RESISTANCE LEVEL OF SOME SOYBEAN (*Glycine max* L. Merr) GENOTYPES TOWARD SALINITY STRESS

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ABSTRACT

Salinity resistance level on soybean which influenced by its genotype is important to be explored.One of the important factors which determine the success of soybean cultivation on saline soil or salt-affected soil is salinity resistance level. Eleven variants or genotypes of soybean were collected from Indonesian Legumes and Tuber Crops Research Institute and were tested on four different electrical conductivity level of soil (0.5 dS/; 5.8 dS/m; 8.4 dS/m; and 12.2 dS/m). Soybeans were planted on pot in green house. Salinity stress will started when plants were on 21 days after planting (DAP). The treatment was watering using some different concentration of sea water for 30 days. Three methodswhich used to determine salinity resistance level of soybean were seed yield reduction level, stress susceptibility index (SSI), and leaf scorch score. Soybean will classified into salinity tolerant genotype group when weight reduction of seed was <66%, leaf scorch score was <2.0 and SSI was <0.95. Results showed that genotypes with 0.5-5.8 dS/mof soil electrical conductivity tolerance were: Wilis, Tanggamus, Gema, LK/3474-403, MLG 3474-991, IAC100/Burangrang//Malabar-10-KP-30-75, MLG 2805-962; genotypes with8.4 dS/m of soil electrical conductivity tolerance were SU-7-1014 and Argomulyo//IAC100-10-KP-40-120; and genotypes with 12.2 dS/m of soil electrical conductivity tolerance were IAC100/Burangrang//Malabar-10-KP-21-50 and Argopuro//IAC100. These results can be used by soybean breeder as a reference in improving salinity resistance level of soybean for further study as anticipation of salt affected soil wide spread.

Key words: Salinity resistance level, genotype, Glycine Max L. merr, *stress susceptibility index, leaf scorch score.*

INTRODUCTION

High salinity level is one of abiotic stress that threaten sustainability of agriculture in countries, including Indonesia. Soil is considered as saline if electrical conductivity number of its saturated paste extract was (ECe) > 4 dS/m (mmho/cm) which equivalent with 40 mM NaCl per liter and less than 15 of exchangeable sodium percentage (ESP) (Gorham, 2007; Marschner, 1985; Sposito, 2008). Salinity stress occurs due to the increasing of salt accumulation in root zone naturally or caused by human activities. Factors which caused salinity stress are salt contained material of soil, sea water intrusion, high salt water irrigation, deforestation, industrial waste pollution, overgrazing, excessive chemical fertilizer use, high evapotranspiration, and global warming (Yadav et al, 2011; Dajic, 2006).

Food and Agriculture Organization (FAO) and Nutrition Management Service (2008) estimated that more than 800 million ha or more than 6% of land in earth is salt-affected (saline and sodic). These area probably will increase every year. Area in Indonesia was estimated about 440.300 ha as saline area with 304.000 ha slightly saline and 140.300 ha saline (Rachman et al., 2007). Tsunami in 2004 destroyed more than 120.000 ha of Aceh agricultural areawith soil electrical conductivity of 2-40 dS/m (Rachman et al., 2008). Sea water intrusion in the North Beach of Indramayu, West Java has caused the increasing of ECe in rice field from 1.11 to 17.40 dS/m with distance 0.5 – 5 km from coastal line (Erfandi and Rachman, 2011).

Soybean is moderate salt sensitive crop with 5.0 dS/m of salinity threshold in 7.5 dS/m of salinity and it has 50% yield potential (Chinusamy et al., 2005; Katerji et al., 2003; Landon, 1984). Salinity stress has bad effect on every phase of plant growth, it causes fast leaves senescence which decrease harvest yield (Flowers et al., 2010). High salinity affect plant growth by disturbing physiological and biochemical process such as osmotic adjustment, Cl^- and Na^+ toxicity, nutrient imbalance because inhibition ofnutrition absorption, imbalance of K^+/Na^+ or Ca^{2+}/Na^+ ion ratio,photosynthesis, accumulation of certain chemical compounds (soluble sugar, proteins, amino acids, amides, quaternary ammonium compounds, polyamines, polyols, and antioxidants) (Ashraf and Harris, 2004; Ashraf, 2004).

