

Effect of planting material and B1 vitamin during acclimatization on the growth of potato (*Solanum tuberosum* cv. Granola)

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Abstract: The research aimed to evaluate effect of planting material and B1 vitamins during acclimatization on potato growth. The research was conducted at greenhouse PT. Adhiguna Jaya Laboratory, Central Java - Indonesia. The study used a completely randomized design - factorial 2 x 3 with four replications. The first factor was planting material: cuttings shoot plantlet (H₁) and whole plantlet (H₂). The second factor was an application of B1 vitamin in growing media : 0 ml. L⁻¹ (M₁), 1 ml. L⁻¹ (M₂), and 2 ml. L⁻¹ (M₃). The results showed that the whole plantlet had a significantly effect on plant height, the number of leaves, shoots, and root length than the cuttings shoot plantlet. Application of B1 vitamin 1 ml. L⁻¹ at growing media showed the highest effect on roots length. Combination of whole plantlet and concentration B1 vitamin at 1 ml. L⁻¹ - 2 ml. L⁻¹ were increased growth the highest of 95.24% - 100% number of leaves, 2.50% - 3.00% shoots, and 15.82% - 19.90% root length. It can be concluded that the whole plantlet and application of 1 ml. L⁻¹ - 2 ml. L⁻¹ B1 vitamin in growing media during acclimatization increased the growth of potatoes.

Keywords : acclimatization, potato cv. Granola, vitamin B1, whole plantlet, shoot plantlet

1. Introduction

Potatoes (*Solanum tuberosum* L.) is a family of *Solanaceae* as one of the main food commodities that occupy the fourth position in the world after wheat, rice, and corn. Potatoes cv. Granola are widely developed and cultivated in Indonesia because they have the advantage of being resistant to diseases, resistance drought, short harvest, and the potential productivity can reach medium to high [1]. However, potato productivity in Indonesia is not optimal due to the low quality and quantity of potato seeds [2]. Increasing potato productivity can be pursue by the production of seeds superior virus-free through in-vitro culture techniques, that is proven to be efficient technique with the final result a production of healthy plantlets, high quality, and high photosynthetic rates [3][4]. The final stage of in-vitro culture activity is the process of acclimatization, which is the process of adaptation of plantlets from a heterotrophic control environment to an autotrophic environment, that cannot control the external environment of both humidity, temperature, and light [5].

The innovation of acclimatization technique developed today is the technique of rapid production by the technique of mini-planlet cuttings. This technique moves one potato plantlet into 2-3 parts of the plant on the acclimatization medium, providing one bud [6]. Nevertheless, this technique has a low success rate in growing plantlets. Single node cuttings are mini potato cuttings from the plantlet and are treated with auxin as a root growth stimulant, but this technique only produces shoots growing less than 25% [7]. The shoots of the plant are parts that have great potential to grow compared to other parts. A higher concentration of natural auxin in the bud can stimulate the formation of plant phytohormones to support plant growth [8][9].

In addition, vitamin B1 can be one of the catalysts to support growth because it acts as a coenzyme of hormonal activity, signaling, activation, and preservation processes in cells and tissues [10]. Vitamin B1 can reduce stress in plants, one of which is at the acclimatization stage. The addition of vitamin B1 can increase plant resistance to biotic and abiotic stress [11], but will be a growth inhibitor if the dose is too much [12]. Based on the description, a study was conducted to assess the influence of

planting material and different concentrations of vitamin B1 on the growth of potato cv. Granola planlets for eight weeks of acclimatization.

2. Materials and methods

The study was conducted in May – July 2021 at the greenhouse of PT. Adhiguna Jaya Laboratory, Gataksari, Kejajar, Wonosobo, Central Java - Indonesia at an altitude of 1,444 meters above sea level with an average temperature of 15⁰C - 29⁰C and humidity between 61% - 98% and in the Chemical Laboratory, Center for the Study of Agricultural Technology, Central Java - Indonesia. The material included potato cv. Granola planlets aged 35 days after the subculture with a height of 10 cm from the Kledung Horticultural Seed Garden, cocopeat, vermicompost, aquades, bactericides, 70% alcohol, root growth stimulating hormones, insecticides, vitamin B1, AB mix fertilizer, and water. The medium was fermented by mixing cocopeat and vermicompost 4 : 1 and added 500 ml : 25 L of effective microorganisms 4 for two weeks. The substrate was put in a pot 25 x 25 cm in size and sprayed 1 ml. L⁻¹ insecticide and left for three days. The substrate was watered with 100 ml of water, one day before planting the planlets.

