The influence of Oryzalin concentrations on the plant growth of two tomato (*Solanum lycopersicum* L.) varieties

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Abstract. The aim of the research was to determine the influence of oryzalin concentration on the two tomato varieties (Var. Permata and Tymoti). The research was conducted in Agricultural Faculty’s screen house, Universitas Sumatera Utara. The research was used Factorial Randomized Block Design with the first factor was Tomato varieties (Var. Permata and Tymoti), and the second was concentration of Oryzalin (0 µM as control, 30 µM, 60 µM, 90 µM and 120 µM). Parameters observed 30 days after sowing were the plant height, leaf number and the stem diameter of both tomato varieties. The results showed that there was no variation between var. Permata and Tymoti in parameters observed. However, there were differences among plants growth treated plants by Oryzalin concentration. In general, the higher the concentration of oryzalin, the shorter the plant height, the fewer leaf number and the smaller stem diameter for both tomato varieties.

1. Introduction

Tomato (*Solanum lycopersicum* L.) is a horticultural commodity that has high economic value that still requires serious handling, especially to improve the yield and quality of its fruit. In North Sumatra province, the productivity and the yield of tomatoes fluctuated during four years. The productivities from 2015 up to 2018 were 23.92 ton/ha, 21.25 ton/ha, 21.27 ton/ha and 19.77 ton/ha and the yields from 2015 to 2018 were 114,652 tons, 99,883 tons, 97,358 tons, and 103,650 tons respectively [1].

In line with the increasing population and increasing level of public knowledge about health, the demand for tomato commodity is also increasing. Increasing tomato production through extensification become more difficult from year to year, for beside competing with other horticultural commodities, also the increasing number of converted lands into buildings. Efforts to get high yielding tomatoes can be pursued through plant breeding programs to obtain genetic diversity of tomatoes which will then be selected to obtain superior seedling. According to Ranney [2], superior seedlings could be obtained with polyploid plant formation. Polyploidy refers to the presence of extra chromosomes [3]. Polyploidy manipulation results in higher triploid, tetraploid, and higher ploidy. This polyploidy grows faster than diploid and haploid individuals [4]. Induction of tetraploid tomato plants would increase the production and quality of fruit crops. Several chemical mutagens like colchicines and oryzalin have been used to induced polyploidy plants.

Oryzalin is an effective herbicide to produce tetraploid plants [5]. It is an anti-MT-agent, a herbicide which belongs to the group of dinitroanilines [6]. There was a variety of effects on the plants...
caused by these chemicals reported. The concentrations needed to evoke clear responses in plants are much lower for oryzalin than for colchicines [7].

The objective of this study is to determine the plant growth of two varieties of tomato (Solanum lycopersicum L.) at several oryzalin concentrations.

2. Materials and methods
The research was conducted at screen house of Agricultural Faculty, Universitas Sumatera Utara. The study was used Factorial Randomized Block Design with two factors. The first factor was tomato variety (Var. Permata and Tymoti) and the second was concentration of Oryzalin (0 μM, 30 μM, 60 μM, 90 μM and 120 μM). Seeds of both tomato varieties (Var. Permata and Tymoti) were soaked in Oryzalin solution with concentrations of 0 μM (control plant), 30 μM, 60 μM, 90 μM and 120 μM, and shaken on the shaker for 24 hours with 100 rpm. Subsequently, the treated seed along with untreated seed (control) were sowed in the seed tray individually. When the seedlings grew to 5–6 cm, which have had two to four leaves, they were then transferred to 20 cm diameter polybag which contain the mixture of top soil, vermicompos and husk =1:1:1. Parameters observed were plant height, leaves number, and stem diameter of plants grown for 30 days.

Analysis of variance was performed using excel program, followed by Duncan’s Range Test at 5% level of significance.

3. Results and discussion
The results showed that there was no variation found in two tomatoes varieties on all parameters observed, however both varieties of tomato were sensitive to Oryzalin treatments. The variance of plant height is presented in Table 1.

Oryzalin concentration significantly affected the plant height of 30 days after sowing for both tomato varieties. Plants height of oryzalin-treated plant were shorter than control plants. The higher concentration of Oryzalin, the shorter the plant height of both tomato varieties up to 90 μM, and increased slightly at higher concentration (120μM). Our result in plants height is in line with Sugiharto et al [8] who reported the results of their study on yellow corn plants treated by several levels of colchicine concentrations (0 ppm up to 600 ppm) and with [8] on Gossypium hirsutum L. Stebbin [9] stated that decreased growth rate of polyploids was caused by the reduced rate of cell division. The supply of the cells with auxins was interrupted, the respiratory ratio was reduced and activities of many enzymes were diminished.

| Oryzalin concentration | Plant height (cm) |
|------------------------|-------------------|
|                        | Permata           | Tymoti            |
| 0 μM                   | 41.65 a           | 23.29 bc          |
| 30 μM                  | 31.27 ab          | 31.39 ab          |
| 60μM                   | 12.26 cd          | 28.25 b           |
| 90μM                   | 4.89 d            | 9.43 d            |
| 120μM                  | 5.23 d            | 9.96 d            |

Values followed by the different letter within a column are significantly different from each other according to Duncan’s Multiple Range Test at 5% level of significance.

