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EFFECTS OF DOLOMITE AND BORAX ON THE QUALITY OF TAINUNG NO. 13 PINEAPPLE

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Abstract

Pineapple(*Ananas comosos* (L.) Merr.) is one of the important fruits in Taiwan. Prior to flower-initiation, Tainung No. 13 contains generally lower concentration of calcium (Ca), magnesium (Mg) and boron (B) in leaves than Smooth Cayneen. This study was conducted to evaluate the supplement of calcium (Ca), magnesium (Mg) and boron (B) by the field application of dolomite and borax to improve the quality and reduce broken-cored disease in Tainung No.13. A randomised complete block design (RCBD) with three replicates and nine treatments of three dolomite rates (i.e. 0, 1, and 2 ton ha^{-1}) and three borax rates (i.e. 0, 15, and 30 kg ha^{-1}) with control treatment was designed in this study. Variations of the soil physical and chemical properties and concentrations of nutritional elements in the leaves before flower-forcing were estimated. Increasing application of dolomite and borax showed a tendency to raise the nutritional elements in both soil and leaf. The fruit length, width and weight were the best by the application of 30kg ha^{-1} borax. The fruit sugar/acidity ratio and percentage of broken-cored disease were both improved when 2 ton ha^{-1} dolomite and 30 kg ha^{-1} borax were applied. This study demonstrated that the supplement of Ca, Mg and B was able to improve the quality of Tainung No. 13 pineapple.

Introduction

In Taiwan, pineapple is one of important fruits for marketing consumption, it was cultivated in 11 thousand hectares that are scattered in the southern to central farmland**.** Two decades earlier smooth Cayenne was predominant cultivar planted and was mainly canned for export. However, the shrinking international market for canned pineapple and increasing domestic demand of fresh fruit cause the downgrade of Smooth Cayenne presently. Tainung No.13 (nickname “Winter-Sweet Pineapple”) is the fresh market cultivar with distinguishing flavor. Except that, as results of containing higher sugars and lower acidity, it became more popular in the market than other cultivars (Wang *et al*., 2009). However, the fruit was suffered from broken-cored disease cause the loss of quality and production. In general, the leaves of Smooth Cayenne before flower-forcing contains 0.8~1.2% Ca, 0.3 % Mg and 30 mg kg^{-1} B (Maier *et a*l., 1996). However, Tainung No.13 contains relatively lower 0.2~0.3% calcium, 0.2% magnesium and 15~22 mg kg^{-1} boron (Lin & Sheu, 2003), it maybe due to the deficient absorption of the three elements by Tainung No.13 pineapple.

The fruit quality and plant physiological disorder are closely related to the nutritional elements. For example, unbalanced nitrogen and potassium will adversely impact the fruit quality and production of Tainung No.13 (Fageria *et al*., 2003). Results of some researches indicate that lack of Ca and B in soil with strong acidity will cause physiological disorder such as black rot and streak disease in the root of wasabia japonica (Adeoye *et al*., 1985). Due to lack of Ca, tomato may appears soft nose or fruit-deformity (Dong *et al*., 2009). The deficiency of boron will cause the fruit deformity, peel thickness and brown jelly core in sugar apple (*Annona Squamosa* L.) (Srivastava *et al*., 2004). This study was conducted to the effect of application of dolomite and borax on soil properties, nutritional element concentration in the leaf, and fruit quality and then the relationships between Ca, Mg and B in leaf and fruit quality of Tainung No.13 pineapple were evaluated. The findings will be valuable references for improving the quality of TainungNo.13 pineapple.

Materials and Methods

Experimental design and items for investigation: The experimental site located in Dashu village, Kaohsiung county, Taiwan. Table 1 showed the soil properties before experiment. The soil, which is sandy loam with pH 3.59, contains 1.79% organic matter (OM), 46 mg kg^{-1} available phosphorus (P), 120 mg kg^{-1} exchangeable potassium (K), 219 mg kg^{-1} exchangeable calcium (Ca), 56 mg kg^{-1} exchangeable magnesium (Mg), 59 mg kg^{-1} exchangeable iron (Fe), and 24 mg kg^{-1} exchangeable manganese (Mn). The pineapples were planted 45000 seedlings ha^{-1} on October 5, 2006; flower- occurred on August 8, 2007, and harvested on December 25, 2008. The varieties of dolomite (0, 1 and 2 tones ha^{-1}) and borax (0, 15 and 30 kg ha^{-1}) were designed in the randomized complete block design (RCBD) with 9 treatments as shown in table 2. Three replicates were proceeded for every treatment, every repetition were blocked in small area of 20 square meters. The application of 30 kg ha^{-1} borax was divided into two batches; 15 kg was applied by mixing with chicken manure and dolomite, and then tilled into the top soil before pineapple planted. Another 15 kg was applied beside the plant after 6 months planting. The organic fertilizer was applied in two batches; 10 tons ha^{-1} of chicken manure was applied before planting, and 5 tons ha^{-1} was mixed with the soil surrounding plants at the flower-forcing stage. As shown in Table 3, the chicken manure with pH 8.4 contain 3.0% total nitrogen (N), 2.5% P_2O_5, 3.0% K_2O and 45% organic matter. Samples of mature leaves and soil were collected for analysis at flower-forcing and before harvesting stage. The plant height was measured at flower-initiation stage; the average fruit length, width, weight, sugar degree (^{o}Brix), acidity, sugar/acidity ratio and percentage of broken-cored disease were measured at harvesting stage.

