Chapter 4

Results

1. The concentration effect of potassium chlorate on flower induction of derooted air-layered longan cv. Daw

The roots of one year old air-layered longans were cut off (derooted, DR) before dipping in potassium chlorate ($KClO_3$) solutions at various concentrations for 24 h then cultured them in water. It was found that $KClO_3$ could induce flowering in DR. The percentage of flowering in Table 1 showed that $KClO_3$ at the concentrations of 300, 400 and 500 ppm could promote flowering in DR longan within 35, 32 and 30 days after treatment (DAT) respectively with the percentage of flowering trees of 30, 20 and 30% respectively. However, the treated plants also showed slightly toxic symptoms from $KClO_3$ toxification such as yellowing or chlorosis and leaf drop in mature leaves. In the high concentrations (1,000, 2,500 and 5,000 ppm) treatments, $KClO_3$ caused severe toxic symptoms i.e. leaf dropped, chlorosis, distorted leaves and leaf dehydration, within 10 DAT (Figure 3). Even though $KClO_3$ could induce flower buds (Figure 4) development in DR + $KClO_3$ longan which cultured in water but the floral bud could not develop into mature inflorescence.

For the treatments which DR+$KClO_3$ were cultured in nutrient solutions after dipping in $KClO_3$ solutions, it was found that DR+$KClO_3$ longans at all concentrations of the $KClO_3$ treatments showed the severe toxic symptoms and all of the plants died within 15-20 DAT.

By these results, dipping the DR longan in 500 ppm $KClO_3$ and culture in water could early promote longan flowering within 30 DAT. Then 500 ppm $KClO_3$ was used for the next experiment 2 and 3.

Table 1 The effect of potassium concentrations on flower induction of derooted air-layered longan cv. Daw

Treatments	Concentration of $KClO_3$ (ppm)	Days to Flowering (days after treatment)	Percentage of Flowering (%)
Cultured in water (at low concentration)	0	-	0
	100	-	0
	200	-	0
	300	35	30
	400	32	20
	500	30	30
	1,000	-	0
	2,500	-	0
	5,000	-	0
Cultured in nutrient	0	-	0
	100	-	0
	200	-	0
	300	-	0
	400	-	0
	500	-	0

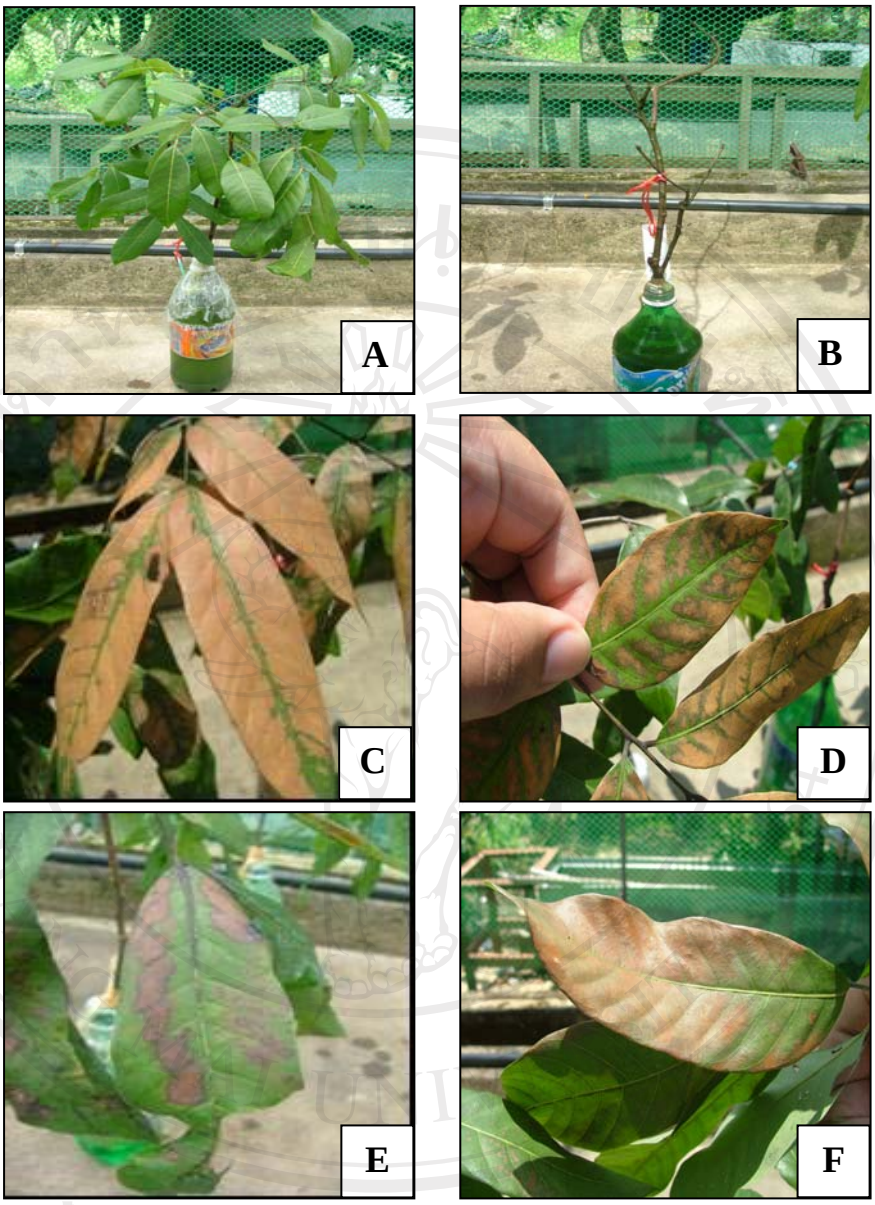

Figure 3 The toxic symptoms of potassium chlorate at high concentrations on derooted air-layered longan cv. Daw (A: normal; B: leaf drop; C, D and E: chlorosis; F: dehydration)

Figure 4 Floral buds of derooted air-layered longan cv. Daw treated with 500 ppm $KClO_3$

2. Effect of potassium chlorate ($KClO_3$) on flowering and morphological change of the terminal buds in air-layered and derooted air-layered longans cv. Daw

The morphological changes of terminal buds were determined at 10, 15, 20, 25 DAT using freezing microtome and paraffin embedded method. The results revealed that apical meristem of air-layered and derooted air-layered longan without $KClO_3$ treatment was spherical in shape of dome and had only leaf primordiam as vegetative phase throughout the experiments (Figure 5 and 6). Whereas air-layered and derooted air-layered longan treated with $KClO_3$, their terminal buds showed extending apical meristem and axillary bud. The axillary buds at the shoot tip could be determined under light microscope as flower buds at 25 DAT (Figure 7 and 8) and the flower bud could be determined by nake eyes at 45 DAT (Figure 9).

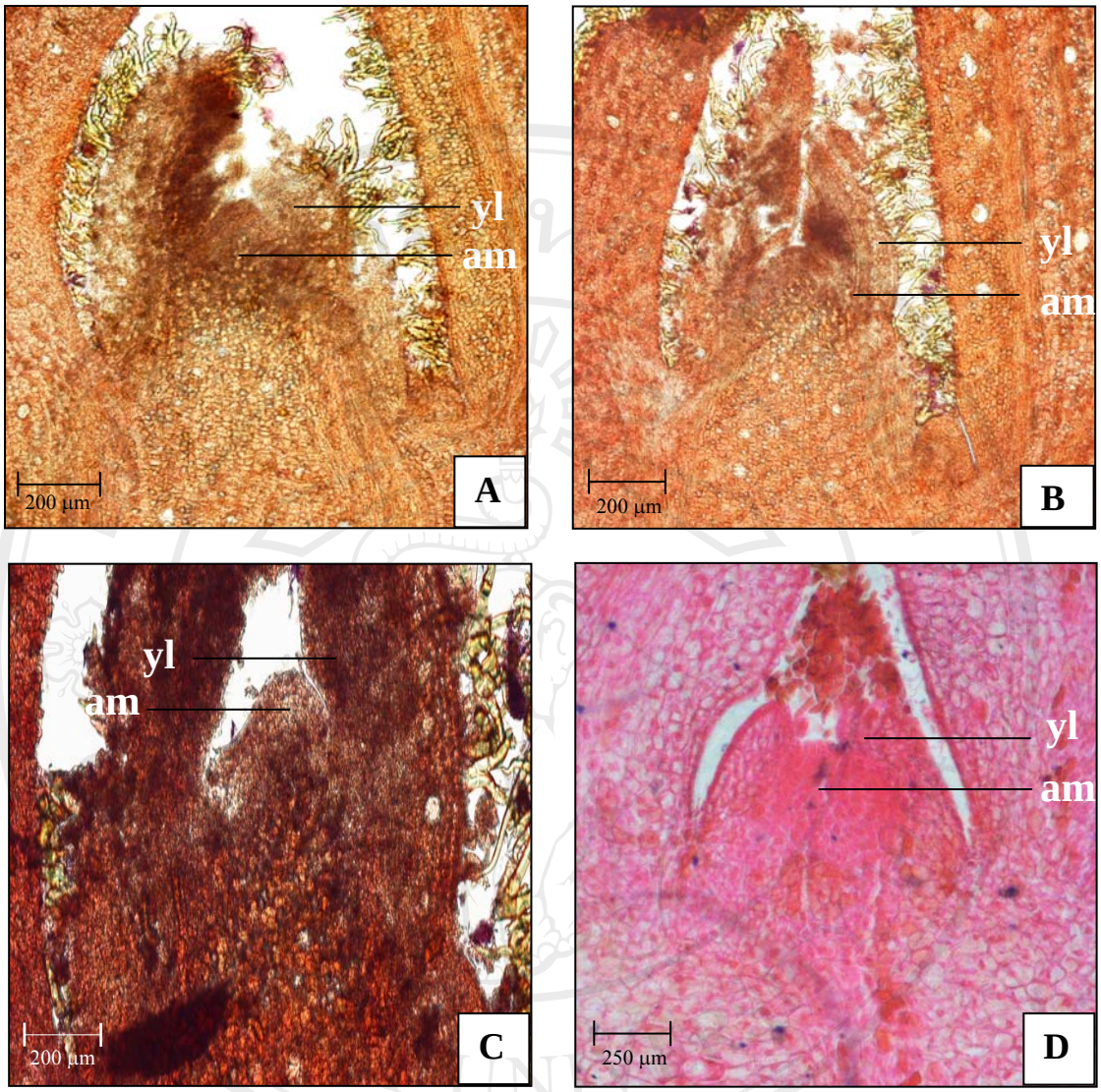

Figure 5 The terminal bud of air-layered longan cv. Daw at 10 (A), 15 (B), 20 (C) and 25 (D) days, without $KClO_3$ treatment (ab = axillary bud, am = apical meristem, yl = young leaf)

