Yield performance of several peanut genotypes under two different soil moisture availabilities during plant growth

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Abstract. Peanut is relatively tolerant to drought stress but the pod yield is influenced by soil moisture availability especially during its critical phases. The experiment was objected to study yield response of genotypes and their tolerance to drought stress during generative growth stage. The experiment was conducted at Muneng Research Station, East Java with D3 climate type. The experiment was undertaken during dry season to avoid interference from rains to the treatment. The split-plot design with three replications was applied. The main plot was watering treatment \textit{i.e.} water available during the growing season and water available during vegetative growth (up to 50 DAS). The subplots were 20 peanut genotypes. Weeding, pest and disease controls were intensively undertaken. The results indicated that the average dry pod yield of 20 genotypes under well watered and drought stress treatments were 2.345 t and 1.585 t/ha. Based on MP, GMP, STI, RED, TOL, and SSI it can be concluded that G1 and G12 were genotypes with high yield and drought tolerant but huge yield reduction under water-stressed condition. G8 was drought tolerant genotype with little yield reduction under stress condition. G11 was susceptible to drought with low productivity and low yield reduction under stress condition.

1. Introduction

Peanuts are the main source of fat/oil, protein, and carbohydrate that beneficial to human health. Instead of these three constituents, peanuts are a source of vitamins, minerals, antioxidants, and electrolytes [1]. These facts support the importance of peanuts to Indonesian people as 89\% of available grains in Indonesia has been utilizing for human consumption in various types of product [2]. Improved cultivars in Indonesia generally contain relatively high oil/fat and protein i.e. 31-53\% and 17.0-32.8\% dry weight basis, respectively [3].

Peanut production worldwide is concentrated in Asia (southern, eastern, and south-eastern part) and Africa (western part) where 94.6\% of total harvested areas and 88.7\% of total peanut production is located. The production sites are mostly in developing countries with semi-arid conditions where peanuts mostly are grown under rainfed conditions. In those continents, low and irregular precipitation is common to occur, and therefore prolonged dry condition especially during later parts of the peanut growth phase is the main constraint for low pod yield [4].

Peanut is relatively tolerant to drought stress. Despite of drought tolerant, crop growth and its pod yield are influenced by the availability of soil moisture especially during the critical growth phase for water. Peanuts grown with soil moisture available lower than field capacity along the growing season ultimately had low pods production, number and weight of pods per plant, and seed size compared to...
those obtained by well-watered crops [5, 6]. Drought stress also affected morphological traits i.e. reducing plant height, root and shoot dry weights [7]. Water is the most important factor in supporting peanut growth and yield, and followed by fertilization and nitrogen factors [8]. Due to dry condition, growing the drought resistant genotype i.e. genotype that enable to grow well with reasonably high productivity, is necessary. This is because of the presence of different responses of peanut genotypes to drought stress [9, 10].

The drought indices such as mean productivity (MP), geometric mean productivity (GMP), stress tolerance index (STI), and drought susceptibility index (DTI) have been successfully utilized to evaluate drought resistance of peanut genotypes [9, 11, 12]. The research, therefore, is objected to assess the yield performance of breeding lines under well-watered and water-stressed condition, and to quantify their tolerance level to drought using drought indices. These genotypes are currently under adaptation or multi-environmental trials i.e the yield trials at least in ten locations as the final step before it is proposed as new drought tolerance cultivar.

2. Materials and methods

The experiment was conducted at Muneng Research Station of Iletri, which has a D3 climate type (Oldemann classification) in dry season 2019. The station is located at Probolinggo Regency (latitude 7°48’04.2” S, longitude 113°09’34.8” E) of East Java Province, Indonesia at in the altitude of 10 m above sea level. The experiment was undertaken during dry season to avoid interference from rains to the treatment. Therefore, water from deepwell served as water source for the crops during the whole growing season. A split plot design with three replications was applied. The main plots were two environments i.e. 1) well-watered condition where water available during the growing season, and 2) water-stressed condition. In this treatment, water is available during vegetative growth only (from sowing up to 50 DAS), after that the crops were under progressively drying condition until harvesting time. The subplots were 20 genotypes that consisted of 16 promising lines resulted from preliminary and advance yield trials and four check cultivars. Each genotype was sown in a 2 m × 5 m plot with 40 cm × 10 cm plant spacing, one seed/hole. A 250 kg of composite NPK fertilizer (15% N, 15% P, 15% K, and 10% S) was applied in the furrow along the seedsrows just after sowing. Weeding, pest and disease controls were intensively applied. The observations were undertaken on plant height, number of branches, number and weight of mature pods per plant, hundred seed weight, and pod yield. All these observations were undertaken on five sample plants, while pods yields was obtained from the 10 m² plot by ripping all mature pods from the plants, sun-dried for 6 days, and weighed the dried pods.