Sampling and analysis of soils and leaves: Soil samples were a blend of three subsamples collected from the upper layer (0–30 cm) of each treatment with three replicates. The samples were air-dried and sieved through a 2 mm sieve. Soil properties such as texture (pipet method), organic matter (Walkley-Black method), pH (soil:water=1:1), electrical conductivity (soil: water=1:1) and P(Bray No.1) were measured as described by Page *et al*., (1982). The exchangeable cations (K, Ca, Mg, Fe, Mn, Cu, and Zn) were measured as described by Vanderhoeven *et al*., (2005). The soil samples were extracted with 1 M CH_3COONH_4 (pH 4.7), and then determined by ICP-AES (Jobin Yvon Ultima 2, France) as described below, the solution was nebulized and then carried by argon into the atomizer to be atomized, and atoms were excited by high temperature electrical plasma. After excited electron returning to the ground state, the special spectras emitted by atom including atomic and ionic spectra were used for qualitative and quantitative analyses of elements. The concentration of estimated elements were computed based on the integration of peak areas. All standards were diluted using 1000 ppm stock solution (Merck, Germany).

Table 1. Physical and chemical properties of soil at the experimental site.

pH (H_2O) 1:1	Texture	OM[1] (%)	Bray-1	Ex. K	Ex. Ca	Ex. Mg	Ex. Fe	Ex. Mn
			---(mg kg^{-1})---					
3.59	SL[2]	1.79	46	120	219	56	59	24

[1]OM: Organic matter
[2]SL: Sandy loam

Table 2. The application rates of dolomite and borax.

Treatment	Dolomite (tone/ha)	Borax (kg/ha)
L_0 B_0	0	0
L_0 B_{15}	0	15
L_0 B_{30}	0	30
L_1 B_0	1	0
L_1 B_{15}	1	15
L_1 B_{30}	1	30
L_2 B_0	2	0
L_2 B_{15}	2	15
L_2 B_{30}	2	30

L: Dolomite
B: Borax

Table 3. The main contents of chicken manure compost.

pH	N	P_2O_5	K_2O	OM
	---(%)---			
8.4	3.0	2.5	3.0	45

Before flower, five pineapple longest leaves from each treatment, with three replicates, were selected from plants at the same sites where soils were sampled. The leaves were washed to remove adhering dust and rinsed with distilled water. After that, leaf samples were placed in nylon nets, dried at 70°C for 24 hours and ground using a grinder. The digestion method described by He & Singh *(*1994a*)* was followed. N concentration was measured by kjeldahl method and P, K, Ca, Mg, Fe, Mn, Cu, Zn and B concentration were analyzed as previously described.

Estimate of fruit sugar degree, acidity and sugar/acidity ratio: Pineapple juice was extracted from peeled fruit; the sugar degree (^{o}Brix) was determined using a hand-held refractometer. 5 ml juice was mixed with 45 ml distilled water, and then the mixture was titrated with 0.1 N sodium hydoxide (NaOH) until the end point of pH 8.1 was reached. The consumption of Sodium hydroxide can be used to calculate the acidity using the following conversion. Acidity (%) = 0.0064 × NaOH titrant(ml)/Sample volume(ml) × 100%. The results are used to calculate the sugar/acidity ratio.

2.4. Percentage of broken-cored disease: Twenty fruits were randomly collected from each harvesting area. The fruit was sliced longitudinally to observe whether broken core occured and calculated the percentage of broken-cored disease. Percentage of broken-cored disease = (Number of fruit with broken-cores disease/ total number of fruit examined) x 100%.

Table 4. The variation of soil pH value for different applications of dolomite and borax.

Treatment	92.4.17	92.12.24
L_0 B_0[2]	3.47[c 1]	3.68[b]
L_0 B_{15}	3.58[c]	3.64[b]
L_0 B_{30}	3.69[c]	3.64[b]
AVG[3]	3.58	3.65
L_1B_0	3.84[bc]	4.08[a]
L_1B_{15}	4.07[ab]	4.04[a]
L_1B_{30}	4.03[ab]	4.00[a]
AVG	3.98	4.04
L_2B_0	4.19[a]	4.31[a]
L_2B_{15}	4.18[a]	4.20[a]
L_2B_{30}	4.35[a]	4.24[a]
AVG	4.24	4.25

[1]The same letter in the same column indicates no significant difference at 0.05 level according to Duncan's multiple range test
[2]L: Dolomite, B: Borax
[3]AVG: Average of same dolomite treatments

Statistical analysis: The Windows SPSS Version 10.0 statistical software was used to carry out for ANOVA analyses. The least significant difference and the Duncan's DMR test were used to distinguish the difference of various treatments. Significant differences were identified @ $p<0.05$.

