Weed extract effect on growth and yield of some corn varieties

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Abstract. One of the impacts of climate change in agriculture is on the diversity of crop pests, plant diseases and weeds. In addition to competition, weeds can suppress growth through allelopathy. The effect of allelopathy can be caused by the presence of alelochemicals produced by weeds. This research aims to gain the influence of weed extract on the growth and yield of some varieties of corn. The study used a complete randomized design with 2 treatment factors namely corn varieties and weed extract. Corn varieties consist of Bisi 18, NK 33, DK 95 and Sukmaraga. Weed extract consists of without weed extract, weed extract grown on corn plants with fertilization 25 kgN.ha-1, weed extract at fertilization 150 kgN.ha-1, and weed extract at fertilization 275 kgN.ha-1. The observed parameters include the plant height, the number of leaves, stem diameter, the length of the leaves, the width of the leaves, the angle of the leaves, the dry weight of the plant, the weight of seeds per plant. Data analysis using analysis of variance and a Duncan Multiple Range Test level of 5%. The results showed that weed extract does not affect the number of leaves, leaf length, leaf width, leaf angle, stem diameter, dry weight of the plant, and seed weight per plant. Weed extract from fertilization 275 kgN.ha-1 lowers the height of corn plants.

1. Introduction
Climate change has a negative impact on agriculture. Climate change is proven to reduce the quantity and quality of vegetable and fruit production. This also happens to food crops [1]. The occurrence of extreme climates has a significant impact on seasonal crops, especially food crops [2]. Climate change triggers environmental changes that cause changes in crop responses. In 2010 there was a La-Niña climate phenomenon with moderate intensity [3]. Formulation of a special strategy is needed to minimize the impacts of climate change which have caused losses of agricultural products [1]. Climate change causes changes in environmental conditions which result in suboptimal plant growth and development, thereby reducing production and yield quality [4].

Climate change also affects the diversity of plant pests, including weeds. Weeds can cause decreased yields through competition and allelopathy. Weed and plant competition is influenced by several factors. Cropping, crop competitiveness, and climatic conditions, as well as other environmental factors. These factors will also determine the magnitude of the decline in yield [5], [6]. Plant age also affects the diversity of weeds. On corn plant, diversity of weed at 4 week after planting different from 8 week after planting. At 4 WAP, the growing weeds consisted of 30 species, whereas at 8 WAP there were 26 weeds species [7]. The dose of fertilizer given to corn crops also affects plant growth. Giving nitrogen at lowest dose (25 kg.ha-1) produced height of plants, leaves number and diameter of stem lower than 150 kg.ha-1 and 275 kg.ha-1 nitrogen doses. The presence of weeds suppresses the growth of corn. Overall, plant growth in weed-free conditions was better than in the weed conditions [8]. That weed interference caused a decrease in total dry weight of corn. The longer...
the presence of weeds will also increase the decrease in plant dry weight. The dry weight of the plant was decreased by 12% in the tasseling phase [9]. According to Ghanizadeh et al (2014) [10], corn canopy dry weight decreased due to the presence of weeds. The dry weight of maize grown in the absence of weeds exceeds the dry weight of maize when there is 47 - 128% redroot pigweed or common lambsquarters weeds.

Allelopathy includes the direct and indirect influence of some crops on other crops through the release of chemical compounds and it plays an important role in agroecosystems [11]. Allelochemicals are chemical compounds that cause allelopathy [12]. Allelochemistry can change physiology and decrease plant growth, development and yield. These chemical compounds have several functions, namely (a) simple excretion, (b) inhibition from predators and pathogens, (c) encouragement of symbionts to form symbiotic relationships, (d) direct influence on competitors, and (e) autotoxicity [13]. Allelochemistry can affect weeds and plants through inhibition of germination and inhibition of plant growth [14]. These allelochemicals have the ability to suppress the germination and growth of several other weeds, and some of these weeds are herbicide resistant [15]. Dactyloctenium aegyptium weed extract had the greatest effect of inhibiting corn germination compared to Cyperus rotundus and Euphorbia heterophylla at 12 DAS [16]. In general, the responses of each varieties of corn to weeds varied widely. Based on the illustration, this research aims to learn the effect of weed extracts on the growth and yield of corn.

2. Material and Methods
This research is an experiment using polybags, located at the Banguntapan, Bantul, Yogyakarta. Laboratory analysis was carried out at the Plant Science Laboratory and Plant Management and Production Laboratory, Faculty of Agriculture, UGM Yogyakarta. The experiment used a 4 x 4 factorial completely randomized design. The first treatment was corn varieties consisting of Bisi 18, NK 33, DK 95, and Sukmaraga. The second treatment is weed extract consisting of no weed extract, weed extract from fertilized corn plants with 25 kgN.ha\(^{-1}\), weed extract from fertilized corn plants with 150 kgN.ha\(^{-1}\), and weed extract from fertilized corn plants 275 kgN.ha\(^{-1}\). The number of experimental units 4 x 4 = 16 treatments, repeated 3 times.