All data were then run in analysis of variance based on statistical program of MStatC 1.4 version developed by Crop and Soil Sciences Department, Michigan State University. The parameters that were significantly different were then run to a Duncan Multiple Range Test (DMRT) to find out the differences among genotypes tested. The variance contribution of treatments were calculated based on [13]:

\[
\text{Variance contribution of } G = \frac{SSg}{\Sigma (SSg + SSl + SSg \times L)} \times 100\%
\]

\[
\text{Variance contribution of } L = \frac{SSl}{\Sigma (SSg + SSl + SSg \times L)} \times 100\%
\]

\[
\text{Variance contribution of } G \times L = \frac{SSg \times L}{\Sigma (SSg + SSl + SSg \times L)} \times 100\%
\]

where G: Genotype, L: Environment, SSg: Sum of square of genotype, SSl: Sum of square of environment, SSg×L: Sum of square genotype and environment interaction. The drought tolerance
indices were calculated based on formulas cited from Paula et al [2019] and Sanogo et al. [2020] as follow:

Mean productivity  \[ MP = \frac{(Y_s+Y_p)}{2} \]

Geometric mean productivity  \[ GMP = \sqrt{Y_sY_p} \]

Tolerance  \[ TOL = Y_p - Y_s \]

Reduction (%)  \[ RED = \frac{(Y_p-Y_s)}{Y_p} \]

Stress tolerance index  \[ STI = \frac{(Y_p-Y_s)}{(\bar{Y}_p)^2} \]

Stress susceptibility index  \[ SSI = \frac{(1-Y_s/Y_p)}{(1-\bar{Y}_s/\bar{Y}_p)} \]

where \( Y_p \) is the yield of genotype under well-watered (optimum) condition, \( Y_s \) is the yield of genotype under water-stressed condition, \( \bar{Y}_p \) is the mean yield of all genotypes under optimum condition, \( \bar{Y}_s \) is the mean yield of all genotypes under stress condition. The analysis of correlation between pod yields (under well-watered and water-stressed conditions) and drought indices was performed based on statistical program of MStatC 1.4 version developed by Crop and Soil Sciences Department, Michigan State University.

3. Results and Discussion

3.1. Analysis of variance

Analysis of variance for pod yield (PY) in each environment pointed out that pod yield of all tested genotypes did not significantly different. Moreover, no. of branches, no. of mature pods per plant, no. of harvested plants, and hundred seeds weight had significant (\( p<0.05 \), \( p<0.01 \), \( p<0.001 \)) differences either under well-watered or water-stressed condition (Table 1). In the other side, genotypes under well-watered condition significantly had different plant heights, whereas under water-stressed condition those genotypes obtained different mature pods yields per plant. Rust disease incidence was significant under both treatments, and conversely for leaf spot disease. Plants got wilting only under water stress treatment (Table 1).

| Parameters                          | Well-watered condition | Water-stressed condition |
|-------------------------------------|------------------------|--------------------------|
|                                     | Genotype | Mean   | CV (%) | Genotype | Mean   | CV (%) |
| Plant height (cm)                   | S**      | 40.9   | 10.4   | NS       | 34.8   | 10.7   |
| No. of branches/plant              | S**      | 5.4    | 13.8   | S**      | 5.5    | 16.2   |
| No. of mature pods/plant           | S*       | 17.7   | 23.7   | S*       | 12.6   | 21.5   |
| No. of harvested plants/10 m²      | S*       | 179.8  | 15.7   | S*       | 180.5  | 11.9   |
| Weight of mature pods/plant (g)    | NS       | 16.5   | 18.9   | S**      | 11.3   | 19.6   |
| Hundred seed weight (g)            | S***     | 28.7   | 9.9    | S***     | 19.2   | 17.6   |
| Pod yield (t/ha)                   | NS       | 2.3    | 23.3   | NS       | 1.6    | 23.7   |
| Rust disease score                 | S***     | 6.9    | 12.1   | S*       | 7.45   | 11.7   |
| Leafspot disease score             | NS       | 3.5    | 13.0   | NS       | 3.7    | 13.7   |
| Leaves wilting score               | NS       | 1.0    | 0.0    | S***     | 4.3    | 8.5    |

CV: coefficient of variation, S: significant, NS: not significant, *\( p<0.05 \), **\( p<0.01 \), ***\( p<0.001 \)

The split-plot analysis of variance showed that environment (L) significantly influenced pod yield, plant height, yield of mature pods/plant, seed size, as well as rust and leaves wilting score. Genotype
(G) significantly affected pod yield and its yield components, and rust, leaf spot, and leaves wilting score as well (Table 2).