Results and Discussions

Effects of dolomite and borax on soil properties: Table 4 showed that soil pH declined 0.12 units at flower-forcing stage than before planting. Malhi *et al.*, (1998) showed that the application of a great deal of nitrogen fertilizer (i.e., $(NH_4)_2SO_4$) will acidify the soil, and then rised before harvesting stage. It showed that the variation of soil pH may be involved in drought and moisture in the soil. The soil pH is influenced by the water and nitrogen contents in the soil (Tian *et al.*, 2002). When soil with strong acidity is subject to drought, the NO_3^--N in the soil will increase to cause a decrease of soil pH, however, sustainable high soil moisture after rainy days in summer will cause the soil pH to rise (Fig. 1) (Adeoye *et al.*, 1985). There is no significantly effect on raising soil pH between applying of 1 ton ha^{-1} to 2 ton ha^{-1} of dolomite, however, the soil pH in the area where dolomite are applied 1 and 2 ton ha^{-1} is obviously higher than that in the check with increase of 0.66 units. Results of applying 30 kg ha^{-1} of borax revealed that the soil pH with borax application is raised 0.19 units than that without borax application before harvesting (Table 4). Table 5 shows that prior to flower-forcing, the soil organic matter content decreases with increasing application of dolomite. It assumed that the improving of soil pH enhances the microbial activities in the soil and hence accelerated the decomposting rate of soil organic matter (Hao *et al.*, 2008), so that the content of soil organic matter was reduced. Before flower-forcing, the soil phosphorus and potassium increase with the application of 1 ton ha^{-1} of dolomite, the soil calcium increased significantly, however, magnesium slightly increased. Iron and manganese decreased may be the precipitation of Fe and Mn with phosphate anion in acid soil. As a result of 5 ton ha^{-1} of chicken manure was applied as supplementary fertilizer during the flower-forcing stage, the soil physical and chemical characteristics were improved after harvesting stage (Table 6). Before harvesting stage, the treatment of dolomite applications has relatively higher pH and lower organic matter content. Applying dolomite may result in higher contents of Ca and Mg in the treatments with dolomite. The soil with dolomite application had higher calcium and magnesium during harvesting stage. The application of borax slightly raised the content of macronutrients and slightly decreased the content of micronutrients.

Table 5. The variation of soil chemical properties for various applications of dolomite and borax before flower-forcing.

Treatment	pH	OM[2] (%)	Bray-1 P	Ex. K	Ex. Ca	Ex. Mg	Ex. Fe	Ex. Mn
			(mg kg^{-1})					
$L_0 B_0$[3]	3.66^{b1}	1.81^{ab}	45^{b}	185^{ab}	82^{b}	42^{a}	105^{a}	98^{a}
$L_0 B_{15}$	3.73^{b}	1.91^{a}	38^{b}	150^{b}	167^{b}	30^{a}	55^{b}	44^{b}
$L_0 B_{30}$	3.89^{ab}	1.66^{abc}	36^{b}	173^{ab}	97^{b}	45^{a}	66^{b}	42^{b}
AVG[4]	3.76	1.79	40	169	115	39	75	61
L_1B_0	4.08^{a}	1.72^{abc}	48^{ab}	178^{ab}	134^{b}	39^{a}	67^{b}	34^{b}
L_1B_{15}	4.13^{a}	1.74^{abc}	63^{a}	183^{ab}	95^{b}	32^{a}	77^{ab}	35^{b}
L_1B_{30}	4.09^{a}	1.82^{ab}	62^{a}	205^{ab}	160^{b}	47^{a}	75^{ab}	70^{ab}
AVG	4.10	1.76	58	189	130	39	73	46
L_2B_0	4.28^{a}	1.42^{bc}	45^{b}	163^{ab}	275^{ab}	35^{a}	68^{b}	52^{ab}
L_2B_{15}	4.34^{a}	1.39^{c}	64^{a}	230^{a}	303^{ab}	52^{a}	67^{b}	44^{b}
L_2B_{30}	4.32^{a}	1.65^{abc}	42^{b}	138^{b}	524^{a}	31^{a}	58^{b}	41^{b}
AVG	4.31	1.49	50	177	367	39	64	46

[1] The same letter in the same column indicates no significant difference at 0.05 level according to Duncan's multiple range test
[2]OM: Organic matter
[3]L: Dolomite, B: Borax
[4]AVG: Average of same dolomite treatments

Table 6. The variation of soil chemical properties for various applications of dolomite and borax before harvested stage.

