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# Response growth and yield of red onion (*Allium ascalonicum* L.) of Bima variety using cholchine and cow manure

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## Abstrak
Permintaan terhadap bawang tinggi tidak terpenuhi karena terkendala luas areal, pupuk mahal, perubahan iklim, harga bibit mahal, serangan hama dan penyakit. Ukuran umbi bawang merah lokal jauh lebih kecil dibandingkan bawang merah impor. Tujuan penelitian untuk mengetahui pengaruh kolkisin dan pupuk kandang sapi terhadap pertumbuhan dan produksi bawang merah varietas Bima. Penelitian dilaksanakan pada bulan Jani-September 2023 di kebun lahan percobaan Fakultas Pertanian Universitas Pembinaan Masyarakat Indonesia. Metode penelitian menggunakan rancangan acak lengkap yaitu konsentrasi kolkisin (0 ppm; 300 ppm; 600 ppm), lama waktu perendaman (0, 4 jam dan 8 jam), pupuk kandang sapi (0, 2kg, 4kg) yang di ulang sebanyak 3 ulangan. Hasil penelitian menunjukkan bahwa konsentrasi kolkisin dengan lama perendaman, dan pupuk kandang sapi berpengaruh nyata terjadi pada tinggi tanaman, jumlah daun, jumlah anakan, diameter umbi, bobot umbi basah per rumpun, dan bobot umbi basah per plot berpengaruh nyata pada perlakuan konsentrasi 300 ppm perendaman selama 8 jam, dan 4 kg pupuk kandang sapi, dan semua perlakuan berbeda nyata terhadap tanaman kontrol.

**Kata kunci:** Bawang merah, Induksi mutasi, Kolkisin, Pupuk kandang sapi, Umbi

## Abstract
Demand for onions is always increasing but is constrained by large areas, expensive fertilizer, sensitivity to climate change, expensive seed prices, pests, and disease attacks. The size of local shallot bulbs is much smaller than imported shallots, but the color of the bulbs is redder and the taste is spicier. In order to overcome this problem, there needs to be an effort to improve the plant and shallot cultivation activities using colchicine to obtain superior properties and in combination with cow manure. . This research aims to determine the effect of colchicine and cow manure on the growth and production of the Bima variety of shallots. The research was carried out in January–September 2023 in the experimental garden of the Faculty of Agriculture, Universitas Pembinaan Masyarakat Indonesia, Medan. The research method used a completely randomized design, namely colchicine concentration (0 ppm, 300 ppm, and 600 ppm), soaking time (0; 4 hours; 8 hours), and cow manure (0; 2kg; 4 kg), which was repeated in 3 repetitions. The results showed that the concentration of colchicine, soaking time, and cow manure had a significant effect on plant height, number of leaves, number of tillers, tuber diameter, wet tuber weight per hill, and wet tuber weight per plot. The 300 ppm soaking concentration treatment had a significant effect on these factors. for 8 hours and 4 kg of cow manure, and all treatments were significantly different from control plants.

***Keywords:*** *Bulbs, Kolkisin, Cow manure, Mutation induction, Shallots*

## Introduction

Shallots (*Allium ascalonicum* L.) are one of the horticultural commodities that are really needed in preparing daily food dishes. Shallots, apart from being used as a cooking spice, are also often made into vegetables such as pickles or salads; fried onions are used as an antimicrobial and anticancer and red onion extract can be used as a plant growth regulator (Lestari et al., 2023). Based on Statistk, (2021) Indonesia's shallot production in 2020 reached 1.82 million tons. This production increased from 2019 by 14.88%, where production in 2019 was 1.58 million tons. The area of shallot-harvested land throughout Indonesia was 9.195 ha in 2019 (Ministry of Agriculture 2019). Shallots are an important horticultural commodity in Indonesia, with demand continuing to increase both to meet domestic needs and for export purposes. In 2020, the household sector consumed up to 729.82 thousand tonnes of shallots, while the export value increased from 2019 by 29.8%, namely from US$ 10.6 million to US$ 13.7 million. Then, shallot production only increased by around 1.6 to 5.1% between 2016 and 2019. In 2020, monthly shallot production still experienced a difference of up to 98% (100.46 thousand tonnes) between the months with the highest and lowest production. This shows that the amount and stability of shallot production need to be increased both between and throughout the year. Increasing shallot production can be done by applying plant breeding techniques or methods in an effort to improve plant genetics, such as obtaining new varieties of shallots that are superior to previous varieties. This method is also used to improve plant characteristics, especially yield and production characteristics.

