Urea effectivity as herbicide adjuvant to control weed in minimum tillage system

Suarna Samai¹ and Muhidin²
¹Department of Biological Education, Faculty of Education, Halu Oleo University, Kendari, Southeast Sulawesi, 93232 Indonesia
²Department of Agrotechnology, Faculty of Agriculture, Halu Oleo University Kendari, Southeast Sulawesi, 93232 Indonesia

E-mail: annasamai65.hanako@gmail.com

Abstract: Efforts to reduce weed control costs, especially in minimum tillage land, can be done by reducing the dose of herbicide per hectare, and the addition of urea fertilizer replaces this reduction. The research was designed using a randomized block design with three replications. The treatments were application of glyphosate 1.44 kg ha⁻¹, 1.80 kg ha⁻¹, and 2.16 kg ha⁻¹ in combination with without urea; urea 5 kg ha⁻¹, 10 kg ha⁻¹ and 15 kg ha⁻¹, and application on minimum tillage, full tillage and control. The results showed that the addition of adjuvants from urea and glyphosate could control weeds, especially in reed weeds in the mixing of herbicide glyphosate 1.44 kg ha⁻¹ + urea 10 kg ha⁻¹, while herbicides 1.44 kg ha⁻¹ + Urea 5 kg ha⁻¹ and glyphosate 1.80 kg ha⁻¹ + Urea 5 kg ha⁻¹ have the same control power effectiveness as glyphosate dose of 2.16 kg ha⁻¹, urea dose of 5 kg ha⁻¹ the effectiveness is equal to 1.80 kg ha⁻¹ + Urea 15 kg ha⁻¹. The herbicide glyphosate disrupts metabolism in plants, causing abnormal growth or even killing weeds. Mixing does not cause poisoning of the corn crop. The use of herbicide glyphosate 1.44 kg ha⁻¹ + Urea 10 kg ha⁻¹ is better based on plant poisoning and corn production. The optimum dose that can minimize the weed population is 8.650 grams, and the combination of herbicide Glyphosate and Urea is effective in controlling weeds with minimum conditions at 1.158 grams of glyphosate and 1.146 grams of Urea.

1. Introduction
Weed control using herbicides is currently considered the best [1-2]. Several environmentally friendly weed control methods have been tested among others using deleterious rhizobacteria [3-4], [5]. However, herbicide use is often an option. This is because besides being effective in suppressing weed populations, it is also far more practical in its implementation, even though weeds have very good adaptation to the environment including herbicides [6-7]. The effectiveness of chemical weed control is strongly influenced by the dose, method of application or use of herbicides used and also supported by environmental conditions [8]. Other advantages are the use of less labor, shorter control times, and
relatively low costs, especially in large areas compared to mechanical control, which is still commonly used by farmers [9].

Glyphosate is a herbicide that is widely used. Glyphosate is a non-selective, post-growth herbicide with a broad spectrum and relatively safe for the environment [10-12]. The use of glyphosate as a post emergence herbicide to suppress the growth of weeds and some broadleaf weeds is also very effective for nut wees.

The success of using glyphosate in weed control takes at least 6 hours after application [13]. Glyphosate is a systemic herbicide that is applied through the leaves and then translocated to all parts of the plant and usually directly disrupts metabolic processes in plants, especially in enzymatic reactions, inhibits growth, occurs chlorosis and necrosis after 4-7 days after application for very sensitive plants, while plants that are less sensitivity 10-20 days after application [14]. Optimization of weed control can be done by mixing two or more active herbicide ingredients in one application, to increase its efficacy [12,15,16]. Anticipation of weaknesses can also be done by combining or mixing herbicides with fertilizers as an adjuvant, so that herbicides are more effective and efficient in controlling weeds [17].

In mixing herbicides and “adjuvants”, a synergistic effect is usually obtained [18], so that the number of controlled weeds increases, does not cause weed resistance, and prevents the formation of weed vegetation which leads to homogeneous weed growth [19-21]. One of the materials that can be used as an adjuvant is urea. Urea can increase the effectiveness of herbicides [22-23]. Several other substances that can be used as an “adjuvant" include ammonium nitrate, Urea, ammonium chloride, ammonium nitrate-Urea and ammonium sulfate [24-25].

Herbicide applications will generally be effective in conservation soil management models with minimum tillage system (MTS) [26]. So far, farmers prefer the conventional land cultivation system, because it has become a habit. The conventional tillage system has so far triggered environmental degradation and decreased soil productivity, so that the MTS to overcome the bad consequences of conventional tillage system [6,27]. In the MTS system, the application of herbicides is needed as a substitute for tillage to kill existing plant debris and to prepare planting areas that are free from weeds.

