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Effect of Difference Weed Control Methods to Yield of Lowland Rice In The SOBARI

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Abstract

Weed competition will reduce rice yield. The research aimed to study the effect of difference weed control methods on rice yield in SOBARI. It has been conducted from October 2013 until February 2014, using Randomized Block design with five treatments (A = manual weeding, B = unweed control, C = herbicide containing Penoxulam + Cyhalofop-butyl, D = Bispyribac sodium, and E = 2, 4 D + Methyl metsulfuron). The results showed that weed control using herbicides containing Bispyribac sodium and 2.4 D + Methyl metsulfuron showed similar results as manual weed control on rice yield.

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Keywords: herbicide, rice yield, SOBARI, weed control

INTRODUCTION

Rice is a major food staple for most people of Asia, especially Indonesia. The rice production has to be increased to meet demand due to population growth [3]. One of the important things on increasing rice production is to minimize crop loss which is caused by weed competition because weeds do not only reduce the rice production but also have an adverse effect on rice grain quality.

The best paddy rice growth occurred in a depth of 2-25 cm stagnant water. Meanwhile, at this time condition of water resources is increasingly limited so that it is necessary to find a method to overcome the existing problem. It includest. the water management in lowland rice farming. One of the technologies that can be applied is the approach of System Organic-Based on Controlled Aerobic Rice Intensification (SOBARI).

SOBARI is a holistic system of rice production based on integrated local input (straw compost, bio fertilizers, and other inputs) with the concept of LEISA (low external input sustainable agriculture). Water management in SOBARI method requires only half to one-third of the conventional way, saturated wetland or flooded. It saves water

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usage by up to 30%; however, these conditions will stimulate the growth and development of weeds compared to flooded rice field [19].

Mostly, weed species population is getting decrease with the increasing of water depth. Flooding irrigation will depress weed growth but will not disturb the growth of rice plants. It shows that the flooding considerably affect to the rice crop and weed growth. On the other hand, SOBARI uses muddy level only, this certainly will enhance the growth of weeds either type or amount. If unchecked, it will lead to a relatively large yield loss, because the weeds grow since the beginning of rice planting, so that the competition has been started from earlier and longer.

In rice cultivation system, the longer presence of weeds in rice cropping paddy, the greater reduction of grain yield. Results of previous studies showed that rice yield loss on systems using intermittent irrigation (SRI) is greater than in conventional system, because the weeds in the rice areas were allowed to grow until the harvest. Loss of rice yield in SRI system (which uses intermittent irrigation) was about 98.02%, while the yield loss in the conventional system was only 74.03% [2]. Therefore, weed control becomes one of the important parts of cultivation that can affect the production of rice plants.

Commonly, weed controls used are water management, mechanically hand weeding and chemical herbicides weeding [8]. The traditional method of weed control practice in Asia countries is hand manual weeding by hoe and hand pulling. Usually, hand weeding is conducted in two or three time during the planting season [1]. Manual weeding, although effective, is becoming difficult due to labor scarcity, cost increase and depend on weather conditions. Moreover, it is incomplete and impractical due to escape or regeneration of perennial weeds having many flushes. Delayed weeding cause crop loss and decreased production. Thus herbicide usage seems indispensable for weed management [18]. It offers selective and economical control of weeds since the beginning, giving the crop an advantage of good start and competitive superiority [15].

Herbicide rotation and mixture herbicide use are two major strategies to prevent development of herbicide resistance in weeds, herbicide with different mode of action when mixed together, bind to different target site in weed and prevent the probability of target site resistance in susceptible species [13]. Technological developments mixing herbicides with different active ingredients aiming to get a broader spectrum control, and is expected to slow the emergence of weeds resistant to herbicides, reduce production costs, and reduce herbicide residues [7]. Based on above explanation, it is necessary to study the effect of difference weed control methods on lowland yield rice in SOBARI cultivation.

