Important Weeds and Their Control in Soybean Production under Rice-Soybean Cropping Pattern

Jenis-jenis Gulma Penting pada Kedelai dan Cara Pengendaliannya dalam Pola Tanam Padi-Kedelai

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ABSTRAK

Pengendalian gulma merupakan salah satu komponen teknologi dalam budi daya kedelai yang menyerap tenaga kerja dan biaya tinggi. Tujuan penelitian adalah untuk menentukan jenis-jenis gulma penting pada budi daya kedelai di lahan sawah setelah padi, dan mendapatkan teknik pengendalian. Penelitian dilaksanakan dua tahap, pertama adalah survei penentuan jenis-jenis gulma penting pada pertanaman kedelai di lahan petani. Survei dilakukan di tiga kecamatan sentra produksi kedelai di Kabupaten Banyuwangi, yaitu di Gambiran, Purwoharjo, dan Tegal Dlimo. Penelitian kedua adalah teknik pengendalian gulma di lahan sawah setelah padi, dilaksanakan di Kebun Percobaan Genteng – Banyuwangi menggunakan rancangan acak kelompok tiga ulangan. Perlakuan terdiri atas: 1) tanpa pengendalian gulma, 2) penyiangan dua kali, 3) herbisida pratumbuh *oxyfluorfen*, 4) *oxyfluorfen* + herbisida pascatumbuh 2,4-D *dimethylamide*, 5) *oxyfluorfen* + penyiangan satu kali, dan 6) penyiangan satu kali. Hasil penelitian menunjukkan bahwa gulma penting untuk kedelai pada lahan sawah setelah padi di Banyuwangi secara berurutan adalah *Oryza sativa, Cyperus rotundus, Ageratum sp., Echinochloa crusgalli,* dan *Pilantus niruri.* Gulma-gulma tersebut dapat dikendalikan secara efektif menggunakan herbisida *oxyfluorfen*. Cara pengendalian ini dapat mengurangi nilai penting gulma, dan meningkatkan hasil kedelai sama dengan tanaman disiang sekali atau dua kali. Hasil kedelai tanpa disiang, disiang sekali, dan menggunakan *oxyfluorfen* berturut-turut 0,60 t/ha, 1,87 t/ha, dan 1,93 t/ha. Penggunaan herbisida pratumbuh *oxyfluorfen*, menghemat penggunaan tenaga kerja dibanding jumlah tenaga kerja yang digunakan pada penyiangan sekali maupun dua kali.

Kata kunci: Kedelai, pengendalian gulma, sawah

ABSTRACT

Weed control is one of technology components in soybean production that needs high labor and cost. The objective of this study was to determine the major weeds and their controls for soybean grown after rice in lowland. The study was conducted in two stages. The first stage was a survey to observe the major weeds in soybean crops grown after rice in the farmers' fields at three central soybean production areas in Banyuwangi, namely Gambiran, Purwoharjo, and Tegal Dlimo subdistricts. The second stage was a trial conducted in lowland after rice in Genteng Research station, Banyuwangi during the dry season of 2013. The treatments were arranged in a randomized completely block design with three replications. The treatments consisted of: 1) without weed control, 2) weeding twice, 3) preemergence herbicide oxyfluorfen,(4) oxyfluorfen + postemergence 2,4-D dimethylamide, (5) oxyfluorfen + once hand weeding, and (6) once hand weeding. The results indicated that the major weeds were *Oryza sativa, Cyperus rotundus, Ageratum* sp., *Echinochloa crusgalli,* and *Pilantus niruri* consecutively. The weeds were effectively controlled by applying preemergence herbicide oxyfluorfen. This control method reduced the major weeds significantly and showed the same increase in seed yield as in other treatments (one and twice hand weeding) compared to the control treatment (without weeding).The soybean yield obtained from the treatment of without weeding,one hand weeding,and using *oxyfluorfen* herbicide was 0.60 t/ha, 1.87 t/ha, and 1.93 t/ha, respectively.The use of oxyfluorfen herbicide is more efficient in terms of labor use than that of hand weeding.

Keywords: lowland, production, soybean, weeds control.