**Table 2.** Analysis of variance and variance contribution of environment, genotypes and its interaction on several parameters. Muneng Research Station, growth season of 2019

| Parameters                  | Analysis of Variance | Variance Contribution (%) |
|-----------------------------|----------------------|---------------------------|
|                             | Main plot: Environment (L) | Subplot: Genotypes (G) | L × G | Environment (L) | Genotypes (G) | L × G |
| Pod yield/ha                | S *                  | S **                      | NS    | 56.7            | 33.4          | 9.9   |
| Plant height                | S **                 | S ***                     | NS    | 47.9            | 42.1          | 10.0  |
| No. of branches/plant       | NS                   | S ***                     | NS    | 0.5             | 89.0          | 10.5  |
| No. of mature pods/plant    | NS                   | S ***                     | NS    | 44.7            | 47.2          | 8.0   |
| Yield of mature pods/plant  | S *                  | S ***                     | NS    | 59.8            | 33.2          | 7.0   |
| No. of harvested plants     | NS                   | S ***                     | NS    | 0.5             | 76.1          | 23.4  |
| Seed size                   | S **                 | S ***                     | S *** | 58.3            | 26.5          | 15.2  |
| Rust disease score          | S *                  | S ***                     | NS    | 9.7             | 83.7          | 6.5   |
| Leaf spot disease score     | NS                   | S **                      | NS    | 4.7             | 64.2          | 31.1  |
| Leaves wilting score        | S ***                | S ***                     | S *** | 93.9            | 3.1           | 3.1   |

S: Significant, NS: Not Significant, *p<0.05, **p<0.01, ***p<0.001

The dominance of L factor as variance contributor was exposed on pod yield, yield of mature pods per plant, seed size, plant height, and leaves wilting incidence with 56.7, 59.8, 58.3, 47.9, and 93.9% respectively (Table 2). It means that soil moisture availability lead the variation in those five parameters. The role of G factor as major variance contributor was shown on no. of branches and no. of mature pods per plant, rust and leaf spot disease scores with 89.0, 47.2, 83.7, and 64.2% of total variation, respectively (Table 2). This indicates the presence of variability in planting materials. Different result was reported by [6, 14] where genotype was the main variance contributor.

The interactive effect of L and G was significant limited to seed size and leaves wilting score (Table 2). This shows the special responses of certain genotypes to different soil moisture availabilities. In these two parameters, L factor was driving more variation than G factor. This statement was supported by 57.6 and 93.9% of environment variance contribution compared to 26.8% and 3.1% of genotype variance contribution (Table 2).

3.2. Pod yield and yield components
Pod yield significantly reduced by 32.4% when peanut plants grew under water stressed condition. This reduction was caused by the reduction of yield components especially seed size and mature pod yield per plant (Table 3).
Table 3. Vegetative and generative components of crop growth under 2 treatments: moisture availability and genotypes. Muneng Research Station, growth season of 2019

| Parameters                        | Well-watered condition | Water-stressed condition |
|-----------------------------------|------------------------|--------------------------|
| Pod yield (t/ha)                  | 2.345                  | 1.584                    |
| Plant height (cm)                 | 40.9                   | 34.8                     |
| No. of branches/plant             | 5.4                    | 5.5                      |
| No. of mature pods/plant          | 17.6                   | 12.6                     |
| Yield of mature pods/plant (g)    | 16.5                   | 11.2                     |
| No of harvested plants            | 179.7                  | 180.4                    |
| Seed size (g/100 seeds)           | 28.6                   | 19.2                     |
| Rust disease score                | 6.9                    | 7.5                      |
| Leaf spot disease score           | 3.5                    | 3.7                      |
| Leaves wilting score √)           | 1.0                    | 4.3                      |

√) as a response to drought stress and presented as leaves wilting score where score 1: turgid-freshly leaves, score 5: totally wilted leaves

