Yield potential and adaptability of several introduced Burley tobacco genotypes across development areas

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Abstract. Burley tobacco is a light air-cured tobacco primarily used in the production of white and kretek cigarettes. Currently the major cultivated variety (TN90) has declined in its performance. To overcome the problem, several new high-quality and productivity genotypes have been introduced. However, these new genotypes have to be evaluated before they are cultivated commercially. This research aimed to determine the yield potential and adaptability of the newly introduced Burley tobacco genotypes for two growing seasons in six locations. Four introduced genotypes (AOB359, AOB656, DBH454, NC7LC) and one check variety (TN90) were arranged in a randomized block design with five replications. Parameters observed included flowering age, leaf number, leaf length and width, yield of dried tobacco leaves, grade index, and crop index. Data were analyzed using PKBT STAT 2.03. The results showed that yield potential varied from 1294.8 – 1527.3 kg ha⁻¹ for dried tobacco leaves, grade index ranged from 55.25 – 55.91, crop index ranged from 70.91 - 84.60 and wide adaptability. The AOB359, AOB656, and NC7LC genotypes produced a potentially higher yield than the check variety.

Keywords: Nicotiana tabacum, stability, yield, grade index, crop index

1. Introduction

Burley tobacco is light air cured that has specific and prominent characteristics. The high-quality Burley tobacco leaves have a yellowish-brown color. Because of its quality, Burley tobacco is used in the production of white and kretek cigarettes. Data showed that the majority of Burley tobacco comes from the main cultivation areas in Java island, particularly Lumajang, Jember and Banyuwangi, with a total area of around 997 ha per year [1]. Apart from those areas, Burley tobacco is also found cultivated in four districts of North Sumatra Province, namely Dairi, Humbang Hasundutan, and Tapanuli districts, with a total area of 225 ha. Burley tobacco in North Sumatra Province is grown to fulfill the need of STTC (The Sumatera Trading Tobacco Company) [2]. In 2015 the export volume of Burley tobacco (17,820 kg) was smaller than the import volume (317,086 kg) [1]. This implies that the domestic needs for Burley tobacco are still lacking. Therefore, there is a great opportunity for the development of Burley tobacco in Indonesia.

The main variety developed in Lumajang is TN 90. For years this variety shows a high and stable performance. However, its productivity and quality decreases nowadays due to genetic factors. Therefore, the introduction of a new high-yielding genotypes is needed to replace the old and degenerated TN90 cultivar. With this background several new variety had been introduced from Brazil and USA. These introduced varieties have good growth and yield performance in their area of origin. However, previous research revealed that a variety with high production potential in
the area of origin might not produce the same performance in the new development area. This is due to high genetic and environmental interaction [4]. Therefore, it is necessary to test the yield potential and adaptability of the newly introduced variety in new development areas with different ecological condition.

This study aimed to test the yield potential and adaptability of newly introduced varieties of Burley tobacco.

2. Materials and methods
2.1. Study site and time
The research was done for two years in the development area of Burley tobacco in Lumajang regency, East Java Indonesia. The descriptions of the study site and rainfall distribution during the study period are listed in Table 1 and Table 2.

### Table 1. Description of the six study sites

| Year | Location          | Coordinate       | Elevation (m asl) | Soil texture |
|------|-------------------|------------------|-------------------|--------------|
| 2015 | 1 Jatisari/Tempeh | 8°14'SL 113°01'EL| 120 m asl         | 1. Sandy loam|
|      | 2 Tumpeng1/Candipuro | 8°12'SL 112°54'EL| 275 m asl         | 2. Sandy loam|

| 2016 | 1 Tumpeng2/Candipuro | 8°12'SL 112°54'E | 275 m asl | 1. Sandy loam |
|      | 2 Nguter Pasirian | 8°19'SL 112°55'EL | 202 m asl | 2. Sandy loam |
|      | 3 Pulo/Tempeh | 8°12'SL 113°04'EL | 132 m asl | 3. Sandy loam |
|      | 4 Sumbersuko/Sumbersuko | 8°08'SL 113°06'EL | 100 m asl | 4. Loam |

