

TOLERANCE OF PEANUT GENOTYPES TO ACIDIC SOIL CONDITION

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ABSTRACT

The acidic soil is generally less productive due to soil pH ranging from 3.1 to 5.0. However, it could be solved through soil amelioration, planting tolerant varieties to acidic soil condition, and a combination of both. Twenty peanut genotypes including two check varieties (Jerapah and Talam 1) were evaluated on dolomite-ameliorated and non ameliorated soil. In the greenhouse, the treatments were laid out in factorial design with four replications, while in the field using strip plot design with three replications. Assessment of tolerance was using Stressed Tolerance Index (STI) according to Fernandez (1992). Results showed that dolomite application at dose equivalent to 0.5 x exchangeable Al was optimal in improving peanut growth, and peanut yield on acidic soil. Lines of GH3 (G/92088/92088-02-B-2-8-1) and GH 4 (G/92088/92088-02-B-2-8-2) genotypes had high STI with average yield of 2.47 t ha⁻¹ and 2.62 t ha⁻¹ of dry pods and potential yield of 4.05 t ha⁻¹ and 3.73 t ha⁻¹ of dry pods, respectively as well as check varieties (Jerapah and Talam-1). It is concluded that peanut genotype of G/92088/92088-02-B-2-8-1 and G/92088/920 88-02-B-2-8-2 were adaptable and tolerance to acidic, and tolerance of peanuts on acidic soil condition were probably controlled by the buffering mechanisms.

Keywords: peanut, acidic soil, tolerance

INTRODUCTION

Acidic dry lands of Ultisol soil are widespread in almost 25% of the total land area of Indonesia. Ultisol generally has deep soil layer and moderate to high cation exchange capacity, and therefore it has an important role in the development of dryland

ranges from acidic to very acidic with pH value from 3.1 to 5.0 (Mulyani, 2006), except on Ultisol developed from limestone that has soil pH of 6.5 to 6.8. Low productivity of this soil is mainly related to low soil pH.

Productivity of Ultisol soil can be improved through soil amelioration, fertilization, the use of tolerant or adaptable varieties, and their combination. Liming was effective to increase pH and decrease exchangeable Al (Rosolem *et al.*, 1999; Sumarno, 1995). However, excessive liming may cause deficiency of some micro-nutrients as a result of increased pH. Liming becomes effective when soil pH was less than 5.0 because at pH above 5.5 Al precipitates into Al(OH)₃ (Prasetyo and Suriadikarta, 2006). Application of organic matter is also effective in coping Al toxicity, because fulvic acid commonly found in organic materials could reduce the toxicity of Al (Hairiah *et al.*, 2000). Lime and organic matter application is effective if acidic stress occurs in topsoil, but they will be better to combine with tolerant or adaptive varieties when acidity occurs in both topsoil and subsoil layers.

Development of peanut in acidic soil is prospective if production technology is available (Makmun *et al.*, 1996; Sumarno 1995; Kasno 2006). Development of peanut variety tolerant to acidic soil had been initiated by crossing in 2001/2002, selection of homozygous lines on low pH condition at the laboratory in 2006, and the selected lines were evaluated on acidic soil through preliminary yield trial in Jasinga in 2007, and advanced yield trial in acidic dry land in Lampung in 2010 (Trustinah *et al.*, 2008, Trustinah *et al.*, 2009 and 2011; Kasno *et al.*, 2011 and 2012). The evaluation at the laboratory was conducted by staining using haematoxyl in that allowed measuring the penetration of Al into the root quickly, so it could determine the degree of tolerance

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of the root. Identification of tolerant genotypes can also be performed directly in the field, but covering large number of genotype requires a lot of time and cost. Staining method based on pot experiments using acid soil or nutrient solution containing Al is an alternative approach as done by Giaveno and Filho (2002) in maize, Voigt and Staley (2004) in white clover, and Zhang *et al.* (2004) in lucerne. Field testing in two environments (*in situ* and improved conditions) is needed to evaluate economic yield (Koesrini and Sabran 1994, Scott and Fisher 1989; Sopandie *et al.*, 2000; Hede *et al.*, 2001; Hede *et al.*, 2002 ; Nursyamsi *et al.*, 2002; Narasimhamoorthy *et al.*, 2007).

There were peanut germplasm accessions tolerant to acidic with Al saturation above 30% (Trustinah *et al.* 2009). Forty seven out of 220 peanut lines were selected from field trial on acidic dry land in Jasinga with high exchangeable Al, and 26 lines were selected from yield trial with pod yield ranging from 2.5 to 3.6 t ha⁻¹. Leaf disease score of those selected lines ranged from 4.7 to 6.0 (moderately resistant). The selected lines should be

tested through adaptation trials before released as new varieties. Fourteen lines had been evaluated in adaptation trials in South Lampung, Central Lampung and East Lampung in 2011 with the highest yield of 3.7 t.ha⁻¹ of dry pods. It was higher than checked variety Talam-1 (2.2 t.ha⁻¹). This suggests that there was an opportunity to acquire new tolerant variety better than Talam-1 (Kasno *et al.*, 2012).

The research objectives were to obtain information of the influence of liming, tolerance assessment, and selection of peanuts lines tolerant to acidic soil condition.

MATERIALS AND METHODS

Greenhouse Experiment

The experiment was conducted in greenhouse of Indonesian Legumes and Tuber Crops Research Institute (ILETRI) from July to October 2012. Soil was taken from Koleang village, Jasinga sub district, Bogor district (West Java) at a depth of 0-20 cm. Chemical and physical characteristic of the soil is presented in Table 1.