Under water-stressed condition the plants grew 28.4% shorter with more wilted leaves than those under well-watered condition. Limited availability of soil moisture resulted in wilted plants, and later on produced significantly smaller seeds (19.2 g per 100 seeds) as the weight of 100 seeds reduced by 32.9% compared to the weight of 100 seeds obtained from well-watered treatment (Table 3). These results were in line with [15] who reported the reduction by 18.7% of no. of pods per plant, 17.1% of hundred seeds weight, and 28.3% of seed yield when peanuts were grown under drought stress in dry land with dry climate in Indonesia. Instead of yield and yield components, water stress also reduced root dry weight, plant dry weight, and root length of peanut plants as reported by [16]. Drought stress during generative growth phase also reduced: pod water content (from 43% under well-watered to 23% under water stressed condition), seed water content (from 39% under well-watered to 26% under water stressed condition), and increased shell hardness so getting more difficult to split [14]. Reducing plant height, no. of leaves, root length, no. of pods, no. and weight of seeds per plant also occurred in bambara groundnut (Vigna subterranea (L.) Verdc.) when water availability was reduced from field capacity to 75% field capacity (FC), and further reduction to 50% FC had resulted no pod and seed yield. Also, number of stomata was significantly reduced by reducing water availability from FC to 75, 50 and 25% FC [17].

Genotype significantly influenced pod yield and yield components (Table 2). Sixteen promising lines (G1 to G16) obtained 6.3-72.6% higher yields than those of Bima cultivar (check cultivar with lower productivity), and from -30.5% to 12.8% compared to pod yield of Katana 1 cultivar (check cultivar with high productivity) (Table 4). G1 obtained the highest pod yield by 2.743 t/ha of pods that was 12.8-72.6% higher than those of check cultivars (Table 4). Pod yield was significantly correlated with no. of mature pods/plant (r = 0.812***), weight of mature pods/plant (r = 0.904***), 100-seeds weight (r = 0.389***), and plant height (r = 0.240**), and negatively correlated with rust disease score (r: -0.295*** and leaves wilting score (-0.457***). Briefly the higher pod yields was the result of increasing yield contributing components i.e. number and weight of mature pods/plant, seed size, and plant height (Table 3). This information was supported by [18] who mentioned that the ultimate contributing parameters for yields were mature pod yield per plant, number of mature pods per plant, and seed size. Pod yield positively correlated (r = 0.210*) with no. of harvested plants. Peanut is a non-tillering plant, and therefore pod yield of peanut in a certain area is influenced by plant population that is harvested.
Table 4. Pod yields of 20 genotypes Muneng Research Station, growth season of 2019

| Genotype  | Pod yield (t ha⁻¹) | Genotype  | Pod yield (t ha⁻¹) |
|-----------|--------------------|-----------|--------------------|
| Genotype 1| 2.473 a            | Genotype 11| 1.805 b-f         |
| Genotype 2| 1.915 a-f          | Genotype 12| 2.427 ab           |
| Genotype 3| 1.992 a-f          | Genotype 13| 2.265 a-d          |
| Genotype 4| 1.928 a-f          | Genotype 14| 1.523 ef           |
| Genotype 5| 1.743d-f           | Genotype 15| 1.983 a-f          |
| Genotype 6| 2.257 a-d          | Genotype 16| 2.118 a-e          |
| Genotype 7| 1.718 d-f          | Cultivar Bima| 1.433 f  |
| Genotype 8| 2.418 a-c          | Cultivar Katana 1| 2.193 a-d |
| Genotype 9| 1.825 b-f          | Cultivar Tala 1| 1.673 d-f          |
| Genotype 10| 1.822 b-f         | Cultivar Tala 2| 1.773 c-f          |

Numbers followed by similar letters mean did not significantly different based on DMRT at 5% level

3.3 Drought indices

The highest pod yield under well-watered condition (Yp) was obtained by G1 (3.13 t/ha), and the lowest yield was obtained by Bima cultivar with 1.69 t/ha. Under water-stressed (Ys), the superior genotype was obtained by different genotype i.e. G8 which resulted in 2.18 t/ha, while Bima and Tala 1 cultivars gave the lowest yields (Table 5). These show that each genotype responded differently to soil moisture condition.

The average pod yield of 20 genotypes under well-watered (Yp) and water-stressed (Ys) treatments was 2.345 t and 1.585 t/ha, respectively (Table 5), which means that drought stress significantly reduced pod yield by 32.4% in average. This is in accordance with the works by [8] who reported higher yield reduction by 73.55% when peanuts were grown under non-irrigated (rainfed) condition in Rumania. Different study reported 13.93% yield reduction due to limited water availability to only 50% water requirement [6].