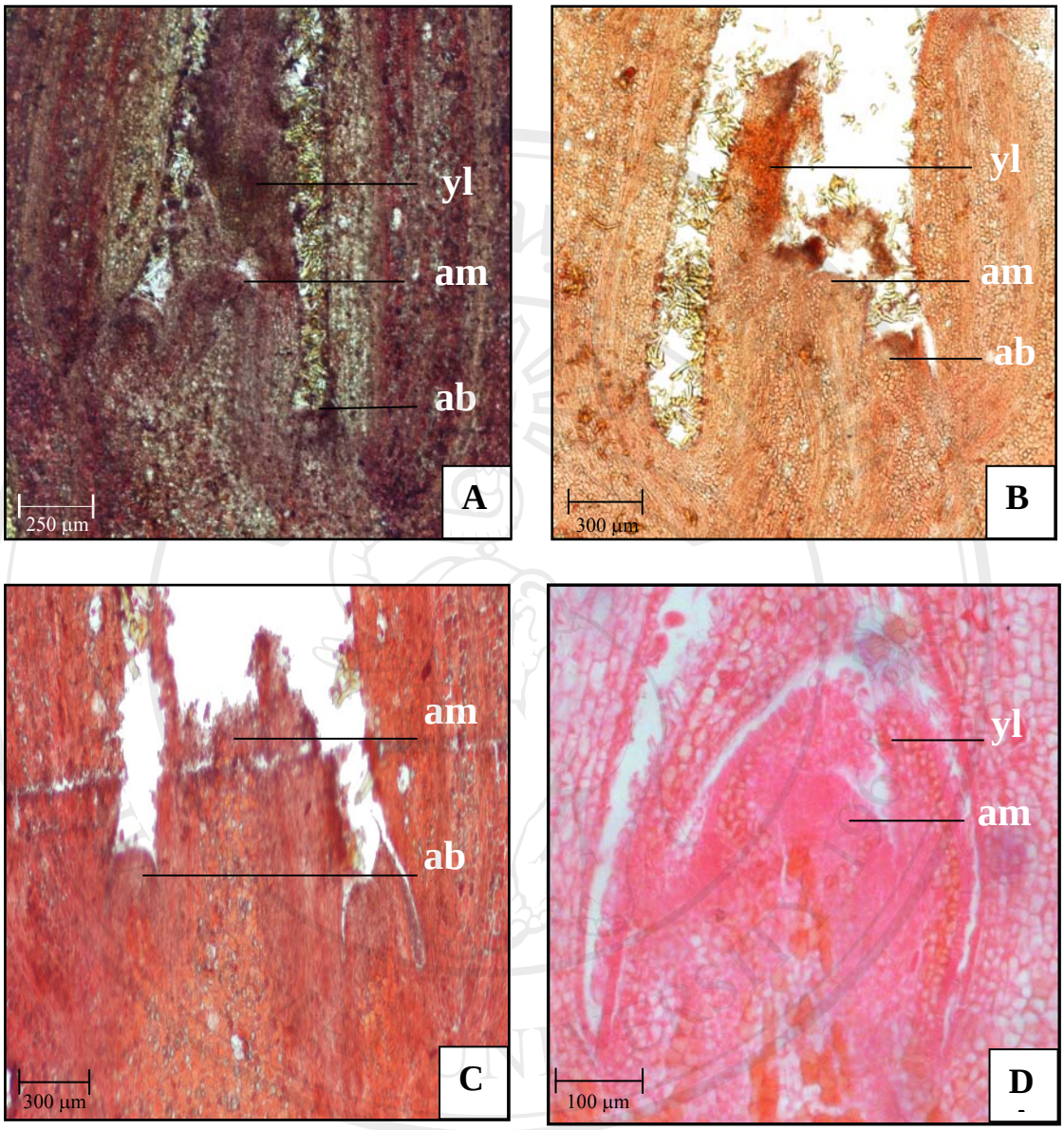

Figure 6 The terminal bud of derooted air-layered longan cv. Daw at 10 (A), 15 (B), 20 (C) and 25 (D) days, with $KClO_3$ treatment (ab = axillary bud, am = apical meristem, yl = young leaf)

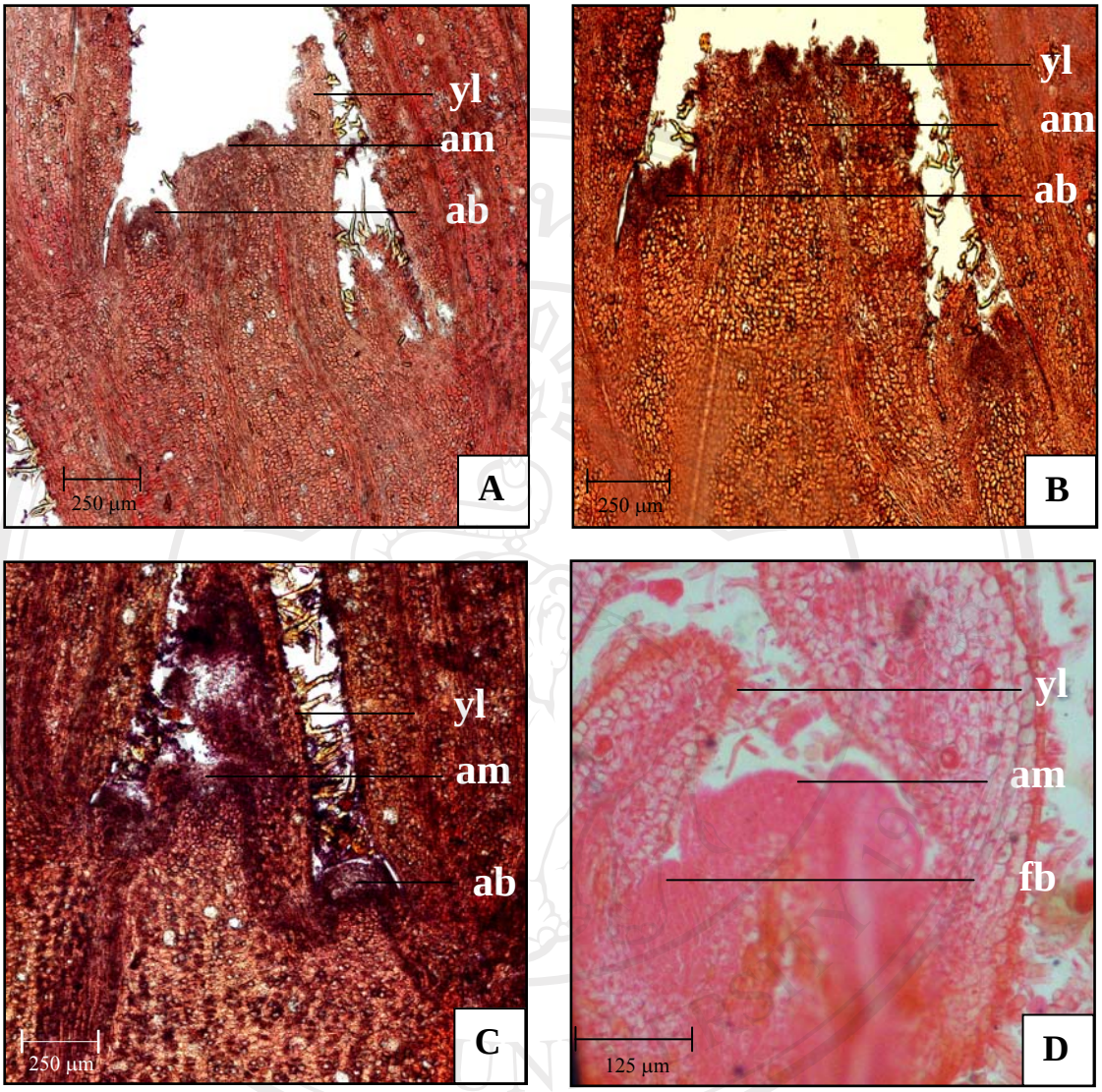

Figure 7 The terminal bud of air-layered longan cv. Daw at 10 (A), 15 (B), 20 (C) and 25 (D) days, with $KClO_3$ treatment (ab = axillary bud, am = apical meristem, yl = young leaf, fb = floral bud)

