FLOWER INDUCTION OF CASSAVA (*Manihot esculenta* Crantz) THROUGH THE APPLICATION OF PACLOBUTRAZOL AND KNO_3

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ABSTRACT

Effects of Paclobutrazol and KNO_3 on the induction of Cassava (*Manihot esculenta* Crantz) flowering were observed. Two experiments were set up. In the first experiment paclobutrazol was sprayed through plant leaves in five concentrations consisted of 0, 250, 500, 750, and 1,000 ppm. The second experiment was set up to investigate the effect of paclobutrazol applied through the soil with two concentrations consisted of 0 and 500 ppm and KNO_3 with concentrations of 1%, 2%, and 3% applied through the leaves. The results showed that 500 ppm Paclobutrazol reduced the vegetative growth and it was effective in stimulating flower. Additionally, Paclobutrazol applied through the soil did not affect the flower induction. There is no interaction effect between Paclobutrazol and KNO_3 on the vegetative growth and induction of flower.

Keywords: Flower, induction, KNO_3, paclobutrazol

INTRODUCTION

Cassava in Indonesia, especially in Lampung Province, has been a strategic crop to increase the prosperity of the farmers. Unfortunately, the productivity of cassava per unit area of land is still low which is about 21.4 ton/ha (BPS, 2013). One way to increase the productivity can be reached through breeding program. In most crops, however, yields can be increased through crossing if the flowers of parental plants bloom at the same time. Unfortunately, in low land area the flowers of many clones of cassava appear in different time which brings into the difficulty in crossing the cassava plants to get better genotypes.

Alves (2002) reported that flowering of cassava plant is affected strongly by environmental factors. In some clones flower induction depends on photoperiod of more than 13,5 hours and also related to temperature. Flower initiation of cassava is very important because flower of most clones of cassava needs relatively a long time and most cassava clones do not flower uniformly in time, especially in lowland. Therefore this condition

makes the breeders unable to increase characteristics diversity of cassava plants towards better genotypes of new clones of cassava through crossing among clones.

One of the attemps to get the flower of some crops is the use of plant growth regulator such as paclobutrazol. Some researchers have been successful to induce the flower of some crops by using paclobutrazol such as orange (Poerwanto and Inoue, 1994), mango (Martinez et al., 2008). The mode of action of paclobutrazol is the inhibition of gibberellic acid synthesis in plants. The induction of flower in cassava was indicated by the formation of branches at the end of the primary stem, the number and the size of leaves reduced (Halsey, et al., 2008).

However, the application of paclobutrazol often can cause vegetative and generative apical dormancy. To break the dormancy, Bartolomew and Criley (1988) used KNO_3 10-40 g/l to induce the flower of mango. Assuming that by reducing the plant size, the distribution of the total dry matter to other organs is an important factor to suppress the vegetative growth affecting the induction of cassava flower. Present study was carried out to examine the effects of paclobutrazol and KNO_3 on flower induction in cassava.

MATERIALS AND METHOD

Two experiments were carried out at University of Lampung Research Station with an altitude of 250 m above sea level. The experiments were conducted in August to November 2011. The cassava used was the clone known as Thailand (UJ3). The 25-cm stakes were cut from the 10-month cassava plants. Each stake was planted in a 5-kg black plastic pockets vertically with 1/3 part of it was in the planting media which was the compound of soil and manure (1 : 4). The pockets were arranged randomly with the distance 0.5 m in between. Each plant was fertilized with 10 g Urea, 10 g TSP, and 20 g KCl per pocket. One experimental unit comprised of 2 pockets. Treatment means were separated using the LSD at 5% level of significance.

Both experiments were set up in a complete randomized block design with three replications. In the first experiment the concentrations of paclobutrazol as the factor of treatment consisted of 0 ppm (P0), 250 ppm (P1) , 500 ppm (P2), 750 ppm (P3), and 1.000 ppm (P4). Paclobutrazol was applied through the leaves in three times of applications with 2-week interval at a rate of 20 ml, 30 ml, and 50 ml per plant respectively, to attain full cover spray. The first application was done on 30 DAP.