Stated that colchicine can increase the size of shallot bulbs so that it can increase productivity and consumer preference for local Indonesian shallots. Colchicine-induced polyploidy and its effects on pharmacologically active secondary metabolites have not been studied. Polyploid breeding has been successful in increasing plant biomass and/or secondary metabolite production (Sari et al., 2019). Colchicine comes from the Colchicium autumnale plant, it can be found in all parts of the plant, especially the seeds and tubers. Colchicine is an alkaloid chemical compound, which can cause mutations and create polyploid plants. Colchicine plays a role in weakening the arrangement of microtubules, causing mitosis to be hampered and causing a doubling of the number of chromosomes, thus creating polyploidy plants. Apart from that, colchicine also affects the diversity of plant phenotypes and genotypes because colchicine affects plant physiology, which causes plants to appear bigger and

stronger. Colchicine can cause variations in the shape, size, and number of chromosomes in shallot plants (*Allium ascalonicum* L.) and the formation of polyploid plant parts or individuals with double the number of chromosomes, so that morphologically, the size looks larger.

Cow dung is one of the organic fertilisers that can increase nutrients in the soil, both macro and micro, and can improve soil structure, increase water holding capacity, stimulate the activity of microorganisms that play a role in the breakdown process, and also increase cation exchange capacity. Using cow dung fertiliser at the right dose will increase plant yields. Based on the description above, the aim of the research is to determine the effect of colchicine application and cow manure application on increasing the production of shallots (*Allium ascalonicum* L.) of the Bima variety.

## MATERIALS AND METHODS

The research will be carried out from June to September 2023 at the experimental garden of the Faculty of Agriculture, Indonesian Community Development University, Medan City, North Sumatra, at an altitude of approximately ± 30 meters above sea level.

The materials used are Bima variety shallot bulbs, colchicine, cow manure, and top soil. The tools used were polybags measuring 30 x 35 cm, calipers, measuring tape, analytical scales, hoes, machetes, treatment boards, handsprayer, gembor, dropper pipette, digital camera, tissue, cotton wool, and other stationery that supports research.

This study used a completely randomized design (CRD) with three factors, namely: colchicine concentration (C0: no colchicine, C1: 300 ppm concentration, C2: 600 ppm concentration), colchicine soaking time (P0: no soaking, P1: 4 hours of soaking, P2: 8 hours soaking), and cow manure (S0: without cow manure, S1: 2 kg/polybag, S2: 4 kg/polybag). Each treatment was repeated 3 times, and there were 27 treatments, and there were 3 samples from each treatment.

Table 1. Combination treatment of colchicine concentration, colchicine soaking time, and cow manure on the growth and production of shallots

| Treatment |
|---|
| K0 = without colchicine, soaking time, and cow manure |
| K1 = colchicine 300 ppm + 4 soaking time + cow manure 8:2 |
| K2 = colchicine 300 ppm + 8 soaking time + cow manure 8:2 |
| K3 = colchicine 600 ppm + 4 soaking time + cow manure 8:2 |
| K4 = colchicine 600 ppm + 8 soaking time + cow manure 8:2 |
| K5 = colchicine 300 ppm + 4 soaking time + cow manure 6:4 |
| K6 = colchicine 300 ppm + 8 soaking time + cow manure 6:4 |
| K7 = colchicine 600 ppm + 4 soaking time + cow manure 6:4 |
| K8 = colchicine 600 ppm + 8 soaking time + cow manure 6:4 |

The research was carried out starting with the land being cleared of weeds, plant root remains, and rocks and then leveled, making a plot 120 cm long and 120 cm wide with a plot height of 30 cm, a distance between plots of 50 cm, and a distance between polybags of 30 cm at the same time. trench with a depth of 30 cm.