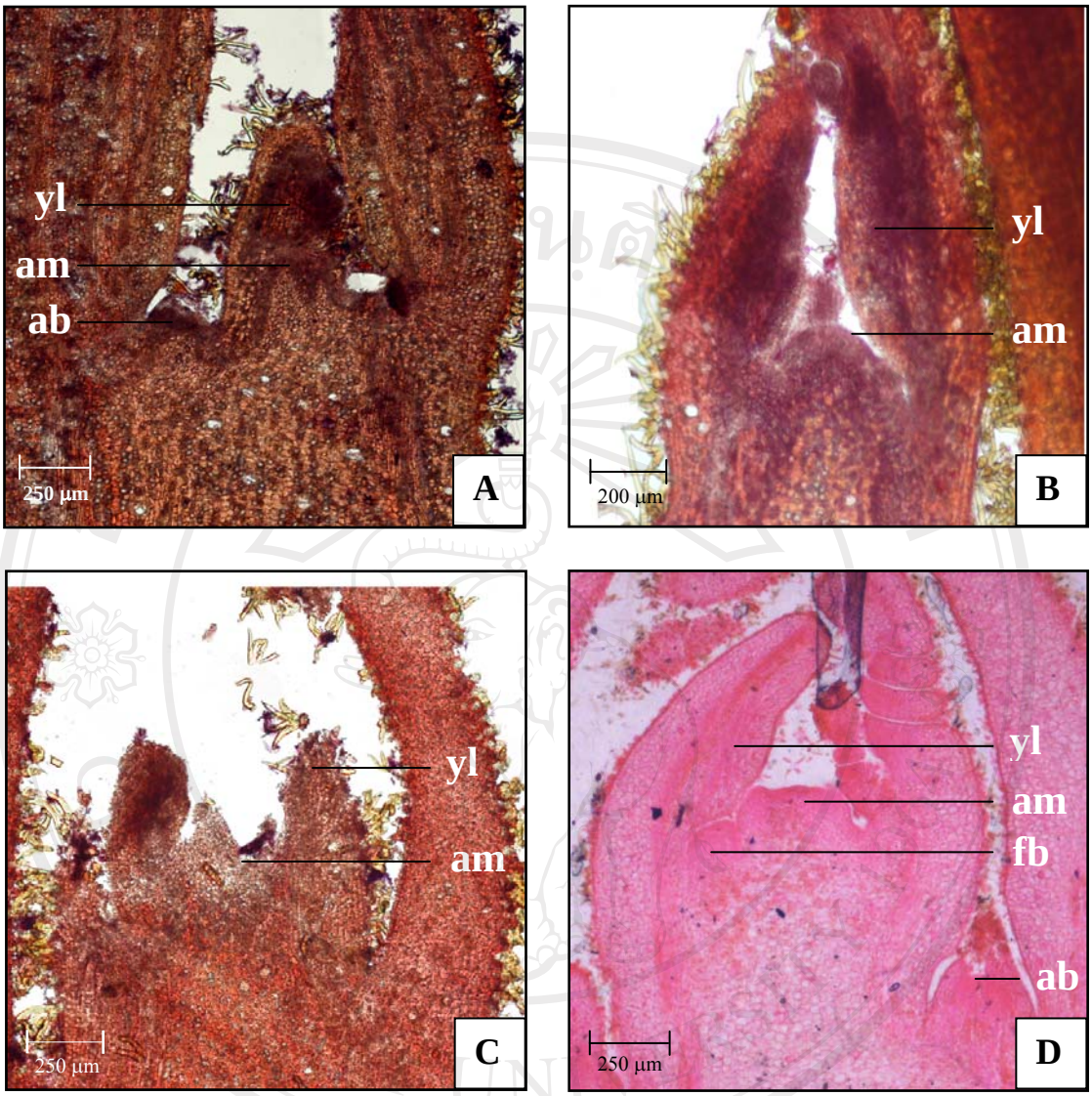

Figure 8 The terminal bud of derooted air-layered longan cv.Daw at 10 (A), 15 (B), 20 (C) and 25 (D) days, with $KClO_3$ treatment (ab = axillary bud, am = apical meristem, yl = young leaf, fb = floral bud)

Figure 9 Floral buds induced by potassium chlorate of derooted air-layered longan at 35-40 DAT

3. Effect of potassium chlorate on physiological and biochemical changes in leaves and shoots of air-layered and derooted air-layered longan cv. Daw

3.1 The chlorophyll content

Chlorophyll a contents before treatments of leaves were 0.0698-0.0754 $mg \cdot gFW^{-1}$ (Table 2). The chlorophyll a contents of R and DR tended to decrease. But the chlorophyll a content of $R+KClO_3$ and $DR+KClO_3$ did not change. However, the chlorophyll a contents of all treatments did not show significant differences throughout the studied period. Chlorophyll b contents before treatments were 0.1070-0.1211 $mg \cdot gFW^{-1}$ (Table 4) which were about two times higher than chlorophyll a. The chlorophyll b within treatment of DR tended to decrease as the other treatments seemed to unchange.

For total chlorophyll contents before the treatments were 0.1769-0.1964 $mg \cdot gFW^{-1}$ (Table 6). The total chlorophyll contents of all treatments did not show significant differences throughout the studied period. But the contents within R and DR tended to decreased in small amount.

However, changing percentage of chlorophyll a contents in R tended to increase as other treatments did not change and it showed the significant increasing at 20 DAT. The percentages of chlorophyll a contents at 20 DAT of R, R+$KClO_3$, DR and DR+$KClO_3$ were 15.00, 13.28, -10.49 and 2.17% respectively. (Table 3 and Appendix table 1). But the changing percentage of chlorophyll b contents of all treatment were not significantly different, and the changing percentage within treatment also were not significantly different throughout the studied period. These results was similar to the changing percentage contents of total chlorophyll.

Table 2 The chlorophyll a contents ($mg \cdot gFW^{-1}$) of leaves of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Treatments	Chlorophyll a ($mg \cdot gFW^{-1}$)						$LSD_{0.05}$
	Day (s) after treatments (DAT)						
	0	5	10	15	20	25	
R	0.0698 B	0.0724 B	0.0702 B	0.0737 B	0.0802 A	0.0719 B	0.0051
R+$KClO_3$	0.0740	0.0750	0.0732	0.0769	0.0834	0.0758	NS
DR	0.0754 A	0.0727 AB	0.0694 B	0.0675 B	0.0673 B	0.0614 C	0.0052
DR+$KClO_3$	0.0700	0.0689	0.0656	0.0669	0.0710	0.0622	NS
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 3 The changing percentage of chlorophyll a (%) of leaves of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Treatments	Changing percentage of chlorophyll a (%)						$LSD_{0.05}$
	Day (s) after treatments (DAT)						
	0	5	10	15	20	25	
R	0	3.81 B	0.70 B	5.72 B	15.00 aA	2.99 B	7.30
R+$KClO_3$	0	1.47	-0.78	4.42	13.28 a	3.11	NS
DR	0	-3.45	-7.79	-10.35	-10.49 b	-18.27	NS
DR+$KClO_3$	0	-1.33	-5.92	-4.01	2.17 ab	-10.40	NS
$LSD_{0.05}$	-	ns	ns	ns	16.68	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 4 The chlorophyll b contents ($mg \cdot gFW^{-1}$) of leaves of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate ($+KClO_3$) at the concentration of 500 ppm

Treatments	Chlorophyll b ($mg \cdot gFW^{-1}$)						$LSD_{0.05}$
	Day (s) after treatments (DAT)						
	0	5	10	15	20	25	
R	0.1100	0.1116	0.1104	0.1130	0.1175	0.1122	NS
$R+KClO_3$	0.1132	0.1150	0.1167	0.1185	0.1197	0.1220	NS
DR	0.1211 A	0.1159 AB	0.1109 ABC	0.1055 BCD	0.1019 CD	0.0953 D	0.0110
$DR+KClO_3$	0.1070	0.1057	0.1015	0.1029	0.1081	0.0970	NS
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

A, B, C, D: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 5 The changing percentage of chlorophyll b (%) of leaves of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Treatments	Changing percentage of chlorophyll b (%)						$LSD_{0.05}$
	Day (s) after treatments (DAT)						
	0	5	10	15	20	25	
R	0	1.65	0.46	2.83	6.99	1.97	NS
R+$KClO_3$	0	1.88	3.77	5.64	6.74	9.42	NS
DR	0	-4.20	-8.21	-12.61	-15.53	-20.79	NS
DR+$KClO_3$	0	-0.98	-4.59	-2.94	2.11	-7.90	NS
$LSD_{0.05}$	-	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

Table 6 Total chlorophyll contents ($mg \cdot gFW^{-1}$) of leaves of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Treatments	Total Chlorophyll ($mg \cdot gFW^{-1}$)						$LSD_{0.05}$
	Day (s) after treatments (DAT)						
	0	5	10	15	20	25	
R	0.1798 B	0.1839 B	0.1805 B	0.1867 B	0.1977 A	0.1840 B	0.0109
R+$KClO_3$	0.1871	0.1899	0.1898	0.1954	0.2030	0.1977	NS
DR	0.1964 A	0.1885 AB	0.1802 ABC	0.1729 BCD	0.1691 CD	0.1566 D	0.0158
DR+$KClO_3$	0.1769	0.1746	0.1672	0.1698	0.1791	0.1593	NS
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

A, B, C, D: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 7 The changing percentage of total chlorophyll (%) of leaves of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Treatments	Changing percentage of total chlorophyll (%)						$LSD_{0.05}$
	Day (s) after treatments (DAT)						
	0	5	10	15	20	25	
R	0	2.49	0.55	3.95	10.10	2.37	NS
R+ $KClO_3$	0	1.71	1.95	5.13	9.31	6.87	NS
DR	0	-4.63	-8.06	-11.75	-13.60	-19.84	NS
DR+$KClO_3$	0	-1.10	-5.06	-3.30	2.17	-8.76	NS
$LSD_{0.05}$	-	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD
NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

3.2 Carbohydrate analysis

3.2.1 Total nonstructural carbohydrate (TNC)

Leaf TNC contents before treatments were 34.74-41.56 mgD-glucose equivalent·gDW^{-1} (Table 8). Leaf TNC contents of all treatments tended to decrease and they showed the significant differences throughout the studied period except at 20 DAT and the contents in DR+$KClO_3$ had higher contents than the other treatments. AT 25 DAT, leaf TNC contents of R, R+$KClO_3$, DR and were 31.64, 30.07, 32.39 and 37.05 mgD-glucose equivalent·gDW^{-1} respectively.

Shoot TNC contents before treatments were 42.26-48.97 mgD-glucose equivalent·gDW^{-1} which were higher than the leaf TNC contents. Shoot TNC contents also showed the significant differences at 15, 20 and 25 DAT which the contents in DR seemed to be higher than the others At 25 DAT, shoot TNC contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 40.45, 36.25, 44.43 and 38.85 mgD-glucose equivalent·gDW^{-1} respectively. But leaf and shoot TNC contents within each treatment did not show significant differences.

However, the changing percentage of TNC contents in leaves of all treatments did not show significant differences. But the changing percentage of them within DR+$KClO_3$ tended to decrease gradually throughout the studied period as the other treatments did not change. At 25 DAT, the decreasing percentage changes of leaf TNC contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were -8.64, -10.44, -7.73 and -10.86% respectively (Table 9 and Appendix table 4).

The shoot TNC content changing percentages only showed significant differences at 10 DAT which the TNC content of R and DR+$KClO_3$ tended to lower than the other treatments. Whereas the changing percentages of TNC content within R and DR+$KClO_3$ tended to decreased throughout the studied period. At 25 DAT, the changing percentages of shoot TNC content of R, R+$KClO_3$, DR and DR+$KClO_3$ were -9.12, -14.04, -9.39 and -10.67% respectively.