The experiment was carried out including the preparation of planting media. Planting maintenance (fertilizing, watering, thinning, replanting, and controlling pests and diseases), giving weed extracts, and harvesting. Weed extract was given at 2, 4, 6, and 8 WAP. Weed extracts are made by cutting the weeds and crushed. After that, the weeds are soaked using distilled water for 24 hours. The ratio between weeds and distilled water is 1: 3. After soaking for 24 hours, then filtered and the extract is poured into polybags according to each treatment. The data observed included height of plant, leaves number, diameter of stem, length of leaf, angle of leaf, ear length, ear diameter, row number per ear, seed number per row, weight of 1000 seeds, seed weight per plant, harvest index). Analysis of data obtained using analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) with 95% level of confidence [17].

3. Result and Discussion
3.1. Plant Height
Plant growth is influenced by internal and external factors. Based on the results of data analysis, there was no interaction between varieties and weed extracts on the height of plant at 10 WAP, but varieties and weed extracts had a significant effect. The response of corn varieties to the application of weed extracts was quite diverse at each plant age. At the beginning of growth, weed extracts had no effect so there was no difference in height of plant in all varieties. The same thing also happened to several soybean cultivars planted with Ageratum conyzoides and Boreria alata that at 4 and 6 WAP there was no difference in plant height in all cultivars [18]. At the age of 10 WAP, the highest plant produced by Sukmaraga. but it was not significantly different from Bisi 18 and DK 95. The plant height of a corn variety was also influenced by the genetics of each variety.
Based on Table 1, the highest plants at 10 WAP were produced in the treatment without weed extracts and it was not significantly different from giving of weed extracts at a dose of 25 kgN.ha\(^{-1}\) and 150 kgN.ha\(^{-1}\), while the lowest plants were given weed extracts with doses. Nitrogen of 275 kgN.ha\(^{-1}\) and significantly different from other weed extracts. The highest plants are those that are not given weed extracts. This showed that the weed extracts given could interfere with the growth of corn plants. Allelochemistry can have different effects. The giving of Imperata cylindrica extracts with various concentrations resulting in the same plant height of cucumber without using Imperata cylindrica extract [19]. Research on two rice cultivars (Basmati Pak and Basmati Super) showed that sunflower residue caused a decrease in plant growth and yield of Basmati Pak, while Basmati Super cultivar was an allelopathic tolerant cultivar so that growth and yield were not affected [20].

3.2. Leaves number and stem diameter
At 10 WAP, there was no difference in leaves number on all varieties and all weed extracts (Table 1). This shows that the weed extracts grown on corn plants given nitrogen fertilizer at a dose of 25 kgN.ha\(^{-1}\). 150 kgN.ha\(^{-1}\) and 275 kgN.ha\(^{-1}\) did not affect the leaves number formed in all varieties studied. On stem diameter, at 10 WAP the stem diameter of DK 95 was the lowest and significantly different from other varieties. Stem diameter in all varieties increased with increasing plant age. This indicates that all varieties experience growth so that the stem diameter increases with age of the plant.

The effects of allelopathy on plants can be both detrimental and beneficial. The effect of each weed on plant growth is also different. In this experiment, the weed extracts were given in the form of a mixture of all types of growing weeds so that it was thought that this had a different effect on plant growth. In the application of extracts of one type of weed, for example. Extract of Imperata cylindrica leaf gives different effects depending on the concentration. In the water - extract ratio of 1: 3 it is detrimental because it reduces the early growth of corn, whereas in the water - extract ratio of 1: 6 and 1: 9 shows the same effect as the control or without extract [21].

Weed extract had no significant effect on leaves number and diameter of stem on 10 WAP. Corn plants that were given weed extracts grown from corn plants given nitrogen 25 kgN.ha\(^{-1}\). 150 kgN.ha\(^{-1}\)

### Table 1. Height of plant, leaves number and diameter of stem at 10 WAP of several varieties of corn with various weed extracts.

