# Weeds found associated with wheat crop at Alahan Panjang, West Sumatra

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**Abstract**. Crop production is of major supports for ever-growing population. As for other crops, wheat cannot escape from weed interference which may result in significant loss of yield. Therefore, the success of agricultural practices depends on pest and diseases management including weeds. Agricultural chemicals such as herbicides has been widely applied to maximize crop yield including wheat. The present study was conducted to determine the appropriate herbicide to control weeds associated with wheat and wheat growth and yield. The experiment was carried out at farmer's land at Batu Bagiriek, Jorong Galagah, Kenagarian Alahan Panjang, Solok, the Province of West Sumatra from May to September 2015. The experimental sites is located at 1.0729° S, 100.7831° E, 1616 m above sea level with temperature ranging from 20 to 25 °C. Three treatments i.e herbicide metsulfuron-methyl (25 g ai ha$^{-1}$), herbicide 2,4 dimethylamine (1.5 L ai ha$^{-1}$), and no weed control treatment were studied. Each treatment was replicated four times in a completely randomized design. Data were analysed with ANOVA and mean separation of Tukey HSD at 5%. Results demonstrate that herbicide 2,4 dimethylamine was best to control broad leaf weeds resulted in the highest yield of wheat grain of 6.14 tonnes/ha. Lawn grass (*Axonopus compressus*) and goose grass (*Eleusine indica*) were found to be dominant weeds.

## 1. Introduction

Wheat (*Triticum aestivum* L.) is of world major cereal crops and is a non-tropical origin. Wheat plants have been important for their carbohydrate and proteins. Wheat grains are the raw material for making various food products such as bread, noodles, biscuits, and other snacks. Indonesia has been world major wheat importer and the volume of wheat import consistently increases every year. USDA projected that Indonesia, in 2016, will import wheat as much as 7.6 million metric tonnes (MMT) and this has increased for 1.6% from last year [1]. This situation has burdened Indonesia financially as well as socially. Alternative means have to be sought to minimise the problems.

Indonesia mainly rely on rice for its major source of carbohydrate whilst wheat contributes for as much as 14.26%. It is interesting to note that rice contribution to carbohydrate tended to decline (-0.73%) for the last five years. On the contrary, the contribution of wheat flour to the carbohydrate source in Indonesia has increased for 12.5% per annum. Increasing number of Indonesian people is now aware of a necessity for food diversity and wheat flour is important for such purposes. Universitas Andalas, along with national and international partners, has attempted to grow and study wheat in Indonesia since 2011. Experiments have proven that some wheat genotypes grew well in Indonesian climates. Our research on the introduction of Slovak-origin wheat genotypes resulted in some wheat genotypes potential to be cultivated in West Sumatra.

Like all other crops, wheat interacts with unwanted plants (weeds) that grow in its vicinity. The interaction, resource competition and/or allelopathy, significantly reduces wheat growth and yield. Weeds reduce agricultural crop growth and yield trough resource competition and/or allelopathy. Weeds compete with wheat for water, light, space and nutrients. The competition will severely affect the crop in an area with limited natural resources such as in poor marginal land. Weed interference may cause significant yield reduction in wheat. Furthermore, weeds can also slow harvest, increase equipment repair costs, and lower the quality of wheat grain [2]. Crop-weed competition causes losses costing around $1 billion per annum in the Western Australian wheat belt [3]. The losses incurred due to control of weeds and those that reduced the yield.

Weed control, mostly by herbicide application, is one of the key management factors of most agricultural systems. Only a few herbicides have been registered worldwide and about 50 have been considered to possess high potential for commercialization [4]. Various means have been applied to control weeds in agricultural land [5] [6] [7]. Moreover, research have also proven many examples of successful of plant pathogen to control weed using the classical and bioherbicide approaches [8] [9] [10]. Despite its success in weed control, herbicides create problem in developing weed resistant to herbicide and residual effect in the soil [11]. The problem of weed resistance, in general, has encouraged farmers to use more cultural control measures such as ploughing and crop rotation specially when herbicides is the main measure to control weeds. As wheat crop is relatively new in West Sumatra, there is a lack of information on weed control in wheat production system. Therefore, research reported here dealt with weed associated with wheat in response to herbicide application as well as wheat growth and yield.