The second experiment consisted of two factors. The first factor was the application of paclobutrazol consisted of 0 ppm (P0) and 500 ppm (P1) and the second factor was KNO_3 application, consisted of 1% (K1), 2% (K2), and 3% (K3). The treatments were performed on 30 DAP. Paclobutrazol was applicated through the soil with 100 ml per plant once during the experiment while KNO_3 was applied through the leaves in three times of application with 1-week interval at a rate of 20 ml, 30 ml, and 50 ml to spread evenly. Measurements were taken until 120 DAP included plant height, number of leaves, time of flowering, fresh and dry weight of plant.

RESULTS AND DISCUSSION

First Experiment

Paclobutrazol treatment has not affected siginifantly the growth of plant since the first week of application. At the period 90 DAP the characteristics of vegetative growth such as number of leave and stem dry weight were statistically different (Table 1). The data in Table 1 depicted that paclobutrazol had a trend to affect vegetative traits of cassava. Stem dry weight data indicated that there was a reduction of cell division and elongation proportionally with the increasing concentration of paclobutrazol. The data of plant height (Figure 1) show that the non-treated plants were higher than the treated ones, especially at 5 weeks application of paclobutrazol.

Number of leave exhibited a trend of reduction with the increasing dose of paclobutrazol. Plants that were not treated by paclobutrazol showed 12.33 leaves (P0) while plants treated with 1.000 ppm (P4) showed fewer number of leaves i.e., 7.60 leaves. Therefore, it is clear that paclobutrazol had taken its role to inhibit the gibberelic acid synthesis in plants. The results which were not statistically different may be due to the period of observation which was considerably short, i.e., 8 weeks after application.

Physiological changes noticed to form early flowering took place at 9 weeks after planting. All of paclobutrazol treatments could induce to direct the physiological changes to mature condition of plant according to dose of paclobutrazol. Percentage of plants that branched as the first phase of flower induction in 250 ppm paclobutrazol was 16,67%, 500 ppm 66.7%, 750 ppm 66.7%, and 1,000 ppm 16.7%. Among those branches of each level of paclobutrazol the cluster of flower appeared in only 16,67% of branches in 250 ppm and 33.33% in 500 ppm.

The best cluster of flower was noticed in 500 ppm of paclobutrazol (Figure 2). Unfortunately, the cluster of flower was easy to drop off. It may be due to lack of nutrients needed by the flower to grow and develop. The results above gave the evidences that paclobutrazol applied through the leaves has worked to suppress the work of gibberellins acting as flowering inhibitors thereby allowing the flower-promoting factor(s) to work. Flower initiation as the effect of paclobutrazol has been reported by Te-chato (2009), Martinez (2008), and Upreti (2013).

Second Experiment

In the second experiment paclobutrazol applied through the soil alone reduced the vegetative characteristics significantly. Application of KNO3 through the leave did not affect the vegetative variables statistically. The plants treated by paclobutrazol 500 ppm were shorter than those untreated ones (Table 2). Application of paclobutrazol could suppress the height of the plants about half of the height of untreated plants, while KNO_3 with three concentrations had no effect on plant height. The effect of paclobutrazol and KNO_3 were not significant on the number of leave. However, the interaction effect of paclobutrazol and KNO_3 together could affect the stem dry weight (Table 3)

The data in Table 3 depicted that the increase of KNO_3 up to 2% could reduce stem dry weight, at higher concentration the combination with paclobutrazol gave non-significan effect on stem dry weight. On the other hand, paclobutrazol combined with KNO_3 suppressed stem dry weight significantly.

Through the visual performances of the treated plants (Figure 4), the plants treated by paclobutrazol clearly had suppressed the plant growth even though paclobutrazol was combined with KNO_3 up to 3% through the leaves. It may be due to paclobutrazol given through the soil was too high so that the plants had no capability to branch and flower. The application of KNO_3 to all levels of paclobutrazol did not affect the plant development. It is obvious that there was no KNO_3 application with no paclobutrazol that formed bramching at the end of the stem as the beginning of physiological changes of plant development to form flower.