MATERIALS AND METHODS

The study used a randomized block design experimental method, with five treatments and three times replications. Treatment consisted of five difference weed control methods namely: A = manual weeding, B = UN weed control, C = herbicide containing Penoxulam + Cyhalofop-butyl, D = herbicide containing Bispyribac sodium, and E = herbicide containing 2, 4 D + Methyl metsulfuron. All treatment was done at age 20 day after planting (DAP), except the manual weeding which was done at the age 20 and 45 DAP. Each plot has an area of 4 m x 5 m, with a spacing of 35 cm x 35 cm.

The experiment has been conducted at Sadang Mukti Farmers Groups rice field, Sadang Sari Village, Bandung, West Java at 668 m above sea level, from October 2013 until February 2014. The soil characteristics of the experimental site: soil type: clay, pH: 7.2 (wet), organic carbon 3.25 % (high), available of P: 2.14 ppm (very low), available of K: 10.00 ppm (very low).

In this experiment, seeds of rice varieties used were Sintanur which were planted on the field. Seeds were transferred to the field after reaching the age of 10-15 days after sowing, using twin seedlings planting system, which in each planting hole consist of 2 seeds within 5 cm on saturated water level conditions. Water level management was done by saturated water level (0 cm water level) at first, then the water supply was stopped and the water level allowed falling naturally. Provision of irrigation water to a height of 0 cm of water carried back when the ground water level has gone down and reach the specified depth limit on treatment -5 cm from the ground.

Measurement of the depth of the ground water level was done by using pipe with 4 inches diameter and length 35 cm and ½ perforated with holes with a distance of 1 cm x 2 cm (Figure 1) which were placed in the fields (Figure 2). Installation of the pipe was done by immersing 20 cm of length of PVC into the ground, and let rest 15 cm above the soil surface. Water level management was done since 7-10 day-old plants until the plant reaches maximum vegetative phase (half way to generative phase), until the presence of the panicle phase (7 days before the 100% flowering period up to 7 days after flowering) all treatment were continuously flooded to prevent water deficiency in plants. At the ripe stage until harvest time, the whole plant was not watered. Pest and disease control was done mechanically, physically or using pesticides according to the target.

Figure 1. Gauges of water level monitoring

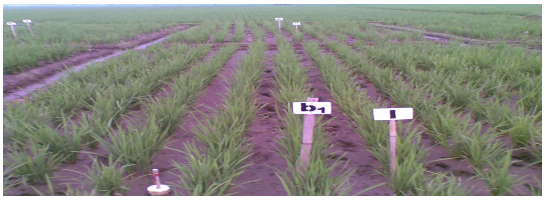

Figure 2. Water level monitoring equipment installed in the field.

Straw compost application was done one week after planting at a dose of 2.5 tones ha^{-1}. To add to the nutrition, inorganic fertilizer was given, namely Urea 250 kg ha^{-1}, NPK 100 kg ha^{-1}, and KCL 50 Kg ha^{-1}. Urea and NPK fertilizer application was applied 3 times; at planting time, 28 DAP and 50 DAP, whereas KCl was applied once, only at 50-day-old plants.

Harvesting was done using a sickle, performed after physiological maturity of plants marked by yellowing grain threshing, and the results were weighed to obtain the dry weight of the grain harvest. Variable response observed were yield components of rice plants including: number of panicle, 1000 grain weight (g), filled grain percentage, and grain yield (g).

RESULT AND DISCUSSION

COMPONENT OF YIELDS

Weed control is conducted to reduce weed competition caused by rapid grow. If the weed is left unchecked, it will absorb the nutrients from the soil, so that the growth of the rice plant will be disrupted [12].

C_4-type weeds have a low level of photosynthesis efficiency and wasteful in the use of water. This causes weed to absorb a lot of water and nutrients from the soil than rice plants. According to Caton et al., [3] C_3-type weeds become invasive due to high speed of growth through vegetative propagation.

