Various Modified Treatments on Improving G0 Seed Multiplication in Potato

Meksy Dianawati*, *Yati* Haryati, and *Kiki* Kusyaeri Hamdani

Research Center for Horticulture and Plantation, National Research and Innovation Agency, Republic of Indonesia, Jl. Raya Cibinong Km 46, Bogor, Indonesia

Abstract. Many tubers are needed for the production of G0 potato seeds because potato seeds are sold in units of quantity. This research aimed to increase the number of tubers in G0 potato seed production. The study was conducted in a plastic house in Lembang, West Bandung, West Java from October 2017 to January 2018. The study used a randomized block design with six replications. The treatments tested were control (A), application of gibberellins (B), cutting of planlet cuttings followed by application of gibberellins (C), application of paclobutrazole (D), and application of paclobutrazole followed by gibberellins (E). Data were analyzed by F test and continued with orthogonal contrast, and correlation test at 95% confidence level and PCA biplot. The results showed that various introduced treatments failed in increasing the number of tuber total. However, the results of PCA biplot showed that C and D treatments were potential to be studied further by increasing the size of small tubers due to their greater number of tubers in total.

1 Introduction

Conventional propagation of G0 potato seeds from plantlets in Indonesia produces 3-5 tubers [1, 2]. Thus, it takes a lot of cuttings to meet the needs of the national potato seed which has implications for the current inefficient national seed production [3-5]. Whereas on the other side, the G0 production business requires quite an expensive investment, a long business cycle, and special skills and expertise [4, 6]. This is one of the reasons for the low availability of certified potato seeds at the farmer level [4, 6, 7], resulting in a high gap in research results and average potato productivity of 25 vs 15.9 tons per hectare[8].

G0 is a seed produced from plantlet cuttings in a screen house of insects in the media without direct contact with the soil [6]. Many tubers is needed for the production of G0 potato seeds because potato seeds are sold in units of quantity [6, 9]. However, small-size G0 seeds are in great demand by farmers because they can save on transportation costs and are cheaper [4]. Thus, various treatment modification efforts were made to increase the number of tubers so that the G0 seeding business was efficient and profitable. Modification of the treatment by applying exogenous hormones such as gibberellins and anti-gibberellins by stopping vegetative growth to switch to tuber growth [10-13].

* Corresponding author: meksyd@yahoo.com

Cutting shoots aims to eliminate apical dominance and increase the number of branches in order to obtain high vegetative growth to store food reserves for further growth [14]. The application of gibberellins after cutting these shoots is thought to induce the emergence of new stolons, so that new tubers are obtained besides the existing ones. [10] stated that the application of exogenous gibberellins can have a long day effect which can support stolon and crown elongation.

Giving anti-gibberellins can inhibit vegetative growth and switch to tuber growth [11, 12]. [16] reported that paclobutrazol at 28 DAP increased the percentage of stolons forming tubers and application at 42 DAP increased the number of small sized tubers. Giving gibberellins after giving anti-gibberellins is expected to also stimulate the growth of new stolons, so that a number of new tubers are obtained besides the existing ones, after being forced to have tubers. [17] reported that the application of gibberellins 5 days after application of anti-gibberellins increased the number of medium-sized tubers.

This study aimed to study various modified treatments to increase the multiplication in G0 potato seed production.

2 Method

The research was conducted in West Java, Indonesia, at -6,80304, 107,61476, 1324,1 m, 300^{O}, from October 2017 to January 2018.

The research used a randomized block design with six replications. The modified treatments tested were control (A), application of gibberellins (B), cutting of plantlet cuttings followed by application of gibberellins (C), application of paclobutrazole (D), and application of paclobutrazole followed by gibberellins (E). Thus, there were 30 experimental units where each experimental unit consisted of three plants, so there were 90 plants.

The plantlet cuttings used were cuttings from the 2nd healthy plantlet which already had 5-6 leaves. The soil used was subsoil used for vegetables with a depth of between 20-40 cm. The manure used had been fermented and ready to be used as organic fertilizer. The roasted husks used were products sold in the market. Basamid® was used for sterilizing media ®. The research was carried out in polybags with 25 cm x 30 cm size. Polybag was arranged in plastic house with a zigzag manner in one row. The polybag was filled ¾ of the media and was filled when heaping was done at 30 DAP. The media composition was subsoil: manure: fuel husks (1:1:1) in volume ratio.