However, our result in plant height is contrary to the result of the study obtained by Dani and Rosamiti [10] using colchicines in watermelon with the range from 0 (control) % up to 4 %. They
found that the higher concentration of colchicine, the higher the plant length of watermelon. The application of high-concentration Oryzalin can cause stunted plant growth, because Oryzalin can inhibits cell division. Jones et al [11] stated that application of Oryzalin at lower concentration is more effective to induce the polyploidy plant.

The performance of the plants 30 days after sowing is presented in Figure 1. Plant even at the lowest concentration of oryzalin seemed depressed.

![Figure 1. The performance of the 30 days old tomato plants var Permata (left untreated plant followed By oryzalin treated plants (30, 60, 90 and 120 respectively)](image)

The study also revealed that oryzalin cause reduction in leaf number of both varieties of treated tomatoes with higher concentration compared to untreated plant. The variation on leaf number at 30 days after sowing is presented in Table 2. Leaf number produced by the plants, treated with 30 μM oryzalin was not significantly different from leaf number untreated plants. It seemed Permata variety was more sensitive to oryzalin than var. Tymoti. Tomato var Tymoti at 60 μM still produced more leaf number than untreated plant. However, there was a sharp reduction in leaf number for both varieties treated with oryzalin ≥ 60 μM. The results we obtained in leaf number of both varieties were in agreement with Sinaga et al [12] who reported that high concentration of colchicine (0.16%) caused a reduction in leaf number, and also in line with Sugiharto et al [13] that study the effect of colchicine on yellow corn plants.

| Oryzalin concentration | Leaf Number (Sheet) |
|------------------------|---------------------|
|                        | Permata  | Tymoti   |
| 0 μM                   | 15.20 ab | 13.47 bc |
| 30 μM                  | 14.60 abc| 19.00 a  |
| 60 μM                  | 10.27 cd | 12.47 bcd |
| 90 μM                  | 4.40 ef  | 8.47 de  |
| 120 μM                 | 3.93 f   | 5.47 ef  |

Values followed by the different letter within a column are significantly different from each other according to Duncan's Multiple Range Test at 5% level of significance.
High concentration of Oryzalin caused disruption of plant growth due to at higher concentration, oryzalin become toxic to plant. Permadi et al [14] stated that induction polyploidy will cause physiological damage, commonly occurs on the first generation of treated plant, which is indicated by the slower in plant growth. Normasiwi and Nurlaeni [15] stated that toxicity effect of Oryzalin could cause the seedlings ungrowth or even dead.

The relationship between the concentration of oryzalin and stem diameter of both tomato varieties was presented in Table 3. Data showed that stem diameter of the treated plants with 30 μM, for both varieties were slightly bigger than untreated plants, however were decreased sharply at the concentration of oryzalin ≥ 60 μM. This result is in line with Sugiharto et al [13] that found decreasing in stem diameter of yellow corn plants treated with high concentration of colchicine.

| Oryzalin concentration | Stem diameter (mm) | Permata | Tymoti |
|------------------------|--------------------|---------|--------|
| 0 μM                   | 1.33a              | 1.15 ab |
| 30 μM                  | 1.35a              | 1.28 a  |
| 60µM                   | 0.95bc             | 0.77 c  |
| 90µM                   | 0.22d              | 0.37 d  |
| 120µM                  | 0.17 d             | 0.11 d  |

Values followed by the different letter within a column are significantly different from each other according to Duncan’s Multiple Range Test at 5% level of significance

Application of oryzalin supposed to stimulate the increasing of vegetative growth. According to Sulistianingsih [16], polyploid plants usually appear more muscular plants and larger plant parts (roots, stems, leaves, flowers and fruit). In our results however, in plant growth (plant height, leaf number, and stem diameter), the use of oryzalin caused the growth of the plant depressed so that its growth becomes slower compared to untreated plants. Probably in the next growth phase, the cells and tissues treated plants become adapt well to free radicals and change the structure and function of cell membrane that cause increasing in plant growth, as Kujin et al [17] stated.

4. Conclusions
Tomato var. Permata and Tymoti were responsive to Oryzalin concentration. High concentration of Oryzalin caused the reduction in the plant height, leaf number and stem diameter for both tomato varieties at the first stage of the plant growth. The comparison between the two varieties showed that Permata is more sensitive to oryzalin, even though statistically is not significantly different.

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