Table 1. Physical and chemical characters of soil from three sites at depth of 0-20 cm Malang 2012

Soil Variables	Methods	Sites		
		Koleang	Jasinga	Lebak
Soil texture (%)	Pipet			
Sand		6.00	22.00	13.00
Silt		25.00	47.00	27.00
Clay		69.00	31.00	60.00
pH-H ₂ O	1:5	4.20	4.70	4.30
C-organic (%)	Walkley & Black	1.07	1.28	2.07
N-total (%)	Kjeldahl	0.11	0.11	0.20
P ₂ O ₅ (ppm)	Bray 1	2.30	5.30	1.30
Exch-K (cmol _e kg ⁻¹)	1 N NH ₄ -Acetat pH 7	0.20	0.22	0.14
Exch-Ca (cmol _e kg ⁻¹)	1 N NH ₄ -Acetat pH 7	2.21	9.36	1.58
Exch-Mg (cmol _e kg ⁻¹)	1 N NH ₄ -Acetat pH 7	1.22	3.72	1.22
Exch-Na (cmol _e kg ⁻¹)	1 N NH ₄ -Acetat pH 7	0.29	0.07	0.08
Exch-Al (cmol _e kg ⁻¹)	KCl 1 N	2.95	1.32	4.00
Exch-H (cmol _e kg ⁻¹)	KCl 1 N	3.16	0.26	1.32
CEC _e (cmol _e kg ⁻¹)	Summation	10.03	14.95	8.34
Al saturation (%)		29.40	8.80	48.00
Base saturation (%)		39.10	89.40	36.20

Remarks: Analysis by Soil Laboratory of Soil Research Institute, Bogor

The treatment consisted of two factors. The first factor was 20 peanut genotypes, including two checked varieties (Jerapah and Talam 1). Peanut

lines tested were derived from various crosses in 1993 through 2000 (F_{22} - F_{31}) which were selected for their tolerance to acidic soil condition.

The second factor was three levels of liming with dolomite [$\text{CaMg}(\text{CO}_3)_2$] calculated based on exchangeable Al (exch-Al), namely 0.0, 0.5, and 1.0 x exch-Al. The treatment combinations were laid out randomized complete block design, four replications (two replications for destructive sampling and another two for harvest).

The weight of soil per pot used was 7.5 kg air-dried soil (moisture content 24.9%) or equivalent to 5.63 kg/pot oven dry soil. Dolomite of technical grade (30% CaO, 12-24% MgO) was mixed with soil before planting. Four peanut seeds were dibbled in each pot and then thinned to two plants/pot on day 14 after planting (DAP). Soil moisture content was maintained around field capacity by addition of tap water. Phonska fertilizer (15% N, 15% P_2O_5 , 15% K_2O , 10% SO_4) at rates of 300 kg ha^{-1} (1.8 g/pot) and SP36 (36% P_2O_5) at rates of 100 kg ha^{-1} (0.6 g pot^{-1}) were mixed with soil before planting (dosage per pot calculated based on plant population). Due to abnormal crop growth until 15 DAP, fertilization at same dosage was applied on 20 DAP. Whitefly (*Bemisia tabaci*) was major insect during crop growth, but it could be controlled using insecticide with active ingredient of piridaben 135 g l^{-1} .

Data collected consisted of soil analysis before treatment applied (soil texture, pH, total N, available P, exch-K, exch-Ca, exch-Mg, exch-Na, CEC, C-organic, Fe, Mn, exch-Al, and exch-H); soil analysis on 50 DAP (pH, available P, exch-K, exch-Ca, exch-Mg, exch-Na, Fe, Mn, exch-Al, and exch-H); plant tissue analysis on 50 DAP (K, Ca, Mg, Al, Fe, and Mn), root length on 14 and 50 DAP, plant height on 50 DAP, and at harvest; number of branches on 50 DAP and at harvest; shoot and root dry weight on 14, 50 DAP and at harvest (oven-dried at temperature of 105 °C for 48 hours), number of filled pods and empty pods at harvest, pods and seeds dry weight at harvest.

Field Experiment

The experiment was carried out in Pajagan village, Sajira sub district, Lebak district (Banten

province) and at Neglasari village, Jasinga sub district, Bogor district (West Java) during dry season of 2012. Treatment consisted of two factors. The first factor was 20 peanut genotypes, including two checked varieties (Jerapah and Talam 1). The second factor was two levels of liming with dolomite [$\text{CaMg}(\text{CO}_3)_2$] calculated based on exchangeable Al (exch-Al), namely 0 and 1 x exch-Al. The treatments were laid out in strip plot design with three replications. The liming treatments set up as horizontal factor and genotypes as vertical factor.

In each liming treatment, each genotype was planted in 6 rows along 4.5 m with spacing of 40 cm between rows and 15 cm within the rows, and 2 seeds/hole. Phonska at rates of 250 kg/ha and 100 kg/ha SP36 was applied as basal fertilizer.

Data collected consisted of plant height at harvest, growth scores on 45 DAP (1 = tolerant, normal growth, green leaf, and vigorous, 2 = quite tolerant, rather normal growth, and less vigorous, 3 = quite vulnerable, infertile crops, and the leaves turn yellow, 4 = vulnerable, stunted, and yellow leaf, 5 = very vulnerable, very dwarf, brown leaves, and crops were dead before flowering), pod yield, 100 seeds and pods weight, and seed color.

Assessment of tolerance was based on Stressed Tolerance Index (STI) (Fernandez, 1992) with the formula $STI = (Y_p)(Y_s)/(Y_P)^2$, where Y_p , Y_s and Y_P is the appearance of character without stress, appearance of character with stress, and average appearance of character without stress, respectively.

Resistance to rust and leaf spot diseases were scored based on Subrahmanyam *et al.*, (1995). Assessment of resistance to bacterial wilt was based on percentage of wilted crops between 14 to 49 DAP. The crops were classified as resistant to bacterial wilt when the percentage of wilted crops during these periods was <18%, and moderately resistant when the value was 18-30%.

