Evaluation of anthocyanin corn under various agro-environment in Indonesia

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Abstract. In the last decade, purple corn gain more attention mainly due to its high nutritional value and attractive color appearance. Purple corn contain anthocyanin 350% higher than normal corn. Based on its excellence, the research was conducted to find out of high yield purple opv corn with good resistance to downy mildew. The experiment was conducted by using randomized block design with three replication. The variable observed including agronomic character like vegetative, generative and scored disease of downy meldows. The result showed that two opve candidate were PMU(S1).Synth.F.C1 and PMU(S1).Synth.D.C1 have the highest yield, 6.80-6.85 t/ha, higher 50% than PLU.C0 (check). PMU(S1).Synth.F.C1 showed moderate resistance to downy meldows (20%-35%) and PMU(S1).Synth.D.C1 susceptible (>60%).

1. Introduction
Corn is one of staple food in the world after rice and wheat. Various varieties have been generated to deal with environment stresses and meet human nutrition needs. Therefore, study about purple corn with high anthocyanin which acts as an anti-oxidant. Purple maize is a specialty corn that contains of higher anthocyanins than white or yellow corn, which can reach 350% higher than normal corn. Anthocyanins is useful for the treatment of various types of diseases including improving blood circulation, preventing premature aging [1]. Therefore, purple corn in the last decade has attracted a lot of attention of consumer due to high nutritional value and attractive color appearance [2]. Currently, Indonesian Cereals Research Institute (ICERI) has purple corn germplasm (anthocyanin) both from local collections and introduced from Vietnam, Thailand, China and CIMMYT.

Purple corn germplasm has actually been planted by farmers, planted for generations but its productivity is still low < 3.0 t/ha. Therefore, ICERI conducted population improvement so that new high-yielding varieties of purple corn were obtained with open pollination. It was explained by [3] that the breeding varieties before being disseminated were first released by the Ministry of Agriculture to determine the superiority of yield, resistance to plant pest organisms, environmental stress, early maturity, yield quality, plant type, value of economy, in addition to optimal locations and according to farmer practices.

The objective of experiment was determine the high yield and selected agronomic character of OPV purple corn under lowland central corn in Indonesia. The hypothesis was be founded of high yield candidate opv purple corn than two check and resistance of downy meldows
2. Methodology

2.1. Genetic material
The genetic material of purple corns OPV (Open Pollinated Variety) listed in the Table 1 along with the environment research. The experiment was conducted by randomized block design with three replications. There are ten genotypes as candidates included two check. There are four locations to conducted since in dry and rainy season. Environment of the research <50 m above the sea under lowland tropical zone. Data were observed like as vegetative characters and yields component. The model and data analysis was used in some steps:

1. Single effect of each genotype (G) with a mathematical model:
   \[ Y_i = \mu + \alpha_i + \beta_j + \epsilon_{ij} \]
   \( Y_i \): the results of observations
   \( \mu \): general mean
   \( \alpha_i \): genotype effect
   \( \beta_j \): block effect
   \( \epsilon_{ij} \): error

   The significant different of treatment by statistical LSD in 95% level

2. The effect of two factors interaction (GxE) was carried out by a combined analysis of all environment and season. Mathematical model was [4]:
   \[ Y_i = \mu + \alpha_i + \beta_j + \delta_k + (\alpha \delta)_{ik} + \epsilon_{ijk}, \]
   \( Y_i \): observation result
   \( \mu \): general mean
   \( \alpha_i \): genotype effect
   \( \beta_j \): block effect
   \( \delta_k \): environment effect
   \( (\alpha \delta)_{ik} \): interaction x
   \( \epsilon_{ijk} \): error

3. Three factors interaction were genotype, environment, and the seasons (GxExS)

4. Calculating the value of the regression coefficient (\( \beta_i \)) on ten genetic material (G) with the t-test. The regression coefficient of the independent variable (\( x_i \)) is the environmental index and \( Y \): yield with w.c 15%.