Martinez et al. (2008) observing the effects of paclobutrazol combined with KNO_3 on flower induction in mango precisely found that neither paclobutrazol nor KNO3 alone had a significant effect on flowering. However, in contrast they found that the effect of those

treatments on flowering was seen when paclobutrazol was combined with KNO_3. Other research (Yeshitela, 2013) showed that KNO_3 alone did not give any significant effect on flowering. Significancy was found when it was supplemented by urea.

The application of paclobutrazol of 500 ppm through the leaves suppressed the vegetative growth of the plant and induced the plant to flower. The effect of paclobutrazol was indicated firstly by reduction in vegetative traits of the plant. Paclobutrazol applied through the soil, even though it still inhibited growth of the plant but it had no significant effect on flowering. The application of KNO_3 directed to supplement the negative effect of paclobutrazol had no significant effect on flowering. It is noted that the flower induced by paclobutrazol in this study could not last before the flower opened.

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Table 1. The effects of paclobutrazol application on some vegetative traits of cassava on 90 DAP

Paclobutrazol (ppm)	Number of leave (pc/plant)	Stem dry weight (g/plant)
0(P0)	30.33 b	9.00 a
250(P1)	30.33 b	6.67 b
500(P2)	37.67 a	8.33 ab
750(P3)	24.00 b	8.00 ab
1,000(P4)	32.33 b	8.00 ab
BNT(0.05)	**11.94**	**1.70**

Means followed by the same letters do not differ significantly at 5% level of significance

Table 2. The effect of paclobutrazol and KNO_3 on plant height on 90 DAP and 120 DAP

Paclobutrazol (ppm)	Plant Height (cm)		Stem Dry Weight (g/plant)
	90 DAP	120 DAP	
0 (P0)	24 a	32.2 a	59.2 a
500 (P1)	14.5 b	16.8 b	32.6 b
BNT5%	2.11	3.26	8.6

Means followed by the same letters do not differ significantly at 5% level of significance

Table 3. The effect of paclobutrazol and KNO_3 on the stem dry weight on 120 DAP

KNO_3	Stem Dry Weight (g/plant)	
	Paclobutrazol	
	0 ppm	500 ppm
1%	12.6 a (x)	5.56 a (y)
2%	9.3 b (x)	6.58 a (y)
3%	11.5 ab (x)	6.75 a (y)
BNT 5%	2.2	

Means followed by the same letters vertically and horizontally do not differ significantly at 5% level of significance

