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Drought Resistance Selection on Soybean Somaclonal Variants

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ABSTRACT

Results of *in vitro* selection for tolerant to Poly Ethylene Glycol (PEG) on soybean do not always give the appearance of dry resistant when tested in the field. This research was conducted to evaluate the yield potential of 20 soma clone variants resulted from *in vitro* selection when planted under drought stress condition in the field. Field test was done by planting the variants, the parents, and check varieties in the field during dry season, and was irrigated once a week for non-stress and once two weeks for drought stress treatment. Split-plot design arranged in a factorial (2 x 28) with three replications was used in this research. Observations were done on yield and yield components. Analysis of variance was used to see the difference between treatments and then it was continued being analysed using Honestly Significant Difference test to find out the best treatments. There was no interaction between genotype and drought stress on seed yield. Different genotypes showed a significantly difference on this character. It indicated that the yield potential of selected variants was not affected by the drought stress treatment. Result of this research is 10 variants having the potential to be developed as drought resistant genotypes. However, these ten potential genotypes need to be further tested in field trials to find out the yield adaptability and stability and their resistance to drought stress.
Keywords: soma clonal variant, *in vitro* selection, drought stress, soybean, selection

INTRODUCTION

National soybean production is currently experiencing a very unfortunate setback, which only 45 % of domestic demands can be covered by the Indonesian soybean farmers. There are some obstacles decreasing the soybean productivity in Indonesia. One of them is drought stress. Soybeans are often planted on dry land or after the main food crops at the end of the rainy season, so that water availability is often becoming a limiting factor. Directorate General of Food Crops, Ministry of Agriculture of Indonesia since 2003, seeking increased productivity and expansion of land cultivated through Bangkit Kedelai Program to reduce soybean imports. The expansion of planting areas directed towards rain fed (non-irrigation), and dry land has not been used optimally. While the development of high yielding varieties tolerant of environmental stress and is expected to make a real contribution to the improvement of soybean production.

Varieties play an important role to improve the productivity of soybean. Therefore, productivity improvement programs need to be supported by the development of superior varieties of high yielding and tolerant to environmental stress. This will assist the development of soybean in the area that has problems of water availability on a specific planting period. Although drought stress is one factor limiting soybean production, but drought tolerant soybean varieties are not many which have been released. From 1000 soybean germplasm selection number in Indonesia, only around 62 varieties have been cultivated by farmers [1]. However from this amount there is no information about the level of tolerance of drought stress. The result of screening on 30 varieties of soybeans at germination and vegetative stages in the greenhouse and *in vitro* in the laboratory, which has been done previously, showed that most soybean varieties tested were classified in the group of drought sensitive. Varieties that show good tolerance and drought stress are Tidar and Dieng [2].

Previous research has been conducted in order to obtain high yielding and tolerant soybean varieties to drought stress through the induction of soma clonal variation and selection *in vitro* for tolerance to drought stress on soybean somatic embryo population on PEG selective media. The soma clones results of *in vitro* selection are 2B17, 2S3, 2S7, 2S13, 2S14 resulted of *in vitro* selection of strains MLG 2999; soma clonal variants of 3B6, 3B7, 3B14, 3B17, 3B18, 3B20, 3S7, 3SE2, 3SE4, resulted of *in vitro* selection from strain B3731; and soma clonal variants of 8B3, 8B4, 8B5, 8B6, 8B7 and 8B12 resulted of *in vitro* selection from the strains of MSC 8606 [3]. However, the yield and the level of tolerance to drought stress in the field of these variants are unknown yet. Therefore it is necessary for field screening of these variants to find out the yield and resistance to drought stress in the field.

MATERIALS AND METHODS

The materials used in this research were 20 variants of *in vitro* selection on PEG media, i.e. 2B17, 2S3, 2S7, 2S13, 2S14 3B6, 3B7, 3B14, 3B17, 3B18, 3B20, 3S7, 3SE2, 3SE4, 8B3, 8B4, 8B5, 8B6, 8B7 and 8B12

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derived from the *in vitro* selection of strains MLG 2999, MLG 3731 and MSC 8606 obtained from the results of previous research [3]. For comparison, we used the clones and varieties tolerant of MLG 2805, Dieng and Tidar and the sensitive clones and varieties of MSC 9019, Burangrang and Tambora. This research was conducted from June until September 2009 in the experimental field of the Faculty of Agriculture, University of Brawijaya, which is located in Jatikerto village, Kromengan district, Malang regency, East Java, Indonesia, with elevation of 303 asl, and the type of soil is alfisol.

The design used in these experiments was split plot design which was arranged in a factorial (2x28) with three replicates. The main plot was irrigation treatment, and the sub plot was soybean variant consisted of 20 variants. The parameters observed included yield and yield components. To see the differences in variables observed among the treatments, it was then performed the analysis of variance (ANOVA) followed by Tukey Significance test or Honestly Significant Difference Test.