Seedlings were planted with three cuttings per hole. Watering was done every day if the humidity of the medium was low. Formula of the AB mix fertilizer, electrolyte conductivity (EC) and acidity (pH) of fertilizerfollowed the instruction of and [17]. Fertilizing was given 100 m at 1-3 WAP, 200 ml at 3-4 WAP, and 300 ml at 5-8 WAP.

Gibberellins was given at 30 DAP with a concentration of 1.3 g/L [18] in treatment B while paclobutrazol was given at 45 DAP with a concentration of 0.5 ppm [17] in treatment D. The shoots were cut at 25 days old, then gibberellins were applied at 30 DAP with a concentration of 1.3 g/L in treatment C. Paclobutrazol was applied at 40 DAP with a concentration of 0.5 ppm and continued with gibberellins at 45 DAP with a concentration of 1.3 g/L [17] in treatment E. The control treatment was not carried out by hormone application or cutting of shoots.

At 100 DAP harvest, the number of tubers per plant was observed, the number of tubers based on weight per tuber (< 1 g was small tuber, 1-10 g was medium tubers, and l > 10 g was large tubers), and tuber weight per plant. Tuber weight per plant was the weight of all tubers produced per plant. Data were analyzed by F test and continued with orthogonal contrast and correlation test at 95% confidence level and PCA biplot.

3 Result and Discussion

The control treatment (A) was not subjected to any modification treatment and resulted in the formation of tubers with an average tuber number of around 8 and a mean tuber weight of 335 g per plant (Table 1). Treatment A was in quadrant III of the biplot with the best weight per plant, weight per tuber, number of large tubers and number of medium sized tubers (Figure 1).

The modified treatment group (B, C, D, E) did not affect plant height, number of shoots, number of medium-sized tubers, small tubers, and total tubers, but could reduce the number of large tubers, tuber weight per plate and weight per tubers compared to the control treatment (A) with orthogonal contrast test (Table 1). This showed that the modified treatment group could interfere with tuber production, especially large tubers, so that the number of tubers of large size and tuber weight per plant was low.

Tabel 1 Variable yield of potatoes in various efforts to increase the number of tubers

Modified treatments *	Plant height (cm)	Number of shoot	Number of tuber size				Tuber weight per plant (g)	Weight per tuber (g)
			Large	Medium	Small	Total		
A	80.0	3.0	2.7	3.7	2.0	8.3	335.0	48.4
B	89.0	8.3	1.0	2.3	1.7	5.0	159.3	33.3
C	103.0	7.7	1.3	2,7	6.3	10.3	222.7	21.3
D	78.0	3.0	2.0	4.0	4.0	10.0	232.0	23.8
E	52.3	4.3	1.0	1.7	1.7	4.3	124.3	28.1
CV (%)	8.94	23.51	(25.17) **	(24.29) **	(27.57) **	29.71	22.93	23.59
A vs B,C,D,E	80 vs 81	3.0 vs 5.8	2.7 vs 1.3***	3.7 vs 2.7	2.0 vs 3.4	8.3 vs 7.4	335 vs 184***	48 vs 27***
C,D vs B, E	90 vs 71	5.3 vs 6.3	1.6 vs 1.1	3.2 vs 2.2 ***	4.0 vs 2.8 ***	10.2 vs 4.5 ***	223 vs 140 ***	22 vs 29

* A: Control, B: Gibberellins, C: Cutting + gibberellins, D: Paclobutrazole, E: Paclobutrazole + gibberellins
** data was transformed by √(x+0.5)
*** showed a significant difference with the orthogonal contrast test at the level of confidence 95%