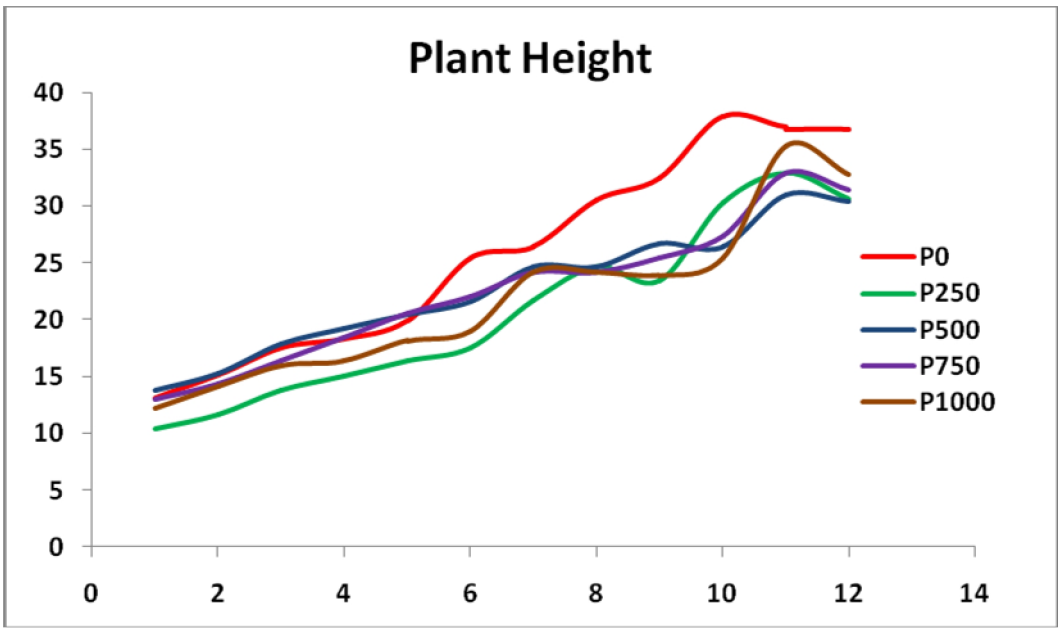

Figure 1. Plant height of cassava treated by paclobutrazol started from one week after application until 12 weeks after application