5. The simple regression model is: \( Y = \alpha + \beta_i x \). The coefficient \( \beta_i \) (I = 1, 2, .., 10) is calculated by the formula:
   \[ \beta_i = (\sum \sum x_{ij} \bar{y}) / \sum \bar{y}^2 \]
   \( \bar{y} \)= population mean in all environment
   \( \sum x_{ij} \)= population mean in each environment
   The proposed hypothesis is \( H_0 : \beta_i = 1 \) vs \( H_1 : \beta_i \neq 1 \) in db n – 1

6. Finlay and Wilkinson were use criteria to selected of genotype for new candidate variety are (1) coefficient regression was \( \beta_i >1.0 \) and (2) average yield> than check. Hypotesis be computing by t-test of \( H_0 : \beta = 1 \) vs \( H_1 : \beta \neq 1 \)

Table 1. The treatment genotypes of purple maize

| Genotype | Name | Seed texture |
|----------|------|--------------|
| **Candidates** |      |              |
| G1. PMU(S1).Synth.F.C1 | Manado purple maize | Flint |
| G2. PMU(S1).Synth.D.C1 | Manado purple maize | Dent |
| G3. PPU.FS.C2 | Palu purple maize | Dent |
| G4. PPU(S1).F.C1 | Palu purple maize | Flint |
| G5. PPH.FS.C1 | Palu black maize | Flint |
| G6. PTU(S1).F.C1 | China purple maize | Semi flint |
| G7. PTH(S1).F.C0 | China black maize | Flint |
| G8. PVU(S1).F.C0 | Vietnam purple maize | Flint |
| **Check** |      |              |
| G9. PLU.C0 | Palu purple maize | Flint |
| G10. Pulut URI 1 | URI 1 | Flint |
Table 2. Environment of research and planting time

| Location                  | Altitude | Soil type | Ecology        | Planting time          |
|---------------------------|----------|-----------|----------------|------------------------|
| Dry season (2015)         |          |           |                |                        |
| L1. Maros, South Sulawesi | 5        | Entisol   | Normal field   | 25 Juli-20 Okt         |
| L2. Bajeng, South Sulawesi| 10       | Entisol   | Normal field   | 29 Jun-29 Sep          |
| L3. Polman regency, West  | 5        | Ultisol   | Protected forest | 4 Ags-5 Nop           |
|                           |          |           |                |                        |
| Rainy season (2016)       |          |           |                |                        |
| L1. Maros, South Sulawesi | 5        | Entisol   | Normal field   | 1 Feb-27 Apr           |
| L2. Bajeng, South Sulawesi| 10       | Entisol   | Normal field   | 29 Jan-6 Apr           |
| L3. Polman regency, West  | 5        | Ultisol   | Protected forest | 10 Feb-6 Mei         |
|                           |          |           |                |                        |
| L4. Donggala regency, Sulteng | 10 | Andosol   | Cacao field   | 3 uli-5 Okt           |
| L5. Muneng, Jatim         | 30       | Andosol   | Dry land       | 25 jun-29 Sep          |

Data be observed like: plant and ear height (cm), weight of cobs (kg), moisture content of seeds harvested (%) and yield component: length of cob (cm) diameter of cob (cm), weight of five cob and seed, weight 1000 seeds.

Yield was to conversion in kg/ha by CIMMYT formula:

\[
Yield\ (\frac{kg}{ha}) = \frac{10,000}{LP} \times \frac{100 - wc}{85} \times B \times 0.80
\]

Ka: seed water content
LP: production area
B: wet pooled cob weight
Wc: water content of seed harvested

3. Result and Discussion.

The yields under dry and wet season could be shown in (Table 3). Shown that candidate G1 (PMU(S1).Synth.F.C1) and G4 (PPU(S1).F.C1) was the highest yield respectively but the comparison variety has the lowest. The seed weight variable showed that there was a difference between the two candidates from 7.8 to 28.7%.