Salinity resistance is the ability of plant to grow and pass its life cycle in salinity stress. Plant mechanisms for survive in salinity stress are by three level of tolerances. First tolerance is tissue tolerance, leaves accumulate more salt but compartmentalized it inside cell (especially vacuole) also optimized ion transportation, proton pump and synthesis of dissolved substance. Second tolerance is osmotic tolerance by minimizing or inhibited canopy growth which related to unknowing sensing and signal mechanism. Third tolerance is by ion exclution, such as Na^+ and Cl^- transportation especially in root to prevent Na^+ and Cl^- become toxic to leaves in high concentration. It may retrieve ion Na^+ from xylem, ion compartment in vacuoles of cortical cells, and ions efflux back to soil, stabilize water in canopy, accumulation of dissolved saccharide,protein, and amino acid, also osmotic adjustment of ion K^+ and Ca^+ (Abd El-Samad and Shaddad, 1997; Roy et al., 2014).

Salinity tolerance can be measured by measurement of yield, leaf chlorophyll content, with tolerance limit of 50% (EC_{50}) from germination percentage, dry weight of root and canopy, green leaves number and area, tiller capacity, senescence leaves number, and yield (Hussain et al., 2013; Maas and Hofman, 1977; Wahid et al., 1997). Another parameter that can be used is leaf chlorosis score or visual of foliar symptoms, Na^+ and Cl^- accumulation in leaves and roots, ion N,K^+,Na^+ level in seeds, also emergence and soybean seedling growth (Dong lee et al., 2008; Mohamed and Kramany, 2005; Pantalone et al., 1997; Valencia et al., 2008; Wang and Shanon, 1999).

Improvement of salt tolerance in soybean and increasing its productivity are goals of legumes breeding programs. Many methods have been used to identify plant genotypes tolerance to environmental stresses, for example is salt stress. Mathematical models can be used to comparing results of seed yield in both of stress and non-stress condition of. Loss of seed yield in both of stress and non-stress condition defined stress tolerance (TOL) using Stress Tolerance Index (STI), Geometric Mean Production (GMP), Stress Intensity (SI), and mean productivity (MP) (Fernandez, 1992; Fischer and Maurer, 1978; Mccaig and Clarke, 1982; Rossielle and Hamblin, 1981). Direct selection method is based on high yield and high salinity tolerance. The more decreasing of yield percentage, the more sensitive genotype toward stress condition (Nageswara Rao et al., 1989).

Salinity stress tolerance level of soybean genotypes need to be identified to get information about soybean genotypes with high level of salinity stress tolerance. There is no genotypes which tolerance to salinity stress of 82 soybean variants which launched by the Ministry of Agriculture of the Republic of Indonesia until 2015. This study expected to take a contribution in the strategies development on food production maintaining under environmental stress/sub-optimal conditions.

MATERIALS AND METHODS

This study was conducted at greenhouse of Indonesian Legumes and Tuber Crops Research Institute in 2013. Experimental design was complete block randomized design with three replications. This study was using 11 genotypes of soybean, they are Wilis (1), Tanggamus (2), Gema (3), LK/3474-403 (4), SU-7-1014 (5), MLG2805-962 (6), MLG3474-991 (7), IAC100/Burangrang//Malabar-10-KP-21-50 (8), IAC100/Burangrang//Malabar-10-KP-30-75(9), Argomulyo//IAC100–10–KP–40–120(10), Argopuro //IAC100 (11). Four levels of soil salinity made from different watering sea water salinity levels level (0.5 dS/m; 5.8 dS/m; 8.4 dS/m; and 12.2 dS/m). Those soybean were planted on plastic pot with 30 cm of high, and 28 cm of diameter. Each of plastic pot were filled with 6 kg of soil.

