Management of Weeds in Direct Seedling Rice with Mixed Herbicides Florpyrauxifen-Benzyl and Cyhalofop

Abdul Rizal AZ[1], Dyah Arbiwati[2]

[1]Department of Agrotechnology, Faculty of Agriculture, Universitas Pembangunan Nasional Veteran Yogyakarta, Indonesia, abdul.rizal@upnyk.ac.id
[2]Department of Soil Science, Faculty of Agriculture, Universitas Pembangunan Nasional Veteran Yogyakarta, Indonesia, d_arbi@upnyk.ac.id

Abstract

Weeds are a bigger problem in direct seeding rice systems compared to conventional ones, because weeds germinate and grow at the same time as the rice. so it's more competitive. Chemical weed control with herbicides, if done with one active ingredient repeatedly, will cause resistance which threatens biodiversity. This research aims to determine the appropriate dose of the Florpyrauxifen-Benzyl and Cyhalofop mixture in controlling weeds in direct seeding lowland rice plants. The research was conducted in Sambi Village, Sambirejo District, Sragen Regency, Central Java in July - November 2023. The experiment used a complete randomized block design, the treatments were: (1) Florpyrauxifen-Benzyl dose 1000 ml/ha. (2) Florpyrauxifen-Benzyl dose 1250 ml/ha, (3) Florpyrauxifen-Benzyl + chyalofop dose 750 ml/ha + 1000 ml/ha, (4) Florpyrauxifen-Benzyl + chyalofop dose 800 ml/ha + 1000 ml/ha (5) Manual control and (6) no weed control. The experiment was repeated in 4 repetitions with an area of 100 m in each experimental unit2. Research result: Herbicide application Florpyrauxifen-benzyl alone and Florpyrauxifen-benzyl at a dose of 1000 ml/ha b.a. + cyhalofop-butyl dose 750 ml/ha b.a. does not cause poisoning in rice plants. Florpyrauxifen-Benzyl + chyalofop dose 800 ml/ha + 1000 ml/ha showed very mild poisoning and symptoms of poisoning were not visible 14 days after application. Herbicide application Florpyrauxifen-benzyl alone against E. cruis-galli and L. chinensis Some control is not satisfactory, while broadleaf weeds are controlled. The mixed herbicide Florpyrauxifen-Benzyl+chyalofop provides perfect control for all target weeds. The rice yield saved by the single application of the herbicide Florpyrauxifen is between 47.44% - 50.57%, while with the use of the mixed herbicide Florpyrauxifen-benzyl+ cyhalofop-butyl it is 52% -53, 28%.

Keywords: Direct seedling rice, weeds, florpyrauxifen-benzyl, cyhalofop-butyl.

Direct seeding technology for rice has several advantages compared to transplanting or conventional systems, namely; saving time and labor, [1] overcoming the problem of labor shortages [2], saving production costs, the unit input-output rate is 20% - 25% higher than conventional, and the economic benefits increase significantly [3]. shorten the growth period [4], and can make full use of family labor [5].

Weeds are a bigger problem in direct seeding systems compared to conventional ones, because weeds germinate and grow at the same time as rice so they are more competitive [6]. Yield losses due to weeds can reach 75%, which accounts for more than 30% of the total costs incurred in rice cultivation [7]. Important weeds in rice fields are Echinochloa spp. Echinochloa crus-galli (L.) Beauv., Echinochloa colona (L.) Link., Echinochloa oryzicola Wasinger.), and Cyperus spp. (Cypress is deformed L., Cyperus esculentus L., Cyperus would L., Cypress round L. Species Leptochloa, Cynodon dactylon (L.) Pers., Eleusine indicates (L.) Gaertn., Ischaemum rugosum Salisb., and Paspal's couplet. This species is difficult to control primarily because of its tolerance to herbicides.[8]

Continuous use of herbicides with a single active ingredient can result in weed resistance problems to the herbicide. One alternative to extend weed resistance unless it is done using herbicides with different active ingredients in each application, can be using a mixture of herbicide active ingredients. The phenomenon of weed resistance to herbicides is a concern because its development in the field causes an increase in production costs [9.10].