Table 8 Total nonstructural carbohydrate (TNC) (mg D-glucose equivalent·gDW^{-1}) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	TNC (mg D-glucose equivalent·gDW^{-1})						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	34.74 b	34.62 b	33.96 b	32.41 b	32.56	31.64 b	NS
	R+$KClO_3$	35.58 b	32.21 b	32.04 b	31.17 b	30.93	30.07 b	NS
	DR	35.15 b	34.50 b	34.73 ab	33.87 b	33.15	32.39 b	NS
	DR+$KClO_3$	41.56 a	39.94 a	38.92 a	38.58 a	37.76	37.05 a	NS
$LSD_{0.05}$		4.82	5.20	4.38	4.51	ns	4.01	
Shoots	R	44.54	43.50	42.86	41.36 ab	40.82 ab	40.45 ab	NS
	R+$KClO_3$	42.26	39.26	37.93	36.92 b	36.81 b	36.25 b	NS
	DR	48.97	47.19	44.85	45.10 a	45.39 a	44.43 a	NS
	DR+$KClO_3$	43.63	42.20	41.97	40.61 ab	39.63 b	38.85 b	NS
$LSD_{0.05}$		ns	ns	ns	4.85	5.12	4.77	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 9 The changing percentage of total nonstructural carbohydrate (TNC) (%) of leavesand shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate ($+KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Changing percentage of TNC (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0	-0.32	-1.86	-6.44	-5.89	-8.64	NS
	$R+KClO_3$	0	-4.12	-4.60	-7.21	-7.90	-10.44	NS
	DR	0	-1.88	-1.20	-3.57	-5.76	-7.73	NS
	$DR+KClO_3$	0	-3.89 A	-6.76 AB	-7.20 AB	-9.16 B	-10.86 B	4.27
$LSD_{0.05}$		-	ns	ns	ns	ns	ns	
Shoots	R	0	-2.31 A	-3.74 aA	-7.10 B	-8.33 B	-9.12 B	2.03
	$R+KClO_3$	0	-6.97	-10.20 b	-12.54	-12.84	-14.04	NS
	DR	0	-3.63	-8.37 b	-7.98	-7.41	-9.39	NS
	$DR+KClO_3$	0	-3.38 A	-3.77 aA	-6.73 AB	-8.93 B	-10.67 B	4.50
$LSD_{0.05}$		-	ns	2.48	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

3.2.2 Total sugar (TS)

Leaf total sugar (TS) contents before treatments were 29.61-30.97 mg D-glucose equivalent·gDW^{-1} (Table 10). Leaf TS contents of all treatments did not show significant differences throughout the studied period. And leaf TS contents within treatment of DR+KClO3 tended to decrease gradually as the leaves age increased. At 25 DAT, leaf TS contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 28.03, 27.74, 27.67 and 26.48 mg D-glucose equivalent·gDW^{-1} respectively.

Shoot TS contents before treatments were 19.54-20.67 mg D-glucose equivalent·gDW^{-1} which were lower than the leaf TS contents. Shoot TS contents of all treatments did not show significant differences throughout the studied period as same as the leaves. But shoot TS contents within each treatment tended to decrease in small amount. At 25 DAT, shoot TS contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 17.49, 18.31, 17.80 and 18.04 mg D-glucose equivalent·gDW^{-1} respectively.

However, changing percentage of leaf TS contents of all treatments mostly did not showed significant differences except at 25 DAT which in DR+$KClO_3$ tended to decrease in higher percentage than other treatments. But changing percentage contents within treatment of R+$KClO_3$ and DR+$KClO_3$ significantly tended to decrease. The changing percentages of leaf TS contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were -7.13, -7.72, -6.55 and -14.51% respectively (Table 11 and Appendix table 5).

The shoot TS content decreasing percentages in R+$KClO_3$ and DR+$KClO_3$ tended to higher than R and DR. However, they showed the significant differences only at 10 and 20 DAT. At 10 DAT, the decreasing percentages of shoot TS contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were -0.92, -8.13, -4.31 and -9.59% respectively, at 20 DAT, were -6.40, -13.88, -5.61 and -9.74% respectively. But the changing percentages contents within treatment of R, R+$KClO_3$ and DR tended to decrease throughout the studied period.

Table 10 Total sugar (TS) (mg D-glucose equivalent·gDW^{-1}) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	TS (mg D-glucose equivalent·gDW^{-1})						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	30.18	28.75	28.34	29.47	28.05	28.03	NS
	R+$KClO_3$	30.06	30.13	28.73	29.51	28.49	27.74	NS
	DR	29.61	28.26	29.25	28.76	28.32	27.67	NS
	DR+$KClO_3$	30.97 A	29.96 AB	29.28 ABC	28.22 BCD	27.31 CD	26.48 D	1.89
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	
Shoots	R	19.54 A	18.67 B	19.36 A	18.2 C	18.29 C	17.49 D	0.37
	R+$KClO_3$	20.67 A	19.89 AB	18.99 BC	18.15 C	17.80 C	18.31 C	1.19
	DR	19.96 A	19.61 AB	19.10 B	18.94 B	18.84 B	17.80 C	0.73
	DR+$KClO_3$	20.33 A	19.49 AB	18.38 BC	18.47 BC	18.35 BC	18.04 C	1.26
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

A, B, C, D: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 11 The changing percentage of total sugar (TS) (%) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Changing percentage of TS (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0	-4.75	-6.10	-2.34	-7.07	-7.13 a	NS
	R+$KClO_3$	0	0.24 A	-4.44 BC	-1.84 AB	-5.23 BC	-7.72 aC	4.27
	DR	0	-4.57	-1.22	-2.88	-4.37	-6.55 a	NS
	DR+$KClO_3$	0	-3.27 A	-5.45 AB	-8.89 ABC	-11.82 BC	-14.51 bC	7.28
$LSD_{0.05}$		-	ns	ns	ns	ns	5.42	
Shoots	R	0	-4.45 B	-0.92 aA	-6.86 B	-6.40 aB	-10.49 C	2.28
	R+$KClO_3$	0	-3.77 A	-8.13 bB	-12.19 C	-13.88 cC	-11.42 C	2.95
	DR	0	-1.75 A	-4.31 abA	-5.11 A	-5.61 aA	-10.82 B	3.99
	DR+$KClO_3$	0	-4.13	-9.59 b	-9.15	-9.74 b	-10.99	NS
$LSD_{0.05}$		-	ns	5.46	ns	3.09	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b, c: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

3.2.3 Reducing sugar contents (RS)

Leaf reducing sugar (RS) contents before treatments were 19.58-20.77 mg D-glucose equivalent·gDW^{-1} (Table 12). Leaf RS contents of all treatments did not show significant differences throughout the studied period. And leaf RS contents within each treatment tended to have a little decreasing as the leaves age increased. However, they also did not show significant differences. At 25 DAT, leaf TS contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 19.64, 19.54, 18.97 and 19.15 mg D-glucose equivalent·gDW^{-1} respectively.

Shoot RS contents before treatments were 16.09-16.52 mg D-glucose equivalent·gDW^{-1} which were lower than the amount of leaf RS contents. Shoot RS contents of all treatments did not show significant differences throughout the studied period as leaves except at 15 DAT which in R seemed to be higher than the other treatments. Whereas shoot RS contents within treatment of R+$KClO_3$, DR and DR+$KClO_3$ had a little decreasing trends. At 25 DAT, shoot RS contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 14.50, 14.63, 14.70 and 14.92 mg D-glucose equivalent·gDW^{-1} respectively.

However, the changing percentage of leaf and shoots RS contents in all treatments did not show significant differences. And the changing percentage contents of leaf and shoots within each treatment also did not show significant differences throughout the studied period. However, they tended to have a few changes. At 25 DAT, the changing percentages of leaf RS contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were -4.05, 0.29, -8.48 and -7.28% respectively, and the shoot RS content changing percentages of R, R+$KClO_3$, DR and DR+$KClO_3$ were -10.50, -8.97, -10.38 and -9.38% respectively. (Table 13 and Appendix table 6).

Table 12 Reducing sugar (RS) contents (mg D-glucose equivalent·gDW^{-1}) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	RS (mg D-glucose equivalent·gDW^{-1})						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	20.49	20.13	18.86	19.13	19.22	19.64	NS
	R+$KClO_3$	19.58	20.29	20.15	19.78	18.87	19.54	NS
	DR	20.77	19.91	19.40	18.99	18.74	18.97	NS
	DR+$KClO_3$	20.65	19.74	19.45	19.44	19.81	19.15	NS
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	
Shoots	R	16.24	16.10	16.02	16.13 a	15.23	14.50	NS
	R+$KClO_3$	16.09 A	15.30 AB	15.71 A	15.63 abA	14.51 C	14.63 BC	0.75
	DR	16.40 A	15.66 AB	15.55 B	15.13 bBC	14.86 BC	14.70 C	0.77
	DR+$KClO_3$	16.52 A	15.91 AB	15.95 AB	15.26 cBC	14.63 C	14.92 BC	1.07
$LSD_{0.05}$		ns	ns	ns	0.66	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b, c: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 13 The changing percentage of reducing sugar (RS) contents (%) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Changing percentage of RS (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0	-1.57	-7.73	-6.66	-6.11	-4.05	NS
	R+$KClO_3$	0	3.59	3.16	1.20	-3.57	0.29	NS
	DR	0	-3.76	-6.21	-8.06	-9.39	-8.48	NS
	DR+$KClO_3$	0	-4.34	-5.78	-5.78	-4.05	-7.28	NS
$LSD_{0.05}$		-	ns	ns	ns	ns	ns	
Shoots	R	0	-0.81	-1.36	-0.55	-6.00	-10.50	NS
	R+$KClO_3$	0	-4.88	-2.28	-2.82	-9.76	-8.97	NS
	DR	0	-4.53	-5.16	-7.77	-9.36	-10.38	NS
	DR+$KClO_3$	0	-3.14	-3.08	-7.19	-11.04	-9.38	NS
$LSD_{0.05}$		-	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

3.3 Nutrient analysis

3.3.1 Total nitrogen (TN)

Leaf total nitrogen contents before treatments were 5.04-5.26 (Table 14). Leaf TN contents did not show significant differences among treatment. But leaf TN contents within each treatment tended to decrease as the leaves age increased. However, at 25 DAT, leaf TN contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 3.14, 3.13, 3.54 and 3.35% respectively.

Shoot TN contents before treatments were 3.52-4.19% which were lower than the leaf TN contents. Shoot TN contents showed some significant differences among the treatments throughout the studied period. But shoot TN contents within treatment of DR and DR+$KClO_3$ tended to decrease as R and R+$KClO_3$ did not change. At 25 DAT, the shoot TN contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 3.54, 3.38, 3.35 and 3.45 respectively which did not show significant differences.