RESULTS AND DISCUSSION

Soil in Lebak and Jasinga was acid with soil pH 4.2 to 4.7, exch-Al 1.32 to 4.00 $\text{cmol}_e\text{kg}^{-1}$, and Al saturation from 8.8 to 48.0% (low to moderate). Soil fertility was poor as indicated by low organic matter

content and low macro nutrient availability (Table 1).

Al saturation of soil for experiment in the greenhouse was higher than that in the field experiment even from the same district. This was because the soil for greenhouse experiment was collected from dry land, while field experiment was conducted on rice field. Site in Lebak was fallow dry land and therefore it had the highest Al saturation compared to that in the other sites (Table 1).

Effect of Dolomite on Soil Chemical Properties

The addition of dolomite at dose of 0.5 and 1x *exch*-Al (*exch* = exchangeable) increased soil pH, *exch*-Ca, *exch*-Mg, CEC, CECe, and base saturation, but decreased Mn and *exch*-Al. Application NPK fertilizer increased the content of total N, available P and *exch*-K (Table 2). It seems that addition of dolomite could improve acid soil chemical characteristics although the effect was

not maximized yet due to slow reaction of dolomite in the soil.

Effect of dolomite on the growth of peanut had been observed since day 14 after planting (DAP). Application of dolomite affected root length and shoot dry weight, but had no effect on root dry weight. Each genotype showed different response for shoot dry weight, but not for root length and root dry weight. There was no interaction effect between dolomite and genotypes for root length, root dry weight, and shoot dry weight (Table 3). The results suggest that shoot dry weight variable in early growing stage can be used as selection criteria for peanut tolerant to acidic.

Increasing doses of dolomite from 0 to 1 x *exch*-Al did not increase shoot dry weight and even reduced root length (Table 4). Application of dolomite at the dose of 0.5 x *exch*-Al on acidic soil with pH 4.5 and Al saturation 29.5% was sufficient and provided a better growing environment for peanut.

Table 2. Soil analysis on day 50 after application of dolomite. Malang. 2012

Soil Variable	Methods	Dose of dolomite (x <i>exch</i> -Al)		
		0	1/2	1
pH-H ₂ O	1:5	4.50	4.70	4.80
N-total (%)	Kjeldahl	0.15	0.17	0.13
P ₂ O ₅ (ppm)	Bray 1	63.00	32.00	42.10
<i>exch</i> -K (cmole _e kg ⁻¹)	1 N NH ₄ -Acetat pH 7	0.50	0.70	0.79
<i>exch</i> -Ca (cmole _e kg ⁻¹)	1 N NH ₄ -Acetat pH 7	5.06	11.65	15.43
<i>exch</i> -Mg (cmole _e kg ⁻¹)	1 N NH ₄ -Acetat pH 7	5.60	7.90	7.77
<i>exch</i> -Na (cmole _e kg ⁻¹)	1 N NH ₄ -Acetat pH 7	0.50	0.83	0.88
<i>exch</i> -Al (cmole _e kg ⁻¹)	KCl 1 N	10.44	10.49	7.58
<i>exch</i> -H (cmole _e kg ⁻¹)	KCl 1 N	1.21	1.21	1.31
CEC (cmole _e kg ⁻¹)	(1 N NH ₄ -Acetat pH 7	28.40	43.50	49.00
CECe (cmole _e kg ⁻¹)	Summation of cation	23.40	32.80	33.80
Fe (ppm)	Morgan	0.90	0.80	2.30
Mn (ppm)	Morgan	16.30	3.70	13.50
Al saturation (%)	Percent of CEC	36.80	24.10	15.40
Al saturation (%)	Percent of CECe	44.70	32.00	22.40
Base saturation (%)	Percent of CEC	41.30	48.50	50.70
Base saturation (%)	Percent of CECe	50.10	64.30	73.70

Remarks: Analysis by Soil Laboratory of Soil Research Institute, Bogor

Table 3. Variance analysis of effect of dolomite and genotype on agronomic characters of peanuts on 14 DAP in the greenhouse. Malang 2012

Source of variance	df	Root length	Root dry weight	Shoot dry weight
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		(cm)	(mg plant ⁻¹)	(mg plant ⁻¹)
Dolomite (P)	2	*	ns	*
Genotype (G)	19	ns	ns	**
P*G	38	ns	ns	ns
CV(%)		21.8	8.0	22.4

Remarks: * and **: significant at p 0.05 and 0.01 respectively; ns: not significant.

Table 4. Effect of dolomite to agronomic characters of peanut on 14 DAP in the green house. Malang. 2012

Dose of dolomite (x exch-Al)	Root length (cm)	Rootdry weight (mg plant ⁻¹)	Shoot dry weight (g plant ⁻¹)
0	6.7 a	40.6 a	327.8 a
0.5	7.4 b	38.7 a	354.8 b
1	6.9 a	38.6 a	361.5 b
LSD 5%	0.47	10.1	243.9

Remarks: numbers in the same column with the same letter represent no significant difference at LSD 5%

Previous research showed that application of dolomite at the dose of 2 t/ha on Jasinga soil increased soil pH from 4.4 to 5.4 and reduced Al saturation from 91.5% to 61.1%, and increased exch-K, exch-Ca and exch-Mg (Trustinah *et al.*, 2009). Among the characters at germination stage, root length was the most sensitive to Al stress and there were no roots of genotypes which were completely free from the penetration of aluminum, so the root length could be used as indicator of Al tolerance of peanut in the greenhouse experiment (Trustinah *et al.*, 2008). Murata *et al.* (2003) reported that increasing pH from 3 to 5 and 6 as well as the Ca concentration from 0 to 0.2 mM reduced the devastating impact of the effect of low pH. In acidic soil, peanut yield was positively correlated with soil pH, exch-Ca, and negatively correlated with exch-Al and Al saturation (Koesrini *et al.*, 2005).