In rice plants, two or more herbicide active ingredients are often combined and applied together to broaden the control spectrum. The combination of two or more herbicides provides an opportunity for interactions that can be greater than (synergistic) or less than (antagonistic) the expected response [11]. Management of rice weeds in direct seeding systems is very important, especially to find an effective combination of active ingredients to control weeds and maintain yields.

Some common herbicides used to control weeds in direct seed planting rice cultivation include Chyalofop. butachlor, pretilachlor. Pre-emergent herbicides can improve weed control when combined with other post-emergent herbicides [12]. Cyhalofop-butyl is very popular in controlling weeds by direct seeding of rice plants, and has selectivity properties so it does not affect rice. Cyhalofop-butyl is effective in controlling E. crusgalli and L. chinensis, and subsequent plants do not suffer from poisoning.

Florpyrauxifen-benxyl is a new active ingredient from the arylpicolinate herbicide family [13], may provide an alternative for controlling rice weeds. The herbicide Florpyrauxifen-Benzyl is a post-emergent herbicide to control broad-leaved weeds, grasses and sedges in rice [14,15]. Florpyrauxifen-benzyl developed for the United States rice weed (LoyantTM with active RinskorTM, Dow AgroSciences LLC, Indianapolis, IN), requires research to determine the herbicide spectrum. Florpyrauxifen-benzyl (FPB), a class herbicide (WSSA, HRAC Group 4), has been developed for selective use in rice with a broad spectrum of weed control even in rice that is confirmed to be resistant to other herbicides such as E. leg-cock which is quinclorac resistant. [16,13] POST herbicide for the control of broadleaf weeds, grasses, and sedges in rice [13,16]. Florpyrauxifen-Benzyl has the potential to provide efficient weed management for rice production. [17] Florpyrauxifen may provide an alternative mode of action for use in rice production. Mixing herbicides according to mode of action is important to prevent or delay the development of weed resistance [9]. Florpyrauxifen-benzil can be mixed with the herbicides cyhalofop, imazethapyr, penoxsulam, and quinclorac. Commercialization of pre-mixes containing cyhalofop or penoxsulam also appears to be beneficial for maximizing the control spectrum [15,16]

This research aims to determine the appropriate dose of the Florpyrauxifen-Benzyl and Cyhalofop mixture in controlling weeds in direct seeding lowland rice plants.

Methodology

The research was carried out in Jatisari Hamlet, Sambi Village, Sambirejo District, Sragen Regency, Central Java in July –

November 2023. The rice seeds used were the Ciherang cultivar. Urea, SP 36 and KCL fertilizer at recommended doses. The herbicides tested were herbicides containing the active ingredients florpyrauxifen-benzyl and cyhalofop

The field experiment was structured using a randomized complete block design (RCBD) with 4 replications. The treatments were (1) Florpyrauxifen-benzyl at a dose of 1000 ml/ha b.a., (2) Florpyrauxifen-benzyl at a dose of 1250 ml/ha b.a., (3) Florpyrauxifen-benzyl at a dose of 1000 ml/ha b.a. + cyhalofop-butyl dose 750 ml/ha b.a., (4) Florpyrauxifen-Benzyl + chyalofop dose 800 ml/ha + 1000 ml/ha. (5) Manual control and, (6) without weed control. The area of each experimental unit is 100 m2.

The target weeds in this research are: E. cross-galli (ECHCG), L. cinensis(LEFCH),C. difformis (CYPDI), F. miliace (FIMMI), S. zeylanica (SPDZE), L. octovalvis (LUDOC), M. vaginalis (MOVING), M. minute (MORE) C. would (CYPRIS).

Rice is planted with direct sowing seeds, seed requirements are 80 kg/ha. Herbicide applications are carried out when weeds (E. cruss-galli) 2-3 leaf stage (12-14 days after planting). Application Method Foliar spray with a spray volume of 300 L/ha, carried out in conditions where the soil is 1-2 cm waterlogged. Water flooding is carried out three days after herbicide application.