The analysis results of rice yields component in Table 1 show that in SOBARI, treatments tested gave same effect on the number of panicle and 1000 grain weight, this occurred because although herbicides were used in various

move of action against weeds, but it did not affect the growth of rice plants, for instance Cyhalofop-butyl an aryloxyphenoxypropionate rice herbicide that able to control many grass weeds including *Echinocloa* spp, and *Leptochloa chinesnsis with* the action by inhibiting the Acetyl CoA carboxylase enzyme (ACC'ase) [21], which is critical for fatty acid biosynthesis. Inhibition of fatty acid production subsequently inhibits cell division. In rice plant, Cyhalofop-butyl is metabolized to the herbicidal inactive form known as the diacid so it is safe to rice. In grasses, the herbicidal efficacy is due to the biologically active monoacid metabolite. As well as Penoxsulam, a triazolopyrimidinee sulfonamide rice herbicide, which inhibits the plant enzyme AcetoLactate Synthase (ALS) which is essential for the synthesis of branched-chain amino acids valine, leucine and isoleucine. Inhibition of amino acid production subsequently inhibits cell division, can controls annual sedges and many broadleaf weeds, also *Echinocloa* spp, but it is safe to rice [10].

Bispyribac sodium is a selective herbicide, it is effective for the control of grasses, sedges and broadleaf weeds in rice and is effective as a soil or foliar treatment [16]. It is a member of the pyridiminyl oxybenzoic chemical family [5] , and inhibits the enzyme aceto hydroxyl acid synthase, also known as AcetoLactate Synthase (ALS), in susceptible plants. This ultimately reduces transport of photosynthate from source leaves to roots, resulting in root growth inhibition [6]. According [9] absorption and translocation of Bispyribac sodium in rice plant are fairly small and most of Bispyribac sodium remains at the treatment part. On the other hand, in barnyard grass Bispyribac sodium absorbed from leaf, stem and root is Trans located largely and is distributed throughout the plant body. Translocation of Bispyribac sodium in plant body is both in the upward direction and in the down ward direction. Susceptibility of ALS to Bispyribac sodium does not differ between rice and barnyard grass in vitro, Bispyribac sodium shows the highest selectivity between rice and barnyard grass when applied at 2 to 4 leaf stage of rice and barnyard grass. Because absorption and translocation of Bispyribac sodium are far more active in barnyard grass than in rice plant, Bispyribac sodium is metabolized more quickly in rice plant than in barnyard grass.

Table 1. Effect of Difference Weed Control Methods on Yield Components

	Weed Control Methods	Number of Panicle	1000 Grain Weight (g)	Filled Grain Percentage
A	manual weeding	38.000 a	32.933 a	56.570 ab
B	un weed control	27.000 a	27.600 a	55.367 b
C	herbicide containing Penoxulam + Cyhalofop-butyl	35.000 a	34.000 a	53.153 b
D	herbicide containing Bispyribac sodium,	38.000 a	32.267 a	67.030 a
E	Herbicide containing 2,4 D + methyl metsulfuron	35.000 a	28.133 a	60.123 ab

Note: The average numbers followed by the same letter in the same column are not significantly different according to Duncan's Multiple Range Test at the 5% level.

2, 4-D is an herbicide and secondarily a plant growth regulator. It is used for broadleaf weed control. It has little effect on grasses. It appears to work by causing uncontrolled cell division in vascular tissue. Abnormal increases in cell wall plasticity, biosynthesis of proteins, and production of ethylene occur in plant tissues following exposure, and these processes are responsible for uncontrolled cell division [11]. Methyl metsulfuron is a systemic and selective herbicide; it can be used pre and post-emergence for control the broadleaf and sedges [14]. Move of action of this herbicide is able to stop the plant cell division by blocking the action of the enzyme AcetoLactate Synthase (ALS) and AcetoHydroxy Synthase (AHAS) to inhibit the conversion of α-ketoglutarate to 2 acetohydroxybutyrate and pyruvate

into 2-acetolactate resulting acid chain branches amino valine, leucine, and isoleucine are not generated. Without these essential amino acids, the protein can not be formed and lead to the plant die.