The changing percentage of leaf TN contents showed that leaf TN contents in all treatments decreased about 30.91-40.89% after 10 DAT and they did not show significant differences throughout the studied period. Whereas the changing percentage within each treatment also did not significantly show decreasing trends. At 25 DAT, the decreasing percentages of leaf RS contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were -37.78, -40.51, -30.91 and -35.51% respectively.

The shoot TN content changing percentages in all treatments did not show significant differences throughout the studied period. But the shoot TN contents only within treatment of DR+$KClO_3$ significantly showed decreasing trends (Table 15 and Appendix table 7).

The carbohydrate per nitrogen ratios (C:N) in leaf before treatments were 6.88-8.15 (Table 16). The C:N ratios in leaf only show significant differences at 15 DAT which in DR+$KClO_3$ seemed to be higher than the other treatments. The C:N ratios of R, R+$KClO_3$, DR and DR+$KClO_3$ were 10.18, 8.90, 10.14 and 11.54 respectively.

The carbohydrate per nitrogen ratios (C:N) in shoots before treatments were 10.52-12.12. The C:N ratios of shoot in all treatments show significant differences throughout the studied period which in DR seemed to be higher than the other treatments. But C:N of shoot within each treatment did not show significant differences. At 25 DAT, the C:N of R, R+$KClO_3$, DR and DR+$KClO_3$ were 11.43, 10.73, 13.24 and 11.25 respectively.

The changing percentage of leaf C:N in all treatment gave similar results to the changing percentages within each treatment. Both of them did not showed significant differences throughout the studied period. However at 25 DAT, the changing percentage C:N of leaf in R, R+$KClO_3$, DR and DR+$KClO_3$ were 47.46, 50.78, 36.70 and 38.66 respectively (Table 17 and Appendix table 8).

Whereas the changing percentage of shoot C:N show some significant differences among treatment at 10 DAT which in R+ $KClO_3$ decreased as the other treatments increased. And the changing percentage of shoot C:N only within treatment of DR+$KClO_3$ showed significant increasing trends as the other treatments did not showed significant changes throughout the studied period. At 25 DAT, the changing percentage of shoot C:N were 5.89, -10.39, 13.41 and 7.11 respectively.

Table 14 The total nitrogen content (TN) (%) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	TN (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	5.04 A	4.30 B	3.02 C	3.18 C	3.10 C	3.14 C	0.69
	R+$KClO_3$	5.26 A	3.11 B	3.16 B	3.52 B	3.11 B	3.13 B	0.40
	DR	5.16 A	3.32 B	3.48 B	3.34 B	3.20 B	3.54 B	0.82
	DR+$KClO_3$	5.20 A	3.45 B	3.04 B	3.34 B	3.46 B	3.35 B	0.66
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	
Shoots	R	4.15	4.02	3.57	3.51	3.6	3.54	NS
	R+$KClO_3$	3.52	3.58	3.53	3.34	3.38	3.38	NS
	DR	4.19 A	3.50 B	3.54 B	3.50 B	3.38 B	3.35 B	0.46
	DR+$KClO_3$	4.14 A	3.99 A	3.72 B	3.73 B	3.44 C	3.45 C	0.19
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 15 The changing percentage of total nitrogen (TN) (%) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Changing percentage of TN (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0	-14.66	-40.03	-36.86	-38.44	-37.78	NS
	R+$KClO_3$	0	-40.89	-39.87	-33.16	-40.89	-40.51	NS
	DR	0	-35.19	-32.08	-34.94	-37.66	-30.91	NS
	DR+$KClO_3$	0	-30.19	-41.41	-35.51	-33.33	-35.51	NS
$LSD_{0.05}$		-	ns	ns	ns	ns	ns	
Shoots	R	0	-3.13	-13.98	-15.42	-13.25	-14.70	NS
	R+$KClO_3$	0	1.70	0.28	-5.11	-3.98	-3.98	NS
	DR	0	-16.47	-15.51	-16.47	-19.33	-20.05	NS
	DR+$KClO_3$	0	-3.62 A	-10.14 B	-9.90 B	-16.91 C	-16.67 C	4.18
$LSD_{0.05}$		-	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 16 The carbohydrate per nitrogen ratios (C:N) of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	C:N ratios						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	6.90 C	8.23 B	11.24 A	10.18 bA	10.48 A	10.08 A	1.31
	R+$KClO_3$	6.38 C	10.41 A	10.12 AB	8.90 bB	9.93 AB	9.63 AB	1.33
	DR	6.88 B	10.37 A	10.02 A	10.14 bA	10.39 A	9.40 A	2.13
	DR+$KClO_3$	8.15 B	11.70 A	12.80 A	11.54 aA	10.90 A	11.04 A	2.42
$LSD_{0.05}$		ns	ns	ns	1.33	ns	ns	
Shoots	R	10.93	10.88 b	12.04 ab	11.78 b	11.37 b	11.43 b	NS
	R+$KClO_3$	12.12	11.00 b	10.77 b	11.07 b	10.89 b	10.73 b	NS
	DR	11.78	13.49 a	12.68 a	12.89 a	13.42 a	13.24 a	NS
	DR+$KClO_3$	10.52	10.55 b	11.26 b	10.88 b	11.52 b	11.25 b	NS
$LSD_{0.05}$		ns	1.62	1.35	1.04	1.41	0.84	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 17 The changing percentage of carbohydrate per nitrogen ratios (C:N) (%) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate ($+KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Changing percentage of C:N ratios (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0	20.77	63.79	48.70	52.77	47.46	NS
	R+$KClO_3$	0	63.15	59.04	40.05	55.84	50.78	NS
	DR	0	51.34	46.43	47.62	51.79	36.70	NS
	DR+$KClO_3$	0	45.00	60.77	43.98	37.11	38.66	NS
$LSD_{0.05}$		-	ns	ns	ns	ns	ns	
Shoots	R	0	0.22	11.15 a	9.25	4.98	5.89	NS
	R+$KClO_3$	0	-8.57	-10.53 b	-7.83	-9.18	-10.39	NS
	DR	0	15.55	12.68 a	10.02	15.03	13.41	NS
	DR+$KClO_3$	0	0.24 C	11.26 aA	3.44 B	9.49 A	7.11 A	3.09
$LSD_{0.05}$		-	ns	12.87	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

3.3.2 Nitrate contents

Leaf nitrate contents before treatments were 0.4409-0.5225% (Table 18). Leaf nitrate contents of all treatments tended to vary in the small ranges. Only the leaf nitrate contents of DR were increased gradually throughout the studied period. At 25 DAT, leaf nitrate contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 0.5032, 0.5376, 0.6796 and 0.6473% respectively. However, the leaf nitrate contents of all treatments did not show significant differences throughout the studied period except at 25 DAT which the contents in DR and DR+$KClO_3$ were higher than R and R+$KClO_3$ (Table 19 and Appendix table 9).

The changing percentage of leaf nitrate contents showed that leaf nitrate contents of all treatments did not significant differences except at 5 DAT. At 25 DAT, the changing percentages of leaf nitrate contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 14.91, 12.21, 33.17 and 33.72% respectively.

Table 18 The percentage of nitrate (NO_3^-) (%) in leaves of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate(+$KClO_3$) at the concentration of 500 ppm

Treatments	NO_3^- (%)						$LSD_{0.05}$
	Day (s) after treatments (DAT)						
	0	5	10	15	20	25	
R	0.4409	0.5406	0.5398	0.5152	0.4817	0.5032 b	NS
R+ $KClO_3$	0.5055	0.5042	0.5366	0.5017	0.4290	0.5376 b	NS
DR	0.5225 BC	0.5414 BC	0.6151 AB	0.5792 ABC	0.4731 C	0.6796 aA	0.13
DR+$KClO_3$	0.5024	0.5314	0.5602	0.5895	0.6075	0.6473 a	NS
$LSD_{0.05}$	ns	ns	ns	ns	ns	0.08	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 19 The changing percentage of nitrate (NO_3^-) (%) in leaves of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Treatments	Changing percentage of NO_3^- (%)						$LSD_{0.05}$
	Day (s) after treatments (DAT)						
	0	5	10	15	20	25	
R	0	23.36 a	23.33	17.47	9.45	14.91	NS
R+ $KClO_3$	0	1.02 b	8.27	3.05	-9.71	12.21	NS
DR	0	4.02 b	19.48	12.05	-10.07	33.17	NS
DR+$KClO_3$	0	7.14 b	12.56	21.41	29.37	33.72	NS
$LSD_{0.05}$	-	14.94	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

3.3.3 Phosphorus

Leaf phosphorus contents before treatments were 0.17-0.19% (Table 20). Leaf phosphorus contents of all treatments did not show significant differences throughout the studied period. And Leaf phosphorus contents within each treatment tended to unchange as the leaves age increased. At 25 DAT, leaf phosphorus contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 0.15, 0.16, 0.16 and 0.16% respectively.

Shoot phosphorus contents before treatments were 0.17-0.23% which were almost the same as the leaf phosphorus contents. The shoot phosphorus contents showed some significant differences at 0, 5, 15 and 20 DAT. But shoot phosphorus contents within treatment of R+$KClO_3$, DR and DR+$KClO_3$ tended to decrease as R seemed to be unchange. At 25 DAT, the shoot phosphorus contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 0.17, 0.17, 0.17 and 0.16% respectively.

The changing percentage of leaf phosphorus contents showed the same results as leaf phosphorus contents. At 25 DAT, the changing percentages of leaf phosphorus contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were -13.01, -3.48, -12.34 and -10.46% respectively (Table 21 and Appendix table 10).

The shoot phosphorus content in all treatments did not show significant differences throughout the studied period except at 25 DAT which R+$KClO_3$ tended to decrease more than the other treatment. Whereas only the changing percentage of shoot phosphorus within treatment of DR+$KClO_3$ tended to vary in small range. At 25 DAT, the shoot phosphorus content changing percentages of R, R+$KClO_3$, DR and DR+$KClO_3$ were -5.09, -24.31,-10.09 and -5.56% respectively.