Note: asl=above sea level

### Table 2. Rainfall distribution pattern of the six study sites in 2015 to 2016

| Month  | Jatisari | Tumpeng1 | Tumpeng2 | Nguter | Pulo | Sumbersuko |
|--------|----------|----------|----------|--------|------|------------|
| RF     | RD       | RF       | RD       | RF     | RD   | RF         |
| January | 222      | 14       | 226      | 15     | 86   | 12         |
| February | 170     | 13       | 202      | 12     | 395  | 18         |
| March  | 146      | 13       | 202      | 12     | 158  | 12         |
| April  | 272      | 13       | 239      | 17     | 281  | 19         |
| May    | 91       | 4        | 79       | 6      | 198  | 17         |
| June   | 3        | 3        | 15       | 5      | 313  | 13         |
| July   | 0        | 0        | 0        | 0      | 96   | 9          |
| August | 0        | 0        | 0        | 0      | 85   | 11         |
| September | 0     | 0        | 0        | 0      | 236  | 14         |
| October | 0       | 0        | 0        | 0      | 321  | 21         |
| November | 44    | 3        | 45       | 3      | 700  | 25         |
| December | 171   | 11       | 223      | 20     | 281  | 16         |

Note: RF= rainfall; RD= number of rainy days

Jatisari and Tumpeng1 in 2015, the other locations in 2016

2.2. Materials and tools
The materials used in this study included four Burley tobacco genotypes (AOB359, AOB 656, DBH454, and NC7LC) and one check variety (TN90). The High yielding Variety of AOB 359, AOB656 and DBH454 were introduced from Brazil whereas NC7LC comes from the USA.

2.3. Research design
The treatments were arranged in a Randomized Block Design (RBD) with five repetitions. The plot
size was 6.6 m x 11.25 m. Each plot consisted of 150 plants. The 40 days old seedlings were planted in 110 x 45 cm spacing with one seedling per hole. Before planting, the nematicide (carbofuran) was applied to anticipate caterpillar attacks, and the first fertilizer of NPK was applied with a dose of 700 kg per hectare.

Replanting was carried out seven days after planting while weeding was done before applying fertilizers. Ridging was done after fertilization by pulling the soil around the plant at the stem’s base to form a mound. Inorganic fertilization was given twice: on 18-20 DAP with ZA of DAP with NO3 of 13 kg ha⁻¹ and K2O of 45 kg ha⁻¹. Irrigation was added when required. Pruning was carried out at the beginning of flowering for each genotype. Pruning was done when at least one flower was fully bloomed by cutting the top of the plant just below the two flag leaves. The axillary shoots were cut every seven (7) days, Helicoverpa spp and Spodoptera littura insects were controlled using thiodicarb with a concentration of 2 ml l⁻¹ water, while Aphis spp. was controlled using imidacloropid with a concentration of 0.4 ml l⁻¹.

Harvesting was done twice when the leaves were mature enough, indicated by a change in color of the leaves from green to 50% yellow. The mature leaves were picked and dried in hot air (air curing) in a drying warehouse. Then sorting of dry leaves following consumers’ preference (market).

2.4. Observations
Parameters observed included the flowering time, leaf number, leaf length, leaf width, the yield of dried tobacco leaves, grade index, and crop index.

\[
\text{Grade index} = \frac{\sum_{i=1}^{n} (A_i \times B_i)}{\sum_{i=1}^{n} B_i}
\]

Ai = price index of i-th treatment
Bi = weight of the i-th grade
n = number of grades available
Crop index = grade index x yield (ton ha⁻¹)

2.5. Data analysis
Combined variance analysis was done on all data obtained, then continued with Duncan’s Multiple Range Test (DMRT) at a 5% significance. A stability analysis was conducted to determine the yield stability and adaptability of each genotype [4].

3. Results and discussion
3.1. Growth and yield
The growth and yield components of five Burley tobacco were influenced by the interaction between genotype and growth environment (Table 3). At Tumpeng1, DBH454 produced more leaves, AOB359 produced fewer leaves, and the other two genotypes produced a leaf number that was not significantly different from the check variety (Table 4). At Jatisari, DBH454 and AOB359 produced more leaves, and the other two genotypes produced a leaf number that was not significantly different from the check variety. At Tumpeng2, AOB359 produced a leaf number that was not significantly different from the check variety, and the other three genotypes produced more leaves than the check variety. At Nguter, DBH454 produced a leaf number that was not significantly different from the check variety, and the other three genotypes produced more leaves than the check variety. At Sumbersuko, NC7LC produced fewer leaves, and the other three genotypes produced more leaves than the check variety. The leaf number of Burley tobacco was influenced by the genotypes used [5].
Table 3. The combined Analysis variance of the flowering stage, leaf number, leaf length, and leaf width, the yield of dried tobacco leaves, grade index, and crop index

| Source of variation | db | F | P | ** | ** | ** | ** | ** | ** |
|---------------------|----|---|---|----|----|----|----|----|----|
| Location            | 5  | **| **| **| **| **| **| **| **|
| Replication *location | 15 | **| **| **| **| **| **| **| **|
| Genotype            | 4  | ns | ns | **| **| **| **| **| **|
| Genotype *location  | 20 | **| **| **| **| **| **| **| **|
| Error               | 75 | 11.580 | 0.405 | 4.984 | 1.237 | 3.814 | 5.035 | 0.226 |