Colchicine solution is made by dissolving colchicine powder with distilled water and putting it in a sterile bottle for direct use or as a stock solution. The colchicine stock solution was initially made with a concentration of 1000 ppm using 0.008 g of colchicine powder added to 8 mL of distilled water. Next, a solution was made for treatment using the stock solution to become a solution with a concentration of 300 ppm and 600 ppm with up to 8 mL of distilled water, for a colchicine concentration of 0 ppm using 8 mL of distilled water as treatment. Then the tubers are cut off at the bottom and ends and then soaked based on the concentration and length of soaking according to the treatment that has been determined and labeled.

Treatment of cow manure is done by filling it into polybags according to the treatment until the planting medium is 10 kg. Filling the planting medium is done 2 weeks before planting, and watering is carried out every day. Planting the bulbs is done by inserting 1 Bima shallot seed in a planting hole to a depth of 1-2 cm. Then, the hole is covered again with a little soil. Watering is done in the morning and evening. Weeding is carried out if weeds are found growing in the experimental plot. Pest control is carried out after pests attack more than 20% of the total number of plants. Harvesting is done when the plants are ± 9 WAP; the criteria for harvesting shallots are 60-70% of the necks of the leaves have become limp and yellow, the bulbs look full, and some of the bulbs are visible above the ground surface. The color of the bulbs

becomes dark red, purplish red, or red young. Additionally, the upper leaves begin to fall, and harvesting is done by removing all parts of the plant.

Data from research observations were analyzed for variance, if they had a significant effect, then Duncan's Multiple Range Test (DMRT) was carried out at the 5% and 1% levels.

**Results and Discussion**

The results of the analysis of variance showed a significant effect on the observed growth parameters, namely: plant height (cm); number of leaves (strands); the number of tillers (stems), and the average research results are presented in Table 2.

Table 2. Average growth of shallots due to treatment with colchicine concentration, soaking time, and cow manure

| Treatment | Plant height (cm) | Number of leaves (strands ) | Number of tillers (stems) |
|---|---|---|---|
| K0 | 33.42$^{bc}$ | 24.17$^{ab}$ | 9.33$^{abc}$ |
| K1 | 35.32$^{bc}$ | 21.67$^{b}$ | 10.00$^{ab}$ |
| K2 | 34.62$^{bc}$ | 26.17$^{ab}$ | 10.67$^{ab}$ |
| K3 | 39.02$^{ab}$ | 23.67$^{ab}$ | 8.67$^{abc}$ |
| K4 | 44.23$^{a}$ | 30.17$^{a}$ | 11.00$^{a}$ |
| K5 | 36.00$^{bc}$ | 24.17$^{ab}$ | 9.00$^{abc}$ |
| K6 | 37.50$^{abc}$ | 25.83$^{ab}$ | 9.50$^{abc}$ |
| K7 | 31.20$^{c}$ | 19.67$^{b}$ | 7.17$^{c}$ |
| K8 | 32.07$^{bc}$ | 20.00$^{b}$ | 8.17$^{bc}$ |

Note: WAP (weeks after planting); a number followed by a lowercase letter not the same for the same column indicates significant differences based on DMRT test at a 5% level.

Based on the DMRT test at the 5% level, the height parameters of shallot plants after treatment reached 44.23 cm (K4), which had a significant effect on K5, K7, K8, K2, K1, and K0, each of which was 36.00 cm; 31.20 cm; 32.07 cm; 34.62 cm; 35.32 cm; and 33.42 cm.

The highest number of leaves, 30.17 (K4), significantly differed from K7 and K8, which were respectively 23.33 and 24.67 leaves. The maximum number of offspring was 11.00 stems (K4), significantly differing from K7 and K8, with 7.17 stems and 8.17 stems, respectively. According to Ade & Rai, (2010) colchicine ($C_{22}H_{25}O_6N$) It refers to an alkaloid with a white color, obtained from the seeds of the Colchicum autumnale L. plant (Liliaceae family). This compound inhibits the formation of spindle fibers during cell division, resulting in the emergence of polyploid individuals. When colchicine is

used at the appropriate concentration, the chromosome count increases, thus making the plants polyploid (Larsson & Ronsted, 2014). Plants with a polyploid nature typically exhibit larger morphological sizes compared to diploid plants. Consequently, the quality of plants treated in this manner is expected to be better than that of diploid plants. Generally, colchicine works effectively at concentrations between 0.01% and 1% for a period of 6 to 72 hours, although each plant species has a unique response. (Samatadze et al., 2022). The research findings are supported by Fathurrahman et al., (2023) the outcomes of colchicine administration with an extended soaking period demonstrate that the treatment can improve the phenotype and have a substantial impact on long bean growth and production factors, such as plant height, pod weight, pod length, number of pods, and the weight of 100 seeds.