Alfisol which used in this study were on 0.93 dS/m of electrical conductivity (ECs) (non saline) with pH 6.5. Chemical of soil contains were 0.88% of organic carbon, 0.14% of total N, 1.51% of organic matter, 0.77 ppm of K, 0.99 Me/100g of Na, 11.24 Me/100g of Ca, 1.16 Me/100 of Mg, and 94.18 Me/100 g of SO_4. Water capacity of field and wilting point were 0.30 and 0.11 g/g. Soil fraction were consisted 20% of sand, 61%of silt, and 19% of clay. Soybean genotypes were obtained from germplasm collection of Indonesian Legumes and Tuber Crops Research Institute. The average of air temperature and relative air humidity during study were 29.6°C and 65.8%.

There are two of soybeans which planted on each plastic pot. Fertilizers which used was compound fertilizers (N:15% P2O5 : 15% , K2O: 15%, S: 10%). Each pot was given 0.85 g of fertilizer which applied after soybean being planted. Salinity stress treatment started when plants were on 3 weeks old after being planted. On 20 days after planting (DAP) soybeans were treated with non-saline water with 0.5 dS/m of electrical conductivity (ECw). Watering was given as much as water loss through transpiration and evaporation which measured using gravimetric method. Soybeans were treated with diluted sea water on 21 DAP. Sea water which used had 56.2 dS/m of ECw then diluted with tap water into 10% (ECw 6,29 dS/m), 15% (ECw 9,67 dS/m), and 20% (ECw 12,84 dS/m) concentrations. After 30 days of watering with saline water, soil electrical conductivity (ECs) levels were: L1 = 0.5 dS/m , L2 = 5.8 dS/m , L3= 8.4 dS/m and L4 = 12.2 dS/m. Plants were watered with water (ECw = 0.5 dS/m) which conducted until final harvesting.

Salt injury was determined for 11 genotypes in each salinity level by monitoring the leaf scorch score. Leaf chlorosis / leaf scorch scoring was based on Pantalone et al. (1997) modification with Dong lee et al. (2008) criteria. Leaf scorch rated from 1 to 5,which 1 means no apparent chlorosis, 2 means slight (25% of leaves shown chlorosis), 3 means moderate (50% of leaves shown chlorosis and some necrosis), 4 means severe chlorosis (75% of the leaves shown chlorosis and severe necrosis); and 5 means dead (leaves shown severe necrosis and withered). The average score of visual poisoning for every genotype and salinity level was calculated with the following formula:

$$\frac{\sum(\text{LSSi})\text{x}(\text{Number of Plant})}{\text{Total number of plant per replication}} \quad (1)$$

LSSi = leaf scorch score.

Soybean genotype assessed as tolerant if leaf scorch score $\leq$ 2.0 and sensitive if score $\geq$ 3.0.Seed yield was determined under non stress and stress conditions. The percentage of yield reduction was calculated with formula as follow:

$$100 \times \left(1 - \frac{\text{Yc}}{\text{Yo}}\right) \quad (2)$$

Yc= Dry seed yield in salinity stress condition; Yo= Dry seed yield in optimal condition (non stress) (Nageswara Rao et al., 1989).

Susceptibility Index (SSI) Formula

$$\frac{1 - \text{Yc}/\text{Yo}}{1 - \text{Yc}'/\text{Yo}'} \quad (3)$$

Yc' and Yo' are average yield of all plant genotypes in salinity stress condition and non-stress (Fisher and Maurer, 1978).

Seed yield and visual symptoms data was analyzed with analysis of variance (ANOVA) according to randomized complete block design. Means of treatments data were compared using Duncan's Multiple-Range Test (DMRT) at $P \leq 0.05$. Statistical analysis was performed using MSTAT-C microcomputer program (MSTATC,1990).