Table 20 The percentage of phosphorus (%) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Phosphorus (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0.18	0.17	0.16	0.17	0.16	0.15	NS
	R+$KClO_3$	0.17	0.16	0.15	0.16	0.15	0.16	NS
	DR	0.19	0.16	0.16	0.16	0.16	0.16	NS
	DR+$KClO_3$	0.18	0.18	0.16	0.16	0.16	0.16	NS
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	
Shoots	R	0.18 b	0.17 b	0.17	0.17 ab	0.16 b	0.17	NS
	R+$KClO_3$	0.23 aA	0.21 aAB	0.19 B	0.18 aB	0.17 bB	0.17 B	0.0374
	DR	0.19 abA	0.16 bC	0.17 BC	0.17 abBC	0.18 aAB	0.17 BC	0.0178
	DR+$KClO_3$	0.17 bA	0.16 bC	0.17A	0.16 bC	0.17 bAB	0.16BC	0.0073
$LSD_{0.05}$		0.13	0.19	ns	0.06	0.06	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 21 The changing percentage of phosphorus (%) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Changing percentage of phosphorus (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0	-0.80	-9.21	-5.37	-8.14	-13.01	NS
	R+$KClO_3$	0	0.46	-8.43	-2.26	-10.19	-3.48	NS
	DR	0	-8.03	-11.39	-10.59	-8.51	-12.34	NS
	DR+$KClO_3$	0	4.18	-8.94	-7.45	-10.22	-10.46	NS
$LSD_{0.05}$		-	ns	ns	ns	ns	ns	
Shoots	R	0	-4.79	-8.80	-8.21	-10.47	-5.09 a	NS
	R+$KClO_3$	0	-9.56	-18.22	-22.56	-25.76	-24.31 b	NS
	DR	0	-15.35	-10.26	-10.18	-5.09	-10.09 a	NS
	DR+$KClO_3$	0	-9.37 B	0.00 A	-9.37 B	-3.70 AB	-5.56 aAB	6.13
$LSD_{0.05}$		-	ns	ns	ns	ns	11.41	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

3.3.4 Potassium

Leaf potassium contents before treatments were 0.72-0.95% (Table 22). Leaf potassium contents of all treatments did not show significant differences throughout the studied period except at 20 DAT which the contents in DR+$KClO_3$ were higher than the other treatments. Whereas the contents within each treatment seem to be unchanged. At 25 DAT, leaf potassium contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 0.77, 0.86, 0.78 and 0.93% respectively.

Shoot potassium contents before treatments were 0.75-0.92% which were almost the same as the leaf potassium contents. The shoot potassium contents also did not show significant differences throughout the studied period as those of the leaves except at 20 DAT which the contents in R+$KClO_3$ were the lowest. But shoot potassium contents within treatment of DR and DR+$KClO_3$ tended to vary in the small ranges. At 25 DAT, the shoot potassium contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 0.88, 0.83, 0.76 and 0.86% respectively.

The changing percentage of leaf potassium contents in all treatments did not show significant differences throughout the studied period. But the changing percentages within each treatment could be separated in two groups. The first group was R and DR which the potassium contents tended to decrease. The second group was R+$KClO_3$ and DR+$KClO_3$ which the potassium contents tended to increase. However, they did not show significant differences. At 25 DAT, the changing percentage of leaf potassium contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were -0.31, 19.48, -17.32 and 31.49% respectively (Table 23 and Appendix table 11).

The shoot potassium content changing percentages in all treatments did not show significant differences throughout the studied period except at 20 DAT which the changing percentages in R seem to be decreased more than the other treatments. Whereas the shoot potassium content changing percentages within treatment of DR tended to increase in small amount while DR+$KClO_3$ tended to decreased.

Table 22 The percentage of potassium (%) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassiumchlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Potassium (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0.80	0.75	0.77	0.68	0.76 b	0.77	NS
	R+$KClO_3$	0.74	0.76	0.65	0.90	0.74 b	0.86	NS
	DR	0.95	0.74	0.79	0.81	0.71 b	0.78	NS
	DR+$KClO_3$	0.72	0.79	0.76	0.81	0.88 a	0.93	NS
$LSD_{0.05}$		ns	ns	ns	ns	0.12	ns	
Shoots	R	0.92	1.04 a	0.90	0.89	0.75	0.88	NS
	R+$KClO_3$	0.81	0.91 b	0.80	0.82	0.82	0.83	NS
	DR	0.75 D	0.96 abA	0.90 B	0.83 C	0.83 C	0.76 D	0.06
	DR+$KClO_3$	0.88 B	1.02 aA	0.96 AB	0.89 B	0.87 B	0.86 B	0.11
$LSD_{0.05}$		ns	0.08	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C, D: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 23 The changing percentage of potassium (%) of leaves and shoots of air-layered (R)and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Changing percentage of potassium (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0	-5.83	-0.96	-11.47	-2.62	-0.31	NS
	R+$KClO_3$	0	2.24	-11.66	21.08	3.19	19.48	NS
	DR	0	-21.75	-16.49	-14.39	-23.07	-17.32	NS
	DR+$KClO_3$	0	10.19	9.69	12.96	25.30	31.49	NS
$LSD_{0.05}$		-	ns	ns	ns	ns	ns	
Shoots	R	0	12.88	-0.69	-2.90	-19.01 c	-4.51	NS
	R+$KClO_3$	0	14.25	0.33	2.95	0.97 ab	2.67	NS
	DR	0	27.33 A	19.36 AB	10.02 BC	10.15aBC	0.80 C	14.96
	DR+$KClO_3$	0	15.79 A	9.03 B	1.81 C	-1.03 bC	-2.41 C	6.11
$LSD_{0.05}$		-	ns	ns	ns	10.05	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b, c: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

3.3.5 Calcium

Leaf calcium contents before treatments were 2.06-2.59% (Table 24). Leaf calcium contents of all treatments did not show significant differences throughout the studied period. And leaf calcium contents within each treatment also did not show significant differences throughout the studied period. At 25 DAT, leaf calcium contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 2.74, 2.59, 2.68 and 2.66% respectively.

Shoot calcium contents before treatments were 2.75-3.74% which were a few higher than the leaf calcium contents. The shoot calcium contents of all treatments also did not show significant differences throughout the studied period as those of the leaves. But they show some significant decreasing within treatment of R+$KClO_3$ and DR+$KClO_3$. At 25 DAT, the shoot calcium contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 3.30, 2.92, 2.61 and 2.90% respectively.

The changing percentage of leaf calcium contents did not show significant differences throughout the studied period. Whereas the changing percentage contents within each treatment did not change significantly. At 25 DAT, the changing percentages of leaf calcium contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 21.64, 28.91, 10.98 and 21.51% respectively (Table 25 and Appendix table 12).

The changing percentage of shoot calcium contents in all treatments also did not show significant differences until at 25 DAT. The shoot calcium changing percentage contents of R was higher than the other treatments. Whereas the changing percentage contents only within treatment of DR+$KClO_3$ tended to decrease. At 25 DAT, the calcium content changing percentages of R, R+$KClO_3$, DR and DR+$KClO_3$ were 17.68, -20.24, -4.88 and -22.22% respectively.

Table 24 The percentage of calcium (%) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Calcium (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	2.50	2.08	2.70	2.37	2.71	2.74	NS
	R+$KClO_3$	2.06	2.05	2.23	2.65	2.53	2.59	NS
	DR	2.59	2.23	2.58	2.32	2.48	2.68	NS
	DR+$KClO_3$	2.38	2.20	2.11	2.29	2.41	2.66	NS
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	
Shoots	R	3.00	3.33	3.37	3.36	3.35	3.30	NS
	R+$KClO_3$	3.64 A	3.41 B	3.13 C	3.04 C	3.04 C	2.92 C	0.25
	DR	2.75	2.77	2.75	2.75	2.75	2.61	NS
	DR+$KClO_3$	3.74 A	3.58 AB	3.22 BC	3.05 C	3.13 BC	2.90 C	0.44
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 25 The changing percentage of calcium (%) of leaves and shoots of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Changing percentage of calcium (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0	-6.26	19.15	2.37	17.14	21.64	NS
	R+$KClO_3$	0	1.49	12.74	30.19	26.56	28.91	NS
	DR	0	0.37	6.42	0.56	2.49	10.98	NS
	DR+$KClO_3$	0	-3.81	-6.45	5.44	2.42	21.51	NS
$LSD_{0.05}$		-	ns	ns	ns	ns	ns	
Shoots	R	0	17.75	20.35	20.73	19.38	17.68 a	NS
	R+$KClO_3$	0	-6.99	-14.47	-17.97	-16.76	-20.24 b	NS
	DR	0	1.13	0.30	0.19	0.28	-4.88 ab	NS
	DR+$KClO_3$	0	-4.24 A	-14.14 B	-18.16 BC	-16.25 BC	-22.22 bC	5.79
$LSD_{0.05}$		-	ns	ns	ns	ns	28.69	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

3.4 Nitrate reductase activity (NRA)

Nitrate reductase activity of leaves before treatments of were 0.0126-0.0244 $\mu moleNO_2^-h^{-1}\cdot gFW^{-1}$ (Table 26). Leaf NRA of all treatments did not show significant differences throughout the studied period. But the NRA within each treatment tended to decrease gradually. At 25 DAT, leaf NRA were very low. The nitrate reductase activities of R, R+$KClO_3$, DR and DR+$KClO_3$ were 0.0004, 0.0003, 0.0004 and 0.0003 $\mu moleNO_2^-h^{-1}\cdot gFW^{-1}$ respectively (Table 27 and Appendix table 13).

But the changing percentage of leaf NRA of R were significantly higher than the other treatments. However, NRA within each treatment gradually decreased until the activities almost undetectable. At 25 DAT, the deceasing percentages of leaf NRA of R, R+$KClO_3$, DR and DR+$KClO_3$ were -96.33, -98.64, -98.04 and -98.09% respectively.