Note: * and ** mean significantly different based on the F-test at 5% and 1% significance level, respectively. ns: not significantly different

Table 4. Averaged number of leaves per plant of the five Burley tobacco genotypes across six study sites

| Genotype | Tumpeng1 | Jatisari | Tumpeng2 | Nguter | Pulo | Sumberuko |
|----------|----------|----------|----------|--------|------|-----------|
| AOB359   | 23.25 fg  | 28.50 b  | 22.00 h-j | 25.50 cd | 22.00 h-j | 18.75 m |
| AOB656   | 24.00 ef  | 29.00 b  | 22.50 g-i | 25.50 cd | 21.75 i-k | 18.00 mn |
| DBH454   | 24.75 de  | 29.25 ab | 22.50 g-i | 24.50 de | 20.00 i | 18.50 m |
| NC7LC    | 24.00 ef  | 30.00 a  | 22.75 gh  | 26.00 c | 21.00 k | 17.00 o |
| TN 90 (C)| 24.25 e  | 28.75 b  | 22.00 h-j | 24.50 de | 21.50 jk | 17.50 no |

Note: Numbers accompanied by the same letters are not significantly different based on Duncan’s Multiple Range Test (DMRT) at 5% level.

Table 5. Averaged leaf length of the five Burley tobacco genotypes across six study sites

| Genotype | Tumpeng1 | Jatisari | Tumpeng2 | Nguter | Pulo | Sumberuko |
|----------|----------|----------|----------|--------|------|-----------|
| AOB359   | 66.50 a  | 66.50 a  | 64.00 ab | 61.25 b-d | 57.75 de | 46.25 gh |
| AOB656   | 64.25 ab  | 65.75 a  | 60.75 cd | 66.50 a | 56.00 ef | 49.75 f |
| DBH454   | 65.25 a  | 66.00 a  | 64.50 a  | 63.75 a-c | 59.25 de | 44.50 h |
| NC7LC    | 63.75 a-c | 63.75 a-c | 60.25 d  | 64.25 ab | 59.25 de | 48.75 fg |
| TN 90    | 65.00 a  | 64.25 ab | 58.75 de | 64.25 ab | 56.50 ef | 49.25 fg |

Note: Numbers accompanied by the same letters are not significantly different based on Duncan’s Multiple Range Test (DMRT) at 5% level.

At Tumpeng1, AOB656 and NC7LC produced shorter leaves, while the other two genotypes showed no significant difference in leaf length compared to the check variety (Table 5). At Jatisari, NC7LC produced shorter leaves. At Tumpeng2, NC7LC showed no significant difference in leaf length compared to the check variety, while the other three genotypes produced longer leaves than the check variety. At Nguter, AOB656 produced longer leaves, NC7LC showed no significant difference in leaf length compared to the check variety, while the other two genotypes produced shorter leaves than the check variety. At Pulo, AOB656 showed no significant difference in leaf length compared to the check variety, while the other three genotypes produced longer leaves than the check variety. At Sumberuko, AOB359 and DBH454 produced shorter leaves than the check variety. Research showed that the leaf
length of Burley tobacco was influenced by the Burley tobacco genotypes used [6, 7].

The four Burley tobacco genotypes produced broader leaves than the check variety at Tumpeng1, Jatisari, and Nguter sites. On the contrary, the Burley genotype produced narrower leaves than the check variety at Pulo (Table 6). At Tumpeng2, the NC7LC genotype produced narrower leaves, while the other three genotypes produced broader leaves than the check variety. At Sumbersuko, DBH 454 and NC7LC genotypes produced narrower leaves than the check variety. Research of [8, 16] showed that the leaf width of tobacco was influenced by the tobacco genotypes used.