RESULT

Visual symptoms because of salt stress

Salinity stress significantly affected on leaf chlorosis score and seed yield. The increasing of soil salinity will increase leaf scorch scores in all soybean genotypes at 42 Days After Application (DAA) (Table 1). At the highest levels of soil electrical conductivity (12.2 dS /m) Argopuro//IAC100 and IAC100/Burangrang//Malabar-10-KP-21-50 soybean genotypes had score less than 2.0 (slight symptoms) compared to other genotypes which had score above 3.0 (moderate symptoms up dead plant). All of the soybean genotypes showed very mild symptoms and their leaves did not shown visual symptoms of salt toxicity until the harvesting time (Figure 1). Soybean genotypes can be classified according to their soil salinity level. Gema genotype was tolerance to 0.5-5.8 dS/m of soil electrical conductivity. Wilis, Tanggamus, LK/3474-403, MLG 2805-962, MLG 3474-991, IAC100/Burangrang//Malabar-10-KP-30-75 genotypes were tolerance in between 5.8-8.4 dS/m of soil electrical conductivity. SU-7-1014 and Argomulyo//IAC100-10-KP-40-120 genotypes were tolerance to 8.4 dS/m of soil electrical conductivity. IAC100/Burangrang//Malabar-10-KP-21-50 and Argopuro //IAC100 genotypes were tolerance to 12.2 dS/m of soil electrical conductivity.

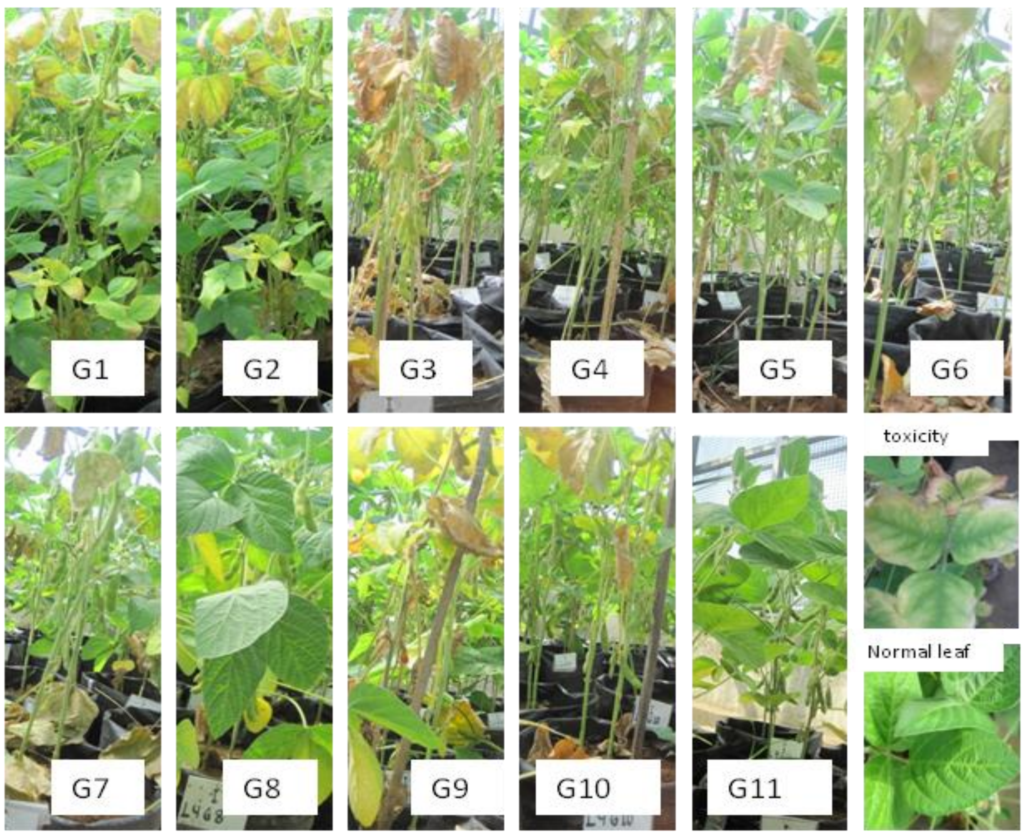

Figure 1. Visual symptoms of 11 soybean genotypes at 12.2 dS/m after 42 days of salinity treatments. (G1) Wilis, (G2) Tanggamus, (G3) Gema, (G4) LK/3474-403, (G5) SU-7-1014, (G6) MLG 2805-962, (G7) MLG 3474-991, (G8) IAC100/Burangrang//Malabar 10-KP-21-50, (G9) IAC100/Burangrang//Malabar-10-KP-30-75, (G10) Argomulyo//IAC100-10-KP-40-120 and (G11)Argopuro//IAC100.