INTRODUCTION

In Indonesia, weed control for soybean crops is one component of technology that needs a lot of labor and cost. Weeds reduce soybean yield through the competition for one or more of growth limiting factors such as nutrients, water, and sunlight. Reduction of soybean yield due to weed infestation varies from 20-84% depending on weed type, weed population, and time of infestation (Tiwari and Kurchania 1990; Kachroo *et al.* 2003). Radjit and Purwaningrahayu (2007) reported that the important weeds for soybean crops in Indonesia are grasses weeds namely *Eleusine indica, Cynodon dactylon, Digitaria ciliaris, Imperata cylindrical;* and broad-leaves weeds namely *Amaranthus sp., Ageratum*

conysoides, and *Borirea alata*. The presence of *Amaranthus sp., D. ciliaris* and *C.rotundus as many as* 20% of the soybean plants population decreased grain yield by 35%, 21% and 15%, respectively (Suhartina and Riwanodja 1997).

The amount of labor requirement for controlling weeds varies depend on weed population and time of its control. Ardjasa and Bangun (1993) reported that hand weeding in soybean cultivation needs 50 man working days/ha (50 MWD/ha). Weed control during the entire soybean growth phase is generally carried out twice, *i.e* at 2-3 and 5-6 weeks after sowing (WAS) that need 20-50 and 15-30 MWD/ ha, respectively. However, such a high amount of labors will be reduced through the use of herbicides despite of its positive and negative impacts. The positive impact of herbicide is weeds can be controlled in shorter time even under large areas and the weeds stover can be used as mulch so that inhibit water evaporation and prevent erosion. The negative impact of herbicides is that it damages the soybean crops, so it should be carefully applied. The continuous use of one type herbicide in the same area will cause increasing weed resistance to herbicide, that make the existing weeds are difficult to control (Situmorang 2011; Bhatti et al. 2013).

Since the amount of family members is continuously reducing, weed control is often done late and even if is not optimally undertaken. This condition causes the soybean plants are unable to grow optimally and therefore produce grains far below its genetic potential. Several kinds of herbicide are effectively reduce weeds growth as well as reduce the production cost. However, the effectiveness of using herbicide is depending on the suitability between the types of herbicide and the targeted weeds (Matzenbacher *et al.* 2014; Harsono dan WIdaryanto 2015). Rustikawati (1987) reported that pre emergence herbicides ametryne and alachlor were able to inhibit the germination of *Paspalum conjugatum* and *Borreria alata* better than that of diuron. Wardoyo *et al.* (2011) reported that the presence of glyphosate residues in the soil will decrease within six weeks after application, whereas the amount was determined by rainfall and water infiltration into the soil. Increasing the doses of glyphosate application will increase P, Mg, and N total contained by the soil, but reduce the population of rhizobium and P-solubilizing bacteria,as well as availability of Ca in the soils. The objectives of the present study were to determine the important weeds in soybean production and to obtain the effective weed control for soybean produced in lowland after rice.

MATERIALS AND METHODS

Two research were conducted in order to determine and control the important weeds of soybean grown in lowland areas after rice. The first research was conducted by observing the important weeds of soybean crops in the farmers' fields and the existing weed controls practised by farmers. The survey was conducted at soybean central production areas in Banyuwangi District, East Java Province during the growing season of 2013. Survey was conducted in three subdistricts, with two villages in each subdistrict. The data collection included the weeds density, weeds dominance, and weeds frequency. These parameters were used to calculate the important value of weeds.

The second research was field trial conducted in lowland after rice at Genteng Research Station in Banyuwangi District, East Java in dry season of 2013. A randomize completely block design with three replications was applied. The treatments were listed in Table 1.

Each treatment was conducted in a 55 m x 8 m plot size. The seeds of Anjasmoro cultivar were planted with plant spacing of 30 cm (interrow) x 15 cm (intrarow), two plants/hill, and fertilized with 50 kg Urea + 50 kg SP36 + 50 kg KCl/ha. Data collected were weeds density, weeds dominance, and weeds frequency (these data were used to calculate the importance value of weeds): plant

Table 1. Treatments of weed controls for soybean grown in lowland areas after rice. Banyuwangi District, dry season 2013.