Table 6. Averaged leaf width of the five Burley tobacco genotypes across six study sites

| Genotype | Tumpeng1 | Jatisari | Tumpeng2 | Nguter | Pulo | Sumbersuko |
|----------|----------|----------|----------|--------|------|------------|
| AOB359   | 39.00 bc | 36.75 d-f | 38.50 bc | 37.75 cd | 36.00 d-g | 27.25 mn |
| AOB656   | 36.75 d-f | 36.50 d-f | 38.75 bc | 40.75 a | 35.75 e-g | 27.25 mn |
| DBH454   | 34.75 g-i | 33.50 i-k | 39.75 ab | 39.00 bc | 37.50 c-e | 26.00 n |
| NC7LC    | 34.00 h-j | 32.00 kl  | 37.00 d-f | 35.50 f-h | 36.75 d-f | 26.50 n |
| TN 90    | 32.75 j-l | 31.75 l  | 37.75 cd | 34.50 g-i | 38.75 bc | 28.25 m |

Note: Numbers accompanied by the same letters are not significantly different based on DMRT at 5% level.

Table 7. Averaged flowering time of the five Burley tobacco genotypes across six study sites

| Genotype | Tumpeng1 | Jatisari | Tumpeng2 | Nguter | Pulo | Sumbersuko |
|----------|----------|----------|----------|--------|------|------------|
| AOB359   | 77.75 d-h | 76.00 f-i | 79.00 b-g | 67.75 kl | 84.25 b | 75.25 f-i |
| AOB656   | 77.50 d-i | 79.50 b-f | 78.00 d-h | 68.50 j-l | 83.25 b-d | 82.00 b-e |
| DBH454   | 78.25 c-h | 79.50 b-f | 79.75 b-f | 67.75 kl | 83.75 bc | 77.25 e-i |
| NC7LC    | 76.75 e-i | 75.00 f-i | 81.75 b-e | 69.00 j-l | 77.75 d-h | 91.00 a |
| TN 90    | 73.25 h-j | 73.75 g-j | 72.00 i-k | 66.50 l | 79.00 b-g | 79.75 b-f |

Note: Numbers accompanied by the same letters are not significantly different based on DMRT at 5% level.

The flowering time of the four Burley tobacco genotypes was longer than the check variety at Tumpeng1, Jatisari, Tumpeng2, and Nguter sites (Table 7). At Pulo, the NC7LC genotype had a shorter flowering stage than the check variety. On the contrary, it had a more extended flowering stage than the check variety at Sumbersuko. The flowering time of tobacco was influenced by the genotypes used [9].

The yield of dried leaves of the AOB359 genotype was not significantly different from the check variety, while the other three genotypes produced a lower yield than the check variety at Tumpeng1. At Jatisari, the yield of DBH454 was not significantly different, while the other three genotypes produced a lower yield than the check variety (Table 8). On the other hand, at Nguter, Pulo, and Sumbersuko, the DBH454 yield of dry tobacco leaves was not significantly different from the check variety. In contrast, the other three genotypes produced a higher yield than the check variety. As for Tumpeng2, all tested genotypes produced a higher yield of dried tobacco leaves than the check variety. Previous research also showed that Burley tobacco yields were influenced by the genotypes used [10, 11].

The grade indices of all tested genotypes were higher than the check variety at Tumpeng1, Tumpeng2, Pulo, and Sumbersuko (Table 9). At Jatisari, genotype DBH454 had a higher grade index than the check variety. NC7LC had a grade index that was not significantly different from the check variety, while the other two genotypes had lower indices than the check variety. At Nguter, AOB359 and NC7LC genotypes had higher grade indices, while the other two genotypes had lower grade indices than the check variety.
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Table 8. Averaged yield of dried tobacco leaves of the five Burley tobacco genotypes across six study sites

| Genotype  | Tumpeng1 | Jatisari | Tumpeng2 | Nguter | Pulo    | Sumbersuko |
|-----------|----------|----------|----------|--------|---------|------------|
| AOB359    | 2182.1 c | 3024.0 ab| 1360.1 ef| 1224.2 f| 989.80 gh| 383.8 lm   |
| AOB656    | 1681.6 d | 2959.2 ab| 1380.3 e | 961.0 g-i| 794.53 i | 377.1 lm  |
| DBH454    | 1904.8 d | 3245.3 a | 1137.9 fg | 612.1 j | 592.53 jk| 276.1 m   |
| NC7LC     | 1772.3 d | 2747.5 b | 1737.2 d | 1340.5 ef| 989.80 gh| 471.3 kl  |
| TN 90     | 2274.9 c | 3150.4 a | 861.9 hi | 618.2 j | 572.33 jk| 336.7 m   |

Note: Numbers accompanied by the same letters are not significantly different based on Duncan’s Multiple Range Test (DMRT) at 5% level.