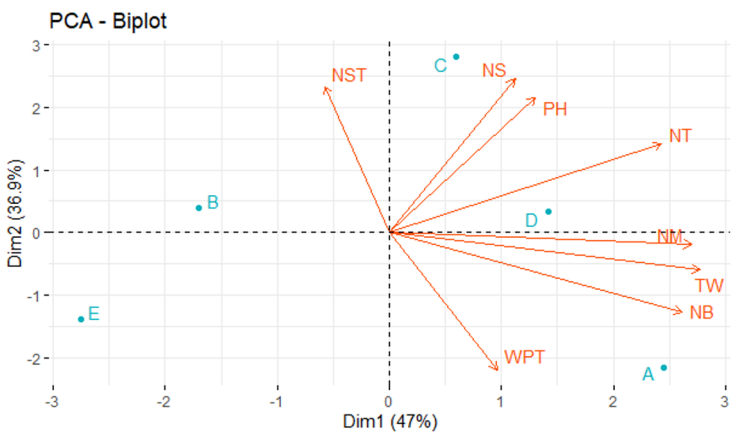

Fig. 1. Modified treatment PCA biplot to increase the number of tubers
A: Control, B: Gibberellins, C: Cutting + gibberellins, D: Paclobutrazole, E: Paclobutrazole + gibberellins, PH: plant height, NST: number of shoot, NT: number of total tuber, NB: number of large tuber, NM: number of medium tuber, NS: number of small tuber, WPT: weight per plant, TW: tuber per weight.

Furthermore, to understand which modified treatment had the potential, a group was divided based on its effect on the total number of tubers. The variable total number of tubers was chosen as the group divisor because it had the highest correlation value which was significantly different in the total number of tubers and the number of small tubers by 83% (Table 2). In addition, because the total number of tubers was the target of this research was to increase the number of tubers so that the benefits of G0 seed production increased. Based on the orthogonal contrast test, groups C and D had a higher total number of tubers, the number of medium and small tubers, and the tuber weight per plant than groups B and E (Table 1). Meanwhile, based on the PCA biplot, the modified treatments that could increase the total number of tubers, the number of small tubers, and plant height were treatments C and D (quadrant I), while treatments B (quadrant II) and E (quadrant IV) reduced the total number of tubers. the number of small, medium, and large tubers and tuber weight per plant and tuber weight (Figure 1). Treatments C and B had a high number of shots (Fig. 1).

Tabel 2. Correlation of plant variables on various efforts to increase the number of tubers

Plant variables	NM	NS	NT	WPT	PH	TW	NST
NB	47	5	50	65*	14	11	-18
NM		8	56	59*	21	-13	-27
NS			83*	26	54*	-56*	29
NT				60*	54*	-46	8
WPT					39	37	-18
PH						-7	68*
TW							-18

PH: plant height, NST: number of shoots, NT: number of total tubers, NB: number of large tubers, NM: number of medium tubers, NS: number of small tubers, WPT: weight per plant, TW: tuber per weight.

Cutting shoots (25 DAP) followed by giving gibberellins (30 DAP) (treatment C) increased vegetative growth as indicated by a large number of shoots (Table 1). This high vegetative growth could be sufficient food [14] for further tuber growth. While the growth in height of plants treated with paclobutrazole (45 DAP) (treatment D) was the same as the control and did not experience growth inhibition as did treatment E. [19] stated that crown growth shortened due to paclobutrazole due to decreased stem elongation due to decreased cell enlargement. The absence of inhibition of growth in treatment D on the application of paclobutrazole was thought to be due to the slower application at 45 DAP compared to treatment E at 40 DAP. [17] reported that when applied once, paclobutrazole should be given after maximum vegetative growth, namely after 40 DAP so that it did not interfere with vegetative growth and could divert it for tuber growth thereby increasing the number of tubers. [16] also suggested slower application of paclobutrazole at 42 DAP to increase the number of tubers

The high total number of tubers from treatments C and D showed a different trend. Treatment C had a high number of small tubers, whereas in treatment D, the distribution of tuber sizes focused not only on small tubers but also on medium tuber sizes (Figure 2). Giving gibberellins at the end of the treatment after cutting the shoots in treatment C to stimulate the growth of new stolons so that new tubers were obtained in this study seemed to be successful. However, the tubers produced were small because the food produced must be divided among many tubers as was the research case [16] without the help of tuber enlargement treatment. Efforts to enlarge tubers in treatment C can be done in various ways such as using potassium nutrients [20].