| Varieties     | Height of Plant (cm) | Leaves Number (sheet) | Diameter of Stem (mm) |
|---------------|----------------------|-----------------------|-----------------------|
| Bisi 18       | 142.98 a             | 10.75 a               | 13.43 A               |
| NK33          | 136.33 b             | 10.58 a               | 14.04 A               |
| DK95          | 139.29 ab            | 11.25 a               | 11.61 b               |
| Sukmaraga     | 142.58 a             | 10.42 a               | 13.67 a               |
| Weed Extract  |                      |                       |                       |
| Without weed extract | 145.06 p            | 10.83 p               | 13.09 p               |
| Weed extract 25 kgN.ha\(^{-1}\) | 142.25 p            | 10.92 p               | 13.03 p               |
| Weed extract 150 kgN.ha\(^{-1}\) | 139.93 p            | 10.67 p               | 13.48 p               |
| Weed extract 275 kgN.ha\(^{-1}\) | 133.94 q            | 10.58 p               | 13.14 p               |
| Average       | 140.30               | 10.75                 | 13.19                 |
| Interaction   | (-)                  | (-)                   | (-)                   |

Note: The numbers followed by the same letter in the same column show no significant difference in the Duncan test at 5% level. (-): no interaction.
and 275 kgN.ha\(^{-1}\) or those without weed extract produced leaves number and stem diameter that were not significantly different. This shows that the kinds of weed extracts did not affect the leaves number and diameter of stem.

3.3. **Length of Leaf, Width of Leaf, & Angle of Leaf**

Based on variance analysis, varieties had a significant effect while weed extract had no significant effect on length of leaf width of leaf and angle of leaf. There was no interaction between both treatments (Table 2).

**Table 2.** Length of leaf (cm), width of leaf (cm), angle of leaf (°) of several varieties of corn with various weed extracts.

| Treatment                  | Length of Leaf (cm) | Width of Leaf (cm) | Angle of Leaf (°) |
|----------------------------|---------------------|--------------------|-------------------|
| **Varieties**              |                     |                    |                   |
| Bisi 18                    | 65.59               | 7.12              | 31.75             |
| NK33                       | 59.05               | 8.38              | 38.42             |
| DK95                       | 56.75               | 7.09              | 34.33             |
| Sukmaraga                  | 61.71               | 7.36              | 40.08             |
| **Weed Extract**          |                     |                    |                   |
| Without weed extract       | 60.46 P             | 7.25 P            | 37.50 p           |
| Weed extract 25 kgN.ha\(^{-1}\) | 60.71 P            | 7.25 P            | 36.17 p           |
| Weed extract 150 kgN.ha\(^{-1}\) | 61.31 P           | 7.74 P            | 34.75 p           |
| Weed extract 275 kgN.ha\(^{-1}\) | 60.63 P           | 7.70 P            | 36.17 p           |
| **Average**                | 60.78               | 7.49              | 36.15             |
| **Interaction**           | (-)                 | (-)               | (-)               |

Note: The numbers followed by the same letter in the same column show no significant difference in the Duncan test at 5% level. (-): no interaction.

The longest leaf was produced by varieties Bisi 18 and was not significantly different from Sukmaraga. DK 95 produced the shortest leaves and was not significantly different from NK 33, while NK 33 was not significantly different from Sukmaraga. NK 33 produces the widest leaves and it is significantly different from other varieties. The largest leaf angle in Sukmaraga and it is not significantly different from NK 33 and DK 95 while Bisi 18 produced the smallest leaf angle and it is not significantly different from DK 95. Weed extract also did not affect to the length width and angle of the leaves.

3.4. **Dry weight of biomass**

At harvest time, there were differences in dry weight of biomass in the varieties studied (Figure 1). Varieties of Bisi 18 had the highest dry weight of biomass and it was not significantly different from DK 95 while Sukmaraga had the smallest dry weight and it was not significantly different from NK 33 and DK 95. On the two wheat varieties studied responses to the presence of sunflower residues also varied. The presence of sunflower residue caused a decrease in crown dry weight in Inqalab 91 varieties while in Punjab 91 varieties sunflower residue had no effect on growth parameters in all phases [20].
Based on Figure 2, there is no difference in the dry weight of biomass for all kinds of weed extracts given. This shows that the kinds of weed extracts do not affect the dry weight of biomass. Dewi et al (2017) [22] reported that the use of *Cyperus rotundus* extracts from various accessions also had no significant effect on the growth of soybean plant height and plant dry weight when compared to controls.

3.5. *Ear length, ear diameter, rows number per ear and seeds number per row*

There was no interaction between varieties and weed extracts on ear length, ear diameter, row number per ear, and seed number per row (Table 3). There was no difference in ear length on all varieties. Table 3 shows the largest ear diameter in NK 33 varieties and it is not significantly different from Bisi 18 while the Sukmaraga varieties produces the smallest ear diameter and it is not significantly different from DK 95. Sukmaraga has the least number of rows per ear and the least number of seeds per row compared to other varieties.