Table 1. The mineral content of the media before fermentation

Media	Mineral Content				
	N (%)	P ₂ O ₅ (%)	K ₂ O (%)	C/N Ratio	Ph
Cocopeat	0.65	68.90	33.90	69.90	5.46
Vermicompost	14.74	0.98	1.81	15.76	5.80

The study was carried out in a factorial 2 x 3 using a Complete Randomized Design (CRD) with four replication. The first factor was planting material; namely, H1 = cuttings shoot planlet, H2 = whole planlets. The second factor was the concentration of vitamin B1, M1 = 0 ml. L⁻¹, M2 = 1 ml. L⁻¹, M3 = 2 ml. L⁻¹. The parameters observed during the study were plant height (cm), number of leaves, number of buds, stem circumference (cm), and root length (cm).

The observational data obtained were further analyzed using analysis of variance (ANOVA) based on a complete randomized design using ms. Excel macro add-ins (DAASTAT version 1.101) at an error rate of 5% and would be further tested with Least Significance Difference (LSD) if the results of the analysis of variance showed significant differences [13].

3. Result and discussion

3.1. Recapitulation of the results statistical analyzed

The planting material with the addition of vitamin B1 concentrations and the interaction of treatments positively responded to the growth parameters of potatoes cv. Granola. The results of the variance analysis are presented in (Table 2).

Table 2. Recapitulation the results of the analysis variety of morphological parameters in potatoes cv. Granola at the eighth-week acclimatization

Observation parameters	Origin of planting material	Vitamin B1 concentration	Treatment interactions
Plant height	*	ns	ns
Number of leaves	*	*	*
Number of shoots	*	*	*
Stem circumference	ns	ns	ns
Root length	*	*	*

Description: significant (*) significantly different at the level of 5%; non-significant (ns) differ at the rate of 5%

The planting materials were the significant differenced in plant height, number of leaves, number of shoots, and length of roots, while the concentration of vitamin B1 and the interaction of treatment factors did not make a significant differenced in the parameters of plant height. The parameters of stem circumference did not show a significant differenced from all treatments. Potatoes cv. Granola after eight weeks of acclimatization were presented in Figure 1.

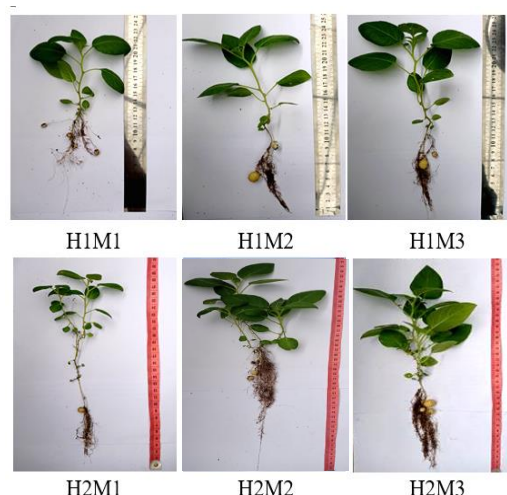


Figure 1. Potato planlets cv. Granola after eight weeks of acclimatization (H1 = cuttings shoot planlet; H2 = the whole planlet ; M1 = concentration of vitamin B1 0 ml. L⁻¹ ; M2 = concentration of vitamin B1 1 ml. L⁻¹ ; M3 = concentration of vitamin B1 2 ml. L⁻¹)

3.2. Plant height

The results showed that planting material had significant effect, while the concentration of vitamin B1 and the interaction of treatment factors had no significant effect on the height of the potato cv. Granola at week eight of acclimatization.