Table 26 The nitrate reductase activity (NRA) ($\mu moleNO_2^-h^{-1}\cdot gFW^{-1}$) of leaves of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate ($+KClO_3$) at the concentration of 500 ppm

Treatments	NRA ($\mu moleNO_2^-h^{-1}\cdot gFW^{-1}$)						$LSD_{0.05}$
	Day (s) after treatments (DAT)						
	0	5	10	15	20	25	
R	0.0126 BC	0.0204 A	0.0142 B	0.0113 C	0.0120 BC	0.0004 D	0.0026
R+ $KClO_3$	0.0244 A	0.0199 B	0.0140 C	0.0109 D	0.0111 D	0.0003 E	0.0027
DR	0.0201 A	0.0167 B	0.0111 CD	0.0098 D	0.0124 C	0.0004 E	0.0017
DR+$KClO_3$	0.0171 A	0.0142 AB	0.0093 C	0.0084 C	0.0110 BC	0.0003 D	0.0046
$LSD_{0.05}$	ns	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

A, B, C, D, E: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 27 The changing percentage of nitrate reductase activity (NRA) (%) of leaves of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Treatments	Changing percentage of NRA (%)						$LSD_{0.05}$
	Day (s) after treatments (DAT)						
	0	5	10	15	20	25	
R	0	67.82 aA	17.36 aB	-7.14 aB	-1.80 aB	-96.33 aC	47.02
R+ $KClO_3$	0	-18.42 bA	-42.57 bB	-55.25 bC	-54.00 bBC	-98.64 bD	11.19
DR	0	-17.14 bA	-45.07 bC	-51.43 bD	-38.62 bB	-98.04 bE	5.85
DR+$KClO_3$	0	-16.80 bA	-45.93 bC	-50.41 bC	-34.08 bB	-98.09 bD	9.61
$LSD_{0.05}$	-	39.05	28.98	20.76	25.52	0.98	

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C, D, E: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

3.5 Hormonal analysis

3.5.1 Indole acetic acid (IAA)

Leaf IAA contents before treatments were 20.85-21.84 $\mu M \cdot gFW^{-1}$ (Table 28). Leaf IAA contents of all treatments did not show significant differences throughout the studied period. But the contents within each treatment tended to decrease except in R which it did not show significant decreasing trends. At 25 DAT, leaf IAA contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 17.30, 15.40, 16.06 and 16.86 $\mu M \cdot gFW^{-1}$ respectively.

Shoot IAA contents before treatments were 20.42-27.40 $\mu M \cdot gFW^{-1}$ which were a little bit higher than the leaf IAA contents. The shoot IAA contents also did not show significant differences throughout the studied period as those of the leaves. And the contents within each treatment also tended to decrease the same as the

leaves. At 25 DAT, the shoot potassium contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 19.50, 17.00, 19.05 and 17.70 $\mu M \cdot gFW^{-1}$ respectively.

The changing percentage of leaf IAA contents of all treatments did not show significant differences throughout the studied period. But the changing percentage contents within treatment of R+$KClO_3$, DR and DR+$KClO_3$tended to decrease gradually as the leaf age increased whereas R did not change. At 25 DAT, the decreasing percentages of leaf IAA contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were -20.28, -29.51, -22.94 and -21.15 $\mu M \cdot gFW^{-1}$ respectively (Table 29 and Appendix table 14).

The shoot IAA content changing percentages showed some significant differences at 5, 15, 20 and 25 DAT which the changing percentage of IAA content of DR+$KClO_3$ tended to be lower than the other treatments. Whereas the changing percentage contents within each treatment tended to decrease gradually throughout the studied period. At 25 DAT, the shoot IAA content changing percentages of R, R+$KClO_3$, DR and DR+$KClO_3$ were -28.69, -16.62, -25.00 and -29.38% respectively.

Table 28 IAA contents ($\mu M \cdot gFW^{-1}$) of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate ($+KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	IAA ($\mu M \cdot gFW^{-1}$)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	21.70	19.86	18.90	19.23	18.60	17.30	NS
	R+$KClO_3$	21.84 A	20.48 AB	19.13 B	18.10 BC	15.66 CD	15.40 D	2.52
	DR	20.85 A	19.88 A	19.20 AB	17.43 BC	17.16 BC	16.06 C	2.02
	DR+$KClO_3$	21.39 A	20.48 AB	19.43 B	18.96 BC	17.60 CD	16.86 D	1.56
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	
Shoots	R	27.40 A	26.82 A	24.70 B	23.75 B	20.80 C	19.50 C	1.38
	R+$KClO_3$	20.42 A	19.85 A	19.10 A	18.50 AB	19.10 A	17.00 B	1.89
	DR	25.40 A	24.22 AB	22.55 BC	22.40 BC	21.10 CD	19.05 D	2.07
	DR+$KClO_3$	25.15 A	23.55 B	22.55 B	19.70 C	18.20 D	17.70 D	1.48
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

A, B, C, D: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 29 The changing percentage of IAA (%) of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Changing percentage of IAA (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0	-8.45	-12.90	-11.37	-14.29	-20.28	NS
	R+$KClO_3$	0	-6.24 A	-12.42 A	-17.15 AB	-28.29 B	-29.51 B	12.75
	DR	0	-4.64 A	-7.91 AB	-16.39 BC	-17.67 BC	-22.94 C	10.45
	DR+$KClO_3$	0	-4.24 A	-9.15 AB	-11.33 B	-17.72 C	-21.15 C	6.01
$LSD_{0.05}$		-	ns	ns	ns	ns	ns	
Shoots	R	0	-2.10 aA	-9.85 B	-13.32 aB	-24.09 cC	-28.69 bC	6.36
	R+$KClO_3$	0	-2.79 abA	-6.46 B	-9.40 aB	-6.46 aB	-16.62 aC	3.24
	DR	0	-4.64 bcA	-11.24 B	-11.83 aB	-16.95 bB	-25.00 bC	5.92
	DR+$KClO_3$	0	-6.38 cA	-10.36 A	-21.69 bB	-27.65 cBC	-29.38 bC	7.06
$LSD_{0.05}$		-	2.20	ns	7.97	6.24	8.37	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

3.5.2 Gibberellin-like substances

Leaf gibberellin-like substance contents before treatments were 0.2310-0.3184 μg GA_3 (Kyowa) equivalent·gFW^{-1} while shoot gibberellin-like substance contents before treatments were 0.2181-0.3184 μg GA_3 (Kyowa) equivalent·gFW^{-1} which were almost as same as those of the leaves (Table 30). Leaf and shoot gibberellin-like substance contents of all treatments did not show significant differences throughout the studied period. But leaf and shoot gibberellin-like substance contents within each treatment tended to decrease gradually. At 25 DAT, leaf gibberellin-like substance contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 0.0321, 0.0235, 0.0293 and 0.0261 μg GA_3 (Kyowa) equivalent·gFW^{-1} respectively whereas the shoot gibberellin-like substance contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 0.0256, 0.0209, 0.0229 and 0.0294 μg GA_3 (Kyowa) equivalent·gFW^{-1} respectively.

The changing percentage of leaf and shoot gibberellin-like substance contents of all treatmenrts show significant differences throughout the studied period which their contents in R were higher than the other treatments. However, the changing percentage of leaf and shoot gibberellin-like substance contents within each treatment tended to decreased gradually throughout the studied period. At 25 DAT, the decreasing percentages of leaf gibberellin-like substance contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were -86.12, -92.45, -90.16 and -91.81% respectively whereas the shoot gibberellin-like substance contents decreasing percentages of R, R+$KClO_3$, DR and DR+$KClO_3$ were -88.26, -93.44, -91.86 and -89.23% respectively (Table 31 and Appendix table 15).

Table 30 Gibberellin-like substance contents (GAs) (µg GA_3 (kyowa) equivalent·gFW^{-1}) of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	GAs (µg GA_3 (kyowa) equivalent·gFW^{-1})						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0.2310 B	0.2757 A	0.2037 C	0.1759 D	0.1255 E	0.0321 F	0.0262
	R+$KClO_3$	0.3112 A	0.2599 B	0.1861 C	0.1711 C	0.1457 D	0.0235 E	0.0199
	DR	0.2975 A	0.2479 B	0.1873 C	0.1506 CD	0.1293 D	0.0293 E	0.0408
	DR+$KClO_3$	0.3184 A	0.2634 B	0.1994 C	0.1541 D	0.1248 E	0.0261 F	0.0230
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	
Shoots	R	0.2181 B	0.2577 A	0.1940 C	0.1530 D	0.1505 D	0.0256 E	0.0178
	R+$KClO_3$	0.3184 A	0.2632 B	0.1943 C	0.1586 D	0.1265 E	0.0209 F	0.0170
	DR	0.2812 A	0.2351 B	0.1739 C	0.1453 D	0.1370 D	0.0229 E	0.0199
	DR+$KClO_3$	0.2731 A	0.2281 B	0.1729 C	0.1397 D	0.1200 E	0.0294 F	0.0136
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

A, B, C, D, E, F: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 31 The changing percentage of gibberellin-like substances (GAs) (%) of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Changing percentage of GAs (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0	19.34 aA	-11.80 aB	-23.84 aB	-45.69 aC	-86.12 aD	19.32
	R+$KClO_3$	0	-16.49 bA	-40.20 bB	-45.03 bC	-53.17 abD	-92.45 bE	3.35
	DR	0	-16.65 bA	-37.04 bB	-49.37 bC	-56.52 bD	-90.16 bE	3.67
	DR+$KClO_3$	0	-17.25 bA	-37.37 bB	-51.59 bC	-60.80 bD	-91.81 bE	4.60
$LSD_{0.05}$		-	15.90	19.42	9.90	7.85	2.58	
Shoots	R	0	18.16 aA	-11.05 aB	-29.85 aC	-30.99 aC	-88.26 D	11.57
	R+$KClO_3$	0	-17.35 bA	-38.97 bB	-50.19 bC	-60.27 dD	-93.44 E	1.14
	DR	0	-16.40 bA	-38.16 bB	-48.33 bC	-51.29 bD	-91.86 E	2.57
	DR+$KClO_3$	0	-16.49 bA	-36.68 bB	-48.84 bC	-56.06 cD	-89.23 E	4.16
$LSD_{0.05}$		-	7.65	5.15	10.75	2.45	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C, D, E: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

3.5.3 Cytokinin-like substances

Leaf cytokinin-like substance contents before treatments were 0.0596-0.0770 µg kinetin equivalent·gFW^{-1} (Table 32). Leaf cytokinin-like substance contents of all treatments did not show significant differences throughout the studied period. But the contents within treatment of R, R+$KClO_3$ and DR+$KClO_3$ show a little bit decrease. At 25 DAT, leaf cytokinin-like substance contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 0.0510, 0.0531, 0.0490 and 0.0484 µg kinetin equivalent·gFW^{-1} respectively.

Shoot cytokinin-like substance contents before treatments were 0.0879-0.1122 µg kinetin equivalent·gFW^{-1} which were tended to be higher than those of the leaves. The shoot cytokinin-like substance contents also did not show significant differences throughout the studied period as those of the leaves. Shoot cytokinin-like substance contents within treatment also tended to decrease gradually during the studied period as in the leaves. At 25 DAT, the shoot cytokinin-like substance contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 0.0605, 0.0626, 0.0475 and 0.0450 µg kinetin equivalent·gFW^{-1} respectively.