The degree of tolerance among peanut genotypes was different in both germination stage and reproductive stage in the field. Individually, IC87123/86680-93-B-75-55-1 genotype had the highest STI in greenhouse at the dose of dolomite 0.5 and 1 x exch-Al, but it had lower STI in the field (Table

5 and 11), meaning that the genotype might have an individual buffer. G/92088/92088-02-B-2-8-1 and G/92088/92088-02-B-2-8-2 had lower STI in the greenhouse, but higher STI in the field (Table 5 and 11), meaning that the tolerance to acidic dryland was controlled by buffer mechanism. Jerapah and Talam 1 varieties, individually, also had low STI in the greenhouse and in the field (Table 5 and 11).

Individually, the best performance of yield components at low soil pH was also different, as in an indication of the interaction among peanut yield component characters. Genotype IC87123/86680-93-B-75-55-1 had the highest pod and seed weight, but it was low in seed size, seed to pod percentage, and harvest index. Similar phenomenon was also observed on G/92088/92088-02-B-2-8-1 and G/92088/92088-02-B-2-8-2 (Table 6). This phenomenon led to difficulties in the selection when the selection was done partially to each character. It is, therefore, suggested to conduct the selection based on many characters simultaneously that are correlated to each other by using a selection index.

Table 5. Variability of pod yield and STI of peanut genotypes in the greenhouse at three rates of dolomite (Malang, 2012)

No.	Genotypes	Dose of Dolomite (x exch-Al)				
		Pod dry weight (g plant ⁻¹)			STI	
		0.5	1.0	0	0.5	1.0
1	MHS/91278-99-C-180-13-5	25.1	26.2	18.5	0.87	1.03
2	G/92088/92088-02-B-2-9	20.4	20.9	16.8	0.64	0.75
3	G/92088/92088-02-B-2-8-1	23.6	20.0	14.3	0.63	0.61
4	G/92088/92088-02-B-2-8-2	23.9	19.3	17.9	0.80	0.74
5	J/J11-99-D-6210	27.1	21.5	21.5	1.10	0.98
6	P 9801-25-2	16.9	27.6	8.8	0.28	0.52
7	G/92088/92088-02-B-8	23.1	19.0	19.9	0.86	0.80
8	MHS/91278-99-C-174-7-3	16.3	23.7	15.8	0.48	0.80
9	Jerapah	23.7	20.4	21.5	0.96	0.93
10	J/91283-99-C-192-17	22.0	20.9	17.6	0.73	0.78
11	MHS/91278-99-C-180-13-7	29.1	20.6	17.0	0.93	0.75
12	M/92088-02-B-1-2	24.9	19.2	12.0	0.56	0.49
13	MLG 7720	22.3	24.8	18.6	0.78	0.98
14	MLG 7638	21.5	24.9	19.7	0.80	1.04
15	GH02/G-2000-B653-54-28	20.4	22.9	19.4	0.74	0.95
16	IC87123/86680-93-B-75-55-1	24.4	24.5	26.4	1.21	1.38
17	IC87123/86680-93-B-75-55-2	28.8	21.1	21.1	1.14	0.95
18	MLGA0306/MLG 7932	21.9	18.7	18.3	0.75	0.73
19	UNILA 2	25.2	24.6	13.0	0.62	0.68
20	TALAM 1 (check)	20.7	12.8	7.2	0.28	0.20

Effect of Liming on Peanuts in the Field

The growth of peanut crops in the field showed good response to dolomite application with growth scores between 1 and 3.5 (Figure 1). Peanut crops showed aluminum toxicity symptoms (brown color in the leaf tips) with growth scores between 1 and 3. Score 1: normal plant growth, leaf green, and vigorous. Score 2: less normal growth, less fertile. Score of 3: less sensitive, infertile plants, and leaf yellowing. Score 4: sensitive, infertile plants, and leaf yellowing. Crops growth scores in Lebak was higher than those of Jasinga, grew shorter, and had very low biomass and pod yield (Figure 1). Data collected from the experiment in Lebak revealed high coefficient variation due to drought stress, and therefore were not included in the analysis.

Application of dolomite improved peanut growth that was indicated by low growth scores, but it did not affect the severity of rust and leaf spot diseases (Table 7). Application of dolomite improved

peanuts growth, filled pod setting, pods yield, percentage of seeds to pods yield, and harvest index (Table 8, 9). Rating character's appearance was inconsistent, as in an indication of the presence of interaction between the characters and interactions with the environment (Table 8, 9).

Liming is aimed primarily to raise soil pH and reduce exchangeability (Rosolem *et al.*, 1999). Another way to cope Al toxicity is by giving application of organic matter to the soil. Soil organic ingredients reduce effect of Al toxicity. Molecule of humus and organic acid complexes with Al in soil solution perform the nontoxic compounds. The formation of organic residue in the short term increases soil pH because of the combination of an organic acid and a proton to proton consumption by decarboxylation of organic acids (Haynes and Mokolobate 2001). Another approach is the use of tolerant varieties. Combined use of tolerant varieties and liming is an effective strategy for increasing productivity of acidic land.