Yield and Seed Weight Reduction

The increasing of salinity caused the decreasing ofobtained seed weight from each plant at all soybean genotypes (Table 2). At the highest levels of soil electrical conductivity (12.2 dS/m) three genotypes : IAC100/ Burangrang//Malabar-10-KP-21-50, IAC100/ Burangrang //Malabar-10-KP-30-75, Argomulyo//IAC100-10-KP-40-120 and Argopuro//IAC100 produced heavier seed than the other genotypes (Wilis, Tanggamus, Gema, LK/3474-403, SU-7-1014, MLG2805-962, and MLG3474-991). The increasing of soil salinity increased the number of empty pods per plant (Table 3). At the highest levels of soil salinity (ECs 12.2 dS/m) genotypes of IAC100/ Burangrang//Malabar-10-KP-21-50, Argopuro//IAC100 and Argomulyo//IAC100-10-KP-40-120 had fewer empty pods

(0-3 empty pods per plant), while Wilis and Tanggamus genotypes had more empty pods (8-9 pods per plant).

Seed weight reduction of LK/3474-403 and MLG 3474-991 genotypes at 5.8 dS/m of soil electrical conductivity was 56.6% (compared with control 0.5 dS/m). Other genotypes had smaller seed weight reduction which ranged from 25.6-47.4%. Genotypes : SU-7-1014, IAC100 /Burangrang//Malabar-10-KP-21-50,Argomulyo//IAC100-10-KP-40-120, and Argopuro//IAC100 had seed weight reduction<56%, while other genotypes had seed weight reduction 71-89%. At the level of the highest soil electrical conductivity (12.2 dS/m), there are two genotypes with seed weight reduction less than 67%, they were IAC100/Burangrang//Malabar-10-KP-21-50 and Argopuro //IAC100. Other genotypes had reduction of seed weight 73-100 %.

Table 1. Leaf scorch score of soybean genotypes in different level of soil salinity after 42 days stress.

Genotype	Leaf scorch score at soil electrical conductivity			
	0.5 dS/m	5.8 dS/m	8.4 dS/m	12.2 dS/m
Wilis	1.00 k	1.43 i-k	2.03 e-i	3.40 bc
Tanggamus	1.00 k	1.77 f-j	3.07 cd	3.83 ab
Gema	1.00 k	2.20 e-h	3.83 ab	4.33 a
LK/3474-403	1.00 k	1.87 f-j	3.40 bc	4.00 ab
SU-7-1014	1.00 k	1.53 h-k	1.57 g-k	3.40 bc
MLG 2805-962	1.00 k	1.33 i-k	2.43 d-f	4.00 ab
MLG 3474-991	1.00 k	1.33 i-k	2.60 de	4.00 ab
IAC100/Burangrang//Malabar -10- KP-21-50	1.00 k	1.17 jk	1.33 i-k	1.87 f-j
IAC100/Burangrang//Malabar -10- KP-30-75	1.00 k	1.30 jk	2.26 e-g	4.23 a
Argomulyo//IAC100-10-KP-40-120	1.00 k	1.17 jk	1.83 f-j	3.67 a-c
Argopuro//IAC100	1.00 k	1.00 k	1.23 jk	1.80 f-j

Means followed by the same letter which not significantly difference in level of 5% of DMRT test; notation a-d is in agreement with letter in alphabetic order: abcd.

Table 2. Seed dry weight of eleven soybean genotypes in different level of soil salinity.