2. Methods

The experiment used was a randomized block design (RBD), which consisted of 15 treatments repeated 3 (three times), in order to obtain 45 experimental units consisting of 15 as "adjuvants" using Urea with the herbicide in active ingredients as Glyphosate (Round Up). The treatments are as follows: (1) = Glyphosate 1.44 kg ha⁻¹, without urea. (2) = Glyphosate 1.80 kg ha⁻¹, without urea, (3) = glyphosate 2.16 kg ha⁻¹, without urea. (4) = Glyphosate 1.44 kg ha⁻¹ + Urea 5 kg ha⁻¹. (5) = Glyphosate 1.80 kg ha⁻¹ + Urea 5 kg ha⁻¹. (6) = Glyphosate 2.16 kg ha⁻¹ + Urea 5 kg ha⁻¹. (7) = Glyphosate 1.44 kg ha⁻¹ + Urea 10 kg ha⁻¹. (8) = Glyphosate 1.80 kg ha⁻¹ + Urea 10 kg ha⁻¹. (9) = Glyphosate 2.16 kg ha⁻¹ + Urea 10 kg ha⁻¹. (10) = Glyphosate 1.44 kg ha⁻¹ + Urea 15 kg ha⁻¹. (11) = Glyphosate 1.80 kg ha⁻¹ + Urea 15 kg ha⁻¹. (12) = Glyphosate 2.16 kg ha⁻¹ + Urea 15 kg ha⁻¹. (13) = Conventional Tillage (Without glyphosate and urea). (14) = Minimum Tillage System (Without glyphosate and urea). (15) = Control (Without tillage, glyphosate and urea). Samples of weeds and plants were taken from sample plots, using destructive plots measuring 0.5 m X 0.5 m, while crop yields were taken from harvest plots measuring 5.50 m X 2 m. Regression analysis was carried out on observations of average growth rate (AGR) and average plant growth rate (APG) according to plant development in order to obtain a plant development curve (Draper and Smith, 1992). Plant damage was analyzed using variance, to determine the difference between the two treatment means the Scott-Knott statistical test was used.

3. Results and Discussion

The presence of new weeds, apart from the application of the herbicide glyphosate is also caused by favorable environmental conditions such as temperature, light, water and soil moisture, which are very helpful and beneficial to certain weeds. In this experiment, changes in weed populations were found, where some of the weeds that grew after herbicide application were not found. It is assumed that in the
herbicide treatment there was a change in environmental factors, causing changes in composition and reduction of existing weeds. Weed growth rate is the rate of adding the total dry weight per unit land area per unit time. The development of weed growth rates averaged 14 days after planting (DAP) at various doses of the quadratic pattern of glyphosate herbicide based on regression analysis (figure 1). The growth rates of all weeds increased from the start to 42-56 DAP, then decreased at 56-70 DAP.

![Figure 1. Effect of Urea as Herbicide Adjuvant on Growth Rate of Corn.](image)

At 28-42 DAP, 42-56 DAP and 56-70 DAP shows the weed growth rate decreased due to the application of the herbicide Glyphosate which greatly affected weed growth and was effective in controlling weeds. Application of the herbicide Glyphosate decreased the average weed growth rate. The low glyphosate dose is 0.72 kg ha$^{-1}$ + 0.87 polyoxymethylene tallow amine did not provide satisfactory control in Imperata cylindrica [17], but generally controlled other weeds. The decrease in the rate of additional dry weight of weeds was not only due to competition between weeds and corn plants, but also due to the closure of the corn plant canopy to sunlight as a source of photosynthesis. In line with the opinion that the shade from the plant canopy inhibited germination of weed seeds under the canopy [19]. The cause of decreasing weed growth rate is also caused by the application of herbicides which have an impact on inhibiting weed growth and have an impact on inhibiting the accumulation of dry matter.