In this study, the herbicides used did not affect to the number of panicle and 1000 grain weight so the genetic potential of rice plants appeared well, indeed when compared with the description according [20] the number of panicle (16-20) and 1000 grain weight (27g), the study resulted larger number (Table 1)

The number of panicle and 1000 grain weight improvement observed these herbicide treatment might be due to better control of weed and weed control efficiency , so that competition between rice and weeds to be reduced, and the whole treatment gives the same effect on the number of panicle and thousand grain weight (Table 1).

On the other hand that highest filled grain percentage was achieved by treatment A (manual weeding), D (herbicide containing Bispyribac sodium) and E (herbicide containing 2,4 D + methyl metsulfuron), this happens because in this study, weed control done manually by "gasrok" showed better results than treatments B (un weed control) and C (Penoxulam + Cyhalofop-butyl herbicide), this indicates that the environmental conditions support a potential best results for A treatment, thus though "gasrok" the soil becomes more friable crumb, better air exchange (aeration), so that rice plants optimum in developing root system and tillering, also increase the strength of the biological role in supplying nutrients and produce bioactive compounds (phytohormones, root exudates) to support the growth of plants. Beside, weeds at one-third of the rice plant age / critical period relatively were fewer than the other treatments, so that the growth of rice plants was better.

Weed control using herbicides that contain active Bispyribac sodium, and 2.4 D + Methyl metsulfuron showed similar results with manual weed control. Thereby, controlling weed by the use of both herbicides were able to replace manual weeding, however, other factors should be considered such as time consuming, expensive and tedious. At present situation of unavailability of labors and high cost, manual weed control is becoming not possible. Hence, chemical weed control appears to provide a great promise in dealing with effective, timely and economic weed suppression [22].

RICE YIELDS

The analysis results on rice yields in Table 2 shows that the highest rice yields in SOBARI was achieved by treatment A (manual weeding), D (herbicide containing Bispyribac sodium) and E (herbicide containing 2,4 D + Methyl metsulfuron), this happened because the rice yield per hectare was determined by outcome components particularly filled grain percentage. Vegetative phase of plant growth from the beginning to generative and ripening phase will determine the grain yield level.

Table 2. Effect of Difference Weed Control Methods on Rice Yields

Weed Control Methods		Grain Yield (g/ha)
A	manual weeding	7853.50 a
B	un weed control	3175.00 b
C	herbicide containing Penoxulam + Cyhalofop-butyl	3271.50 b
D	herbicide containing Bispyribac sodium,	5940.00 ab
E	Herbicide containing 2,4 D + methyl metsulfuron herbicide	6593.50 ab

Note: The average numbers followed by the same letter in the same column are not significantly different according to Duncan's Multiple Range Test at the 5% level

In the above three treatments (A, G and E treatment), the weeds control were work properly, so the competition between crops and weeds become lesser, it could reduce competition between rice plant and weeds on nutrient, water and solar radiation, also growing space. Thus on optimal soil nutrient availability, nutrient uptake will be increased so that the needs for optimal growth and production levels will be elevated. Increasing of growth components and yield components will be followed by an increase in the dry grain production per hectare.

Productivity of rice depends on interaction of various physiological and biological functions in plants. Higher filled grain percentage is the indication of higher photosynthetic efficiency of plants resulting in higher yield [4]. This study suggested that the herbicide application did not create negative impact on photosynthesis of rice crop [17].

CONCLUSION

In rice cultivation with SOBARI weed control using herbicides that contain active Bispyribac sodium, and 2.4 D + Methyl metsulfuron showed similar results with manual weed control to increase the filled grain and rice grain yield. Thereby, the use of both herbicides could replace the manual weeding.

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