Genotype	Seed dry weight per plant (g) at soil electrical conductivity			
	0.5 dS/m	5.8 dS/m	8.4 dS/m	12.2 dS/m
Wilis	8.7 a	5.4 d-f	2.1 l-p	0.6 qr
Tanggamus	7.4 a-c	4.5 e-h	0.8 p-r	0.0 r
Gema	7.6 ab	4.0 f-i	2.2 k-p	1.1 o-r
LK/3474-403	8.3 ab	3.6 h-k	0.6 qr	0.3 r
SU-7-1014	8.3 ab	5.7 de	4.0 f-i	1.4 n-r
MLG 2805-962	7.4 a-c	4.1 f-i	1.7 m-q	0.9 p-r
MLG 3474-991	7.6 ab	3.3 h-l	1.7 m-q	0.7 qr
IAC100/Burangrang//Malabar-10-KP-21-50	7.1 bc	5.2 d-g	3.4 h-l	2.4 j-o
IAC100/Burangrang//Malabar-10-KP-30-75	8.7 a	5.2 d-f	2.7 i-n	1.7 m-q
Argomulyo//IAC100-10-KP-40-120	7.9 ab	5.8 de	3.5 h-l	2.1 l-p
Argopuro//IAC100	8.2 ab	6.1 cd	3.8 g-j	2.8 i-m

Means followed by the same letter which not significantly difference in level of 5% of DMRTtest; notation a-d is in agreement with letter in alphabetic order: abcd.

Table 3. Empty pods number of eleven soybean genotypes in different level of soil salinity.

Genotype	Number of empty pods per plant at several level of soil electrical conductivity			
	0.5 dS/m	5.8 dS/m	8.4 dS/m	12.2 dS/m
Wilis	0.3 l	2.9 f-l	2.7 f-l	8.4 b-d
Tanggamus	0.2 l	1.9 h-l	12.3 a	9.6 a-c
Gema	0.1 l	1.2 i-l	1.9 h-l	4.8 e-i
LK/3474-403	0.4 l	1.3 i-l	11.0 ab	6.8 c-e
SU-7-1014	1.0 kl	1.4 i-l	1.4 i-l	6.1 d-f
MLG 2805-962	0.8 l	1.1 i-l	4.7 e-j	5.7 d-g
MLG 3474-991	0.1 l	1.7 i-l	4.6 e-k	6.2 d-f
IAC100/Burangrang//Malabar-10-KP-21-50	0.3 l	0.2 l	0.3 l	0.6 l
IAC100/Burangrang//Malabar-10-KP-30-75	0.3 l	0.3 l	1.5 i-l	5.4 d-h
Argomulyo//IAC100-10-KP-40-120	2.1 h-l	1.7 i-l	3.7 e-l	3.8 e-l
Argopuro//IAC100	0.4 l	0.3 l	1.7 i-l	2.3 g-l

Means followed by the same letter which not significantly difference in level of 5% of DMRTtest; notation a-d is in agreement with letter in alphabetic order: abcd.

Table 4. Seed weight and itsreduction of various soybean genotypes in different level of soil salinity.

Genotype	Seeddry weight (g) in control treatment (0.5 dS/m)	Seed weight reduction (%) against control treatment (0.5 dS/m)		
		5.8 dS/m	8.4 dS/m	12.2 dS/m
Wilis	8.7	37.9	75.9	93.1
Tanggamus	7.4	39.2	89.2	100.0
Gema	7.6	47.4	71.1	85.5
LK/3474-403	8.3	56.6	92.8	96.4
SU-7-1014	8.3	31.3	51.8	83.1
MLG 2805-962	7.4	44.6	77.0	87.8
MLG 3474-991	7.6	56.6	77.6	90.8
IAC100/Burangrang//Malabar-10-KP-21-50	7.1	26.8	52.1	66.2
IAC100/Burangrang//Malabar-10-KP-30-75	8.7	40.2	69.0	80.5
Argomulyo//IAC100-10-KP-40-120	7.9	26.6	55.7	73.4
Argopuro//IAC100	8.2	25.6	53.7	65.9