Based on the Scot Knott test, the dose of glyphosate 1.44 kg ha$^{-1}$ with the addition of Urea 5, 10 kg ha$^{-1}$ and 15 kg ha$^{-1}$ showed effectiveness in suppressing the percentage of weed growth at 28-42 DAP and at 42-56 DAP. The low doses of glyphosate were quite effective in suppressing weed growth and tended to increase with the increasing concentration of surfactants added [28]. The treatment of low doses of 360 g ha$^{-1}$ + pulse 0.1% and 0.5% increased the dry weight of grass weeds [12], higher than those without adjuvant (table 1).
Table 1. Weed Damage Due to Application of the Herbicide Glyphosate (gram).

| Glyphosate Dosage in Active Ingredient kg ha\(^{-1}\)+ Urea kg ha\(^{-1}\) (gram) | 14 DAP   | 28 DAP   |
|-----------------------------------------------------------------------------|----------|----------|
| A = Glyphosate 1.44 + without urea                                        | 22.590 a | 48.211 a |
| B = Glyphosate 1.80 + without Urea                                        | 29.520 b | 48.645 a |
| C = Glyphosate 2.16 + without Urea                                        | 35.710 b | 49.554 a |
| D = Glyphosate 1.44 + Urea 5                                              | 25.157 a | 56.457 b |
| E = Glyphosate 1.80 + Urea 5                                              | 27.217 a | 62.101 b |
| F = Glyphosate 2.16 + Urea 5                                              | 36.897 b | 59.521 b |
| G = Glyphosate 1.44 + Urea 10                                             | 41.220 b | 58.292 b |
| H = Gilfosat 1.80 + Urea 10                                               | 34.423 b | 60.735 b |
| I = Glyphosate 2.16 + Urea 10                                             | 35.710 b | 63.914 b |
| J = Glyphosate 1.44 + Urea 15                                              | 27.423 a | 65.329 b |
| K = Glyphosate 1.80 + Urea 15                                             | 32.060 b | 63.506 b |
| L = Glyphosate 2.16 + Urea 15                                             | 40.130 b | 64.259 b |

Remarks: Number follow with the same suffix unsignificant different base on Scott Knott Test at \(\alpha\) 5%

Based on the results of Scott Knott's test on 14 DAP observations, the higher the dose of glyphosate the greater the effect of damage to weeds. Glyphosate dosage 1.44 kg ha\(^{-1}\) tested significantly different with a dose of 1.80 kg ha\(^{-1}\). However, it is not significantly different from the dose of 2.16 kg ha\(^{-1}\), this means that 1.80 kg ha\(^{-1}\) has been able to control weeds well. At 14 DAP, the application of Glyphosate did not cause death, but resulted in a change in shape and became a rosette. This situation is due to the mode of action of the herbicide which actively inhibits the formation of tyrosine, tryptophan and phenylalanine. The damage caused by the application of the herbicide Glyphosate is characterized by symptoms in the form of shrinkage and / or changes in the shape of the plant leaves [20]. At 28 DAP, the addition of urea to glyphosate was able to increase weed damage, from the observation that the dose of herbicide mixing with the addition of Urea 5 kg ha\(^{-1}\), 10 ha\(^{-1}\) and 15 ha\(^{-1}\) was significantly different from the dose of glyphosate without urea.

4. Conclusion
It can conclude that urea was effective as adjuvant to increase glyphosate effectivity in control of weed. The optimum dose that can minimize the weed population is 8,650 grams, and the combination of herbicide Glyphosate and Urea is effective in controlling weeds with minimum conditions at 1,158 grams of glyphosate and 1,146 grams of Urea.

References
[1] Perkasa A Y, Ghulamahdi M and Guntoro D 2016 Penggunaan herbisida untuk pengendalian gulma pada budi daya kedelai jenuh air di lahan pasang surut J. Penelit. Pertan. Tanam. Pangan 35 63
[2] Hafsah S, Hasanuddin and Vona M 2019 Corn plant response to several weed control methods on land without tillage J. Agrista 23 32–45
[3] Rakian T C, Fermin U, Bahrawi A, Gusnawaty HS, Asniah, Muhidin, Sutariati G A K and Leomo S 2018 Effectiveness of pseudomonas aeruginosa A08 formulated as bioherbicide for weed control in soybean Biosci. Res. 15 3240–6
[4] Rakian T C, Muhidin, Sutariati G, Gusnawaty H S, Asniah and Fermin U 2018 Selection of deleterious rhizobacterial isolate as bioherbicide to control of weed paspalum conjugatum and ageratum conyzoides on soybean cropland J. Bioscience Research 15 1695–702
[5] Rakian T C, Karimuna L, Taufik M, Sutariati G A K, Muhidin and Fermin U 2018 The effectiveness of various Rhizobacteria carriers to improve the shelf life and the stability of
rhizobacteria as bioherbicide IOP Conference Series: Earth and Environmental Science vol 122

[6] Abbas T, Zahir Z, Naveed M and Kremer R 2018 Limitations of existing weed control practices necessitate development of alternative techniques based on biological approaches Adv. Agron. 147 239–80