Table 6. Pods and seeds dry weight, seed size, seeds to pods percentage, and harvest index of peanut genotypes in the greenhouse (Malang, 2012)

No	Genotypes	Dry pod weight (g 2 plants ⁻¹)	Dry seed weight (g2 plants ⁻¹)	100 seed weight (g)	Percentage of seeds to pods (%)	Harvest Index (HI)
1	MHS/91278-99-C-180-13-5	23.2	16.6	43.4	73.3	0.5
2	G/92088/92088-02-B-2-9	19.6	14.9	38.9	78.3	0.5
3	G/92088/92088-02-B-2-8-1	19.3	15.5	43.2	81.3	0.4
4	G/92088/92088-02-B-2-8-2	20.3	16.1	40.1	76.7	0.5
5	J/J11-99-D-6210	23.3	17.0	48.0	71.7	0.5
6	P 9801-25-2	17.7	12.9	43.5	66.7	0.4
7	G/92088/92088-02-B-8	20.6	16.1	45.3	78.3	0.5
8	MHS/91278-99-C-174-7-3	18.6	12.9	51.3	68.3	0.4
9	Jerapah	21.8	17.5	43.3	80.0	0.5
10	J/91283-99-C-192-17	20.1	14.7	42.6	73.3	0.4
11	MHS/91278-99-C-180-13-7	22.2	15.1	39.5	68.3	0.5
12	M/92088-02-B-1-2	18.7	15.1	33.5	80.0	0.5
13	MLG 7720	21.9	17.3	38.9	78.3	0.5
14	MLG 7638	22.0	12.5	44.9	56.7	0.5
15	GH02/G-2000-B653-54-28	20.9	15.2	54.5	71.7	0.5
16	IC87123/86680-93-B-75-55-1	25.1	19.4	46.2	76.7	0.5
17	IC87123/86680-93-B-75-55-2	23.6	16.7	45.8	78.3	0.5
18	MLGA0306/MLG 7932	19.6	13.6	46.7	66.7	0.5
19	UNILA 2	20.9	14.7	53.1	68.3	0.4
20	TALAM 1 (check)	13.5	8.8	45.9	68.3	0.3
LSD5%		5.1	4.6	8.9	10.3	0.1

Other factors that also influence yield is disease. Liming had no effect on the rust, leaf spot, and wilt diseases. Without liming, the average score of rust and leaf spot diseases was 3.0 and 4.1, respectively, whereas with liming was 3.1 and 4.35, respectively (Table 7). Rust and leaf spot diseases may attack peanuts starting from the active vegetative phase to reproductive phase. Critical period for peanut to leaf diseases that cause yield loss is at 75-80 DAP. Leaf spot disease is more severe than rust disease, and there was indication that liming had no effect on the intensity of rust and leaf spot diseases.

Bacterial wilt is caused by *Ralstonia solanacearum*. Wilt symptoms on young plants cause sudden wilting stems and leaves, while some other leaves remain green. In older plants, wilt symptoms cause leaf yellowing, wilting or death of the branches or the entire plant. Roots of infected plants become rotten and brown. Among the genotypes tested, genotype J/91283-99-C-192-17, M/92088-02-B-1-2, and MHS/91278-99-C-174-7 were susceptible to bacterial wilt disease (Table 8). In the selection process, the genotypes where the percentage of wilt incidence less than 18% during the period of 14 to 49 DAP continued to the next selection step.

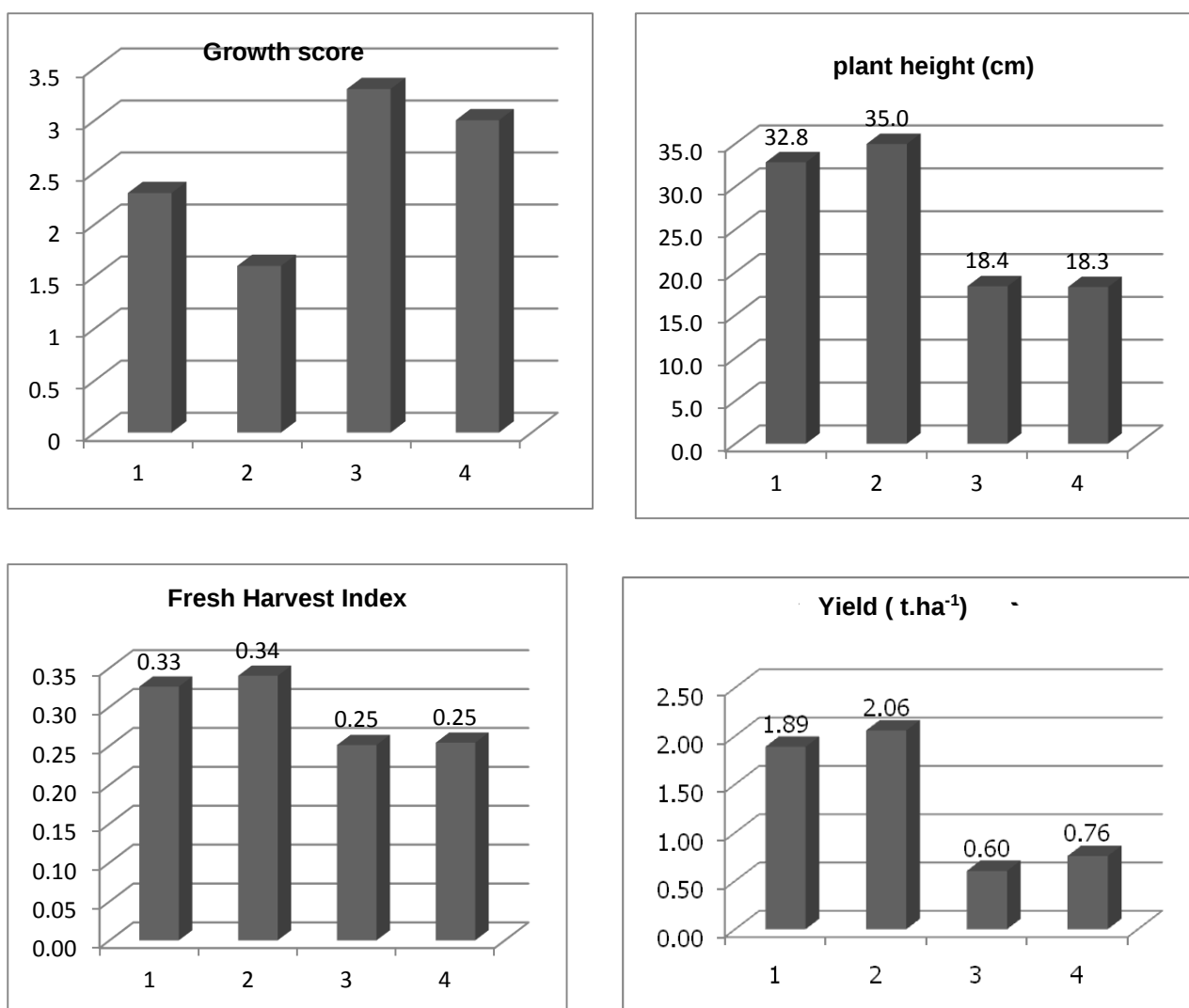


Figure 1. Score growth, plant height, weight of pods + biomass and peanut Yield (t.ha⁻¹) in Jasinga (1=P0, 2=P1) and Lebak (3=P0, 4=P1). DS of 2012