## 2. Material and Method

The experiment was carried out at farmer's land at Batu Bagiriek, Jorong Galagah, Kenagarian Alahan Panjang, Solok, the Province of West Sumatra from May to September 2015. A completely randomized design with three treatments and four replicates was applied to wheat genotype SO-3 (Slovak origin). Treatment was weeds control i.e. herbicide metsulfuron-methyl ($25$ g ai ha$^{-1}$), herbicide 2,4 dimethylamine ($1.5$ L ai ha$^{-1}$), and no weed control. Data were analysed with analysis of variance and mean comparison of Tukey HSD at 5% level.

Wheat seeds were grown in 5 m x 1.25 m plots with 25 cm row spacing. Wheat seeds were previously treated with insecticide Regent® (active ingredient Fipronil 50 g/L) to protect the seedlings from insect attacks during germination. Fertilizer was applied as recommended such as 150 kg/ha Urea, 200 kg/ha SP36, and 100 kg/ha KCl. One-half of the dose of Urea was applied at seven days after planting (DAP) and the rest was applied at 30 DAP. Insecticides Furadan® 3G 6 kg/ha (ai. carbofuran) and Curacron® 500 EC 1 L/ha (ai. profenofos) were applied for insect control. Herbicide was applied using knapsack sprayer at 5 and 10 weeks after planting (WAP).

Weeds were collected from the field prior to land cultivation using a 1-m$^2$-sampling device at five diagonally plotted spots. All weeds were recorded, weighed for fresh and oven dried. Weeds grew associated with wheat were collected at 5, 10, and 14 WAP. Wheat growth was observed and data collection included number of days to panicle emergence, number of panicles, seed weight, and yield. Weed summed dominance ratio (SDR) was calculated as [12]. All weeds were collected, recorded and grouped for every species prior to collecting in paper bag. Weed fresh weight was recorded the oven dried for 48 hours in air-dried oven for its dry weight record.

## 3. Results and Discussion

Some weeds species, broad leaf and grass, were found to be associated with wheat. Various weed species emerged at different time within plots and treatment groups. Although germinated and found at different time, eight weed species were constantly found within the experimental plots. Some weeds affected by the herbicide applied indicated by their disappearance at 10 WAP before found again at 14 WAP. This demonstrated herbicide action to eradicate living weeds followed by germinating of other weed seeds in the soil. Weed control treatments greatly affected weed density. The application of pre-

emergence herbicide such as oxadiazone has cuccessfully controlled *Cyperus iria* and *Trianthema portulacastrum.* The effect were more evident in the second season of rice planting with more individual species of weeds were controlled [13].

Seven weed species were found and identified at the field prior to wheat planting. The area was previously used for horticultural crops such as potato, spring onion, cabbage, and tomatoes. Weed species found belongs to the group of broadleaf and grass (Table 1). The highest number of individual stands of weed found was goose grass (*Eleusine indica*), family Poaceae and was easily found at dry land. In contrast, we found only one stand of cogongrass (*Imperata cylindrica*).