Treatment	pH	OM[2] (%)	Bray-1 P	Ex. K	Ex. Ca	Ex. Mg	Ex. Fe	Ex. Mn
			(mg kg^{-1})					
$L_0 B_0$[3]	3.68^{b1}	1.97^{a}	97^{a}	164^{ab}	77^{a}	76^{ab}	83^{a}	40^{a}
$L_0 B_{15}$	3.64^{b}	1.79^{a}	90^{a}	92^{ab}	354^{a}	44^{b}	149^{a}	60^{a}
$L_0 B_{30}$	3.64^{b}	1.93^{a}	88^{a}	89^{ab}	40^{a}	83^{ab}	65^{a}	60^{a}
AVG[4]	3.65	1.90	92	115	157	68	99	53
L_1B_0	4.08^{a}	2.32^{a}	84^{a}	175^{a}	104^{a}	105^{ab}	84^{a}	63^{a}
L_1B_{15}	4.04^{a}	2.39^{a}	87^{a}	199^{a}	224^{a}	135^{a}	75^{a}	29^{a}
L_1B_{30}	4.00^{a}	2.14^{a}	88^{a}	141^{ab}	168^{a}	108^{ab}	86^{a}	32^{a}
AVG	4.04	2.28	86	172	165	116	82	41
L_2B_0	4.31^{a}	2.09^{a}	95^{a}	87^{ab}	107^{a}	68^{ab}	97^{a}	36^{a}
L_2B_{15}	4.20^{a}	1.94^{a}	79^{a}	103^{ab}	139^{a}	80^{ab}	88^{a}	50^{a}
L_2B_{30}	4.24^{a}	2.07^{a}	91^{a}	51^{b}	358^{a}	69^{ab}	84^{a}	44^{a}
AVG	4.25	2.03	88	80	201	72	90	43

[1]The same letter in the same column indicates no significant difference at 0.05 level according to Duncan's multiple range test.
[2]OM: Organic matter
[3]L: Dolomite, B:Borax
[4]AVG: Average of same dolomite treatments.

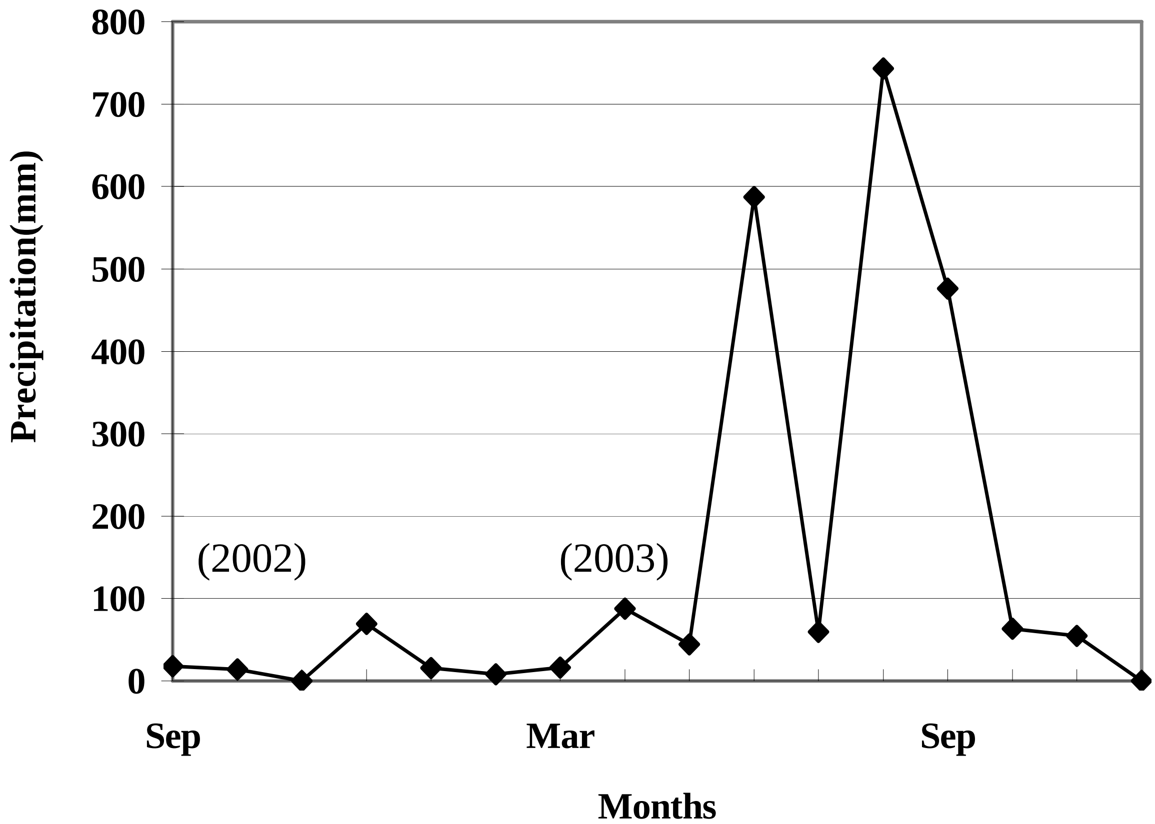

Fig 1. The fluctuation of precipitation from planting to harvested stage of Tainung No.13 pineapple.