Table 7. Growth and leaf disease score with and without dolomite. (Jasinga, dry season, 2012)

No	Genotype	Growth Score		DiseaseLeaf				Dolomite	
		Dolomite		Without dolomite		With dolomite		Without	With
		Without	With	Rust	Leaf spot	Rust	Leaf spot	Wilt (%)	Wilt (%)
1	MHS/91278-99-C-180-13-5	3	2	3	4	3	4	11	11
2	G/92088//92088-02-B-2-9	2	1	3	2	3	3	12	17
3	G/92088//92088-02-B-2-8-1	2	2	3	2	3	3	14	18
4	G/92088//92088-02-B-2-8-2	3	2	3	2	3	4	12	12
5	J/J11-99-D-6210	2	1	3	3	4	4	12	12
6	P 9801-25-2	2	2	3	3	4	4	16	18
7	G/92088//92088-02-B-8	2	1	3	4	3	3	13	17
8	MHS/91278-99-C-174-7 -3	3	2	3	5	3	5	21	25
9	Jerapah	1	1	3	4	3	5	11	11
10	J/91283-99-C-192-17	2	1	3	5	3	5	38	44
11	MHS/91278-99-C-180-13-7	3	2	3	3	3	3	15	15
12	M/92088-02-B-1-2	3	1	3	5	3	5	23	29
13	MLG 7720	3	2	4	5	3	6	14	15
14	MLG 7638	3	2	3	5	3	6	15	17
15	GH 02/G-2000-B-653-54-28	1	1	3	5	3	5	11	12
16	IC 87123/86680-93-B-75-55-1	2	2	3	5	3	4	9	11
17	IC 87123/86680-93-B-75-55-2	2	2	3	5	3	5	11	13
18	MLGA 0306	2	2	3	5	3	5	12	13
19	Unila 2	2	1	3	5	3	5	13	14
20	Talam 1(check)	2	1	3	5	3	5	14	16
Average		2.29	1.58	3.04	4.1	3.11	4.35	14.8	16.2
Minimum		1	1.0	3	2	3	3	9	11
Maximum		3	2	4	5	4	6	38	44

In Indonesia, the yield loss data due to leaf spot and rust diseases has not been well documented. Some researchers suggested that peanut yield loss due to these diseases was significant. Jusfah (1985 in Saleh, 2010) reported that leaf spot disease reduced yield by 50%, and it depended on when the disease arose, disease development, and crops variety. Leaf spot disease reduces the number of pods, number of seeds and seed weight per plant. Insusceptible variety, like

Pelanduk, yield loss due to leaf spot and rust diseases was up to 60%. The level of yield loss was positively correlated with the disease intensity and leaf defoliation. Soenartiningih and Talanca (2002) reported that yield reduction due to bacterial wilt disease in Indonesia ranged from 30 to 60%, and peanut varieties resistant to bacterial wilt were Macan, Banteng, Tupai, Tapir, Pelanduk, Local Tuban, Local Muneng, and local Tasikmalaya.

Table 8. Performance of some crop characters and pod yield of peanut without dolomite Jasinga, dry season 2012

No	Genotype	Plant Height (cm)	Total Biomass Weight (g)	Fresh Pod Weight (g)	Number of filled Pods	Number of immature Pods	Dry Pod Weight (g/plot)	Fresh pod Weight (g/plot)	100 seed weight (g)	Seed to pod ratio	Fresh Harvest Index (HI)
1	MHS/91278-99-C-180-13-5	30.0	308.3	82.3	56	17	35.0	4417	40.6	0.72	0.27
2	G/92088//92088-02-B-2-9	34.7	350.0	125.7	81	14	55.5	4067	48.1	0.78	0.37
3	G/92088//92088-02-B-2-8-1	33.0	341.7	113.7	72	18	45.1	4600	43.4	0.75	0.34
4	G/92088//92088-02-B-2-8-2	28.7	316.7	97.0	62	20	36.7	3867	38.0	0.75	0.34
5	J/J11-99-D-6210	33.7	458.3	122.3	62	15	42.1	3767	42.5	0.67	0.31
6	P 9801-25-2	35.7	525.0	191.7	121	18	87.2	3083	52.9	0.79	0.37
7	G/92088//92088-02-B-8	37.3	500.0	147.3	62	14	48.6	5300	46.7	0.68	0.32
8	MHS/91278-99-C-174-7 -3	33.0	500.0	119.7	65	19	44.2	2867	41.4	0.73	0.27
9	Jerapah	34.3	316.7	78.0	54	8	32.7	3600	37.7	0.74	0.28
10	J/91283-99-C-192-17	33.0	291.7	95.3	52	9	30.1	3400	34.9	0.68	0.37
11	MHS/91278-99-C-180-13-7	33.3	408.3	102.3	74	14	45.1	3500	37.9	0.69	0.26
12	M/92088-02-B-1-2	32.7	375.0	111.3	45	13	34.3	2900	50.0	0.62	0.32
13	MLG 7720	28.7	308.3	99.0	53	17	39.7	3067	41.8	0.78	0.36
14	MLG 7638	28.3	296.7	83.0	52	12	38.5	3250	45.7	0.75	0.29
15	GH 02/G-2000-B-653-54-28	36.7	375.0	104.7	56	7	41.1	3933	41.2	0.70	0.32
16	IC 87123/86680-93-B-75-55-1	36.7	541.7	151.3	86	18	56.3	2833	48.0	0.73	0.30
17	IC 87123/86680-93-B-75-55-2	31.0	300.0	104.3	70	8	46.3	3567	40.5	0.76	0.40
18	MLGA 0306	35.0	458.3	131.3	59	12	45.3	3467	45.7	0.67	0.30
19	Unila 2	30.0	225.0	92.3	53	9	34.7	3383	43.0	0.64	0.47
20	Talam 1(check)	31.0	438.3	113.0	69	7	44.5	3083	41.4	0.68	0.28
Average		32.83	381.2	113	65	13.4	44.1	3598	43.1	0.71	0.33
Minimum		37.33	291.7	78	42	17	30.1	2833	38.0	0.64	0.26
Maximum		37.33	525.0	192	121	20	87.2	5300	52.9	0.79	0.47