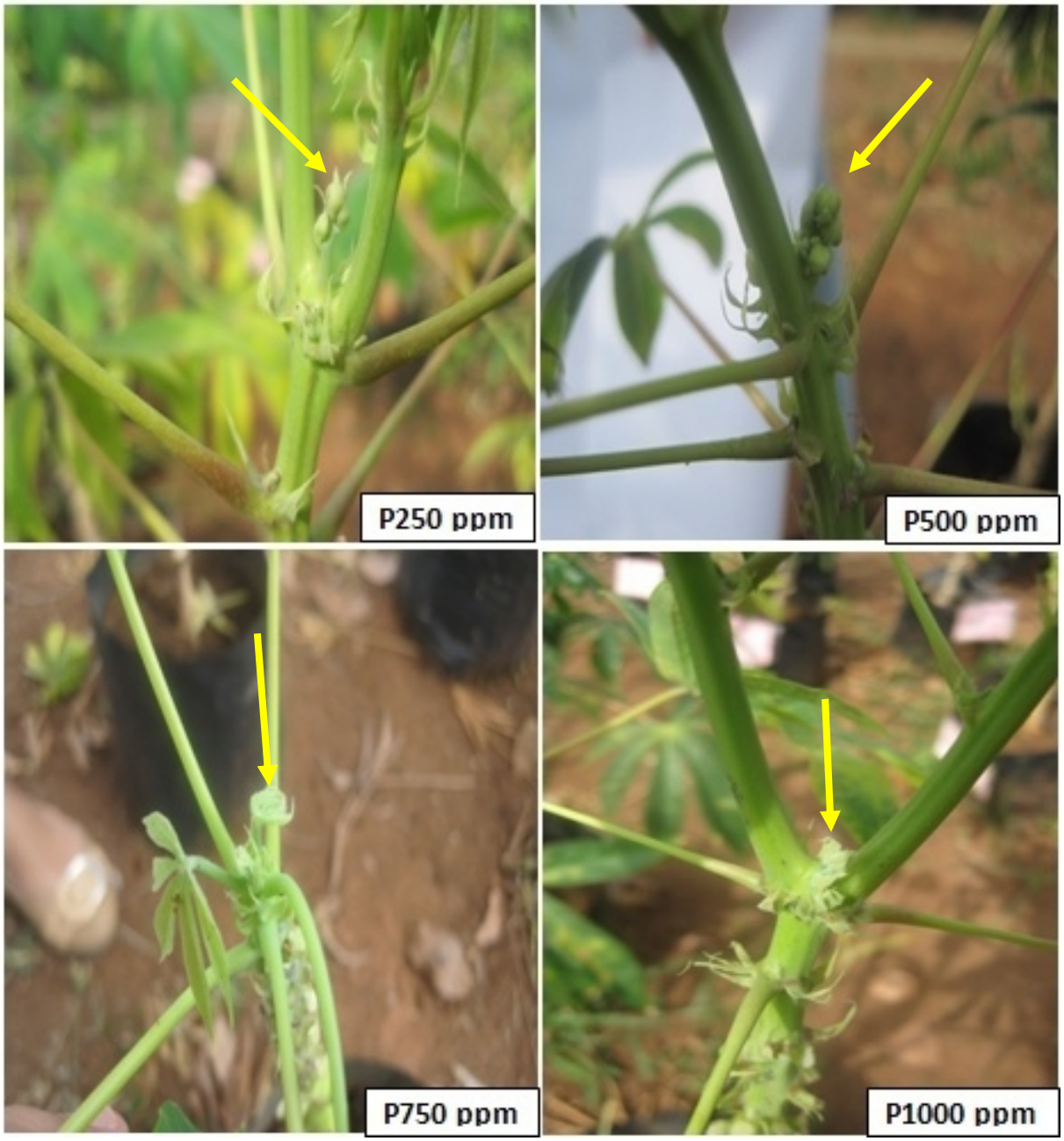

Figure 2. Visual characteristics of plant branching and flowering from each treatment. Branching plants were in treatments 250 ppm, 500 ppm, 750 ppm, and 1.000 Ppm, flowering plants were treated by 250 ppm and 500 ppm (arrows).

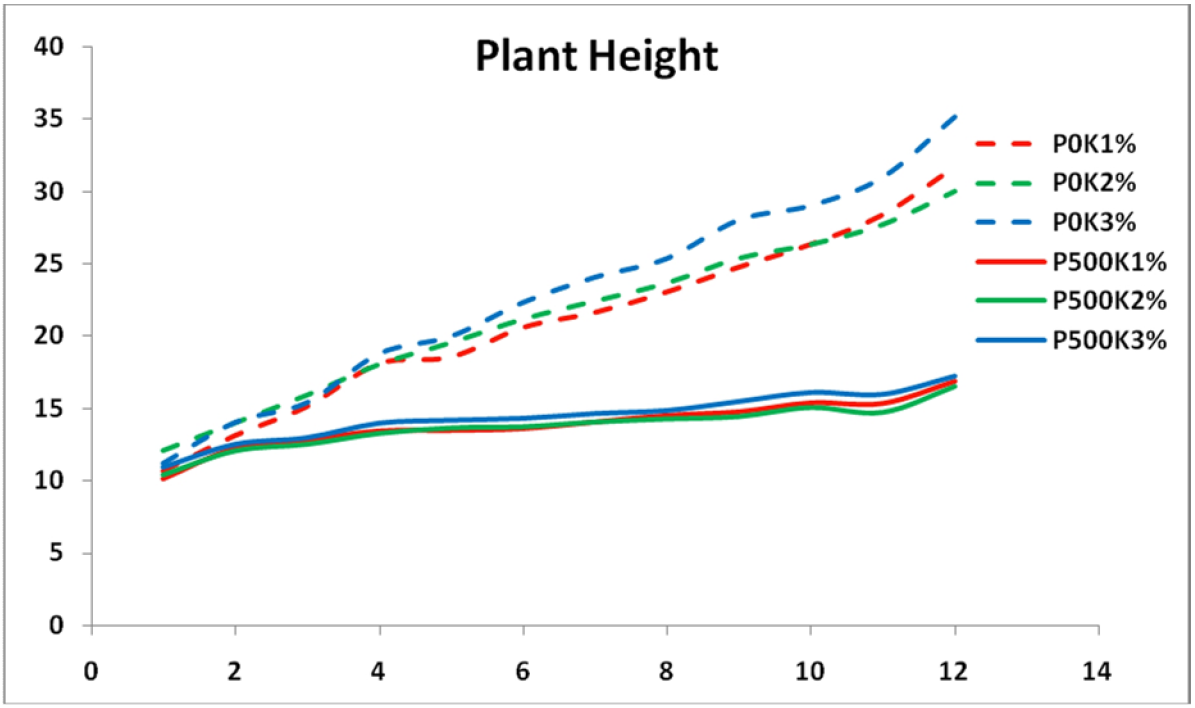

Figure 3. Plant height of cassava treated by paclobutrazol and KNO_3 started from one week after application until 12 weeks after application

