even if there are weeds that grow later, competition is no longer a real lowering the yield of rice plants.

Table 7. The effect of Interaction of Irigation Methods and Plant Spacing On Yield of Rice (Kg/plot)

Treatment	Jarak Tanam			
Irigation Methods	j_1	j_2	j_3	j_4
Sobari	43.61 a B	47.28 a AB	58.91 a A	37.45 a B
Conventional	32.93 a A	38.17 a A	33.41 b B	30.00 a C

Proper irrigation methods can have a positive impact on the growth and yield of rice plants. Irrigation techniques throught SOBARI method which creates more aerobic soil conditions can make the plant roots get more oxygen, so the development become better, and in turn the plants will grow better and provide optimal results (Barkelar, 2001). Aerobic conditions also allows soil microbes get more oxygen thus maintain their survival, and assist in the decomposition of organic materials into materials that can be utilized by plants, its presence can also help in the process of nitrogen fixation around the roots of plants. This becomes a great potential in meeting the needs of nitrogen by rice plants, thus increasing the growth and yield of rice

CONCLUSIONS

Based on the experiment results, it can be conclused :

1. There was interaction between irrigation method and plant spacing on the value of the domination number of weeds, weed dry weight and yield of rice plants
2. Dominant weeds in treatment SOBARI method of irrigation were more than conventional treatment
3. Weed dry weight and yield of rice plants in treatment-SOBARI method of irrigation with spacing of 35 cm x 35 cm had greater than the other treatments.

ACKNOWLEDGEMENTS

Thanks to the Advisor, Post Graduate Program, Padjadjaran University, Director General of Higher Education. West Java Provincial Departments of Education, Chairman Gapoktan Sadang Mukti and The Village Agricultural Extension District Andir Baleendah Bandung regency, for the facilities needed and supported in the research activity. This article is part of Merry Antralina's dissertation with guidance of third and fourth author.

REFERENCES

Aldrich,R.J. 1984. Weed Crop Ecology. Principles in Weed Management. Breton Publisher, a Division of Wadsworth, Inc. Nort Scituate, Massachusetts.

Bhagirath S.Chauhan, David E,Johnson. 2011. Row Spacing and Weed Control Timing Affect Yield of Aerobic Rice. Field Crops Research. Volume 121, Isue 2, 18 March 2011, Pages 226-231, http : // www.sciencedirect.com/science/article/pii/S0378429010003229, diakses 3 Desember 2012

Bakelaar, D. 2001. Sistem Intesifikasi Padi (The System of Rice Intensification-SRI) : Sedikit Dapat Memberi Lebih Banyak. http : // www.elspat.or.id/download/file/SRI-echo%20note.htm. Diakses pada tanggal 30 Juli 2007.

Ihsan,N. 2011. Cara Pengairan Berselang Pada Tanaman Padi. Badan Litbang Pertanian. http://www.litbang.deptan.go.id/berita/one/995/, diakes pada tanggal 9 Desember 2012

Moody, K.1992. Weed Management in Rice. In Handbook of Pest Management in Agriculture', ed D. Pimentel, pp. 301-328 (CRC Press, Boca Raton, FL)

Norhidayati Bt. Sunyob , Abdul Shukor Juraimi, Md. Moshiur Rahman, Md. Parvez Anwar , Azmi Man andAhmad Selamat . 2012. **Planting geometry and spacing influence weed competitiveness of aerobic rice.** Journal of Food, Agriculture & Environment Vol.10 (2): 330-336. 2012. WFL Publisher Science and Technology .Meri-Rastilantie 3 B, FI-00980 Helsinki, Finland . www.world-food.net.

Pons,T.L and H.F.J.M.Schroder, 1997. Significance of Temperatur Fluctuation and Oksigen Concentration for Germinator of The Rice Field Weeds Fimbristylis littoralis and Scirpus juncoides.Oecological 68 : 315-319.

Radovich, S.R and J.S Holt. 1985. Weed Ecology Implication for Vegetation Management. A Wiley Inter Science Publication. New York .

Simarmata, T. 2008. Teknologi intensifikasi padi aerob terkendali berbasis organic (IPAT-BO) untuk melipat gandakan produksi padi dan mempercepat pencapaian kedaulatan pangan di Indonesia. Pidato pengukuhan jabatan guru besar dalam Ilmu Biologi Tanah pada Fakultas Pertanian UNPAD. Bandung.

Simarmata, T dan Yuwariah,Y. 2008. Teknologi Intensifikasi Padi Aerob Terkendali Berbasis Organik (IPAT-BO) untuk melipatgandakan Produksi Padi dan Mempercepat Kedaulatan Pangan. Fakultas Pertanian Universitas Padjadjaran Bandung. http : // www. Pdffactorry.com.