The changing percentage of leaf cytokinin-like substance contents of all treatments did not show significant differences throughout the studied period. But the changing percentage of leaf cytokinin-like substance contents within treatment of R and DR+$KClO_3$ tended to decrease throughout the studied period. At 25 DAT, the decreasing percentages of leaf cytokinin-like substance contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were -32.27, -26.99, -15.16 and -37.24% respectively (Table 33 and Appendix table 16).

The shoot cytokinin-like substance content changing percentages at 5, 15, 20 and 25 in all treatments show significant differences which DR+$KClO_3$ seemed to be decrease more than the other treatments. Whereas the changing percentage contents within treatment of R, DR and DR+$KClO_3$ tended to decrease throughout the studied period. At 25 DAT, the cytokinin-like substance content decreasing percentages of R, R+$KClO_3$, DR and DR+$KClO_3$ were -32.11, -29.53, -44.76 and -59.76% respectively.

The gibberellin-like substances per cytokinin-like substances (GAs:CKs) ratios in leaves before treatments were 3.11-5.07 (Table 34). The leaf GAs:CKs ratios among the treatments did not show significant differences. But the GAs:CKs ratios of leaf within each treatment tended to decrease. At 25 DAT, the decreasing percentages of leaf GAs:CKs ratios of R, R+$KClO_3$, DR and DR+$KClO_3$ were 0.64, 0.45, 0.60 and 0.54 respectively (Table 34).

The gibberellin-like substance per cytokinin-like substances (GA:CKs) ratios in shoots before treatments were 2.44-3.55. The shoot GAs:CKs among the treatments show some significant differences at 0, 5 and 10 DAT which in DR+$KClO_3$ seemed to be lower than the other treatment. Whereas the GA:CKs of shoot within each treatment also tended to decrease throughout the studied period the same as the leaves. At 25 DAT, the decreasing percentages of shoot GAs:CKs of R, R+$KClO_3$, DR and DR+$KClO_3$ were 0.42, 0.34, 0.49 and 0.68 respectively.

Table 32 Cytokinin-like substance (CKs) contents (µg kinetin equivalent·gFW^{-1}) of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassiumchlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	CKs (µg kinetin equivalent·gFW^{-1})						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0.0757 A	0.0685 AB	0.0648 ABC	0.0585 BC	0.0604 BC	0.0510 C	0.0126
	R+$KClO_3$	0.0735 A	0.0692 AB	0.0646 ABC	0.0623 ABC	0.0545 BC	0.0531 C	0.0136
	DR	0.0596	0.0569	0.0551	0.0527	0.0443	0.0490	NS
	DR+$KClO_3$	0.0770 A	0.0713 AB	0.0647 B	0.0615 BC	0.0537 CD	0.0484 D	0.0089
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	
Shoots	R	0.0893 A	0.0852 A	0.0796 AB	0.0718 BC	0.0672 C	0.0605 C	0.0115
	R+$KClO_3$	0.0902 A	0.0846 A	0.0794 AB	0.0730 BC	0.0674 C	0.0626 C	0.0103
	DR	0.0879 A	0.0806 AB	0.0707 BC	0.0672 C	0.0631 C	0.0475 D	0.0126
	DR+$KClO_3$	0.1122 A	0.0982 B	0.0895 B	0.0623 C	0.0557 CD	0.0450 D	0.0126
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

A, B, C, D: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 33 The changing percentage of cytokinin-like substances (CKs) (%) of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Changing percentage of (CKs) (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0	-9.11 A	-13.95 A	-22.59 AB	-19.49 AB	-32.27 B	13.14
	R+$KClO_3$	0	-5.64	-11.98	-14.29	-25.70	-26.99	NS
	DR	0	-3.98	-6.86	-9.40	-24.28	-15.16	NS
	DR+$KClO_3$	0	-7.38 A	-16.04 B	-19.93 B	-30.15 C	-37.24 C	7.88
$LSD_{0.05}$		-	ns	ns	ns	ns	ns	
Shoots	R	0	-4.44 aA	-10.81 B	-19.37 aC	-24.57 aD	-32.11 aE	4.03
	R+$KClO_3$	0	-6.01 a	-11.59	-18.36 a	-24.62 a	-29.53 a	NS
	DR	0	-8.18 abA	-18.88 AB	-23.37 aAB	-27.52 aB	-44.76 abC	14.71
	DR+$KClO_3$	0	-12.47 bA	-20.17 A	-44.34 bB	-50.24 bBC	-59.76 bC	13.60
$LSD_{0.05}$		-	4.39	ns	13.29	14.10	21.23	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C, D, E: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

Table 34 The gibberellin-like substances per cytokinin-like substances ratios (GAs:CKs) of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	GAs:CKs ratios						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	3.11 B	4.08 A	3.15 B	3.06 B	2.08 C	0.64 D	0.88
	R+$KClO_3$	4.30 A	3.80 AB	2.92 BC	2.75 C	2.76 C	0.45 D	0.90
	DR	5.07 A	4.39 B	3.41 C	2.86 C	2.97 C	0.60 D	0.58
	DR+$KClO_3$	4.14 A	3.70 B	3.10 C	2.52 D	2.32 D	0.54 E	0.44
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	
Shoots	R	2.46 bB	3.04 aA	2.45 aB	2.13 B	2.26 B	0.42 C	0.49
	R+$KClO_3$	3.55 aA	3.12 aB	2.45 aC	2.17 D	1.88 E	0.34 F	0.31
	DR	3.25 aA	2.92 aAB	2.46 aBC	2.19 C	2.17 C	0.49 D	0.69
	DR+$KClO_3$	2.44 bA	2.32 bAB	1.93 bB	2.29 AB	2.18 AB	0.68 C	0.44
$LSD_{0.05}$		0.77	0.52	0.33	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significant differences at $p \leq 0.05$ by LSD

A, B, C, D, E, F: Means within the same row followed by different letters were significant differences at $p \leq 0.05$ by LSD

3.5.4 Ethylene contents (ppm)

Leaf ethylene contents before treatments were 1.31-1.43 ppm (Table 35). Leaf ethylene contents of all treatments did not show significant differences throughout the studied period. Whereas the ethylene contents within treatment of R only showed significant differences which it seemed to be increased. At 25 DAT, leaf gibberellin-like substance contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 1.74, 1.78, 1.78 and 1.78 respectively.

Shoot ethylene contents before treatments were 1.38-1.42 ppm which were almost as same as those of the leaf ethylene contents. The shoot ethylene contents of all treatments also did not show significant differences throughout the studied period as those of the leaves. Shoot ethylene contents within each treatment also did not show significant differences throughout the studied period as those of the leaves. At 25 DAT, the shoot ethylene contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 1.65, 1.73, 1.86 and 1.87 ppm respectively.

The changing percentage of leaf ethylene contents of all treatments mostly did not show significant differences except at 10 DAT which the changing percentage of R and DR+$KClO_3$ showed increasing percentage more than R+$KClO_3$ and DR . But the changing percentage of leaf ethylene contents within treatment of R+$KClO_3$, DR and DR+$KClO_3$ significantly showed increasing trends throughout the studied period. At 25 DAT, the increasing percentages of leaf ethylene contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 32.99, 25.35, 28.99 and 24.65 ppm respectively (Table 36 and Appendix table 17).

The shoot ethylene content changing percentages in all treatments did not show significant differences throughout the studied period. But the changing percentage of shoot ethylene contents within treatment of R, DR and DR+$KClO_3$ significantly tended to increase. At 25 DAT, the increasing percentages of shoot ethylene contents of R, R+$KClO_3$, DR and DR+$KClO_3$ were 20.03, 22.88, 34.89 and 35.12% respectively.

Table 35 Ethylene contents (ppm) of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate ($+KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Ethylene (ppm)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	1.31 B	1.42 AB	1.60 A	1.61 A	1.68 A	1.74 A	0.54
	R+$KClO_3$	1.42	1.44	1.51	1.61	1.65	1.78	NS
	DR	1.38	1.43	1.52	1.61	1.66	1.78	NS
	DR+$KClO_3$	1.43	1.56	1.65	1.67	1.72	1.78	NS
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	
Shoots	R	1.38	1.39	1.38	1.54	1.63	1.65	NS
	R+$KClO_3$	1.42	1.44	1.45	1.65	1.66	1.73	NS
	DR	1.38	1.43	1.52	1.75	1.72	1.86	NS
	DR+$KClO_3$	1.39	1.48	1.47	1.65	1.83	1.87	NS
$LSD_{0.05}$		ns	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

A, B: Means within the same row followed by different letters were significantly different at $p \leq 0.05$ by LSD

Table 36 The changing percentage of ethylene (%) of air-layered (R) and derooted air-layered (DR) longan cv. Daw, non-treated and treated with potassium chlorate (+$KClO_3$) at the concentration of 500 ppm

Plant organs	Treatments	Changing percentage of ethylene (%)						$LSD_{0.05}$
		Day (s) after treatments (DAT)						
		0	5	10	15	20	25	
Leaves	R	0	8.63	21.83 a	22.89	28.43	32.99	NS
	R+$KClO_3$	0	1.41 D	6.57 bCD	13.56 BC	16.43 B	25.35 A	7.47
	DR	0	3.86 C	10.63 bBC	16.79 B	20.29 AB	28.99 A	10.76
	DR+$KClO_3$	0	8.84 B	15.35 abAB	17.07 AB	20.47 A	24.65 A	9.55
$LSD_{0.05}$		-	ns	9.16	ns	ns	ns	
Shoots	R	0	1.04 B	-0.25 B	11.44 A	18.08 A	20.03 A	9.62
	R+$KClO_3$	0	1.73	2.32	16.86	17.70	22.88	NS
	DR	0	3.62 C	10.64 C	26.91 AB	24.60 B	34.89 A	8.73
	DR+$KClO_3$	0	6.70 C	6.03 C	18.61 B	31.60 A	35.12 A	8.63
$LSD_{0.05}$		-	ns	ns	ns	ns	ns	

ns: Means within the same column were non significant difference at $p \leq 0.05$ by LSD

NS: Means within the same row non significant difference at $p \leq 0.05$ by LSD

a, b: Means within the same column followed by different letters were significantly different at $p \leq 0.05$ by LSD

A, B, C, D: Means within the same row followed by different letters were significantly different at $p \leq 0.05$ by LSD