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Selection of soybean genotypes by seed size and its prospects for industrial raw material in Indonesia

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Abstract

The main utilization of soybean with large seed size in Indonesia is for industrial (tempeh) raw material. The aim of this research was to select soybean genotypes based on seed size and yield. Experiment was conducted at Jambegede Research Station (Malang), from March until June 2014 using 150 soybean genotypes. The selection revealed the existence of variability among genotypes. A simultaneously selection successfully obtained eight genotypes with yield >2.53 t/ha and seed size > 15.8 g/100 seeds. These selected genotypes prospective for source of tempeh material and need to examine its yield recovery, nutrition (protein) and sensory characteristic.

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Keywords: soybean; selection; high yield; large seed size; tempeh

Introduction

Soybean is an important commodity in Indonesia. From the total supply of soybeans in Indonesia, both imported and domestic, 70% is for tofu and tempeh and 30% for other food needs [1]. Tempe is essential menu in the daily consumption of most Indonesian society,

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especially as a source inexpensive protein. Large seeded soybean are widely used as raw material for tempeh.

Since 1918, Indonesian Agency for Agricultural Research and Development (IAARD) have released 78 soybean improved varieties, and several of them have large seed size (14-17g/100 seeds). The large seed size soybean varieties (e.g. Anjasmoro, Burangrang, Bromo, Argomulyo, and Grobogan) were similar with imported soybeans with an average weight of 16 g/100 seeds and showed similar quality of tempeh (color, aroma, texture, taste) with higher protein content and yield recovery than imported soybean [2,3]. Krisdiana [4] reported that about 93% of tempeh producers preferred large seeded soybean (especially imported soybean) and yellow seed coat because it will produce tempeh with bright colors and large volume. This is reasonable, because according a research by Antarlina et al. [5] concluded that soybean seed size is a factor determinant of the quality of tempeh because positively correlated with weight (r = 0.86 **) and tempeh volume (r = 0.95 **).

Seed-size traits are controlled by multiple genes in soybean, and play an important role in determining seed yield, quality and appearance [6]. Although maximum seed size may be under genetic control, but seed size was determined by environment in the seed filling period [7]. Mathew et al. [8] added that seed size can still be modified by the environment with some internal control moderating the final size of most seeds in all pods.

The opportunity to obtain soybean variety with large seed size is very possible, due to the seed size was determined by the rate of seed growth and duration of dry weight accumulation in seed fraction, which both were genetically controlled and inherited [9,10,11]. A research by Krisnawati [12] had successfully obtained soybean large seed size delivered from crossing using a large seed size parental (>14 g/100 seeds). Cober et al. [13] estimated the heritability for seed size, obtaining moderate to high values 19-56% for seed size, and concluded that an early generation selection was effective due to the high heritability of this trait.

To meet the needs of soybeans, the essential efforts to increase domestic production are through the use of high yielding varieties and appropriate quality seeds. Perry [14] reported that there is a close correlation between seed size and seed nutritional resources, therefore it is expected that an increase in seed size has a positive role in seedling growth and subsequently increasing the seed yield. In favorable germination and growth condition, large seeds will produce larger seedling in compare with small seeds and it can cause to increase the crop

production in the field. The objective of this study was to select soybean genotypes based on seed size and yield.

Materials and methods

Study was conducted in Jambegede Research Station (Malang) from February to May 2014. The type of soil was Entisol Association and Inceptisol, elevation 335 m above sea level, and C3 of Oldeman climate type. The research materials consist of 150 soybean genotypes and using completely block design with two replicates. Grobogan, Anjasmoro, and Argomulyo used as check varieties. Each genotype was planted in 1.2 m x 4.5 m plot size with 40 cm x 15 cm planting distance, two plant/hill. Pests and diseases were controlled optimally. Drainage was applied to maintain optimum soil moisture. Fertilization with 250 kg Phonska/ha + 100 kg SP 36 and 1 t/ha organic fertilizer at planting time.

The data was collected on flowering time (when 50 % of the plant population have been flowering), days to maturity (calculated if 95% of the leaves have turned yellow), plant height (taken from average of 5 randomly sample plants), number of branches (taken from average of 5 randomly sample plants), number of nodes (taken from average of 5 randomly sample plants), number of pods (taken from average of 5 randomly sample plants), 100 seed weight, and seed yield (randomly taken from the seed yield per plot and converted to t/ha).

Result and discussion

Analysis of variance of yield and yield components showed that genotype was significantly affect the flowering time, days to maturity, 100 seed weight, and seed yield. The coefficient of variation value ranged from 1.90% to 34.26% (Table 1).

Seed size was one of essential components which affects the soybean performance and productivity [15,16]. In Indonesia, seed size was divided into three categories: small (< 10 g/100 seeds), medium (10-14 g/100 seeds), and large size (> 14 g/100 seeds). Based on this classification, a grouping of 150 soybean genotypes showed that seed size was dominated by large seed size, and reflected by its average (15.80 g/100 seeds). There were 140 large seed genotypes, seven of medium size, and only three genotypes categorized as small seed size (Figure 1). The check varieties have large seed size, the largest size was Grobogan (18.71 g/100

seeds), followed by Argomulyo (15.49 g/100 seeds) and Anjasmoro (14.65 g/100 seeds), respectively.