Drought resistance selection is done through field testing with the planting of selected variants resulted from *in vitro* selection and their parents and check varieties in the rice field during the dry season. Testing is done by the irrigation once every week for non-stress environment and the irrigation once every two weeks for drought treatment. Every variant in this experiment was planted in separate plots with the size of 3 x 2 m of each plot, with planting distance of 30 x 20 cm. Each variant was planted 50 seeds per plot and was repeated three times for each variant.

RESULTS AND DISCUSSION

Observations on seed yield showed that there was no interaction between variant treatment and drought stress. While variant treatment gave a highly significant effect on seed yield.

Table 1. Seed yield average (ku.ha^{-1}) of 20 soybean drought resistant variants derived from *in vitro* selection

No	Variant	Seed Yield (Ku.Ha^{-1})	Notation
1	B3731	16.07	efghi
2	3B6	11.43	abcde
3	3B7	16.38	fghi
4	3B14	13.50	bcdefgh
5	3B17	12.96	abcdefg
6	3B18	12.69	abcdefg
7	3B20	16.39	fghi
8	3S7	11.78	abcdef
9	**3SE2**	**17.75**	hij
10	3SE4	12.95	abcdefg
11	MSC8606 (Parent)	9.32	ab
12	8B3	11.22	abcd
13	8B4	13.90	bcdefgh
14	**8B5**	**8.48**	a
15	8B6	17.40	ghi
16	8B12	10.33	abc
17	MLG2999 (Parent)	17.25	ghi
18	2S3	14.10	cdefghi
19	2S7	11.36	abcde
20	2S13	11.51	abcde
21	2S14	13.90	bcdefgh
22	2B17	13.70	bcdefgh
Check Varieties and Clones			
23	MLG2805	18.79	ij
24	MSC9019	15.89	defghi
25	Burangrang	13.77	bcdefgh
26	Dieng	22.38	j
27	Tambora	16.27	fghi
28	Tidar	14.85	cdefghi
HSD 5 %		4.72	

Note: Values with the same letter in a column indicate that there is no significantly different based on HSD 5 %.

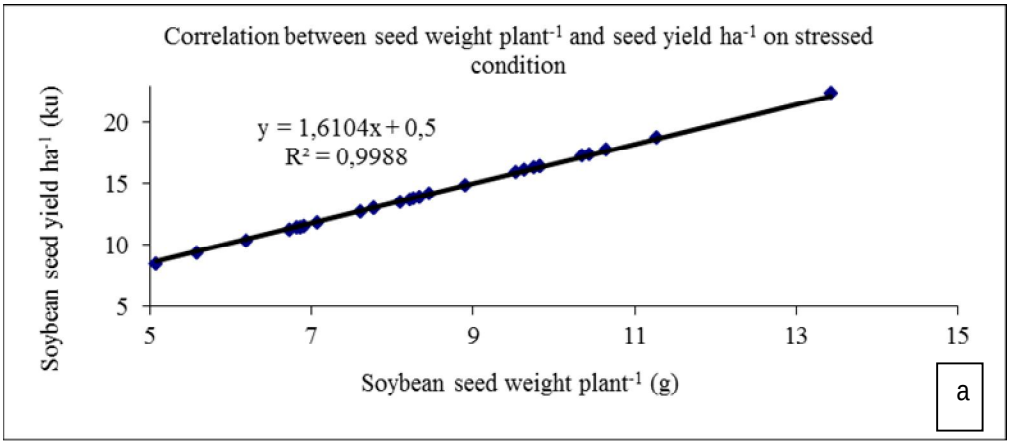
This shows that the result of selection *in vitro* to produce 20 variants which were then tested for resistance to drought in the field has been proven that these 20 variants were not affected by drought treatments. It is indicated by the statistically same result obtained between the normal irrigation and drought stress. Based on the analysis of variance, it can also be ascertained that the difference in seed yield.hectare^{-1} among the 20 variants tested were caused by differences in genotypes of each variant. The average value of seed yield.hectare^{-1} in 20 variants that were planted in drought conditions were ranging from 8.48 to17.75 kuintal.ha^{-1} (1 kuintal = 100 kg), while the average yield on national varieties used for comparison ranged from 13.77 to 22.38 kuintal.ha^{-1} (1 kuintal = 100 kg) (Table 1).

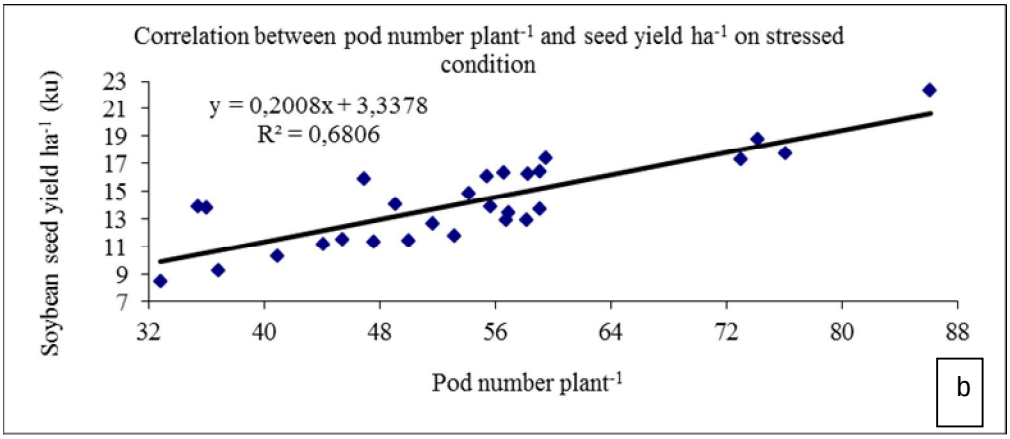
Based on the field tests of the 20 variants selected *in vitro* in this study, it can be obtained 10 variants which are recommended for further drought resistance test, i.e., 3SE2, 8B6, 3B20, 3B7, 2S3, 2S14, 8B4, 2B17, 3B14 and 3B17 (Table 2). This is based on test results comparing the mean value presented in table 1, which showed that 10 variants provides an average seed yield.hectare^{-1} which is not statistically different with the yield of check varieties or clones of Dieng, MLG 2805 and Tambora with an average seed yield.hectare^{-1} is the highest.