Table 9. Performance of some crop characters and pod yield with dolomite Jasinga, dry season 2012.

No	Genotype	Plant Height (cm)	Total Biomass Weight (g)	Fresh Pod Weight (g)	Number of Filled Pods	Number of immature Pods	Dry Pod Weight (g/plot)	Fresh pod Weight (g/plot)	100 seed Weight (g)	Seed to pod ratio	Fresh Harvest Index (HI)
1	MHS/91278-99-C-180-13-5	35.7	425.0	151.3	75	18	59.3	4167	45.2	0.71	0.39
2	G/92088//92088-02-B-2-9	34.7	583.3	186.0	113	27	81.7	4200	48.1	0.78	0.33
3	G/92088//92088-02-B-2-8-1	35.0	716.7	213.0	144	34	88.6	4967	43.6	0.74	0.31
4	G/92088//92088-02-B-2-8-2	27.7	366.7	141.7	89	26	70.3	5000	44.5	0.90	0.42
5	J/111-99-D-6210	37.7	508.3	146.3	76	16	61.6	4850	48.5	0.72	0.31
6	P 9801-25-2	35.3	491.7	155.0	85	15	66.8	3433	49.1	1.03	0.32
7	G/92088//92088-02-B-8	39.0	366.7	119.3	56	13	38.9	4567	43.0	0.65	0.34
8	MHS/91278-99-C-174-7 -3	36.3	458.3	124.7	72	11	56.3	3283	44.3	0.81	0.33
9	Jerapah	38.0	541.7	148.7	90	15	64.5	3600	43.3	0.76	0.30
10	J/91283-99-C-192-17	37.0	378.3	111.7	60	16	39.0	4200	38.0	0.70	0.33
11	MHS/91278-99-C-180-13-7	34.0	333.3	130.0	92	26	48.0	3600	39.1	0.55	0.41
12	M/92088-02-B-1-2	35.0	516.7	163.7	74	16	67.6	2717	53.9	0.71	0.35
13	MLG 7720	32.7	391.7	128.7	74	17	16.8	3450	41.7	0.31	0.36
14	MLG 7638	35.0	400.0	128.7	68	19	53.4	3167	44.7	0.78	0.34
15	GH 02/G-2000-B-653-54-28	36.7	375.0	110.3	69	12	46.9	4050	41.3	0.70	0.30
16	IC 87123/86680-93-B-75-55-1	36.3	725.0	185.3	111	25	75.5	3100	48.0	0.76	0.28
17	IC 87123/86680-93-B-75-55-2	34.0	358.3	118.3	80	11	52.2	3833	39.5	0.72	0.36
18	MLGA 0306	36.0	516.7	127.7	55	23	40.8	3700	48.8	0.75	0.26
19	Unila 2	29.3	195.0	80.0	47	6	30.5	4000	43.2	0.66	0.41
20	Talam 1(check)	34.0	358.3	121.7	71	10	50.6	3767	44.3	0.69	0.34
Average		35	450.3	140	80	17.7	55.5	3883	44.6	0.72	0.34
Minimum		27.7	195	111.7	55	6	16.8	2717	39.1	0.55	0.28
maximum		39	725	213	144	34	88.6	5000	53.9	0.72	0.42

There were yield differences among genotypes, and no significant interaction between genotype and liming, and genotype, liming and location. Due to no significant interaction between genotype and liming, so that interaction between location and genotype became more important, and the implication was the optimum lime dosage in each different location (Table 10).

Table 10. Combined variance analysis for pod yield in two locations (Jasinga and Lebak). Dry season in 2012

Source of Variance	df	Mean Square	F test
Location (L)	1	100.246	***
Liming (P)	1	1.576	***
Genotype (G)	19	0.260	**
Interaction (L*G)	19	0.682	***
Interaction (P*G)	19	1.749	ns
Interaction (L*P*G)	19	0.11	ns

Remarks: ns= not significant

G/92088//92088-02-B-2-8-1 and G/92088//92088-02-B-2-8-2 genotypes performed the highest pod yield, and it was above the average yield of all genotypes, and they also had high STI value (Table 11). It indicates that they were tolerant to and productive on acidic dryland. On the contrary, IC87123/86680-93-B-75-55-1 and IC87123/86680-93-B-75-55-2 genotypes had high STI in the greenhouse, but low STI in the field (Jasinga) (Table 5 and 11), indicating the important role of individuals buffering mechanisms. These phenomena indicate that tolerance and adaptation of peanut on acidic dryland were controlled by buffer mechanism of the population, and hence individual selection method was more reliable on the development of genotype tolerant to acidic condition.