Table 7. The variation of leaf nutrient concentration for various applications of dolomite and borax before flower-forced.

Treatment	N	P	K	Ca	Mg	Fe	Mn	Cu	Zn	B
	---------(%)----------			----(%)-----		--------------($mgkg^{-1}$)--------------				
$L_0 B_0$[2]	0.96^{a1}	0.09^a	3.23^a	0.24^a	0.12^c	502^a	170^a	15^a	40^a	17^a
$L_0 B_{15}$	1.24^a	0.06^a	2.93^{ab}	0.20^a	0.12^c	367^{abc}	150^a	11^a	41^a	15^a
$L_0 B_{30}$	1.11^a	0.10^a	2.83^{ab}	0.22^a	0.13^c	221^c	149^a	10^a	39^a	18^a
AVG[3]	1.10	0.08	3.00	0.22	0.13	363	156	12	40	17
L_1B_0	1.01^a	0.09^a	2.70^{ab}	0.23^a	0.15^{bc}	326^{bc}	154^a	14^a	42^a	19^a
L_1B_{15}	0.99^a	0.10^a	2.58^{ab}	0.25^a	0.14^{bc}	394^{ab}	178^a	10^a	47^a	17^a
L_1B_{30}	1.36^a	0.11^a	2.90^{ab}	0.23^a	0.14^{bc}	483^{ab}	170^a	11^a	49^a	23^a
AVG	1.12	0.10	2.73	0.23	0.14	401	167	12	46	20
L_2B_0	0.96^a	0.10^a	2.33^b	0.24^a	0.16^{abc}	315^{bc}	149^a	8.7^a	43^a	21^a
L_2B_{15}	1.20^a	0.10^a	2.90^{ab}	0.27^a	0.18^{ab}	444^{ab}	182^a	12^a	49^a	23^a
L_2B_{30}	1.25^a	0.10^a	2.83^{ab}	0.29^a	0.19^a	460^{ab}	174^a	12^a	41^a	21^a
AVG	1.14	0.10	2.68	0.27	0.18	406	168	11	45	21

[1]The same letter in the same column indicates no significant difference at 0.05 level according to Duncan's multiple range test
[2]L: Dolomite, B: Borax
[3]AVG: Average of same dolomite treatments

Influence of dolomite application on the nutritional elements in leaves: Table 7 showed that the nitrogen and phosphorus contents in leaves before flower-forcing may not significantly difference between treatments, however, they increase with application of dolomite. This may be related to changes of soil pH that cause mineralization of organic matter in the soil to release essential elements that enhances the plant absorption of nitrogen and phosphorus. However, the potassium content in the plant decrease with applications of dolomite assumed that the increasing absorption of Ca and Mg antagonize the absorption of K, and causing a lower content of K in leaves. With increasing application of dolomite, the plant contained elevated Ca and Mg, however, Fe, Mn, Cu and Zn slightly decreased. K and Fe slightly decreased with application of borax. The various applications of borax made potassium and iron increase but does not affect other elements in the leaves. At harvesting stage, except phosphorus, the leaves of treatment with 1 tone ha^{-1} contained higher macronutrients than the check. And except Zn, all other micronutrients are lower with dolomite applications. Table 8 showed that the leaves of Tainung No.13 contained higher essential elements during harvesting stage than flower-forcing stage. It is assumed that the application of organic fertilizer at flower-forcing stage, and less water absorbed by the plant during the drought season to increase the concentration of elements.

Influence of dolomite applications on the quality and production of Tainung No.13 pineapples: Table 9 revealed that the plant height before flower-forcing, fruit average length, average width and average weight were not significantly difference, however, those grown in treatments without applications of dolomite were better. On the other hand, with increasing application of dolomite, the fruit average sugar increased and the acidity decreased so that the sugar/acidity ratio was highest for treatment with 2 tons ha^{-1} of dolomite. Under various applications of dolomite, the treatment of 30 kg ha^{-1} borax caused the best plant height beforeflower-forcing, fruit average length, average width, average weight and average sugar degree. The occurrence of broken-cored disease decreases with application of dolomite and borax. The results showed that application of 30 kg ha^{-1} borax positively impact the general characteristics of Tainung No.13 pineapple fruit (length, width, and weight). However, The combining applications of 2 ton ha^{-1} dolomite and 30 kg ha^{-1} will further improve the fruit quality and reduce the broken-core disease.