The observation parameters carried out were: Analysis of weed vegetation before planting and after application at 14 days after application (DAA), 28 DAA, 42 DAA and 56 DAA, using the quadratic method with a quadrant size of 100 cm X 100 cm.

Percent poisoning, carried out at 1, 3, 7, 14, 28 HSA, with scoring as follows: 0 = no visible poisoning (0%), 1 = very mild poisoning, only spots (1-3%), 2 = mild poisoning , on one part of the plant (4-7%), 3 = mild poisoning symptoms are visible (7-10%), 4 = yellowing or deformed leaves (15-20%), 5 = burnt leaves (21-25%), 6 = poisoning >25%, 7 , 8 = poisoning>85%= >50% poisoning, 9 = near death (86-95%), 10 = total death. The summed dominance ratio (SDR) is calculated from the relative density and relative frequency divided by two [18]

Weed control efficiency per species in each treatment plot is calculatedat 14, 28, 42 and 56 DAA, using the Abbot formula.

Abbot's Formula:

% Control=

$$\left(\left(\frac{N_{UT}-N_T}{N_{UT}}\right)\right)\times 100$$

(1) NUT = weight of weeds in plots without treatment at the time of observation (2)

NT = Number of weeds in the treatment at the time of observation

According to the standard for observing weed efficiency based on the EWRC scoring reference for efficacy and crop tolerance. Weed control is categorized into 8 categories with a score of 1 (WCE 100%), complete kills, score 2 (WCE 98% - 99%), dead weeds with no green parts visible (Excellent), score 3 (WCE 96% - 98%) weeds are controlled, Scor 4 (WCE 90-95) weeds are quite well controlled, the level of control is acceptable (generally acceptable), Scor 5 weeds (WCE 83%-89%) are partially controlled are not quite satisfactory (moderate but not generally acceptable) Score 6 (WCE 70-82) mostly still looks green (fair), score 7 (WCE 55%-69%) Only half of the weeds are dead (poor) and score 8 WCE (0%-30%) weeds are not affected by treatment (none).

The yield of milled dry grain is calculated using tiles measuring 2.5 mX 25 m.

Discussion

Dominant Weed before experiment

The crop rotation pattern at the research site is rice-rice-rice with technical irrigation, water is available throughout the year. Analysis of weeds before planting found 7 weed species, Dominiman weed is and cruss-roosters with a Sum Dominance Ratio (SDR) of 45.2% followed by co-dominant weeds F. miliace SDR = 35.7% further, L. cinensis SDR = 7.3% Cyperus sp SDR

=8.2 %., S. zeylanica, SDR =2.4% L. octovalvis SDR = 1.2 %

Herbicide Application

As an indicator of herbicide application carried out at the time E. crus-galli is leafy 2-3. Amount E. leg-cock 2-3 leaves in each experimental plot were obtained on average in the treatment: Florpyrauxifen-benzyl dose 1000 ml/ha b.a. as many as 25 weeds, Florpyrauxifen-benzyl dose 1250 ml/ha b.a. 24 weeds, Florpyrauxifen-benzyl dose 1000 ml/ha b.a. + cyhalofop-butyl dose 750 ml/ha b.a. 30 weeds, Florpyrauxifen-benzyl dose 800 ml/ha b.a. + cyhalofop-butyl1000 ml/ha b.a. as many as 32 weeds, manual control of 25 weeds and no weed control of 32 weeds. From the indicators above, herbicide control is carried out at 13 days after planting. The results of calculating the community coefficient for each plot show a value above 83 percent, meaning that it can be concluded that the experimental plots can be said to be uniform.

Phytotoxicity Rice Plant

Poisoning of rice plants occurred during treatment Florpyrauxifene-benzyl dose 800 ml/ha b.a. + cyhalofop-butyl 1000 ml/ha b.a. with the characteristicsvery light, visible spots on the leaves (1-3%) score 1. Poisoning appears on day 3 after herbicide application, gradually disappears. Poisoning was no longer visible on day 14 of DAA. Other herbicide application treatments did not show poisoning of rice plants.

Analysis of weed vegetation in each treatment.

Vegetation analysis in the control plot found 8 target weeds and Cruss-galliis a weed dominant and L. cinensisgulma co dominane.