Whereas the use of paclobutrazole (D) seemed to be able to distribute the food evenly to the number of tubers present so that the number of small tubers was less than that of treatment C which had the shoots cut off. [16] reported that application of paclobutrazole resulted in higher tuber weight because more assimilate flowed into the tuber, compared to vegetative parts such as stems and leaves. This was because paclobutrazole could divert vegetative growth to tuber growth [10, 11]. In addition, [21] also reported that the use of paclobutrazole was effective in increasing the number of tubers compared to the use of gibberellins.

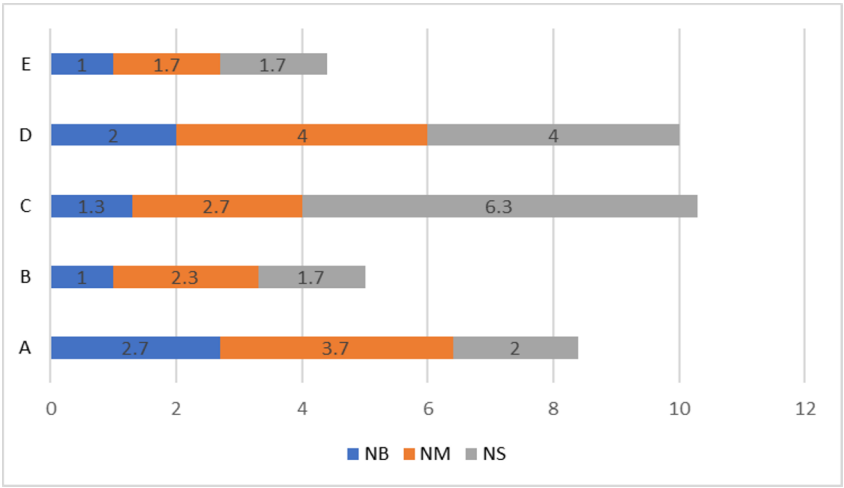

Fig. 2. Distribution of tuber sizes in the modified treatment to increase the number of tubers
A: Control, B: Gibberellins, C: Cutting + Gibberellins, D: Paclobutrazole, E: Paclobutrazole + gibberellins, NB: number of large tubers, NM: number of medium tubers, NS: number of small tubers

Treatments B and E had a lower total number of tubers, number of small and medium-sized tubers, plant height, and tuber weight per plant than treatments C and D (Table 1 and Figure 1). The gibberellins treatment had a fairly high vegetative growth as indicated by the high number of shoots (Table 1). However, the high-food ingredients produced were not used for tuber growth, so only a few small tubers were formed. [22] stated that the application of gibberellins was needed at the beginning of planting to increase shoot growth, especially on seed tubers that had not broken dormancy. Thus, the gibberellins treatment in this study was suspected to be given late at the start of planting or indeed it was unnecessary because the cuttings used were normal and did not experience vegetative growth disturbances, as was the case with treatment C which cut its buds.

Meanwhile, the application of gibberellins after paclobutrazole in treatment E was not successful in increasing the number of tubers (Table 1). The success of the study [17] which increased the number of medium-sized tubers by application of gibberellins 5 days after application of anti-gibberellins did not occur in this study. The application of paclobutrazole at 40 DAP seemed late in this study to be stimulated by gibberellins for vegetative growth, especially new stolons, failing to form new tubers (Table 1). This was because the application of paclobutrazole must be done at the right time, which may not be determined in units of days but can be approached by monitoring the conditions of plant growth. [23] stated that retardant success was influenced by the physiological stage of the plant, namely when there were many stolons to support tuber growth.

Of the four modification treatments to increase the number of tubers, gibberellins could be used to stimulate vegetative growth if it experienced growth inhibition due to the removal of apical dominance which could stimulate stem growth by cutting shoots

(treatment C), so the application of gibberellins alone was not recommended (treatment B). Application of gibberellins after growth inhibition with paclobutrazole (treatment E) needed to be studied further by paying attention to the exact application time. While the single treatment of paclobutrazole (treatment D) had the potential to increase the number of tubers with a fairly even distribution of tuber sizes.

4 Conclusion

Various introduced treatments failed in increasing the number of tuber total, compared to control. However, the results of PCA biplot showed that cutting of plantlet cuttings followed by gibberellins application and paclobutrazol application were potential to be studied further by increasing the size of small tubers due to their large number of tubers in total.

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