Treatments	No weedl contro	Hand weeding	Preemergence herbicide oxyfluorfen 2 L/ha	Postemergence herbicide 2,4-D dimethylamide 2 L/ha
Control (no weeding)	+	-	-	-
Hand weeding (2x)	-	21 DAS 41 DAS	-	-
Preemergence herbicide oxyfluorfen	-	-	10 DBS	-
oxyfluorfen + postemergence 2,4-D dimethylamide	-	-	10 DBS	21 DAS
oxyfluorfen + hand weeding (1x)	-	41 DAS	10 DBS	-
Hand weeding (1x)	-	21 DAS	-	-

DBS = days before sowing, DAS = days after sowing

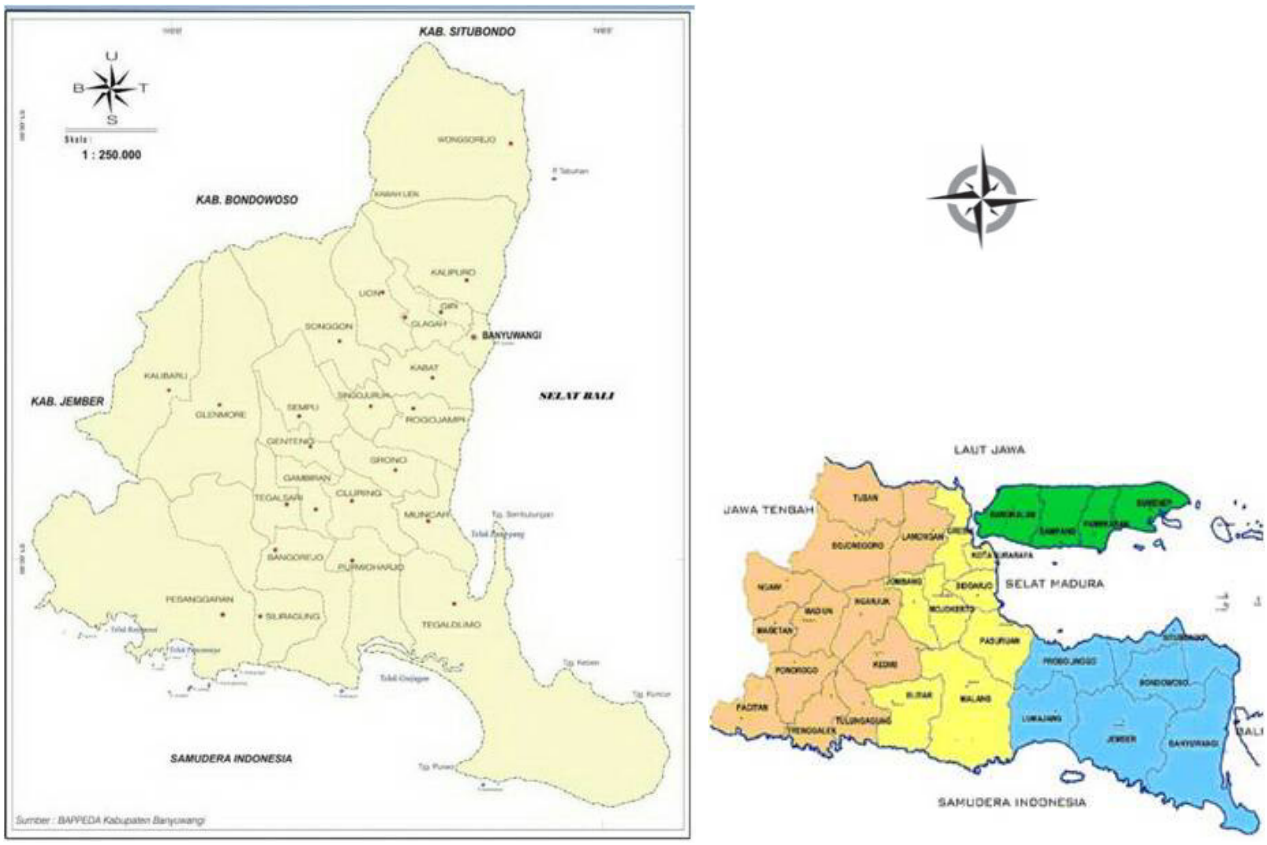

Figure 1. Location of the survey sites in Banyuwangi District: Gambiran, Purwoharjo, and Tegal Dlimo subdistricts; and the field trial location; Genteng Research Station.

height, filled pods number/plant, and grain yield/ plot.

The importance weed value index was calculated by the following formulas (Tjitrosoedirdjo et al. 1984) :

Absolute Weed Frequency (F) =

$$\frac{number\ of\ plots\ that\ contained\ weeds}{total\ number\ of\ the\ plots\ observed}$$

Relative Frequency (FR) =

$$\frac{absolute\ frequency\ of\ a\ species\ of\ weed}{total\ absolute\ frequency\ of\ all\ species\ of\ weeds} \times 100\%,$$

Relative weed density (DR) =

$$\frac{absolute\ density\ of\ a\ species\ of\ weed}{total\ density\ of\ all\ species\ of\ weeds} \times 100\%,$$

Absolute weed density (D) = number of individual weeds species in the sampled plot,

Relative weed dominance (AR)=

$$\frac{absolute\ dominance\ a\ species\ of\ weed}{total\ absolute\ dominance\ of\ all\ species\ of\ weeds} \times 100\%,$$

Absolute Dominance (A) = the basal area of weeds species that cover the plot sample,

Importance Value Index (IVI) = FR + DR + AR.