Table 1,2,3, shows the results in the Florpyrauxifen-benzyl treatment at a dose of 1000 ml/ha b.a., and the Florpyrauxifen-benzyl treatment at a dose of 1250, ml/ha b.a. still found E. Cruss-galli, L. cinensis, C. difformis, C. iria, F. miliace. On treatment Florpyrauxifene-benzyl dose 1000, ml/ha b.a weed S. zeylanica it was still found but at a dose of 1250 ml/ha b.a its presence was not found. L. octovalvis and M. vaginalis. This dose was not found but was found in the control plot. E. Cruss-galli was the dominant weed at 14. 28. 42 and 56 DAA.

In the Florpyrauxifen-benzyl treatment, the dose was 1000 ml/ha b.a. + cyhalofop-butyl dose 750 ml/ha b.a., and Florpyrauxifen-Benzyl + chyalofop dose 800 ml/ha + 1000 ml/ha, all target weeds can be controlled. In manual treatment, the farmer's method is by using manual weed control tools 45 HST. there are still weeds and cruss-roosters and L. cinensis at 42 and 56 DAA.

Table 1. Summed Dominance Ratio E cruss-galli and L. cinensis (Gramineae)

Treatment	SDR (%) *E cruss-galli* --. DAA				SDR (%) *L. cinensis* …DAA			
	14	28	42	56	14	28	42	56
A	29.4	15.2	7.2	15.3	15.7	17.5	12.4	14.7
B	19.4	4.40	5.4	14.40	0	9.9	13.7	23.2
C	0	0	0	0	0	0	0	0
D	0	0	0	0	0	0	0	0
E	0	0	12,7	13.2	0	0	0	10,2
F	15.6	15.5	21.2	16.3	15.5	8.7	17.7	17.2

Notes; A. Florpyrauxifen-benzyl dose 1000 ml/ha b.a. B Florpyrauxifen-benzyl dose 1250 ml/ha b.a., C. Florpyrauxifen-benzyl dose 1000 ml/ha b.a. + cyhalofop-butyl dose 750 ml/ha b.a., D. Florpyrauxifen-Benzyl + chyalofop dose 800 ml/ha + 1000 ml/ha. E. Farmer's control and F. without weed control

Table 2. Summed Dominance Ratio C. difformis, C.iria and F miliace (sedges)

Treatment	SDR (%) *C. difformis* ..DAA				SDR (%) *C. iria* ... DAA				SDR (%) *F. miliace* ... DAA			
	14	28	42	56	14	28	42	56	14	28	42	56
A	19.4	15.7	12.7	11.4	18.1	22.1	18.2	13.2	10.1	14.5	13.1	30.4
B	16.1	22.5	26.1	19.7	24.5	10	15.5	13.5	14	20.1	30.1	24.3
C	0	0	0	0	0	0	0	0	0	0	0	0
D	0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	0	12.6	0	0	0	0	0	0	0	0
F	11.2	10.7	15.9	10	9.1	12.7	12.4	17.4	12.4	14.6	15.3	16.3

Note; A. Florpyrauxifen-benzyl dose 1000 ml/ha b.a., B. Florpyrauxifen-benzyl dose 1250 ml/ha b.a., C. Florpyrauxifen-benzyl dose 1000 ml/ha b.a. + cyhalofop-butyl dose 750 ml/ha b.a., D. Florpyrauxifen-Benzyl + chyalofop dose 800 ml/ha + 1000 ml/ha. E. Farmer's control and F. without weed control

Table 3. Summed Dominance Ratio Analisis vegetasi S. zeylanica, L. octovalvis and M. vaginalis (Brodleaf)

Treatment	SDR (%) *S. zeylanica*... …DAA				SDR (%), *L. octovalvis* …DAA				SDR (%)*M. vaginalis* .. ...DAA			
	14	28	42	56	14	28	42	56	14	28	42	56
A	17.4	15	26.3	15	0	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0	0	0	0	0	0
C	0	7.5	10.3	0	0	0	0	0	0	0	0	0
D	0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0	0	0	0	0
F	28.4	30	7.3	6	4.2	3.5	5.8	13.6	3.6	4.3	3.2	3.2