Table 3. The average plant height (cm) of Granola potatoes at the eighth week of acclimatization

The concentration of vitamin B1	Origin of planting material		Average
	Cuttings shoot planlet	Whole planlet	
0 ml. L ⁻¹	9.78	20.23	15.00
1 ml. L ⁻¹	14.03	19.65	16.84
2 ml. L ⁻¹	15.28	23.13	19.20
Average	13.03 ^b	21.00 ^a	(-)

Description: The number followed by the different letter shows an significant effect on the 5% LSD test

Whole planting material showed an average plant height (21.00 cm) higher than cuttings shoot material planlets. Whole planlets had a height that was not much different from potatoes cv. Granola planted on the fields with a row space of 70 cm x 30 cm without fertilization, an average number of leaves of 24.75 at the eighth week after planting [14]. Whole planlets had completed organs, making it easier to adapt and carry out better growth metabolism during acclimatization. A good planlets for the acclimatization stage had a stocky feature, completed organs, and a steady green color of shoots, leaves, and stems [15]. However, the planting material of the cuttings shoot planlets also had a reasonably good plant growth in the presence of endogenous auxin content. This natural auxin plays a role in cell division, cell elongation, and differentiation of primordial cells [16]. In addition, the juvenile and meristematic planting material of shoot cuttings planlet allows the stem more easily differentiated to form adventitious roots [17] that can support growth.

3.3. Number of leaves

The results showed that the planting material, the concentration of vitamin B1, and the treatment interaction had a marked influence on the number of leaves of potato cv. Granola at week eight of acclimatization.

Table 4. The average number of leaves of potatoes cv. Granola at the eighth week of acclimatization

The concentration of vitamin B1	Origin of planting material		
	Cuttings shoot planlet	Whole planlet	Average
0 ml. L ⁻¹	33.50 ^b	42.00 ^b	37.75 ^b
1 ml. L ⁻¹	33.75 ^b	82.00 ^a	57.87 ^a
2 ml. L ⁻¹	37.50 ^b	84.00 ^a	60.75 ^a
Average	34.92 ^b	69.33 ^a	(+)

Description: The number followed by the different letter shows an significant effect on the 5% LSD test

Combination of whole planlets with the concentration of vitamin B1 1 ml. L⁻¹ and 2 ml. L⁻¹ has the highest number of leaves at 82 and 84 leaf blades (Table 4). It showed that whole planting material with completed organs combined with vitamin B1 could adapt faster than cuttings shoot planlet. Whole planting material has more stem segments as a place for both budding and leaf primordia [8]. The application of vitamin B1 in plants can increase the absorption rate of nitrogen and phosphorus elements and improve plant metabolism when climate change occurs, so that plant growth is more optimal [11]. At the same time, the cuttings of shoots has a lower number of leaves. The acclimatization technique of potato mini-cuttings from planlets by Sarjan et al. [7], only produced shoots growing less than 25%, thus affecting the growth of plant organs, one of which is the number of leaves. Vitamin B1 given to the planting material of cuttings shoot planlet allowed more of a role in the adaptation process in new media. Vitamin B1 was an energy supply in defense metabolism and the plant's response to environmental stress [11,18].

3.4. Number of shoots

The treatment of planting material with a concentration of vitamin B1 and these interactions significantly differs in the number of shoots based on analysis. The average number of shoots after eight weeks of acclimatization is presented in (Table 5).

Table 5. The average number of shoots of granola potatoes at the eighth week of acclimatization

The concentration of vitamin B1	Origin of planting material		
	Cuttings shoot planlet	Whole planlet	Average
0 ml. L ⁻¹	0.75 ^{bc}	1.25 ^b	1.00 ^b
1 ml. L ⁻¹	0.25 ^c	3.50 ^a	1.88 ^{ab}
2 ml. L ⁻¹	0.75 ^{bc}	4.00 ^a	2.38 ^a
Average	0.58 ^b	2.92 ^a	(+)

Description: The number followed by the different letter at same row or coloumn or interaction shows an significant effect on the 5% LSD test

Combination of whole planting material with the concentration of vitamin B1 1 ml. L⁻¹ and 2 ml. L⁻¹ showed the highest average number of shoots of 3.5 and 4.0 buds compared to the whole planlet without the addition of vitamin B1. According to Dhillon et al. [19], cuttings plants with the addition of vitamin B1 give the highest average bud gain. Whole planting material allowed a more significant number of buds than planting material shoots that have one bud, as well as the role of vitamin B1 in supporting the growth and development of buds. Cuttings of the plant with two buds and application of vitamin B1 to soil and compost media showed the fastest bud emergence time compared to single bud cuttings [20]. Cuttings of plant with three buds and adding 2 mg of vitamin B1 produced the highest average number of buds compared to the treatment of the below level at 42 days from the end of planting [21]. Each planting material has an optimum limit and different responses to the addition of vitamin B1. The addition that is not suitable of vitamin B1 concentration, can have the opposite effect (inhibitory) on plants. The role of vitamin B1 can support the growth of shoots [22].