RESULT AND DISCUSSION

The Important Weeds in Soybean Production

The important weeds in soybean crops grown in lowland areas after rice in Banyuwangi District were *O. sativa*, *C. rotundus*, *E. crusgalli, Ageratum* sp., and *P. niruri* (Table 2).This information was supported by Triyono (2010) who found the same dominant weeds in soybean crops grown in paddy/ rice. *C. rotundus* and *E. crusgalli* were also reported by Riry (2006) as the dominant weeds in soybean crops in Karawang District, West Java. Therefore, for cultivating soybean in lowland after rice, those weeds need special attention to control.

In Purwoharjo Subdistrict, farmers generally grow soybean in lowland areas following the cropping pattern of rice-soybean-soybean. The existing technology consists of regular plant spacing (30-40 cm x 10-15 cm, two plants/hill), post-emergence glyphosate herbicide with the rate of 11 tanks/ha, the application of 150 kg SP36/ha,

Table 2. The important value of weeds for soybean grown in lowland after rice in Banyuwangi. Dry season 2013

Name	Important value (%) in Subdistrict*			
	Purwoharjo	Tegal Dlimo	Gambiran	Average
Cyperus rotundus	37,2	10,8	12,8	20,3
Pilantus niruri	8,9	4,3	2,7	5,3
Ageratum sp	0,4	0	1,8	0,7
Oriza sativa	38,5	45,7	19,2	34,5
Panicum repens	2,9	0	0	1,0
Cynodon dactilon	0,2	0	0	0,1
Richardia stiliaris	1,2	0	0	0,4
Echinochloa crusgalli	4,6	18,3	9,1	10,7
Erigeron sumatrensis	4,5	0	0	1,5
Axonopus compressus	0,8	0	0	0,3
Euphorbia hirta	0,4	0	0	0,1
Eleusine indica	0,4	0	0	0,1
Echinoclhoa colonum	0	5,3	0	1,8
Ageratum sp	0	2,2	37,2	13,1
Murdannia nudiflora	0	1,1	0	0,4
Digitaria sp	0	12,3	0,9	4,1
Cleome	0	0	0,5	0,2
Physalis angulata	0	0	0,7	0,2
Other weeds	0	0	13,9	0,4

and six times insecticides application, that resulted 2,0 - 2.5 t/ha of soybean yield. The five important weeds in the first soybean crops of the cropping pattern were *O. sativa* (seedlings stubble), *C. rotundus*, *P. niruri, E. crusgalli,* and *E. sumatrensis,* respectively (Table 2).

In Tegal Dlimo Subdistrict, soybeans are usually planted by broadcasting the seeds onto the rice field without any preemergence herbicide application. Consequently, weed population during vegetative growth phase of soybean crops was very high and it was difficult to control. Planting soybean by broadcasting the seeds on the ground is unfavorable because it triggers the growth of weeds due to irregular plant spacing. The plant spacing among soybean plants significantly affect the growth of weeds (Young *et al.* 2001; Hock *et al.* 2006) *i.e* at wide plant spacing the density of weeds is higher compared to those in narrow plant spacing, especially the interrow spacing. Five important weeds for soybean grown after the lowland rice in Gambiran were *O. sativa, E. crusgalli, Digitaria sp* and *C. rotundus, E. colonum* (Table 2). The soybean yield obtained with the existing technology generally in the range of 1.0-1.4 t/ha.

In Gambiran Subdistrict, farmers generally plant soybean after rice by broadcasting the seeds with inappropriate soil preparation and weed control. This is because soybean should be planted immediately after rice was harvested, meanwhile farmer faced labor shortage for preparing the soil and planting soybean especially when soybean should be planted with regular plant spacing. The weeds growth and densities are usually very high, so their effect on soybean growth and yield was very significant. The soybean yield obtained with farmer's technology was generally in the range of 0.8 to 1.2 t/ha. The five important weeds for soybean crops in Gambiran were *Ageratum* sp., *O. sativa, C. rotundus*, *E. crusgalli,* and *P. niruri* (Table 2).