The results of the analysis of variance showed a real influence on the observed harvest parameters, namely: tuber diameter (mm), wet tuber weight per hill (g); and wet tuber weight per plot, and the average research results are presented in Table 3.

Table 3. Average harvest parameters due to colloidal silver treatment, immersion time, and cattle manure fertilizer

| Treatment | Tuber diameter (mm) | Wet tuber weight/hill (g) | Wet Tuber Weight/plot per Plot (g) |
|---|---|---|---|
| K0 | 9.61$^{abc}$ | 81.78$^{bc}$ | 188.24$^{bc}$ |
| K1 | 9.90$^{ab}$ | 81.94$^{bc}$ | 189,94$^{bc}$ |
| K2 | 10.08$^{ab}$ | 99.16$^{a}$ | 228.25$^{a}$ |
| K3 | 9.25$^{bc}$ | 83.43$^{bc}$ | 192.04$^{bc}$ |
| K4 | 10.24$^{a}$ | 93,04$^{ab}$ | 213.83$^{ab}$ |
| K5 | 9.45$^{abc}$ | 81.29$^{bc}$ | 188,03$^{bc}$ |
| K6 | 9.76$^{abc}$ | 84.12$^{bc}$ | 194.29$^{bc}$ |
| K7 | 8.92$^{c}$ | 70.78$^{c}$ | 162.59$^{c}$ |
| K8 | 9.22$^{bc}$ | 72.00$^{c}$ | 165.40$^{c}$ |

Note: WAP (weeks after planting); a number followed by a lowercase letter not the same for the same column indicates significant differences based on DMRT test at a 5% level.

Treatment (K4) of 600 ppm colchicine + 8 hours soaking + cow manure 8:2 resulted in a root diameter of 10.24 mm and showed significant differences compared to K7, which used 600 ppm colchicine + 4 hours soaking + cow manure 6:4, producing roots of 8.92 mm in length. Additionally, K8, with 600 ppm colchicine + 8 hours soaking + cow manure 6:4, resulted in a root diameter of 9.22 mm. For the wet root weight per bulb (K2), the treatment with 300 ppm colchicine + 8 hours soaking + cow manure 8:2 produced the highest weight of 99.16 g, and was significantly different from treatments K0, K1, K3, K5, K6, K7, and K8, with weights of 81.78 g; 81.94 g; 93.04 g; 81.29 g;

84.12 g; 70.78 g; and 72.00 g, respectively. The wet root weight per bulb will be followed by the wet root weight per plot, where K2, with 300 ppm colchicine + 8 hours soaking + cow manure 8:2, achieved a weight of 228.25 g, not significantly different from the 8:2 cow manure + 600 ppm colchicine + 8 hours soaking treatment with a weight of 213.83 g, but significantly different from the other treatments.

Genetic material changes due to influences from within the cell are a characteristic that sets living organisms apart from non-living ones, as they can undergo mutations and maintain the necessary biological diversity. In the case of red onion variety Bima, this process ensures its continued existence and adaptation.Colchicine, a well-known chemical mutagen, is frequently employed to induce polyploidy in both animals and plants. Consequently, higher colchicine concentrations are necessary to double plant cell chromosomes and enhance tuber production, which aligns with research findings. Sari et al., (2019) to fulfill market demands and boost production, shallot crop enhancement can be achieved through implementing plant breeding techniques or methods. This approach aims to improve plant genetics, resulting in superior shallot varieties compared to their predecessors. Additionally, these techniques focus on enhancing plant attributes, particularly yield and production traits.