Relationship between broken-cored percentage and concentrations of Ca, Mg and B in leaves for Tainung No.13 pineapple: Figures 2 and 4 showed that the percentage of broken-cored disease were decreased with Ca, Mg and B contents in leaves. The correlation coefficients (r) were –0.50, -0.62 and –0.73, respectively. The results demonstrated that the occurrence of broken-cored disease will decrease with the content of these three essential elements in leaves. Although application of dolomite slightly raised soil pH in this study, however, it increased Ca and Mg contents in soil and leaves. On the other hand, the treatment with 30 kg ha^{-1} borax showed higher boron content in leaves and less broken-core than the treatments with no borax and 15 kg ha^{-1} borax. Results in this study have shown that application of 2 tons ha^{-1} dolomite and 30 kg ha^{-1} borax may improve the fruit sugar degree and reduce the broken-cored disease of Tainung No.13.

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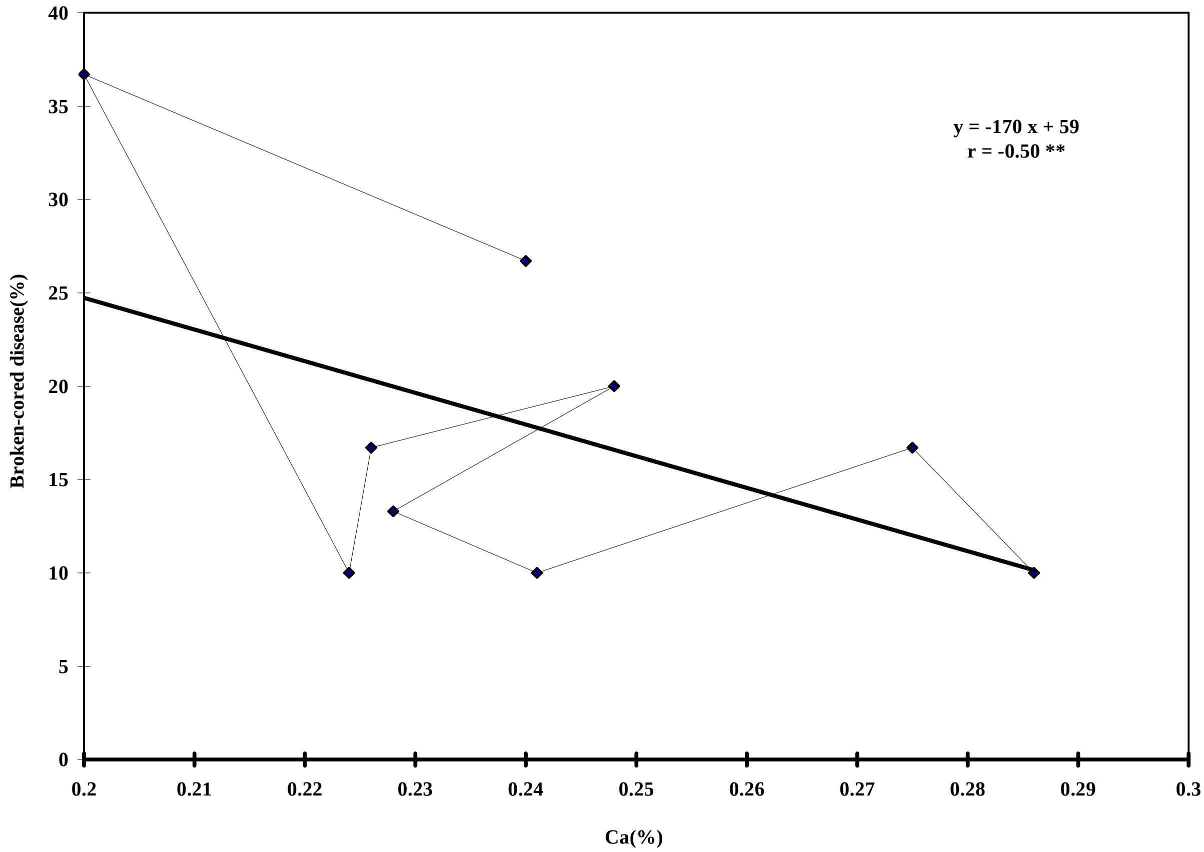

Fig 2. Inversely linear relationship between leaf calcium concentration and broken-cored severity of Tainung No.13 pineapple.