Table 9. Averaged grade index of the five Burley tobacco genotypes across six study sites

| Genotype  | Tumpeng1 | Jatisari | Tumpeng2 | Nguter | Pulo    | Sumbersuko |
|-----------|----------|----------|----------|--------|---------|------------|
| AOB359    | 53.67 g-j| 50.00 kl | 66.38 b  | 57.88 ef| 59.65 c-f| 47.88 lm   |
| AOB656    | 50.33 j-l| 45.67 m  | 68.88 ab | 54.29 g-i| 62.59 e  | 51.75 i-k  |
| DBH454    | 53.33 h-k| 54.00 g-j| 66.20 b  | 49.93 kl| 58.64 d-f| 49.38 l   |
| NC7LC     | 51.00 i-l| 50.33 j-l| 69.83 a  | 60.67 c-e| 57.18 e-g| 50.94 i-l  |
| TN 90     | 49.67 kl | 50.33 j-l| 61.88 cd | 56.40 f-h| 53.96 g-j| 45.45 m   |

Note: Numbers accompanied by the same letters mean not significantly different based on Duncan’s Multiple Range Test (DMRT) at 5% level.

The crop indices of all tested genotypes were lower than the check variety at Tumpeng1. On the contrary, those genotypes had higher indices at Tumpeng2, Nguter, and Pulo (Table 10). At Jatisari, the NC7LC genotype had a lower crop index, AOB359 had a crop index not significantly different from the check variety, while the other two genotypes had higher indices than the check variety. At Sumbersuko, the DBH454 genotype had a lower crop index, AOB656 had a higher crop index, while the other two genotypes had indices not significantly different from the check variety.

Table 10. Averaged crop index of the five Burley tobacco genotypes across six study sites

| Genotype  | Tumpeng1 | Jatisari | Tumpeng2 | Nguter | Pulo    | Sumbersuko |
|-----------|----------|----------|----------|--------|---------|------------|
| AOB359    | 119.64 cd| 166.68 ab| 77.30 f  | 62.03 g-i| 54.19 i-k| 22.58 no   |
| AOB656    | 99.40 e  | 179.47 a | 80.48 f  | 59.37 h-j| 50.63 jk | 23.74 mn   |
| DBH454    | 101.48 e | 175.62 a | 65.98 g-h| 33.45 l  | 32.90 l  | 16.05 o    |
| NC7LC     | 106.45 de| 152.35 b | 96.98 e  | 74.97 fg | 55.00 h-k| 21.86 no   |
| TN 90     | 129.74 c | 167.41 ab| 45.65 k  | 29.96 lm | 27.20 l-n| 20.75 no   |

Note: Numbers accompanied by the same letters are not significantly different based on Duncan’s Multiple Range Test (DMRT) at 5% level.

3.2. Stability

The agroecological conditions of the burley tobacco development area are varied. Therefore, the introduction of a new variety must be planned for its yield potential and stability. A plant variety is said to be stable if the yield obtained remains high in various agro-ecological conditions. Table 3 showed that yield of dried tobacco leaves, grade index, and crop index were influenced by the interaction between the genotype and the growth environment. Based on this result analysis was then continued to a stability test. The result of the stability test for yield dried tobacco leaves, is shown in Table 11. It showed that all the introduced genotypes produced a regression coefficient value (bi) not different from 1 and a standard deviation value (S^2_{bi}) not different from 0. Thus, the introduced genotypes could
be considered stable or had wider adaptability. In contrast, the check variety (TN 90) was unstable or had narrow adaptability. Interesting to note that AOB359 and AOB656 genotypes produced a higher yield of dried tobacco leaves than the check variety and had wider adaptability. This is because TN90 has been planted in development area too long since 2003. TN90 has decreased in productivity and quality and is unstable. This is probably due to plant degeneration. Therefore, in terms of yield of dried leaves both genotypes are considered promising candidates for Burley development in Lumajang regency. Based on research the result of [12] that each tobacco genotype had different adaptability. Research result shows that genotypes generally remain constant from each environment, but sometimes it changes and produces wide range of phenotypes in a different environment. The change is referred to as genotype-environment interactions (GEI) [13, 14].