Note; A. Florpyrauxifen-benzyl dose 1000 ml/ha b.a., B. Florpyrauxifen-benzyl dose 1250 ml/ha b.a., C. Florpyrauxifen-benzyl dose 1000 ml/ha b.a. + cyhalofop-butyl dose 750 ml/ha b.a., D. Florpyrauxifen-Benzyl + chyalofop dose 800 ml/ha + 1000 ml/ha. F. Farmer control and (6) no weed control

Weed Control Efficiency

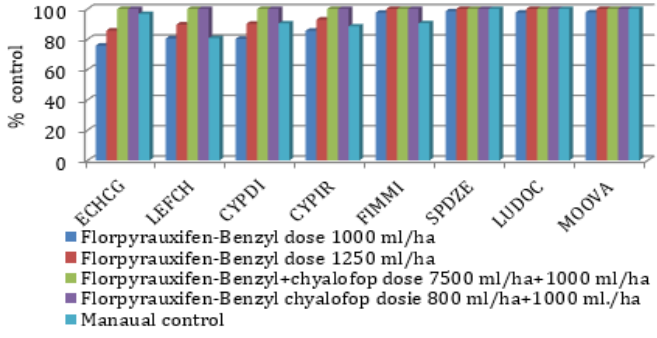


Fig. 1. Weed Control Efficiency 14 DAA

Figures 1. 2. 3 and 4. show Efficiency at 14, 28, 42 and 56 DAA

Weed Control Efficiency 14 DAA (Figure 1) shows that in the treatmentFlorpyrauxifene-

benzyl dose 1000 ml/ha b.a.,E. crus-galli, L. Chinensis, and C. diformismost still look green (score 6) with consecutive WCE values of 75.8%, 80.5% and 80.30%, whileC.iria andF. miliace partially controlled but not enough to satisfy WCE values of 85.6% and 85.9% (Score 5). All broadleaf weeds (S. zylanica, L. octovalvis andM. vaginalis all the weeds are dead, no green parts can be seen (Scor 2). On treatmentFlorpyrauxifene-benzyl dose 1250 ml/ha b.a. E. crusgalli andL. chinensis controlled with WCE 85.7 and 89.7% (score 5). C. diformis, C. iria and F. miliacecontrolled quite well WCE 95.2%, 95% and 95,3% (score 4). TreatmentFlorpyrauxifen-benzyl dosis 1000 ml/ha b.a. + cyhalofop-butyl dosis 750 ml/ha b.a., (4) Florpyrauxifen-Benzyl + chyalofop dosis 800 ml/ha + 1000 ml/ha. provides perfect handling WCE 100% (scor 1). Handling the farmer's way provide control with value WCE 90%-95% weed control is pretty goods, the level of control is acceptable (generally acceptable).

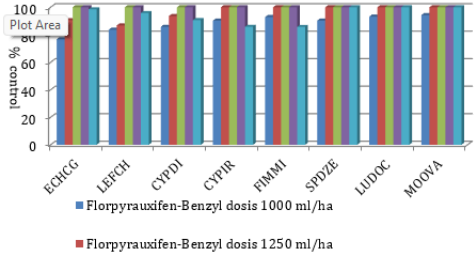


Figure 2. Weed Control Efficiency 28 DAA

Weed Control Efficiency 28 DAA (picture 2) shows that in the treatment of Florpyrauxifen-benzyl dose 1000 ml/ha b.a., E. cruss-galli, L. chinensis, and C. diformis partially controlled, not quite satisfactory (moderate but not generally acceptable), included in a score of 5 (WCE 83%-89%), moderate C. would largely under control but not satisfactory (scor 4) and broadleaf weeds (S. zylenica, L. octovalvis , M. vaginalis) controlled quite well, the level of control is acceptable (Scor 4). Florpyrauxifen-benzyl treatment dose 1000 ml/ha b.a. + cyhalofop-butyl dose 750 ml/ha b.a., (4) Florpyrauxifen-Benzyl + chyalofop dose 800 ml/ha + 1000 ml/ha. provides perfect control WCE 100% (scor 1). The control method used by farmers provides a WCE value of 90%-95% of controlled weeds which is quite good, the level of control is generally acceptable.