Influence of Salinity on Stress Susceptibilty Index

Stress Susceptibility Index (SSI) is mathematical model which used to compare genotypes sensitivity in environmental stress conditions. SSI in this study was calculated from weight of dry seed that obtained from optimal conditions compared with weight of dry seed in salinity stress conditions. SSI 2 was calculated from the seed yield of control condition/non stress with soil electrical conductivity of 0.5 dS/m (L1) which compared with seed weight from 5.8 dS/m (L2) of soil electrical conductivity. SSI 3 was calculated from seed yield in 8.4 dS/m (L3) of soil electrical conductivity, and SSI 4 obtained seed weight from 12.2 dS/m (L4) of soil electrical conductivity. SSI calculation results at each level of soil electrical conductivity shown in (Table 5). Soil electrical conductivity in each soybean genotypes in this study were increased (Table 4). Based on the criteria of Clarke et al. (1984) Stress Susceptibility Index which stated that SSI <0.95 means tolerance, SSI > 0.95 to 1.10 means moderate tolerance, and SSI>1.10 means sensitive/intolerance, soybean genotypes in this study can be grouped into 3 groups. First group genotypes are tolerance in up to 12.2dS/m of soil electrical conductivity (IAC100/ Burangrang//Malabar-10-KP-21-50, Argomulyo//IAC100-10-KP- 40-120 and Argopuro//IAC100 genotypes). Second group genotypes are tolerance in up to 8.4dS/m of soil electrical conductivity (SU-7-1014). Third group is genotypes which tolerance in up to 5.8dS/m of soil electrical conductivity (Wilis, Tanggamus, Gema, MLG2805-962, IAC100/Burangrang//Malabar-10-KP-30-75, LK /3474-403, and MLG3474-991).

Table 5. Stress susceptibility index (SSI) of 11 soybean genotypes under different soil electrical conductivity levels

Genotype	SSI 2	SSI 3	SSI 4
Wilis	0.98	1.09	1.11
Tanggamus	1.11	1.28	1.19
Gema	1.18	1.02	1.02
LK/3474-403	1.41	1.33	1.15
SU-7-1014	0.78	0.74	0.99
MLG 2805-962	1.15	1.11	1.05
MLG 3474-991	1.41	1.12	1.08
IAC100/Burangrang//Malabar-10-KP-21-50	0.67	0.75	0.79
IAC100/Burangrang//Malabar-10-KP-30-75	1.01	0.99	0.96
Argomulyo//IAC100-10-KP-40-120	0.66	0.80	0.87
Argopuro//IAC100	0.64	0.77	0.78

SSI 2=Stress susceptibility index (SSI) in soil electrical conductivity of 5.8 dS/m, SSI 3= SSI in soil electrical conductivity of 8.4 dS/m, SSI 4= (SSI) in soil electrical conductivity of 12.2 dS/m

DISCUSSION

Eleven soybean genotypes were evaluated at four levels of soil conductivity (0.5, 5.8, 8.4, and 12.2 dS/m) and shown different resistance level in some different level of soil conductivity. The increasing of soil salinity level harmed growth of all soybean genotypes, one the parameters is leaf scorch. Leaf scorch begun at 21 days after salinity treatment. Low score of leaf scorch indicates that soybean genotypes was tolerant to salinity stress. Leaf scorch symptoms were leaves turned into yellow with curly edges and burning, eventually fall out. The increasing of in Na and Cl ions accumulation cause toxic effects, it will induce leave cells necrosis and leaf edges curl(Levitt, 1980).Genotypes which tolerant its leaves will remain green. IAC100/Burangrang//Malabar-10-KP-21-50 and Argopuro//IAC100 genotypes were tolerant in up to highest salinity stress treatment (ECs 12.2 dS/m).This means that both of IAC100/Burangrang//Malabar-10-KP-21-50 and Argopuro//IAC100 genotypes have potential as tolerant genotypes.Similar results were obtained by Dong-lee et al. (2008) also Yang and Blanchar (1993) salinity stress tolerant genotype shown less visual symptoms and Cl content than sensitive genotypes. Leaf damage is related to Cl concentration on leaf tissue (Abel and Mackenzie, 1964). High salt accumulation on leaf tissue caused necrosis and decreased photosynthesis level which disturbed plant growth (Munns, 2002).