Large-sized soybean seeds is desirable trait in tempeh industry to fulfill the community's preference. Shifting preferences of soybean farmers and tempeh industries from seed medium into a large soybean seeded (14 g / 100 seeds), become an important main reason to improve the genetic potential of soybean varieties in Indonesia. Due to the progressively increase of soybean in Indonesia [17], therefore the improvement of soybean genetic potential is may not only in terms of seed size, but also in aspect of yield.

The both of high yielding and large seed size genotypes was an ideal combination. A scatter plot of seed size versus the seed yield was presented in Figure 2. Although most of genotypes were large seeded size, but more than 75% only yielded < 2.5 t/ha. Based on selection on the general mean ($\bar{x}$) and the standard deviation (SD) [18], obtained the limit selection for yield was 2.53 t/ha. Hence, the simultaneously selection on both of large seed size (above the general mean which was > 15.8 g/100 seeds) and high seed yield (>2.53 t/ha) resulted eight selected genotypes. The agronomic characters of those genotypes was presented in Table 2.

The performance of agronomic characters of eight selected soybean genotypes and three check varieties consist of plant height, number of branches/plant, number of nodes/plant, number of pods /plant, flowering time, days to maturity, 100 g seed weight, and yield (Table 2). The range of agronomic characters of eight genotypes: plant height was from 57.65 – 69.53 cm (average of 62.33 cm), number of branches per plant was 2.20 – 4.10 (average of 2.90 branches), range of nodes number per plant from 14.50 – 17.10 nodes (average of 15.60 nodes), range of number of pods per plant was 32.40 – 44.90 pods (average of 38.71 pods), flowering time ranged from 32 – 39 days (average of 34 days), days to maturity from 76 days to 81 days (average of 78 days), 100 seed weight ranged from 15.67 to 18.72 g (average of 16.78 g), and seed yield was from 2.54 t/ha to 2.92 t/ha (average of 2.64 t/ha).

Table 2 showed plant height, number of branches/plant, number of nodes/plant, number of pods /plant, flowering time between selected genotypes with check varieties were varied. Days to maturity of all selected genotypes were categorized as early maturity, except G 511 H/Anjasmoro-1-2 (medium maturity). The earliest maturing genotype was G 511 H/Arg//Arg///Arg///Arg-5-4 (76 days). All the check varieties categorized as early maturing varieties. The comparison of seed size between selected genotypes with check varieties showed

that the seed size of selected were over the two check varieties of Anjasmoro and Argomulyo. Identification from aspect of yield revealed that all selected genotypes produced yield over the all check varieties.

Based on the data that has been presented, this research successfully selected eight soybean genotypes with both of high yielding and large seed size. These selected genotypes prospective for source of tempeh material. Based on the requirements to obtain tempeh with good quality, therefore those genotypes need to examine its yield recovery, nutritional (protein) and sensory evaluation to produce tempeh suitable to consumer preference.

Table 1. Analysis of variance for days to maturity and seed yield of 150 soybean genotypes. 2014.

Parameter	Mean Square		CV (%)
	Replication	Genotype	
Plant height (cm)	917.98016**	122.83229^{ns}	17,03
Number of branches	0.4485333^{ns}	1.0510926^{ns}	34,26
Number of nodes	0.000033^{ns}	17.779013^{ns}	26,44
Number of pod	55.98720^{ns}	100.74768^{ns}	23,28
Flowering time (days)	19.304033*	14.668248**	6,18
Days to maturity (days)	41.813333**	8.691275**	1,90
100 seed weight (g)	1.5943230^{ns}	4.0918322**	5,85
Seed yield (t/ha)	3.25729200**	0.43928466**	19,05

CV = coefficient of variation, * = significant at 1% probability level ($p<0.01$),
** = significant at 5% probability level ($p<0.05$), ns = not significant.