Table 1. Weeds found prior to land preparation for wheat crop at Alahan Panjang, West Sumatra

| Weed Species | Number of weed stands | | | | |
|---|---|---|---|---|---|
| | Plot sampling number | | | | |
| | 1 | 2 | 3 | 4 | 5 |
| *Ageratum conyzoides* | 143 | 24 | 22 | 19 | 5 |
| *Amaranthus spinosus* | 6 | 4 | - | - | 2 |
| *Axonopus compressus* | 7 | 168 | 5 | 10 | - |
| *Cirsium arvense* | - | - | 4 | 3 | - |
| *Eleusine indica* | 212 | 33 | 200 | 107 | 150 |
| *Imperata cylindrica* | - | - | 1 | - | - |
| *Solanum tuberosum* | 21 | - | - | - | 3 |

Note: - = no weed was found

Weed population dynamic found in this experiment suggested the weed seed resource in the soil was dynamically germinated and grew when suitable environmental factor such as temperature or soil aeration was met following land cultivation [5]. Weed dormancy and germination are of major means of weed population survival in an area. The seed resources in the soil build up through seed production by mother plants and dispersal by various means in nature. In contrast, the seed bank depletes through germination, predation, and decay. Variation in weed populatoin dynamic may result from the agronomic land-use change from one planting season to the next ones [14] which applies to this experiment where potato and onion were major crops prior to wheat. Yet another factor is changes in weed management or herbicide application calendar. Prior to land cultivation, goatweed (*Ageratum conyzoides*) was found to be a dominant (213 stands) broad leaf weed species in the experimental site. In contrast, goose grass (*Eleusine indica*) was the dominant weed species (702 stands) among the grasses (Table 1). Lawn grass (*Axonopus compressus*), weed species belongs to family Poaceae, was being dominant in almost all replicates with higher value of summed dominance ratio (SDR) as demonstrated in Tables 2 and 3. Herbicide 2,4-dimethylamine was effective to control broad leaf weeds leaving *Axonopus compressus* and *Eleusine indica*, both are grasses, to be dominant.

Following the application of herbicide, various weed species emerged or died (Tables 2 and 3). For instance, spiny amaranth (*Amaranthus spinosus*) was affected by the herbicide applied. However, a few weeks later this weed species emerged from the soil indicating weed seed reserve in the soil that helps the species existence in certain area. Different herbicide treatments changes the density of individual weeds and the dominance relationships amongst species. However, this situation caused almost no change in the species present in the community [15]. Annual application of the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) on weed community in wheat crop demonstrated no weed species were eradicated over three decades of the experiment, yet no new species were able to invade the community as a direct result of herbicide application. However, the only changes observed was quantitative changes in the relative abundance of species. This report emphasises the population dynamics of weeds following weed control. Our work also confirmed with other previous reports that showed various weed species emerged following treatments of herbicides.

Table 2. Weeds found associated with wheat crop at Alahan Panjang, West Sumatra at different time of collecting (Replicates 1 and 2)