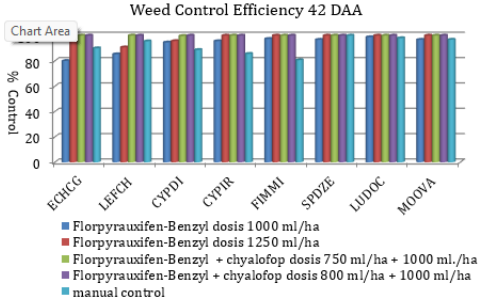


Figure 3. Weed Control Efficiency 42 DAA

Florpyrauxifen-benzyl dose 1000 ml/ha b.a., shows that E. cruss-galli, L. chinensis, and C. diformis partially controlled, not quite satisfactory (moderate but not generally acceptable), included in a score of 5 (WCE 83%-89%), moderate C. would mostly under control but not quite satisfactory (WCE 86.3% = score 4). broadleaf weeds provide a fairly good level of controlled weed control, an acceptable level of control (Scor 4). Florpyrauxifen-benzyl treatment dose 1000 ml/ha b.a. + cyhalofop-butyl dose 750 ml/ha b.a., and Florpyrauxifen-Benzyl + chyalofop dose 800 ml/ha + 1000 ml/ha. provides perfect control WCE 100% (scor 1). The control method used by farmers to provide weed control is quite good, the level of control is acceptable (generally acceptable).

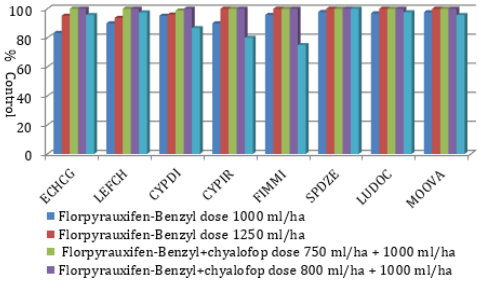
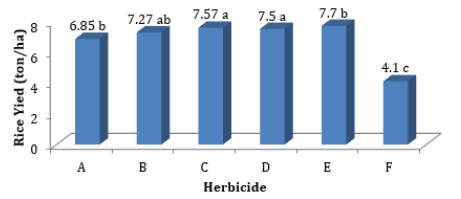


Fig. 4. Weed Control Efficiency 56 DAA

Weed Control Efficacy 56 DAA (Figure 4) Florpyrauxifen-benzyl dose 1000 ml/ha b.a., shows thatE.cruss-gall and L. Chinensis controlled is not satisfactory enough (WEC 83.4% and 89.3%) Score 5.C. diformis most still look green with a WCE value of 96.2%, (Score 3), mediumC. would WCE = 90% (Scor 4) weed control is quite good, control is acceptable. Broadleaf weeds under control (Scor 3). In the Florpyrauxifen-benzyl treatment the dose was 1250 ml/ha b.a., E. the leg of the rooster and L. chinens is partially controlled, not quite satisfactory WCE 85.2% and 85.7% (score at 5). C. diformis and C. would control is quite good, the level of control is acceptable (generally acceptable = score 4), Broadleaf weeds provide perfect control, WCE 100%. (Score 1). Florpyrauxifen-benzyl treatment dose 1000 ml/ha b.a. + cyhalofop-butyl dose 750 ml/ha b.a. and Florpyrauxifen-Benzyl + chyalofop dose 800 ml/ha + 1000 ml/ha. all weeds are perfectly controlled WCE 100% (scor 1). Manual control is still available E. Crus-galli and L. chinensis, but controlled with WCE 96,7% and 97,5%.

Rice crop yields

The yield of the rice crop was weighed with a rice water content of 14% (Figure 5).