Table 11. Averaged yield of dried tobacco leaves (kg ha\(^{-1}\)) and stability parameters of the five Burley tobacco genotypes

| Genotype | The yield of dried tobacco leaves (kg ha\(^{-1}\)) | Bi     | \(S^2_{di}\) | Stability |
|----------|-----------------------------------------------|--------|--------------|-----------|
| AOB359   | 1527.3 a                                      | 0.966  | 0.990 ns     | Stable    |
| AOB656   | 1359.0 b                                      | 0.899  | 3.661 ns     | Stable    |
| DBH454   | 1294.8 b                                      | 1.184  | 2.144 ns     | Stable    |
| NC7LC    | 1509.8 a                                      | 0.792  | 2.022 ns     | Stable    |
| TN 90    | 1302.4 b                                      | 1.160  | 7.242 *      | Unstable  |
| Mean     | 1398.6                                        |        |              |           |

Note: \(b_i\) : regression coefficient; \(S^2_{di}\) : standard deviation; *, ** and ns: significantly different, very significantly different, and not significantly different based on the t-test for \(b_i\) and F-test for \(S^2_{di}\).

The result of stability analysis for the grade index is listed in Table 12. It showed that all tested Burley tobacco genotypes and the check variety produced a \(b_i\) value not different from 1 and \(S^2\) value not different from 0 (Table 12).

Table 12. Averaged grade index and stability parameters of the five Burley tobacco genotypes

| Genotype | Grade Index | Bi      | \(S^2_{di}\) | Stability |
|----------|-------------|---------|--------------|-----------|
| AOB359   | 55.91 ab    | 0.958   | 8.418 ns     | Stable    |
| AOB656   | 55.59 ab    | 1.208   | 2.484 ns     | Stable    |
| DBH454   | 55.25 b     | 0.788   | 1.458 ns     | Stable    |
| NC7LC    | 56.66 a     | 1.205   | 3.474 ns     | Stable    |
| TN 90    | 52.95 c     | 0.841   | 3.692 ns     | Stable    |
| Mean     | 55.27       |         |              |           |

Note: \(b_i\) : regression coefficient; \(S^2_{di}\) : standard deviation; *, ** and ns: significantly different, very significantly different, and not significantly different base on the t-test for \(b_i\) and F-test for \(S^2\).

Thus, in terms of grade index all genotypes and the check variety were stable and hence had wider adaptability. It is noted that AOB359, AOB656, and NC7LC genotypes produced the highest grade indices and broader adaptability. Decision-making to choose a superior variety can be done based either on production, grade index or crop index. The selection based on the crop index, however is the right choice because the crop index shows the level of income earned by farmers.

The result of stability analysis for crop index is listed in Table 13. It appeared that all the introduced genotypes had a regression coefficient value (\(b_i\)) not different from 1 and a regression deviation value (\(S^2_{di}\)) not different from 0 (Table 13). Thus, all of these genotypes were stable or had wider adaptability. In contrast, the check variety was considered unstable or had narrow adaptability. When examined, genotypes AOB359, AOB656, and NC7LC not only had a wider stability but also they produced a higher crop index than the check variety. Therefore, it can be concluded that those three genotypes are adaptable in all areas of Burley tobacco development which indicated that the introduced genotypes have the genetic potential to adapt to changing environments rapidly [15].
Table 13. Averaged crop index and stability parameters of the five Burley tobacco genotypes

| Genotype  | Crop Index | $b_i$  | $S'_{bi}$ | Stability |
|-----------|------------|--------|-----------|-----------|
| AOB359    | 83.74 a    | 0.981  | 0.252     | Stable    |
| AOB656    | 82.18 a    | 0.907  | 0.287     | Stable    |
| DBH454    | 70.91 b    | 1.157  | 0.261     | Stable    |
| NC7LC     | 84.60 a    | 0.826  | 0.009     | Stable    |
| TN 90     | 70.12 b    | 1.129  | 0.504     | Unstable  |

Mean 78.31

Note: $b_i$: regression coefficient; $S'_{bi}$: standard deviation; *, ** and ns: significantly different, very significantly different, and not significantly different base on the t-test for $b_i$ and F-test for $S^2$.

4. Conclusion

The yield potential of the introduced genotypes varied from 1294.8 – 1527.3 kg ha$^{-1}$ of dried tobaccolaves, grade index ranged from 55.25 – 55.91, and crop index ranged from 70.91 – 84.60 with broader adaptability. AOB359, AOB656, and NC7LC are the promising genotypes found in this study that can be used directly to replace the old cultivar TN 90.

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