| Treatments | Weeds | Replicate 1 | | | | | Replicate 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5 [a] | 10 [a] | 14 [a] | RDW | SDR | 5 [a] | 10 [a] | 14 [a] | RDW | SDR |
| No weed control | *Amaranthus spinosus* | - | - | √ | 0.009 | 0.100** | - | - | √ | 0.077 | 0.087** |
| | *Axonopus compressus* | √ | - | √ | 0.335 | 0.277 | √ | - | - | 0.553 | 0.466* |
| | *Bidens pilosa* | - | - | √ | 0.068 | 0.141** | - | - | √ | 0.397 | 0.321** |
| | *Chrysopogon aciculatus* | - | - | √ | 0.168 | 0.169** | - | - | √ | 0.188 | 0.177** |
| | *Cirsium arvense* | √ | - | √ | 0.012 | 0.114 | - | - | - | N/A | N/A |
| | *Eleusine indica* | √ | - | √ | 0.968 | 0.694 | √ | - | √ | 0.359 | 0.549 |
| | *Solanum tuberosum* | √ | - | - | 0.309 | 0.261* | √ | - | - | 0.178 | 0.314 |
| | *Synedrella nodiflora* | √ | - | √ | 0.101 | 0.241 | - | - | - | N/A | N/A |
| Metsulfuron-methyl (25 g ai ha⁻¹) | *Amaranthus spinosus* | √ | √ | - | 0.050 | 0.211* | - | √ | √ | 0.010 | 0.178** |
| | *Axonopus compressus* | √ | √ | √ | 0.812 | 0.699 | √ | √ | √ | 1.761 | 1.324 |
| | *Bidens pilosa* | √ | - | - | 0.014 | 0.120* | √ | - | √ | 0.221 | 0.244* |
| | *Chrysopogon aciculatus* | - | - | √ | 0.108 | 0.150** | - | - | √ | 0.192 | 0.233** |
| | *Cirsium arvense* | √ | √ | - | 0.172 | 0.312 | √ | - | - | 0.012 | 0.097 |
| | *Eleusine indica* | √ | √ | - | 1.844 | 1.508 | √ | √ | √ | 0.803 | 0.924 |
| | *Solanum tuberosum* | - | - | - | N/A | N/A | - | - | - | N/A | N/A |
| | *Synedrella nodiflora* | - | - | - | N/A | N/A | - | - | - | N/A | N/A |
| 2,4-dimethylamine (1.5 L ai ha⁻¹) | *Amaranthus spinosus* | √ | √ | - | 0.013 | 0.111* | - | √ | √ | 0.071 | 0.394** |
| | *Axonopus compressus* | √ | √ | √ | 1.889 | 1.531 | √ | √ | √ | 0.214 | 0.679 |
| | *Bidens pilosa* | √ | - | - | 0.002 | 0.064* | √ | - | - | 0.051 | 0.130* |
| | *Chrysopogon aciculatus* | - | - | - | N/A | N/A | - | - | √ | 0.086 | 0.100 |
| | *Cirsium arvense* | - | - | - | N/A | N/A | - | √ | - | 0.002 | 0.056** |
| | *Eleusine indica* | √ | √ | √ | 0.690 | 0.860 | √ | √ | √ | 0.482 | 0.544 |
| | *Solanum tuberosum* | - | √ | √ | 0.384 | 0.293** | √ | √ | √ | 0.132 | 0.230 |
| | *Synedrella nodiflora* | √ | - | - | 0.029 | 0.144* | - | √ | √ | 0.043 | 0.228** |

Notes: a = Week after planting (WAP), RDW = weed relative dry weight, SDR = summed dominance ratio,
 * = weed died, ** = weed emerged, - = weeds not found

Not all weed species found prior to land preparation could again be found associated with wheat following the herbicide treatments. For instance, goatweed (*Ageratum conyzoides*) and cogonggrass (*Imperata cylindrica*) were not found to be associated with wheat crop at this experiment. Meanwhile, new weed species were found including lesser spear grass (*Chrysopogon aciculatus*), Spanish needle (*Bidens pilosa*), and nodeweed (*Synedrella nodiflora*). The emergence of these new weed species resulted from land cultivation that improved soil aeration as well as physical movement of the weed seeds from deeper soil onto (near) the surface [16].

Metsulfuron-methyl is a very strong inhibitor of acetolactate synthase enzyme - ALS [17], the first common enzyme in the biosynthetic pathway of branched-chain amino acids. In ALS assays, the herbicide concentration required for 50% inhibition was 0.125 µM indicating, the high sensitivity of ALS to inhibition by this herbicide. Since ALS is not found in humans, it is an effective target for herbicides [18]. Metsulfuron-methyl is commonly used by farmers to deal with various broadleaf weeds. ALS-inhibiting herbicides are widely used because of their low doses, low environmental impact, low mammalian toxicity, and high efficacy [19]. Any disruption in ALS function will lead to abnormality in amino acids formation. Consequently, functional and structural protein in targeted weeds is affected leading to reduction in growth. Herbicides metsulfuron, thifensulfuron, triasulfuron and tribenuron are registered for weed control in wheat. These herbicides provide good broadleaf weed control efficacy [20]. This is in line with our data reported here demonstrating some broadleaf weeds species were effectively controlled by metsulfuron-methyl. *Synedrella nodiflora*, *Bidens pilosa*, *Cirsium arvense*, and *Solanum tuberosum* were effectively controlled (Tables 2 and 3). These weeds were found at 5 weeks after planting (WAP) then died at the later sampling times (10 and 14 WAP).