A. Florpyrauxifen-benzyl dose 1000 ml/ha b.a.
B. Florpyrauxifen-benzyl dose 1250 ml/ha b.a.,
C. Florpyrauxifen-benzyl dose 750 ml/ha b.a.+cyhalofop-butyl dose 1000 ml/ha b.a.,
D. Florpyrauxifen-Benzyl dose 800 ml/ha b.a.+chyalofop-butyl doses 1000 ml/ha b.a.

Fig.5. Effect of herbicide application on rice yield (ton/ha)

The results of variance analysis show that there is an influence of herbicide application on rice yields. Application treatment of the herbicide Florpyrauxifen-benzyl at a dose of 1000 ml/ha b.a. showed no significant difference with Florpyrauxifen-benzyl at a dose of 1250 ml/ha b.a., but Florpyrauxifen-benzyl at a dose of 1250 ml/ha b.a., did not show a significant difference to the herbicide Florpyrauxifen-benzyl at a dose of 1000 ml/ha b.a. + cyhalofop-butyl dose 750 ml/ha b.a. and Florpyrauxifen-Benzyl + chyalofop butyl dose 800 ml/ha + 1000 ml/ha. and manual control. The results without treatment showed the lowest results and were significantly different from other treatments. The yield saved by using the herbicide Florpyrauxifen alone ranges from 47.44% - 50.57%, while using the mixed herbicide Florpyrauxifen-benzyl+ cyhalofop-butyl is 52% -53.28%. High yields when using mixed herbicides can be caused by a perfect control effect (scor 1), so that there is no competition between weeds and rice plants.

Conclusion

Application of the herbicide Florpyrauxifen-benzyl alone and Florpyrauxifen-benzyl at a dose of 1000 ml/ha b.a. + cyhalofop-butyl dose 750 ml/ha b.a. does not cause poisoning in rice plants. Florpyrauxifen-Benzyl + chyalofop dose 800 ml/ha + 1000 ml/ha showed very mild

poisoning and symptoms of poisoning were not visible 14 days after application.

Single application of the herbuicide Florpyrauxifen-benzyl againstE. cruis-galli andL. chinensis Some control is not satisfactory, while broadleaf weeds are controlled. The mixed herbiicide Florpyrauxifen-Benzyl+chyalofop provides excellent control of all target weeds.

The yield saved by using the herbicide Florpyrauxifen alone ranges from 47.44% - 50.57%, while using the mixed herbicide Florpyrauxifen-benzyl+ cyhalofop-butyl is 52% -53.28%.

Thank-you note

Thank you to LPPM UPN Veteran Yogyakarta for providing research costs through research grants, so that this research can be carried out.

WORKS CITED

Xia Su, Jingjing Zhan, Juqin Wang, Xiaomin Li, Yihao Wei, Hui Wu*, Haifang Dai.2022* Development Status of Direct Seeding Rice and Study on Response Mechanism of Submergence. Open Access Library Journal DOI: 10.4236/oalib.1108613

Ning, Y.N. and Yang, S.D. (2020) Advantages, Disadvantages, and Promotion Suggestions of Rice Machine Direct Seeding Technology. Modern Agricultural Science and Technology, 49, 43, 45. http://doi.org/10.3969/j.issn.1007-5739.2020.06.024

Kong, L.J., Wang, X.G. and Pan, G.Y. (2018) Investigation and Reflection on the Production of Direct Seeding Rice in Anhui Province. Anhui Agronomy Bulletin, 24, 34-36. http://doi.org/10.3969/j.issn.1007-7731.2018.02.011

Zhang, H., Yu, C., Chen, K.W., Kong, X.S., Liu, H.L., Chen, J.Y., Gu, J.F., Liu, L.J., Wang, Z.Q. and Yang, J.C. (2017) Effect of Direct-Seeding Methods on Physiological Characteristics and Grain Yield of Rice and Its Cost Analysis. Journal of Agricultural Engineering, 33, 58-64. http://doi.org/10.11975/j.issn.1002-6819.2017.13.008

Wang, Y., Zhang, Z.L., Zhang, Y.S. and Cui, H.G. (2007) Research and Progress of Rice Direct Sowing at Home and Abroad. Journal of Agricultural Mechanization Research, 29, 48-50. http://doi.org/10.3969/j.issn.1003-188X.2007.01.016

Chauhan, B.S. 2012. Weed Management in Direct-Seeded Rice Systems; International Rice Research Institute: Los Baños, Philippines, p. 20.