Table 2. Average seed yield of the highest seed yielded soybean variants resulted from *in vitro* selection to drought resistance

No	Soma clonal Variants	Seed Yield (Ku.Ha^{-1})
1	3SE2	17,75
2	8B6	17,40
3	3B20	16,39
4	3B7	16,38
5	2S3	14,10
6	2S14	13,90
7	8B4	13,90
8	2B17	13,70
9	3B14	13,50
10	3B17	12,96

Results of correlation analysis performed on several yield components (seed weight.plant^{-1}, number of pods.plant^{-1} and 100 seed weight) of soybean seed yield.hectare^{-1} showed a linear regression relationship for seed weight.plant^{-1} (r = 0.99) (figure 1a) and number of pods.plant^{-1} (r = 0.83) (figure 1b) for seed yield.hectare^{-1}, whereas the correlation between 100 seed weight and seed yield.hectare^{-1} showed a quadratic regression relationship (r = 0.12) (figure 1c).





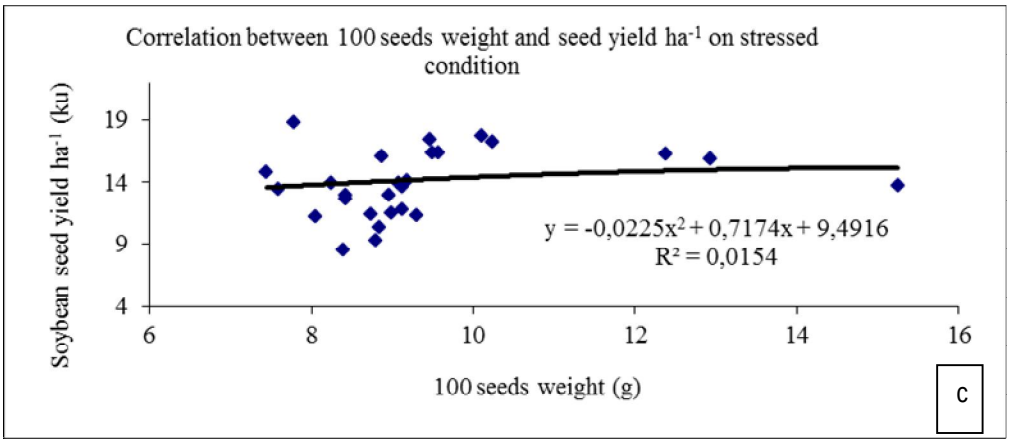


Figure 1 Correlation between yield.ha^{-1} and yield components: seed weight.plant^{-1} (a), pod number.plant^{-1} (b), and 100 seed weight (c).

This indicates that the seed yield.hectare^{-1} is more significantly influenced by seed weight.plant^{-1} and number of pods.plant^{-1} in the form of linear regression relationships. In other words, an increase in soybean seed weight.plant^{-1} and pod number.plant^{-1} will be followed by increasing of soybean seed yield.hectare^{-1} linearly. While the weight of 100 seeds of soybeans will only increase seed yield.hectare^{-1} up to a certain point then it will reduce seed yield in case of further improvements on the weight of 100 seeds.

Soybean yield is more determined by two components, i.e., the number of grains per land area and weight of individual seeds [4]. Since the number of seeds.pod^{-1} is genetically controlled, then the number of seeds depends on the number of pods.plant^{-1}, which is the number of pods is determined by the amount of flower converted into pods and maintained until harvest [5]. It is mentioned that the component output of the number of pods and weight of individual seeds were genetically controlled [6] and influenced by environmental conditions that cause complete failure of expression during reproductive development [7].

Thus, yield components such as seed weight.plant^{-1} and number of pods.plant^{-1} on variants soybean selected have also been observed other than seed yield.hectare^{-1} in testing for resistance to drought on further tests.

CONCLUSION

There was variability observed in the yield of soybean variants tested, which were derived from *in vitro* selection under drought stress condition. Variants yield were lower than the yield of check variety of Dieng. However, there was indication that some variants had higher yield than its parent. It is obtained 10 variants which potentially have the characteristics of drought resistance and high yield to be tested further in the field.

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