Herbicide 2,4-dimethylamine is known to effectively control broad leaf weeds. It controlled some weeds species in experiment reported here including spiny amaranth (*Amaranthus spinosus*), Spanish needle (*Bidens pilosa*), creeping thistle (*Cirsium arvense*), wild potato (*Solanum tuberosum*), and

nodeweed (*Synedrella nodiflora*) (Tables 2 and 3). This herbicide is a selective herbicide and is commonly used to control weeds associated with cereal crops, maize, soybeans, sugarcane, garlic, spring onion, and cotton [21]. The reduction in weed dominance in the abovementioned weeds in response to herbicide application suggested the effective control of the herbicide. Moreover, efficient application of herbicides reduced weed interference [22] which in turn increased winter wheat growth and yield [11]. Herbicide application in the experiment reported here was conducted at 5 and 10 weeks after planting. Earlier weed control helps reducing resource competition between weed and crop during rapid vegetative growth stage. [23] reported the importance of early season control of hemp sesbania (*Sesbania exaltata*) in several crops, including rice, soybean, and cotton.

Table 3. Weeds found associated with wheat crop at Alahan Panjang, West Sumatra at different time of collecting (Replicates 3 and 4)

| Treatments | Weeds | Replicate 3 | | | | | Replicate 4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 5 [a] | 10[a] | 14[a] | RDW | SDR | 5 [a] | 10[a] | 14[a] | RDW | SDR |
| No weed control | *Amaranthus spinosus* | √ | - | √ | 0.363 | 0.241 | √ | - | - | 0.007 | 0.069* |
| | *Axonopus compressus* | √ | - | √ | 0.637 | 0.617 | √ | - | √ | 0.819 | 0.690 |
| | *Bidens pilosa* | - | - | - | N/A | N/A | - | - | - | N/A | N/A |
| | *Chrysopogon aciculatus* | - | - | √ | 0.235 | 0.273** | - | - | - | N/A | N/A |
| | *Cirsium arvense* | √ | - | √ | 0.225 | 0.236 | √ | - | - | 0.005 | 0.068 |
| | *Eleusine indica* | √ | - | √ | 0.700 | 0.574 | √ | - | √ | 0.694 | 0.649 |
| | *Solanum tuberosum* | √ | - | √ | 0.181 | 0.140 | √ | - | √ | 0.264 | 0.302 |
| | *Synedrella nodiflora* | - | - | - | N/A | N/A | - | - | - | N/A | N/A |
| Metsulfuron-methyl (25 g ai ha$^{-1}$) | *Amaranthus spinosus* | √ | √ | √ | 0.046 | 0.238 | - | √ | √ | 0.003 | 0.116** |
| | *Axonopus compressus* | √ | √ | √ | 2.135 | 1.762 | √ | √ | √ | 1.752 | 1.298 |
| | *Bidens pilosa* | √ | - | - | 0.007 | 0.058* | - | √ | √ | 0.003 | 0.116** |
| | *Chrysopogon aciculatus* | - | - | - | N/A | N/A | - | - | √ | 0.226 | 0.257** |
| | *Cirsium arvense* | - | - | - | N/A | N/a | - | - | - | N/A | N/A |
| | *Eleusine indica* | √ | √ | √ | 0.803 | 0.835 | √ | √ | √ | 0.838 | 0.879 |
| | *Solanum tuberosum* | √ | - | - | 0.009 | 0.062* | √ | - | - | 0.132 | 0.222* |
| | *Synedrella nodiflora* | - | - | - | N/A | N/A | √ | - | - | 0.047 | 0.114* |
| 2,4-dimethylamine (1.5 L ai ha$^{-1}$) | *Amaranthus spinosus* | √ | - | - | 0.218 | 0.146* | - | - | - | N/A | N/A |
| | *Axonopus compressus* | √ | √ | √ | 1.070 | 1.076 | √ | √ | √ | 2.110 | 1.624 |
| | *Bidens pilosa* | √ | √ | - | 0.348 | 0.394 | - | - | - | N/A | N/A |
| | *Chrysopogon aciculatus* | - | - | √ | 0.386 | 0.371** | - | - | - | N/A | N/A |
| | *Cirsium arvense* | √ | - | - | 0.003 | 0.066* | √ | √ | √ | 0.760 | 0.489 |
| | *Eleusine indica* | √ | √ | √ | 0.863 | 0.910 | √ | √ | √ | 0.703 | 0.843 |
| | *Solanum tuberosum* | - | - | - | N/A | N/A | √ | - | - | 0.105 | 0.181* |
| | *Synedrella nodiflora* | - | - | - | N/A | N/A- | √ | - | - | 0.006 | 0.092* |