3.5. Stem Circumference

The results showed that the planting material and addition of vitamin B1, as well as the interaction of two factors, were not significantly different in the stem circumference of the Granola potato. The average stem circumference at the eighth week of acclimatization was presented in (Table 6).

Table 6. The average stem diameter on Granola potatoes at the eighth week of acclimatization

The concentration of vitamin B1	Origin of planting material		
	Cuttings shoot planlet	Whole planlet	Average
0 ml. L ⁻¹	0.85	0.65	0.75
1 ml. L ⁻¹	0.75	0.76	0.76
2 ml. L ⁻¹	0.80	1.10	0.95
Average	0.80	0.73	(-)

The treatment of planting material and the addition of vitamin B1 had no significant differenced in the stem circumference. Latif et al. [23] state that application of vitamin B1 and atomics do not affect the diameter stem of the plant after six weeks of acclimatization. Vitamin B1 given to both whole planlet and cuttings shoot planlet can reduce plant stress during acclimatization. Vitamin B1 contribute to stress-tolerant [24] and induce the formation of hormones as a recovery of plant energy in the early stages of stress [25] due to cuttings and media transfer.

3.6. Root length

The length of the roots of potatoes cv. Granola at the eighth week of acclimatization gained a noticeable influence from the treatment of planting material, the addition of vitamin B1 concentrations, and the interaction of two treatment factors according to the results of statistycal

analyzed. The average length of the roots of potatoes cv. Granola after eight weeks of acclimatization is shown in (Table 7).

Table 7. The average root length (cm) of potato granola during the eighth week of acclimatization

The concentration of vitamin B1	Origin of planting material		
	Cuttings shoot planlet	Whole planlet	Average
0 ml. L ⁻¹	9.42 ^c	9.47 ^c	9.45 ^b
1 ml. L ⁻¹	9.12 ^c	20.90 ^a	15.01 ^a
2 ml. L ⁻¹	6.50 ^c	16.82 ^b	11.66 ^{ab}
Average	8.35 ^b	8.47 ^a	(+)

Description: The number followed by the difference letter at same row or column or interaction shows an significant effect on the 5% LSD test

Based on Table 7. the whole planting material has an average root length of 8.47 cm higher than the cuttings shoot planlet. This is because the whole planting material has an initial root length, while the planting material of shoots does not have roots at the beginning of planting. Nevertheless, the average length of the roots of both planting materials has not too far different. The juvenile and meristematic planting material of shoot cuttings planlet allows the stem more easily differentiated to form adventitious roots [17].

Combined treatment of whole planting material with a concentration of 1 ml. L⁻¹ vitamin B1 showed the highest average root length of 20.9 cm. According to Srilestari and Suwardi [26], the addition of vitamin B1 2 ml. L⁻¹ has the highest number of roots and root length compared to a concentration of 1 ml. L⁻¹ and 3 ml. L⁻¹. Whole planting material without the addition of vitamin B1 (concentration of 0 ml. L⁻¹) differs not real by planting material shoots either at a concentration of vitamin B1 0 ml. L⁻¹ ml. L⁻¹, as well as 2 ml. L⁻¹. This shows that each planting material requires a different concentration of vitamin B1 at the optimum growth stage. Each planting material has a different ability to form roots and buds due to differences in type and variability of carbohydrates and other stored materials from photosynthesis [27]. The number stress of roots and the length of the plant's roots are not acquiring a noticeable influence from the vitamin B1 given [28]. The guess from the response of giving vitamin B1 to whole planting material increase growth, while in the planting material shoots have not affected the pattern of physiological activity at intervals but acts as an adaptation resistance response. This follows research that adding vitamin B1 can reduce plant stress and recovery of energy after moving media [11][18][25].

4. Conclusions

Whole planting material affects higher plant height, the number of leaves, shoots, and the length of roots. Application of vitamin B1 1 ml. L⁻¹ gives the highest response at the roots length parameter. The combination of whole planting material with the application of vitamin B1 1 ml. L⁻¹ – 2 ml. L⁻¹ increased number of leaves by 95.24% - 100%, the number of shoots by 2.50% - 3.00%, and the length of roots by 15.80% - 19.90% compared to the concentration of vitamin B1 0 ml. L⁻¹.

5. References

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