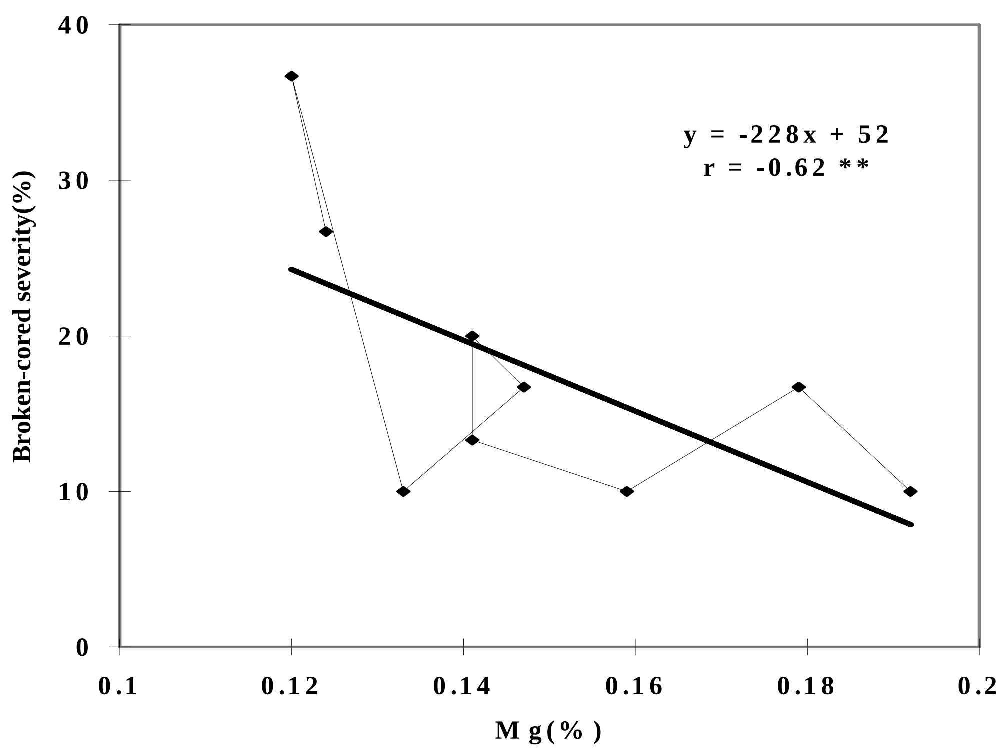

Fig 3. Inversely linear relationship between leaf magnesium concentration and broken-cored severity of Tainung No.13 pineapple.

Table 8. The variation of leaf nutrient concentration for various applications of dolomite and borax before harvested stage.

Treatment	N	P	K	Ca	Mg	Fe	Mn	Cu	Zn
	---------(%)----------			----(%)-----		--------------(mgkg^{-1})--------------			
L_0 B_0[2]	1.23[a1]	0.14[a]	2.68[a]	0.34[a]	1293[ab]	769[a]	220[a]	13[a]	29[b]
L_0 B_{15}	1.09[a]	0.14[a]	2.68[a]	0.35[a]	1197[b]	365[b]	214[a]	9.7[a]	37[ab]
L_0 B_{30}	1.09[a]	0.12[a]	2.63[a]	0.45[a]	1383[ab]	325[b]	204[a]	10[a]	38[ab]
AVG[3]	1.13	0.13	2.66	0.38	1291	486	213	11	35
L_1B_0	1.10[a]	0.12[a]	3.10[a]	0.35[a]	1717[a]	382[b]	186[a]	9.4[a]	40[ab]
L_1B_{15}	1.25[a]	0.12[a]	2.58[a]	0.43[a]	1556[ab]	380[b]	160[a]	9.4[a]	44[ab]
L_1B_{30}	1.41[a]	0.13[a]	2.83[a]	0.48[a]	1573[ab]	469[ab]	151[a]	9.5[a]	44[ab]
AVG	1.25	0.12	2.83	0.42	1615	411	166	9.4	43
L_2B_0	1.23[a]	0.11[a]	2.78[a]	0.41[a]	1492[ab]	419[ab]	146[a]	8.3[a]	38[ab]
L_2B_{15}	1.25[a]	0.12[a]	2.83[a]	0.38[a]	1624[ab]	460[ab]	156[a]	11[a]	45[a]
L_2B_{30}	1.11[a]	0.13[a]	2.73[a]	0.40[a]	1446[ab]	656[ab]	125[a]	11[a]	35[b]
AVG	1.19	0.12	2.78	0.40	1520	511	142	10	39

[1] The same letter in the same column indicates no significant difference at 0.05 level according to Duncan's multiple range test