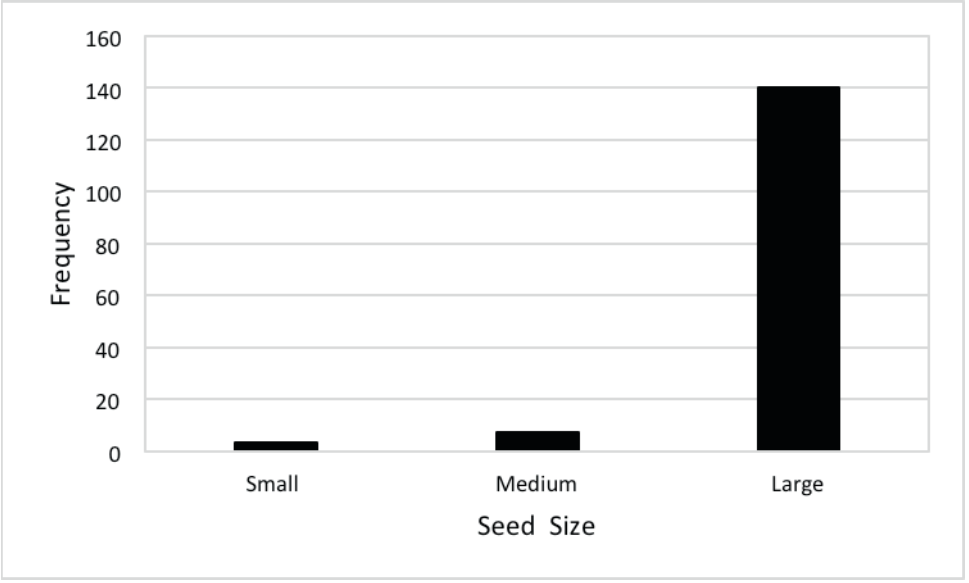

Figure 1. Histogram of seed size of 150 soybean genotypes. 2014.

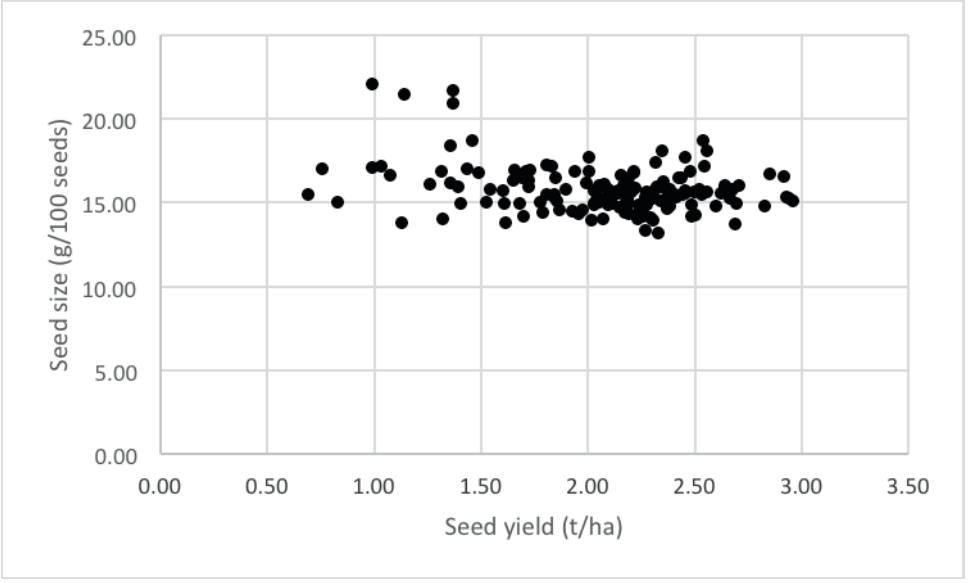

Figure 2. Scatter of seed size vs. seed yield of 150 soybean genotypes. 2014.

Table 2. Agronomic characters from eight soybean genotypes and three check varieties. 2014.

No	Genotype	PH (cm)	NOB	NON	NOP	FT (days)	DTM (days)	SW (g)	Yield (t/ha)
1.	G 511 H/Anjasmoro//Anjasmoro-2-13	64.08	2.90	14.30	38.00	35	78	18.72	2.54
2.	G 511 H/Arg//Arg///Arg///Arg-45-4	58.51	2.40	14.50	33.50	34	78	18.12	2.56
3.	G 511 H/Arg//Arg///Arg///Arg-45-1	69.53	4.10	17.10	40.20	34	78	16.58	2.92
4.	G 511 H/Anjasmoro-1-1	60.73	2.90	16.00	43.20	33	80	15.84	2.68
5.	G 511 H/Arg//Arg///Arg///Arg-5-4	60.78	2.20	14.40	32.40	33	76	17.21	2.55
6.	G 511 H/Arg//Arg///Arg///Arg-22-5	57.65	2.90	15.30	38.00	33	77	16.06	2.64
7.	G 511 H/Arg//Arg///Arg///Arg-5-3	63.93	3.00	16.30	39.50	34	77	16.05	2.71
8.	G 511 H/Anjasmoro-1-2	63.40	2.80	16.90	44.90	39	81	15.67	2.56
	Average	62.33	2.90	15.60	38.71	34	78	16.78	2.64
9.	Argomulyo (check variety)	66.18	2.80	13.70	40.20	36	77	15.49	2.41
10.	Anjasmoro (check variety)	62.65	2.20	15.30	47.10	37	79	14.65	2.37
11.	Grobogan (check variety)	59.81	3.10	13.50	36.50	32	77	18.71	1.46

PH = plant height (cm), NOB = number of branches/plant, NON = number of nodes/plant, NOP= number of pods/plant, FT = flowering time, DTM = days to maturity (days), W = 100 seed weight (g).

Conclusion

Eight soybean genotypes were selected with both of high yielding and large seed size. These selected genotypes provided the prospect source of tempeh material and need to examine its yield recovery, nutrition (protein) and sensory characteristic.

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