Rao, A.; Johnson, D.; Sivaprasad, B.; Ladha, J.; Mortimer, A. 2007. Weed anagement in Directt-Seeded Rice. Adv. Agron. 2007, 93, 153-255

Kraehmer, H.; Jabran, K.; Mennan, H.; Chauhan, B.S. 2016. Global distribution of rice weeds A review. Crop Prot.; 2016; 80, pp. 73-86. [DOI: https://dx.doi.org/10.1016/j.cropro.2015.10.027

Norsworthy, Jason K; Ward, Sarah M; Shaw, David R; Llewellyn, Rick S; Nichols, Robert L;2012l. Reducing the Risks of Herbicide Resistance: Best Management Practices and Recommendations. Weed Science; Lawrence Vol. 60, (2012): 31-62

Pannell, D.J.; Tillie, P.; Rodríguez-Cerezo, E.; Ervin, D.; Frisvold, G.B. Herbicide resistance: Economic and environmental challenges. AgBioForum; 2016; 19, pp. 136-155.

Fish, John Caleb; Webster, Eric P; Blouin, David C; Bond, Jason A. 2015. Imazethapyr Co- Application Interactions in Imidazolinone-Resistant Rice.Weed Technology; Lawrence Vol. 29, Iss. 4, (Oct-Dec 2015): 689-696.

Martin, Robert; Bunna Som; Janiya, Joel; Ratha Rien; Yous, Sophea; 2020. Integrated Management of Weeds in Direct-Seeded Rice in Cambodia.. Agronomy; Basel Vol. 10, Iss. 10, (2020): 1557. DOI:10.3390/agronomy10101557

Epp, J.B.; Alexander, A.L.; Balko, T.W.; Buysse, A.M.; Brewster, W.K.; Bryan, K.; Daeuble, J.F.; Fields, S.C.; Gast, R.E.; Green, R.A.2016,l. The discovery of ArylexTM active and RinskorTM active: Two novel auxin herbicides. Bioorg. Med. Chem.; 2016; 24, pp. 362-371. [DOI; https://dx.doi.org/10.1016/j.bmc.2015.08.011] [PubMed: https://www.ncbi.nlm.nih.gov/pubmed/26321602]

Perry DH, Ellis AT, Langston VB, Lassiter R, Thompson GD, Viator RP, Walton LC, Weimer MR (2015) Utility of a new arylpicolinate herbicide from Dow Agrosciences in U.S. mid-south rice. Weed Sci Soc Am Abst 55:204. http://wssaabstracts.com/public/30/abstract-204.html. Accessed: Agst. 14, 2022

Ryan Miller, M.; Norsworthy, J.K.; Scott, R.C. 2018a. Evaluation of florpyrauxifen-benzyl on herbicide-resistant and herbicide-susceptible barnyardgrass accessions. Weed Technol.; 2018; 32, pp. 126-134. [DOI: https://dx.doi.org/10.1017/wet.2017.100]

Ryan Miller; Norsworthy, Jason K . 2018b. Florpyrauxifen-benzyl Weed Control Spectrum and Tank- Mix Compatibility with other Commonly Applied Herbicides in Rice. Weed Technology; Lawrence Vol. 32, Iss. 3, (Jun 2018):319-325. DOI:10.1017/wet.2017.107

Travlos, I.; Kanatas, P.; Tsekoura, A.; Gazoulis, I.; Papastylianou1, P.; Kakabouki, I.; Antonopoulos, N. 2020. Effcacy of Different Herbicides on Echinochloa colona (L.) Link. Control and the First Case of Its Glyphosate Resistance in Greece. Agronomy; 2020; 10, 1056. [DOI: https://dx.doi.org/10.3390/agronomy10071056]

Chen, Yi Chang, Chen Fa Wu, and Shin Hwei Lin. 2014. Mechanisms of Forest Restoration in Landslide Treatment Areas. Sustainability 6: 6766–6780. doi:10.3390/su6106766.