[2]L: Dolomite, B: Borax

[3]AVG: Average of same dolomite treatments

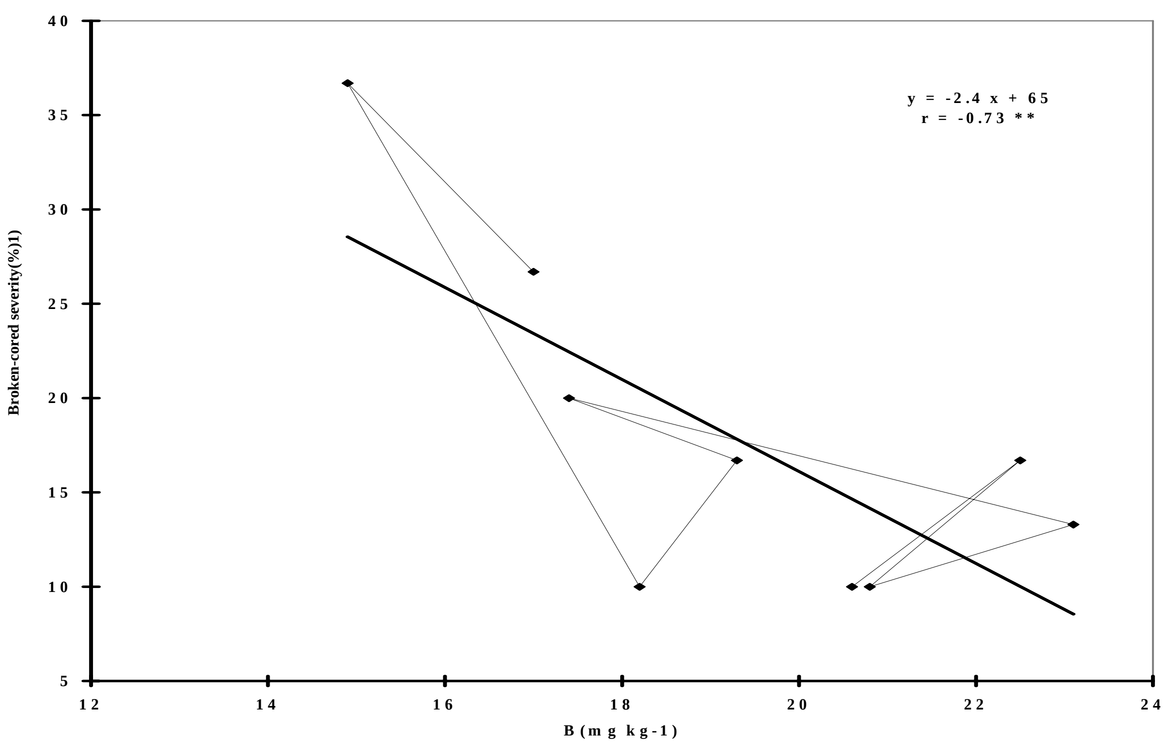

Fig 4. Inversely linear relationship between leaf boron concentration and broken-cored severity of Tainung No.13 pineapple.

Table 9. The variation of plant height, and fruit quality before flower-forcing for various applications of dolomite and borax.

Treatment	Plant height (Before anthesis (cm)	Fruit length (cm)	Fruit width (cm)	Fruit weight (kg)	Sugar (°Brix)	Acidity (%)	Sugar/ acidity	Broken-cored disease (%)
L_0 B_0[2]	103.2[a1]	18.5[a]	11.1[a]	1.24[a]	17.3[bc]	0.98[ab]	17.7[bc]	26.7[ab]
L_0 B_{15}	108.5[a]	17.0[a]	11.7[a]	1.36[a]	17.2[bc]	0.97[ab]	17.7[bc]	36.7[a]
L_0 B_{30}	115.1[a]	17.9[a]	11.5[a]	1.18[a]	16.3[c]	0.93[ab]	17.5[bc]	10.0[c]
AVG[3]	108.9	17.8	11.4	1.26	16.9	0.96	17.6	24.5
L_1B_0	100.8[a]	16.6[a]	11.4[a]	1.16[a]	18.7[ab]	1.00[ab]	18.7[b]	16.7[bc]
L_1B_{15}	107.3[a]	16.5[a]	11.3[a]	1.18[a]	17.7[abc]	1.17[a]	16.0[c]	20.0[abc]
L_1B_{30}	103.9[a]	16.4[a]	11.2[a]	1.07[b]	17.3[bc]	0.78[b]	22.2[a]	13.3[bc]
AVG	104	16.5	11.3	1.14	17.9	0.98	18.3	16.7
L_2B_0	103.4[a]	17.1[a]	11.8[a]	1.22[a]	16.7[bc]	0.80[b]	20.9[ab]	10.0[bc]
L_2B_{15}	107.8[a]	16.9[a]	11.2[a]	1.28[a]	18.4[abc]	0.88[b]	20.9[ab]	16.7[bc]
L_2B_{30}	104.5[a]	16.8[a]	11.2[a]	1.09[b]	19.5[a]	0.90[b]	21.7[a]	10.0[bc]
AVG	105.2	16.9	11.4	1.20	18.2	0.86	21.2	12.2

[1]The same letter in the same column indicates no significant difference at 0.05 level according to Duncan's multiple range test.
[2]L: Dolomite, B: Borax
[3]AVG:Average of same dolomite treatments.

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