Table 6. The level of resistance of 11 soybean genotypes against the level of soil electrical conductivity based onseed yield reduction, stress susceptibility index and leaf scorch score

Genotype	Seed yield reduction	Stress susceptibility index	Leaf scorch score
	Tolerance up to soil electrical conductivity		
Wilis	5.8 dS/m	5.8 dS/m	5.8 dS/m
Tanggamus	5.8 dS/m	5.8 dS/m	5.8 dS/m
Gema	5.8 dS/m	5.8 dS/m	5.8 dS/m
LK/3474-403	5.8 dS/m	5.8 dS/m	5.8 dS/m
MLG 2805-962	5.8 dS/m	5.8 dS/m	5.8 dS/m
MLG 3474-991	5.8 dS/m	5.8 dS/m	5.8 dS/m
IAC100/Burangrang//Malabar-10-KP-30-75	5.8 dS/m	5.8 dS/m	5.8 dS/m
SU-7-1014	8.4 dS/m	8.4 dS/m	8.4 dS/m
Argomulyo//IAC100-10-KP-40-120	8.4 dS/m	12.2 dS/m	8.4 dS/m
IAC100/Burangrang//Malabar-10-KP-21-50	12.2 dS/m	12.2 dS/m	12.2 dS/m
Argopuro//IAC100	12.2 dS/m	12.2 dS/m	12.2 dS/m

Growth and metabolism disturbance during salinity stress will influence growth phases of soybean plant which different in each genotypes. Disturbance on photosynthesis affected on pod formation. Soybean genotypes which planted on high salinity stress had more empty pods. The increasing of salinity stress affected on plant growth and chlorophyll destruction which disturbed the formation and development of seed pod, this condition decreased seed yield (Taufiq and Purwaningrahayu, 2012). Seed yield reduction in some soybean cultivars and *Vigna unguiculata* L. Walp due to salinity stress reported by (Ghassemi-Gholezani et al., 2011; Ghassemi-Gholezani et al., 2009; Jacob and Francis, 2015). It was related to the low leaves chlorophyll index and photosystem II activity. Salinity cause osmotic stress in root cells which limited the absorption of some dissolved mineral and ion.

This study used three selection criteria to classify salinity tolerance level in soybean genotypes, there were yield loss/seed yield reduction, stress susceptibility index (SSI), and leaf scorch score. Leaf scorch scores is easily observed parameter that represents salt toxicity in vegetative phase. While its result is not represent salt toxicity if plant already on generative phase. Other researchers had classified broadbean, durum wheat, corn, potato, soybean, sugar beet, sun flower, and tomato as plant which tolerant on salinity stress level based on result study of soil electrical conductivity, relative evapotranspiration, and water stress day index (Katerji et al., 2001). Visual toxicity on soybean leaves caused by chloride accumulation (Valencia et al., 2008; Dong lee et al., 2008). This parameter can be used to identify salinity stress tolerance level on groundnut (Singh et al., 2008), green gram (Ahmed, 2009) and wheat genotypes/lines (Sordouie-Nasab et al., 2014).

Yield reduction percentage which compared with optimal condition can be used as consideration to assess tolerance genotypes. Plant with 66% of yield reduction classified as tolerance genotype. Seed yield is an important variable in plant breeding programs with resistance in environmental stress. Based on the results it can be suggested that genotypes with tolerance to salinity level high gives hope for development as salinity tolerant varieties or as parents in plant breeding programs to produce soybean varieties tolerant of salinity. Furthermore, resistance level of soybean genotypes in different salinity level information is useful to adjust level of soil salinity in field.

Based on the percentage of seed yield reduction, stress susceptibility index and leaf scorch score, eleven soybean genotypes were classified into tolerance toward soil electrical conductivity up to 5.8 dS/m (Wilis, Tanggamus, Gema, LK/3474-403, MLG3474-991, IAC100/Burangrang //Malabar-10-KP-30-75, and MLG2805-962), tolerance toward soil electrical conductivity up to 8.4 dS/m (SU-7-1014 and Argomulyo//IAC100-10-KP-40-120), and genotypes tolerance toward soil electrical conductivity up to 12.2 dS/m (IAC100/Burangrang//Malabar-10-KP-21-50 and Argopuro//IAC100). Plant breeder can utilize the research result as a reference to assemble soybean varieties with tolerance toward salinity and high yield. The assemble of tolerant soybean varieties toward high salt level is one of strategies to overcome the spread of saline land.

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