Table 3. Average yield under dry and rainy season 2015/2016

| Genotype                  | dry 2015 | rainy 2016 | Means |
|---------------------------|----------|------------|-------|
| **Candidate**             |          |            |       |
| G1. PMU(S1).Synth.F.C1    | 7.63 ab  | 6.31 b     | 6.97 ab |
| G2. PMU(S1).Synth.D.C1    | 6.97 ab  | 6.81 b     | 6.89 ab |
| G3. PPU.FS.C2             | 6.92 ab  | 6.25 b     | 6.59 ab |
| G4. PPU(S1).F.C1          | 6.93 ab  | 6.39 b     | 6.66 ab |
| G5. PPH.FS.C1             | 7.06 ab  | 6.16       | 6.61 ab |
| G6. PTU(S1).F.C1          | 7.11 ab  | 5.68       | 6.40 ab |
| G7. PTH(S1).F.C0          | 6.68 ab  | 5.79       | 6.24 ab |
| G8. PVU(S1).F.C0          | 5.76     | 5.87       | 5.82 ab |
| **Check**                 |          |            |       |
| G9. PLU.C0 (check 1)      | 4.73     | 5.79       | 5.26  |
| Genotype (G) | Maros exp. field | Bajengexp. field | Polman | Donggala | Munengexp. field | Means |
|-------------|------------------|------------------|--------|----------|------------------|-------|
| G1          | 8.48 ab          | 8.17 ab          | 7.51 ab| 8.47 ab   | 5.53 ab          | 7.63 ab|
| G2          | 7.65 ab          | 7.86 ab          | 6.69 ab| 7.29 b    | 5.37 ab          | 6.97 ab|
| G3          | 7.06 ab          | 7.91 ab          | 6.44 ab| 8.68 b    | 6.31 ab          | 6.92 ab|
| G4          | 7.46 ab          | 7.76 ab          | 7.87 ab| 5.97 b    | 5.56 ab          | 6.92 ab|
| G5          | 6.95 ab          | 7.57 ab          | 6.33 ab| 8.27 a    | 6.19 ab          | 7.06 ab|
| G6          | 7.40 ab          | 7.92 ab          | 6.30 ab| 7.36 b    | 6.59 ab          | 7.11 ab|
| G7          | 6.64 ab          | 6.62 ab          | 6.26 ab| 7.70 b    | 6.20 ab          | 6.68 ab|
| G8          | 5.64             | 5.60             | 5.32   | 5.20      | 7.05             | 5.76  |

**Check**

| Genotype (G) | Maros exp. field | Bajengexp. field | Polman | Donggala | Munengexp. field | Means |
|-------------|------------------|------------------|--------|----------|------------------|-------|
| G9          | 4.86             | 5.97             | 5.07   | 4.37     | 3.36             | 4.73  |
| G10         | 4.26             | 5.25             | 4.9    | 6.57     | 3.77             | 4.97  |

Average:

| Genotype (G) | Maros exp. field | Bajengexp. field | Polman | Donggala | Munengexp. field | Means |
|-------------|------------------|------------------|--------|----------|------------------|-------|
| G1          | 6.64             | 7.06             | 6.28   | 6.82     | 5.60             | 6.48  |
| G2          | 13.08            | 11.81            | 13.20  | 10.70    | 7.70             | 11.53 |
| G3          | 1.05             | 1.01             | 1.01   | 1.25     | 0.50             | 1.28  |
| G4          | 1.44             | 1.39             | 1.39   | 1.71     | 0.69             | 1.75  |

**Table 4.** The yield (t/ha) in five environment of lowland, dry season 2015

| Genotype (G) | Maros exp. field | Bajengexp. field | Polman | Donggala | Munengexp. field | Means |
|-------------|------------------|------------------|--------|----------|------------------|-------|
| G1          | 7.95 ab          | 7.28 b           | 6.94   | 3.73     | 5.65             | 6.31 b|
| G2          | 7.70 ab          | 9.01 a           | 6.76   | 2.36     | 8.24             | 6.81 b|
| G3          | 6.69             | 7.12 b           | 7.84 ab| 4.23     | 5.35             | 6.25 b|
| G4          | 7.96 ab          | 6.75             | 7.80 ab| 3.96     | 5.48             | 6.39 b|
| G5          | 6.97             | 7.36 ab          | 6.17   | 3.44     | 6.84             | 6.16  |
| G6          | 6.86             | 5.58             | 6.67   | 2.96     | 6.32             | 5.68  |
| G7          | 6.75             | 6.41             | 6.71   | 4.31     | 4.78             | 5.79  |
| G8          | 6.56             | 7.33 b           | 7.13   | 3.83     | 4.52             | 5.87  |