Mean productivity (MP) and geometric mean productivity (GMP) show the pod yield potential under well-watered or water-stressed conditions. Genotype 1 (G1) obtained the highest MP (2.47 t/ha) and conversely, G14 and Bima cultivar had the lowest MP with 1.53 t/ha and 1.44 t/ha, respectively (Table 5). The highest GMP by 2.40 t/ha was obtained by G8, while the lowest GMP by 1.50 t/ha belonged to G14 and Bima cultivar with GMP of 1.41 t/ha (Table 5). It was considered that MP and GMP tell the genotype ranks based on pod yields rather than the tolerance status of genotypes.

Tolerance (TOL) is the yield difference between that was obtained under well-watered and water-stressed conditions. The higher the TOL values, the larger the pod yields reduction or the less yields obtained under stress condition. Low TOL values expressed good pod yields under drought stress. The result of the experiment showed G1 and G12 had highest TOL value (1.32 t/ha), which mean that these genotypes had biggest yield differences between two water conditions or these were less tolerant or more susceptible to drought. G11 had lowest TOL value (0.13 t/ha) means that this genotype had smallest yield gap between well-watered and water-stressed conditions, or more tolerant to drought.

The reduction value (RED) revealed the percent loss of pod yield because of stress. The lowest RED of 7.0% belonged to G11 with pod yields of 1.87 t and 1.74 t/ha under well-watered and water-stressed conditions, which only 0.13 t yield reduction. The highest RED value of 42.7 and 42.3% belonged to G12 and G1. The biggest yield reduction of 46.1% was obtained by checked cultivar of Tala 1 cultivar. In these three genotypes, the yield reduction was more than 1 t/ha.
It can be summarized that low values of TOL and RED in this experiment owned by G11. These values indicate that G11 had low yield reduction between well-watered and water-stressed. The TOL was closer to the RED since they identified tolerant genotype without considering the rank of pod yield under both water conditions.

**Table 5.** Estimates of drought tolerance indices from the potential yield and the stress yield data for 20 peanut genotypes evaluated in dry season at Muneng Research Station of Indonesia

| Genotype   | Yp  | Ys  | MP  | GMP | TOL  | RED  | STI  | SSI  |
|------------|-----|-----|-----|-----|------|------|------|------|
| Genotype 1  | 3.13| 1.81| 2.47| 2.38| 1.32 | 42.2 | 1.03 | 1.28 |
| Genotype 2  | 2.28| 1.55| 1.92| 1.88| 0.73 | 32.0 | 0.64 | 0.97 |
| Genotype 3  | 2.24| 1.75| 2.00| 1.98| 0.49 | 21.9 | 0.71 | 0.66 |
| Genotype 4  | 2.40| 1.46| 1.93| 1.87| 0.94 | 39.2 | 0.64 | 1.19 |
| Genotype 5  | 2.21| 1.28| 1.75| 1.68| 0.93 | 42.1 | 0.51 | 1.28 |
| Genotype 6  | 2.74| 1.77| 2.26| 2.20| 0.97 | 35.4 | 0.88 | 1.07 |
| Genotype 7  | 2.14| 1.29| 1.72| 1.66| 0.85 | 39.7 | 0.50 | 1.20 |
| Genotype 8  | 2.65| 2.18| 2.42| 2.40| 0.47 | 17.7 | 1.05 | 0.54 |
| Genotype 9  | 2.26| 1.39| 1.83| 1.77| 0.87 | 38.5 | 0.57 | 1.17 |
| Genotype 10 | 2.06| 1.58| 1.82| 1.80| 0.48 | 23.3 | 0.59 | 0.71 |
| Genotype 11 | 1.87| 1.74| 1.81| 1.80| 0.13 | 7.0  | 0.59 | 0.21 |
| Genotype 12 | 3.09| 1.77| 2.43| 2.34| 1.32 | 42.7 | 0.99 | 1.29 |
| Genotype 13 | 2.73| 1.80| 2.27| 2.22| 0.93 | 34.1 | 0.89 | 1.03 |
| Genotype 14 | 1.82| 1.23| 1.53| 1.50| 0.59 | 32.4 | 0.41 | 0.98 |
| Genotype 15 | 2.52| 1.45| 1.99| 1.91| 1.07 | 42.5 | 0.66 | 1.29 |
| Genotype 16 | 2.29| 1.94| 2.12| 2.11| 0.35 | 15.3 | 0.81 | 0.46 |
| Cultivar Bima| 1.69| 1.18| 1.44| 1.41| 0.51 | 30.2 | 0.36 | 0.91 |
| Cultivar Katana 1 | 2.67| 1.72| 2.20| 2.14| 0.95 | 35.6 | 0.84 | 1.08 |
| Cultivar Tala 1 | 2.17| 1.17| 1.67| 1.59| 1.00 | 46.1 | 0.46 | 1.40 |
| Cultivar Tala 2 | 1.95| 1.60| 1.78| 1.77| 0.35 | 17.9 | 0.57 | 0.54 |
| Average     | 2.345| 1.585| |