Applying colchicine treatment can enhance shallot bulb size, which in turn boosts productivity. This may help satisfy local Indonesian consumer demands for shallots. (Husain et al., 2022). The morphological variations observed in this study are attributed to both genetic and environmental factors. Despite using the same variety, colchicine treatment impacts shallot growth parameters when planted in polybags. Colchicine administration leads to alterations in shallot (Allium ascalonicum L.) chromosome shape, size, and number. This results in polyploid plant parts or individuals with double the chromosome count, visibly exhibiting larger sizes. (Hailu et al., 2021). Optimally concentrated colchicine can generate polyploid plants with larger stems compared to control plants. However, excessively high concentrations or extended soaking periods may lead to stunted growth and development in plants. (Arindyaswari et al., 2022). Soaking for 12 hours led to polyploidy in plant chromosomes, increasing the stem diameter compared to the control. Colchicine treatment at 1% altered shallot root tips' chromosome numbers and shapes. Ploidy level and chromosome morphometric variations, such as cell area, chromosome length measurement, and doubling of chromosome numbers, were observed. These genetic changes in shallot plants can be distinguished morphologically and agronomically from

the control plants.

The use of organic fertilizers is one solution to provide nutrients for plants and can also improve soil structure. Organic fertilizers that are widely available in the community include cow manure. Cow manure contains 0.46% N, 0.83% P2O5, and 0.30% K2O. Using 30 tonnes.ha$^{-1}$ of cow manure can increase the growth rate of onion plants and the number of bulbs (Sakti and Sugito, 2018). Providing 25 tonnes.ha$^{-1}$ of manure gave better shallot bulb yields with an average productivity of 6.30 tonnes.ha$^{-1}$ or increased yields of 2.2 tonnes compared to without manure.The Bima red onion bulbs increased due to Ami (2015) research, with 95% of this growth attributed to higher cow manure doses, and 5% influenced by unobserved factors. The rise in plant P concentration is linked to the increased available P from the enhanced tuber P concentration caused by cow manure decomposition..

Feeding livestock manure provides the highest effect on increasing plant P concentration and bulb onion concentration. The increase in plant P concentration and bulb onion concentration is believed to be closely related to the availability of P due to the decrease in P absorbers such as Al or Fe, and the improvement of soil conditions (increase in pH soil) caused by humic and sulfuric acids from the decomposition of livestock manure, as well as the possibility of P contribution from the mineralization of livestock manure provided. When the macro nutrients in the soil increase, the amount that can be absorbed by the plant also increases, along with the formation of organic compounds in the plant's structure. Furthermore, the volume of photosynthesis that can be produced by the plant is not only determined by the absorption of sunlight but also by the availability of nutrients in the ribosome obtained through the absorption of nutrients from the soil. Improving nutrient absorption is also influenced by the improvement of soil pH (Paputri et al., 2018).

According to Wahyudi (2009), improving soil conditions causes the growth and development of plant roots to improve so that the roots can absorb nutrients well, and in the end, this will improve plant growth and development. Candra et al., (2023) reported that as the availability of macronutrients from cow manure in the soil increases, the amount that can be absorbed by plants also increases, accompanied by the formation of organic compounds in shallot plant tissue. Apart from that, the volume of photosynthate that plants can produce is not only determined by the absorption of sunlight but also by the level of availability of raw materials in riboson, which is obtained through the absorption of nutrients from the soil. Improvements in nutrient absorption are also influenced by improvements in soil pH (El-nour, 2021). This is

because cow manure can have a positive influence on the soil and provide the nutrients needed for the growth of shallots. The availability of nutrients in the soil, the condition of the soil structure, and good soil aeration greatly influence the growth and development of plant roots. Optimal root system development will support plants through their vegetative and generative phases (Atmaja et al., 2019).

**Conclusions and recommendations**

The results of the research showed that the treatment of colchicine concentration, soaking time, and cow manure had a significant effect on shallot growth parameters, namely: plant height (cm), number of leaves (strands), and number of tillers (stems). Shallot harvest parameters resulting from treatment had a significant effect on bulb diameter (mm), wet bulb weight per cluster (g), and wet tuber weight per plot (g). The combination treatment with a colchicine concentration of 300 ppm followed by soaking the seeds for 8 hours using polybags and media consisting of 8 kg cow manure and 2 kg topsoil was the best compared to the control using no colchicine concentration. The length of soaking in colchicine and cow manure had no effect on all the parameters observed.

Suggestions for further research are to use the application of 300 ppm colchicine concentration with 8 hours of soaking and 8 kg of manure, followed by several additional media such as burnt husks, sand, and topsoil, to increase shallot production.

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