The Effectiveness of Weed Control Technology

In line with the important or main weeds that were found during survey in Banyuwangi, the important weeds found in the control plots (no weeding treatment) of the field trial at Genteng, Banyuwangi were *Echinochloa sp., C. rotundus, P. niruri,* and *O. sativa*. This high population of *O. sativa* in the field trial (Table 3) was very common as the previous crop was rice, and postharvest losses in the form of grains were left on the fields. Weed control techniques could change the type of important or main weeds among the soybean crops. The high important value of weed means the weeds highly covered the field with high population and frequency.

This study showed that at 20 DAS the weeds control by twice hand weedings reduced the importance value of weeds, but did not reduce the

Table 3. Effect of weed control methods on the importance of weeds in soybean crops at 20, 40 and 60 DAS. Genteng. Dry season 2013

Weed species	Importance value of weed on different weed control method (DAS)																	
	No weeding			Twice Weeding			Pre emergence herbicide oksifluorfen			oksifluorfen + 2,4-D dimethylamide			oksifluorfen + Once weeding			Once Weeding		
	20	40	60	20	40	60	20	40	60	20	40	60	20	40	60	20	40	60
Amaranthus sp.	8.26	3.07	0	0.35	0.23	0.12	0	0.25	1.96	1.07	0	0	0	0.24	0.22	0.24	0.14	0.20
Richardia brasilliensis	12.12	3.48	0.11	0.31	0.14	0.18	41.39	0.47	12.36	0	0.27	0.23	24.56	0.45	0.21	0.26	0.28	0.32
Echinochloa colonumoa	6.47	14.58	0.34	0.39	0.86	0.32	9.96	0.62	1.03	0.42	0.51	0.31	5.86	0.72	0.94	0.27	0.65	0.34
Phaspalum dilatatum	13.74	8.64	0.38	0.54	0.39	0.66	5.80	0.34	19.97	0.14	0.32	0.81	8.82	0.38	0.37	0.59	0.34	0.90
Axonopus compresus	14.36	0.00	1.07	0.47	0.21	0.33	15.30	0	5.05	0.34	0	0.43	11.89	0	0.32	0.44	0	0.18
Oryza sativa	1.99	28.23	0.38	0.23	0.12	0.22	11.41	0.23	5.76	0.78	0.40	0.66	22.94	0.33	0.28	0.19	0	0.19
Philanthus niruri	28.79	19.28	0.26	0.36	0.39	0.45	0	0.40	12.40	0.13	0.53	0.15	0	0.13	0.24	0.65	0.36	0.31
Portulaca oleracea	7.07	0	0	0.17	0	0	0	0	0	0	0	0	0	0	0	0.10	0	0
Cyperus rotundus	7.42	16.67	0.28	0.10	0.57	0.63	18.15	0.53	41.12	0.46	0.34	0.36	27.98	0.55	0.78	0.20	0.49	0.57
Physalis angulata	2.03	2.34	0	0.11	0	0.13	0	0	0	0	0	0	0	0	0.18	0.14	0.27	0
Legetan	0	0.99	0.12	0.13	0.33	0	0	0	2.89	0	0	0	0	0.10	0.12	0.17	0	0
Digitaria sp.	0	0.12	0	0	0	0	0	0.36	0	0	0.78	0	0	0.19	0	0	0.60	0
Ageratum	0	0	0	0	0.12	0.25	0	0	0	0	0	0	0	0	0	0	0	0

DAS = Days after sowing

number of weed species growing. This means that hand weeding only reduced the population of individual weed and did not reduce the number of weed species that grow after weeding (Table 3). These findings are in accordance with Amare *et al*. (2014) who stated that hand weeding was effectively reduced weed population over control (untreated plot). Meanwhile, the use of preemergence herbicide besides capable of reducing the important weeds, it was also able to reduce weeds diversity (Table 3). The important weeds were significantly decreased by the combination treatment between pre-emergence herbicide oxyfluorfen and postemergence herbicide 2,4-D dimethylamide. The combination of pre and postemergence herbicides treatment was able to reduce the weed population similar to that obtained by twice hand weeding, and was also able to reduce more numbers of weed species (weeds diversity). Chauhan *et al.* (2012) and Anwar (2017) reported that combining herbicides was often more efective for controlling weeds rather than its individual application.