Notes: a = Week after planting (WAP), RDW = weed relative dry weight, SDR = summed dominance ratio,
* = weed died, ** = weed emerged, - = weeds not found

Various weed control resulted in different growth response of wheat genotype SO-3 (Table 4). Panicles emerged in almost similar time in all treatment groups. Although the effect was not significant, herbicide 2,4 dimethylamine resulted in the earliest time and no weed control group showed the longest time to panicle emergence. The earlier the panicle emerged the higher the number of panicles per m$^2$ of land. Earlier emergence of the panicle may result from early control of the weed [23]. This herbicide 2,4 dimethylamine consistently demonstrated wheat growth better than that of other treatment groups. Wheat grain yield from this treatment group was the highest and all treatment groups differed to one another. The highest yield in wheat grain is reflected from a consistently higher number of panicles and higher wheat grain weight per m$^2$ in the 2,4 dimethylamine group than in other treatments.

Table 4. Wheat growth and yield response to herbicide application at Alahan Panjang, West Sumatra

| Treatments | A | B | C | D |
|---|---|---|---|---|
| No weed control | 62.38 | 203.50 a | 232.6 | 5.53 a |
| Metsulfuron-methyl | 61.00 | 266.25 b | 284.7 | 5.90 b |
| 2,4 dimethylamine | 58.88 | 346.13 c | 375.4 | 6.14 c |

**Note**, A = time to panicle emergence (days after planting), B = number of panicle per plot, C = wheat grain weight (g/plot), D = Yield (tonnes/ha). Numbers followed by different letters (in column B and D) are significantly different according to Tukey HSD at 5%.

High yield is closely related to accumulation of net photosynthesis in the grain. The presence of weeds may cause resource competition between weeds and crops [24]. Both weeds and crops need soil nutrient for their growth and development. The needs become higher when both species are at the early growth period simultaneously [25]. However, weed co-existence with crop may compete for soil nutrient and other resources. Furthermore, weed interference in crops may happen in both resource competition and/or allelopathy. Research has proven yield loss in some crops due to resource competition with weeds [26] and/or allelopathic effect of weeds to crops. On the other hand, weed may function as alternative feed for insects which, to some extent, balances agricultural ecosystem [27] and enhances floral diversity of a cropping system. Weed interference in crops may cause direct, either negative or positive, effects on cropping system [28] which, in turn, reduces crop growth and yield.

**4. Conclusion**
Herbicide 2,4 dimethylamine was most effective to control weeds, specially broad leaf weeds, associated with wheat crop at Alahan Panjang, West Sumatra. This method of weed control resulted in the highest wheat grain yield of 6.14 tonnes/ha. Lawn grass (*Axonopus compressus*) and goose grass (*Eleusine indica*) were found to be dominant weeds.

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