[7] Lakara K, Verma S, Maurya A, Singh S, Meena R S and Shukla U 2019 Enhancing crop competitiveness through sustainable weed management practices (India:Scientific Publisher)

[8] Network P A 2017 Alternative methods in weed management to the use of glyphosate and other herbicides (Belgium: Pesticide Action Network Europe)

[9] Anwar R, Wahyudi D, Suzanna E and Aryani F 2020 Unihaz formulation herbicide testing in various types of weeds J. Agroqua 18 129–39

[10] Sigalingging D R, Sembodo D R and Sriyani N 2014 Efikasi herbisida glifosat untuk mengendalikan gulma pada pertanaman kopi Agrotek Trop. 2 258–63

[11] Aini N, Sembodo D and Sugiatno S 2014 Efikasi herbisida glifosat terhadap gulma pada lahan tanaman karet (Hevea brasiliensis [Muell.] Arg) J. Agrotek Trop. 2 232903

[12] Purba W O, Priwiretama H and Susanto A 2020 Effectiveness of indaziflam and glyphosate tank mix to control weed in mature oil palm J. Penelit. Kelapa Sawit 28 99–108

[13] Tjitra Soedirdjo S, Utomo I H and Wiroatmodjo J 1984 Pengelolaan gulma di perkebunan (Jakarta: PT. Gramedia)

[14] Vencil W K, Ambrust K, Hancock H G, Johnson D, McDonald G, Kinter D, Lichtner F, Mclean H, Reynold J, Rushing D, Senseman S and Wauchope D 2002 Herbicide handbook (Lawrence, KS: Weed Science Society of America)

[15] Wibawa W, Mohamad R B, Omar D, Zain N M, Puteh A B and Awang Y 2010 Comparative impact of a single application of selected broad spectrum herbicides on ecological components of oil palm plantation African J. Agric. Sci. 5 2097–102

[16] Mohamad R, Mohayidin M G, Wibaya W, Juraimi A S and Lassim M M 2010 Management of mixed weeds in young oil-palm plantation with selected broad-spectrum herbicides Pertanika J. Trop. Agric. 193–203

[17] Nasution U 1988 Pemakaian adjuvant untuk mengurangi takaran glifosat dalam pengendalian alang-alang (Imperata cylindrica di Perkebunan Karet) Prosiding Konperensi HIGI XI (Bogor) pp 399–412

[18] Rao V S 2000 Principles of weed science (CRC Press)

[19] Radosevich S R, Holt J S and Ghera C 1997 Weed ecology: implications for management (Toronto: John Wiley & Sons)

[20] Ashton F M and Monaco T J 1991 Weed science: principles and practices (Toronto:John Wiley and Sons Ltd)

[21] Beckie H J 2020 Herbicide resistance in plants Plants J. MDPI 9 7–10

[22] Tahir M, Nadeem M A, Tanveer A, Ayub M, Hussain A, Naeem M and Javed H M R 2011 The effect of urea as adjuvant on herbicide effectiveness, yield and weeds of maize with full and reduced doses of herbicide Pak. J. Life Soc. Sci 9 45–51

[23] Pacanoski Z 2015 Herbicides and adjuvants Herbicides, Physiology of Action, and Safety 125–47

[24] Koger C H, Dodds D M and Reynolds D B 2007 Effect of adjuvants and urea ammonium nitrate on bispyribac efficacy, absorption, and translocation in barnyardgrass (Echinochloa crus-galli). I. Efficacy, Rainfastness, and Soil Moisture Weed Sci. 55 399–405

[25] Akhter M J, Abbas R N, Waqas M A, Noor M A, Arshad M A, Mahboob W, Nadeem F, Azam M and Gull U 2017 Adjuvant improves the efficacy of herbicide for weed management in maize sown under altered sowing methods J. Exp. Biol. Agric. Sci. 5 22–30

[26] Weber J F, Kunz C, Petenatos G G, Zikeli S and Gerhards R 2017 Weed control using conventional tillage, reduced tillage, no-tillage, and cover crops in organic soybean J
[27] Usman K, Ullah I, Khan S M, Khan M U, Ghulam S and Khan M A 2012 Integrated Weed Management Through Tillage and Herbicides for Wheat Production in Rice-Wheat Cropping System in Northwestern Pakistan J. Integr. Agric. 11 946–53

[28] Utomo I H and Soebardja B 1990 Efikasi penggunaan glifosat + surfaktan pulse untuk mengendalikan alang-alang Prosiding Konferensi. HIGI X (Malang: Universitas Brawijaya) pp 434–7