Tolerance is the ability of plants to grow, develop and reproduce in a certain environment. Several procedures have been formulated to get high performance genotype in optimal and sub optimal state. According to Fernandez (1992), the use of Tol, MP, and SSI as selection criteria fails to distinguish the genotypes of high yielding and tolerant with other groups (high yield and intolerant,

low yield and tolerant, low yield and intolerant). Therefore, Fernandez (1992) proposes an index of tolerance to stress (stress tolerance index/STI) as selection criteria to identify superior genotypes in both the optimal and suboptimal in the neighborhood. STI is calculated using the geometric mean to avoid extremes that often arise from the calculation based on the average value of algebra. It was also done on the wheat (Mohammadi *et al.*, 2010; Akcura *et al.*, 2011).

Value of stress tolerance index (STI) was positively correlated with pod yield on acidic condition without liming. Therefore, the tolerance to soil acidity was in line with the value of STI. Based on the STI and pod yield, G/92088//92088-02-B-2-8-1 and G/92088//92088-02-B-2-8-2 had STI of 1.45 and 1.25 (first or second highest rank), and average pod yield of 2.29 t ha⁻¹ and 2.09 t ha⁻¹, respectively, on the soil without liming. The yield of these genotypes increased to 2.82 t ha⁻¹ and 2.67 t ha⁻¹ with liming, higher than average yield of all genotypes both without (1.83 t ha⁻¹) and with liming (2.11 t ha⁻¹), and also higher than Jerapah and Talam 1 (Table 11).

Pod yield of G/92088//92088-02-B-2-8-2 was similar to G/92088//92088-02-B-2-9, but G/92088//92088-02-B-2-8-2 was more adaptive on acidic (Table 11). Moosavi *et al.*, (2008) uses ATI (abiotic tolerance index = index of tolerance to abiotic stresses), SSPI (stress susceptibility percentage index = index percentage sensitivity to stress), and IPNS (production index without stress) to assess the genotypes of sorghum to drought stress. Tolerance is a difference of sorghum yield in the environment without stress to with drought stress. ATI and SSPI very effectively select genotypes of sorghum tolerant to drought stress and are also stable in yield, and may be used for conformational elders of the population QTL genotypes for yield stability in irrigated and non irrigated conditions. The IPNS is closely and positively correlated with changes in sorghum yield in the irrigated and non irrigated, so it is recommended to use the IPNS because sorghum can select genotypes of high and stable yield in both the irrigated and non irrigated.

Table 11. Pods yield (tha^{-1}) without liming and with liming, and stress tolerance index (STI) to acidic soil in Jasinga. Dry season of 2012

No	Genotype	Liming		STI
		Without	With	
1	MHS/91278-99-C-180-13-5	1.97	2.32	1.03
2	G/92088//92088-02-B-2-9	2.14	2.32	1.12
3	G/92088//92088-02-B-2-8-1	2.29	2.82	1.45
4	G/92088//92088-02-B-2-8-2	2.09	2.67	1.25
5	J/J11-99-D-6210	1.91	2.38	1.02
6	P 9801-25-2	1.68	1.76	0.67
7	G/92088//92088-02-B-8	1.92	2.61	1.13
8	MHS/91278-99-C-174-7 -3	1.66	1.75	0.65
9	Jerapah	1.88	1.94	0.82
10	J/91283-99-C-192-17	1.77	2.02	0.80
11	MHS/91278-99-C-180-13-7	1.96	2.15	0.94
12	M/92088-02-B-1-2	1.48	1.64	0.55
13	MLG 7720	1.55	1.95	0.68
14	MLG 7638	1.81	1.88	0.76
15	GH 02/G-2000-B-653-54-28	2.09	2.37	1.11
16	IC 87123/86680-93-B-75-55-1	1.52	1.54	0.52
17	IC 87123/86680-93-B-75-55-2	2.00	2.11	0.95
18	MLGA 0306	1.90	1.91	0.82
19	Unila 2	1.47	2.09	0.69
20	Talam 1	1.59	1.96	0.70
Average		1.83	2.11	
Minimum		1.47	1.54	
Maximum		2.29	2.82	

CONCLUSION AND SUGGESTIONS

CONCLUSION

Liming with dolomite at the dose of 0.5 to 1 x exchangeable Al increased soil pH by 0.2 and 0.3 unit and base saturation by 7.1 and 9.4%, and reduced aluminum saturation by 7.2 and 9.4%. Improving chemical properties of acidic soil due to liming improved peanut growth. The content of Al, Fe and Mn in the shoot was high, but no visual toxicity symptoms in leaves.

Lime with dolomite increased number of filled pods, pods filling, and pods yield. Dolomite application at a dose equivalent to 0.5 x exchangeable Al was optimal in improving peanut growth, peanut yield and its components grown on acidic soil.

Peanut genotype of G/92088//92088-02-B-2-8-1 and G/92088//92088-02-B-2-8-2 had highest STI values, and they were identified adaptable and

tolerance to acidic dry land with average yield of 2.47 tha^{-1} and 2.62 t ha^{-1} of dry pods and potential yield of 4.05 t ha^{-1} and 3.73 t ha^{-1} of dry pods, respectively.

Adaptation and tolerance of peanuts on acidic soil condition were probably controlled by the buffering mechanisms.

SUGGESTIONS

Peanut genotype of G/92088//92088-02-B-2-8-1 and G/92088//92088-02-B-2-8-2 may be proposed to be released as new peanut varieties adaptive and productive on acidic dry land.

Peanut genotype of IC87123/86680-93-B-75-55-1 showed good individual buffer, and it may be released as a new variety adaptive and productive on non acidic dry land.

Dolomite application at the dose of 0.5 x exchangeable Al may be recommended for soil amelioration for peanut on acidic dry land with pH

of 4.5 to 4.7, exchangeable Al up to 4.0 cmol_ekg⁻¹ and Al saturation up to 48%.

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