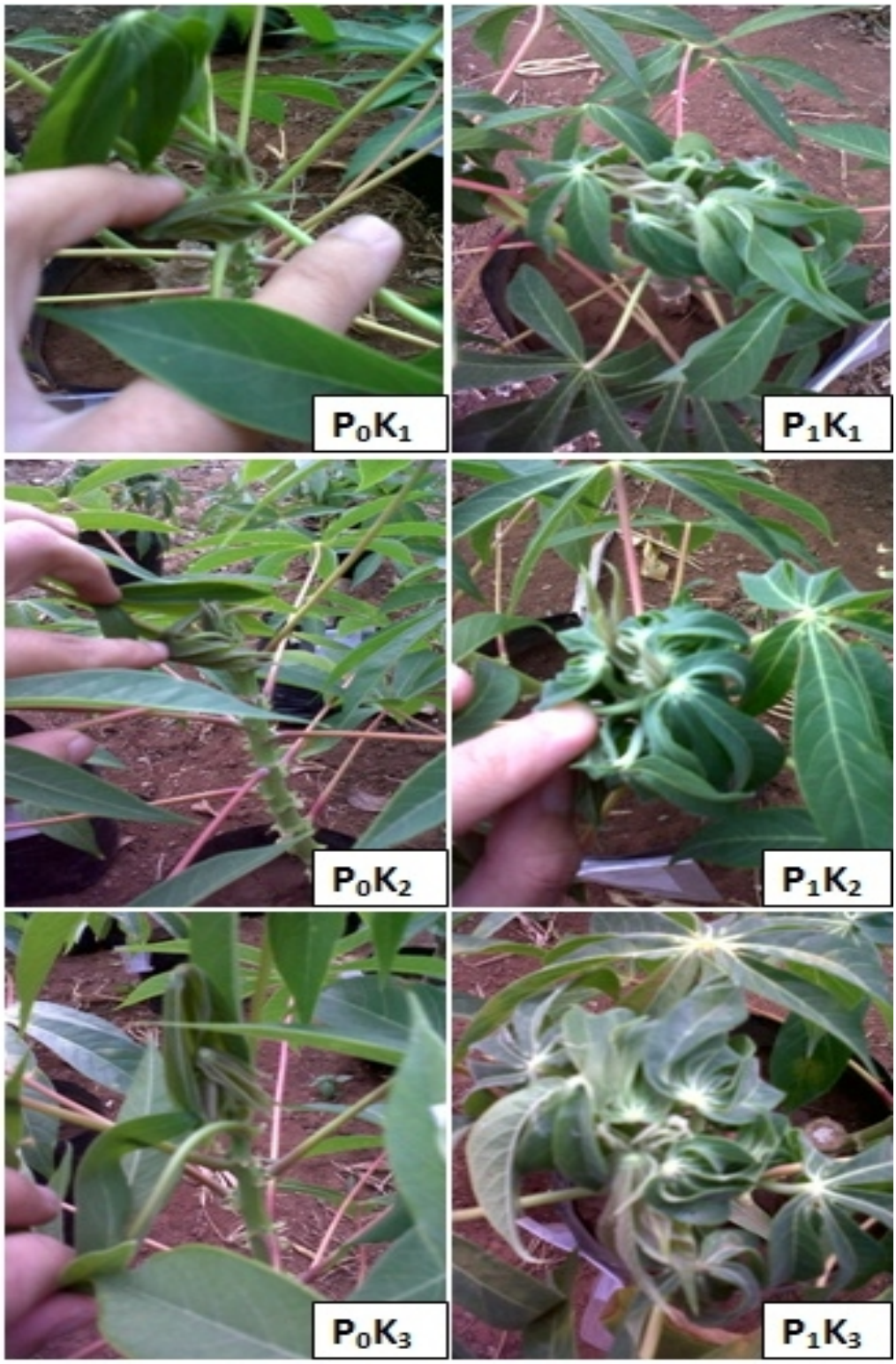

Figure 4. Plant shoots of cassava on 4 weeks after application of paclobutrazol through the soil and KNO3 through the leaves