Yp = yield under well-watered condition, Ys = yield under water-stressed condition, MP = mean productivity, GMP = geometric mean productivity, TOL = tolerance index, RED = yield reduction, STI = stress tolerance index, SSI = stress susceptibility index

Stress Tolerance Index (STI) higher than 1 (>1) indicates drought tolerant [15]. G1 and G8 with STI 1.03 and 1.05 owned this category. These genotypes produced high yields in well-watered (3.13 t and 2.65 t/ha) and water stressed conditions (1.81 t and 2.18 t/ha). In the other side, G14 obtained the lowest STI value by 0.41 with 1.82 t and 1.23 t/ha under well watered and drought stress, respectively. These yields were considerably low and therefore the genotype was reported as susceptible genotype. Different from STI, Stress Susceptibility Index (SSI) is an indicator of susceptibility level. SSI value higher than 1 (>1) indicates susceptible to drought and vice versa [16]. G8, G11, and G16, which had the least values (<1) were the least susceptible to drought or more tolerant to drought.
3.4. Correlation of drought indices

The perfect correlations with coefficient equal to 1 or -1 were found between GMP and MP, STI and GMP, and between SSI and RED (Table 6).

**Table 6.** Correlation coefficients among drought indices and pod yields in well-watered and water-stressed conditions.

| Drought Indices | Yp    | Ys    | MP   | GMP  | TOL | RED | STI | SSI |
|-----------------|-------|-------|------|------|-----|-----|-----|-----|
| Yp              | -     |       |      |      |     |     |     |     |
| Ys              | 0.58  |       |      |      |     |     |     |     |
| MP              | 0.93  | 0.84  |      |      |     |     |     |     |
| GMP             | 0.89  | 0.89  | 1.00 |      |     |     |     |     |
| TOL             | 0.73  | -0.14 | 0.42 | 0.34 |     |     |     |     |
| RED             | 0.41  | -0.50 | 0.04 | -0.04| 0.92|     |     |     |
| STI             | 0.89  | 0.88  | 0.99 | 1.00 | 0.35| -0.03|     |     |
| SSI             | 0.41  | -0.50 | 0.04 | -0.04| 0.92| 1.00| -0.03| -   |

Yp = yield under well-watered condition, Ys = yield under water-stressed condition, MP = mean productivity, GMP = geometric mean productivity, TOL = tolerance index, RED = yield reduction, STI = stress tolerance index, SSI = Stress susceptibility index

These results were supported by experiment on peanut mutant lines grown in optimum and water-stressed condition in Egypt [6]. Yp was positively correlated (r = 0.58) to Ys means that higher Yp was followed by higher Ys. This value showed that there was some other factor beyond soil water availability governed the pod yields. Yp and Ys was strongly and positively correlated with MP, GMP, and STI. Therefore, drought tolerance indices such as MP, GMP, and STI which showed high positive correlations with pod yields both under well-watered and water-stressed conditions, are good indicators that can be applied in screening of groundnut genotypes for drought tolerance for peanut cultivar grown in dry land with dry climate in Indonesia [15]. Similar drought indices had been suggested by [19] in assessing durum wheat genotypes tolerance to drought.

4. Conclusions

G1 and G12 superior in Yp, Ys, MP, GMP, and STI but inferior in SSI. These genotypes also had big yield reduction as pointed out by high value of TOL and RED. G1 and G12 were then categorized as high yield with drought tolerant but high yield reduction when under water-stressed condition. G8 obtained reasonably high Yp, MP, GMP, and superior Ys and STI. G8 also had low value of TOL, RED, and SSI. G8 was drought tolerant with little yield reduction under stress condition. Conversely, G11 had lowest Yp, Ys, MP, GMP, and STI despite of its least RED, TOL, and SSI. G 11 was considered as susceptible to drought with low productivity and low yield reduction under stress condition.

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