Kinds of weed extract significantly affected rows number per ear. Without giving weed extracts, the highest rows number per ear was obtained, but it was not significantly different from the weed extracts from corn with nitrogen doses of 25 kgN.ha\(^{-1}\) and 150 kgN.ha\(^{-1}\). Weed extracts from corn with a nitrogen dose of 275 kgN.ha\(^{-1}\) produced the least number of rows per ear.
Table 3. Ear length (cm), ear diameter (mm), rows number per ear, and seeds number per row of several corn varieties with various weed extracts.

| Treatment                  | Ear Length (cm) | Ear Diameter (mm) | Rows Number per Ear (row) | Seeds Number per Row (seed) |
|----------------------------|-----------------|-------------------|---------------------------|----------------------------|
| Varieties                  |                 |                   |                           |                            |
| Bisi 18                    | 13.48 a         | 38.33 a           | 12.83 a                   | 22.67 ab                   |
| NK33                       | 13.46 a         | 39.49 a           | 12.00 a                   | 24.17 A                    |
| DK95                       | 13.71 a         | 36.07 b           | 11.92 a                   | 25.67 A                    |
| Sukmaraga                  | 13.29 a         | 35.63 b           | 10.50 b                   | 19.67 B                    |
| Weed Extract               |                 |                   |                           |                            |
| Without weed extract       | 13.54 p         | 37.59 p           | 12.58 p                   | 25.00 P                    |
| Weed extract 25 kgN.ha⁻¹    | 13.88 p         | 37.83 p           | 11.67 pq                  | 22.25 P                    |
| Weed extract 150 kgN.ha⁻¹   | 13.50 p         | 37.95 p           | 12.00 p                   | 21.25 P                    |
| Weed extract 275 kgN.ha⁻¹   | 13.02 p         | 36.15 p           | 11.00 q                   | 23.67 P                    |
| Average                    | 13.49           | 37.38             | 11.81                     | 23.04                      |
| Interaction                | (-)             | (-)               | (-)                       | (-)                        |

Note: The numbers followed by the same letter in the same column show no significant difference in the Duncan test at 5% level. (-): no interaction.

3.6. Weight of 1000 seed, seed weight per plant and harvest index

There was no interaction between varieties and weed extract on weight of 1000 seed, weight per plant and harvest index. Varieties had a significant effect, whereas weed extracts had no significant effect (Table 4).

Table 4. Weight of 1000 seeds (g), seed weight per plant (g) and harvest index of several varieties of corn with various weed extracts.

| Treatment                  | Weight of 1000 seeds (g) | Seed Weight per Plant (g) | Harvest Index |
|----------------------------|--------------------------|---------------------------|---------------|
| Varieties                  |                          |                           |               |
| Bisi 18                    | 329.09 a                 | 79.49 a                   | 0.51 a        |
| NK33                       | 328.16 a                 | 84.60 a                   | 0.57 a        |
| DK95                       | 262.51 b                 | 79.14 a                   | 0.54 a        |
| Sukmaraga                  | 286.28 b                 | 52.97 b                   | 0.48 a        |
| Weed Extract               |                          |                           |               |
| Without weed extract       | 297.84 p                 | 79.77 p                   | 0.55 p        |
| Weed extract 25 kgN.ha⁻¹    | 317.13 p                 | 72.64 p                   | 0.52 p        |
| Weed extract 150 kgN.ha⁻¹   | 314.03 p                 | 74.53 p                   | 0.50 p        |
| Weed extract 275 kgN.ha⁻¹   | 277.03 p                 | 69.28 p                   | 0.53 p        |
| Average                    | 301.51                   | 74.05                     | 0.53          |
| Interaction                | (-)                      | (-)                       | (-)           |

Note: The numbers followed by the same letter in the same column show no significant difference in the Duncan test at 5% level. (-): no interaction.

Bisi 18 and NK 33 produced the largest weight of 1000 seeds and were significantly different from DK 95 and Sukmaraga. This shows that the response of each varieties of corn to the application of weed extract is quite diverse. The seed weight per plant of Sukmaraga was the smallest, while NK 33 varieties produced the largest seed weight per plant. Each varieties responded differently to application
of weed extracts. Bashir et al. [20] reported that the rice varieties Basmati Pak decreased grain yield by 34%.

The kinds of weed extracts did not affect the weight of 1000 seeds, seed weight per plant and harvest index. This is thought to be due to the fact that corn plants are also capable of releasing certain chemical compounds which also affect growth, so that in the treatment without weed extracts are the same as corn plants given weed extracts. In soybean plants, the application of nutmeg extracts from various accessions did not have a significant effect on the weight of 100 seeds and weight of soybean grains when compared to controls [22].

4. Conclusion
Climate change and applied cultivation technology affect the diversity and chemical compound of weed in each treatment. In this research, weed extract does not affect the number of leaves, leaf length, leaf width, leaf angle, stem diameter, dry weight of the plant, and seed weight per plant. Besides that, the giving of weed extracts from corn crops with 275 kgN ha\(^{-1}\) fertilization produce the lowest plants.

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