At 40 DAS, the use of preemergence herbicide oxyfluorfen was consistently reduce the importance of weeds value of each weed species similar to those of twice hand weeding, and it also reduced the number of weed species. It means, the application of preemergence herbicide caused the seeds of some weeds species were unable to germinate and resulted in weeds succession.The use of preemergence herbicide oxyfluorfen followed by postemergence herbicide 2,4-D dimethylamide reduced weeds growth better than that of twice hand weeding through the reduction of the importance value of all weeds species. Similarly, the use of preemergence herbicide oxyfluorfen followed by once hand weeding was able to decrease the growth of weeds (Table 3).

The application of preemergence herbicide oxyfluorfen reduced the growth of weeds up to 40 DAS (Table 3). The importance value of individual weeds decreased when the use of preemergence herbicide was accompanied by postemergence herbicide or with hand weeding. Weed control by preemergence herbicide, or by the combination of pre and postemergence herbicides, consistently reduced the species of weeds and the importance value of individual weed better than that of hand weeding.

Grasses weeds such as *R. brasilliensis, E. colonumoa, P. dilatatum, A. compresus* and *C. rotundus* are important weeds that could not be properly controlled by preemergence herbicide. The combination of pre and postemergence herbicides, however, it was more effective in controlling weeds. Jannink *et al.* (2000) reported that *C. rotundu*s was

difficult to control and significanly reduced the soybeans growth and yield due to competition of moisture, carbon dioxide, light,and nutrient. It seems that there was an allelopathic effects as well. *Amaranthus sp* and *P. niruri*are broad leaves weeds, are relativety have a short of life period, however they have rapid multiplication rate by producing a lot of seeds (Deuber 1992), so they are relativelly difficult to control. Table 3 shows that *P. niruri* is found in almost all treatments, while *P. oleracea* is a broad leaves weed that easiest to control. This weed was found only in 20 days old soybean crops and then it will not grow to any further. Other species of weeds such as *P. angulata, Digitaria sp.,* and *Ageratum* belong to the group of weeds that moderately difficult to be controlled.

The plant height of soybean at 20, 40, 60 DAS and harvest was not affected by all weed control methods including control treament (Table 4) due to faster weeds growth rather than the soybean plants growth. The use of preemergence herbicide oxyfluorfen as well as its combination with post-emergence herbicide 2,4-D dimethylamide did not inhibit the soybean growth. Akter *et al.* (2016) reported that weed management play a significant role in determining soybean growth and seed yield. The different sowing date and weed control methods had significant effect on relative weed density, weed biomass, plant height, and seed yield of soybean.

Weed control treatments increased number of filled pods and grain yield. The use of preemergence herbicide oxyfluorfen was able to produce highest number of filled pods, and subsequently followed by twice hand weedings, oxyfluorfen + once hand weeding, and once hand weeding (Table 5). Combination of preemergence herbicide oxyfluorfen and postemergence herbicide 2,4-D dimethylamide produced the highest grain yield of 2.11 t/ha or 251% higher than that without weed control (0.60 t/ha). However, the seed yield of this treatment did not significantly different from those of preemergence herbicide oxyfluorfen; oxyfluorfen + postemergence 2,4-D dimethiylamide, once hand weeding, and twice hand weeding (Table 5). In terms of labor use, the application of preemergence herbicide oxyfluorfen was more efficient compared to once or twice hand weedings. Peer *et al.* (2013) reported that integrated use of herbicides gave higher soybean seeds yield compared to its individual application. According to Akter *et al.* (2016) sowing date and weed management play a significant role in determining soybean growth and yield. The different sowing dates and weed control methods had significant effect on relative weed density, weed biomass, plant height, and seed yield of soybean. Two times hand weeding (20 and 40 DAS) controlled the weeds most effective and gave highest seed yield (2.23 t/ha) which was statistically similar (2.19 t/ha) to that of herbicide application.

CONCLUSION

Weeds become an important issue in soybean central production areas in Banyuwangi, East Java. The important weeds for soybean crops grown in dry season at the lowland after rice were *O. sativa, C. rotundus, E. crusgalli, P. niruri,* and *Ageratum sp.* The weeds could be effectively controled by the use of preemergence herbicide oxyfluorfen. This control method reduced the importance of weeds significantly, and increased soybean yield similar to the yield obtained by soybean crops with once or twice hand weedings. The soybean yields without any weeding, once hand weeding, preemergence herbicide oxyfluorfen were 0.60 t, 1.87 t, and 1.93 t/ha, respectively. From this research activity, it can be suggested that weed control in soybean cultivation is sufficiently useing preemergence herbicide oxyfluorfen. This method was able to give soybean yield equal to that of once or twice hand weedings.

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