**Check**

| Genotype (G) | Maros exp. field | Bajengexp. field | Polman | Donggala | Munengexp. field | Means |
|-------------|------------------|------------------|--------|----------|------------------|-------|
| G9          | 5.80             | 6.02             | 5.93   | 5.04     | 6.18             | 5.79  |
| G10         | 5.88             | 6.18             | 6.16   | 3.22     | 5.45             | 5.38  |

Average:

| Genotype (G) | Maros exp. field | Bajengexp. field | Polman | Donggala | Munengexp. field | Means |
|-------------|------------------|------------------|--------|----------|------------------|-------|
| G1          | 6.91             | 6.90             | 6.81   | 3.71     | 5.88             | 6.04  |
| G2          | 12.62            | 9.04             | 17.19  | 16.98    | 15.47            | 13.86 |
| G3          | 1.49             | 1.28             | 1.39   | 1.86     | 1.86             | 1.43  |
| G4          | 2.05             | 2.16             | 2.06   | 2.85     | 2.14             | 1.96  |

**Table 5.** The yield (t/ha) in five environment of lowland rainy season 2016

a : significant different in LSD under 95% to check 1
b : significant different in LSD under 95% to check 2
3.1 Pooled analysis and yield stability
The anova of interaction by two factors GxE in rainy and dry season shown in Table 6 and 7. Interaction three factors GxExS in Table 6. Yield stability could be founded in Table 6. The interaction GxE was significant in rainy and dry season and could be assume that genotype of opv purple corn was significant different on yield variable in two season (Table 7). [5] reported significant interaction effect of GxE during the experiment.

### Table 6. Anova of interaction GxE under rainy season 2015 and dry season 2016

| Source of Variation | df  | S. S  | M. S  | F. calc. | Prob. |
|---------------------|-----|-------|-------|----------|-------|
| **Dry season**      |     |       |       |          |       |
| Environment (E)     | 4   | 38,419| 9,605 | 5,538**  | 0.012 |
| Replc/Environment (R/E) | 10  | 17,342| 1,734 | -        | -     |
| Genotype (G)        | 9   | 129,705| 14,412| 29,949** | 0.000 |
| Interaction (GxE)   | 36  | 60,739| 1,687 | 2,921**  | 0.000 |
| Error               | 90  | 51,988| 0,578 |          |       |
| **Total**           | 149 | 298,192|      |          |       |
| **Rainy season**    |     |       |       |          |       |
| Environment (E)     | 4   | 227,159| 56,790| 123,305  | 0.000 |
| Replc/Environment (R/E) | 10  | 4,606 | 0,461 | -        | -     |
| Genotype (G)        | 9   | 23,566| 2,618 | 2,466**  | 0.014 |
| Interaction (GxE)   | 36  | 75,858| 2,107 | 1,984    | 0.004 |
| Error               | 90  | 95,552| 1,062 |          |       |
| **Total**           | 149 | 426,740|      |          |       |

**: highly significant under level of 99%

Dry season
CV = 11.74%
Sy = 0,2404 (n=30)
Sy = 0,1962 (n=15) = 0,4388(n=3)

The interaction three factor GxExS was significant and be concluded that there are genotypes included check was founded difference yield on each environment under dry season and rainy season (Table 7).

### Table 7. Anova of interaction GxExS under rainy season 2015 and dry season 2016

| Source of Variation | df  | S. S  | M. S  | F. calc. | Prob. |
|---------------------|-----|-------|-------|----------|-------|
| **Season (S)**      | 1   | 14,096| 14,096| 17,197** | 0.000 |
| Environment (E)     | 4   | 207,350| 51,837| 63,242** | 0.000 |
| SxE                 | 4   | 50,228| 14,557| 17,759   | 0.159 |
| Replc/(SxE)         | 20  | 21,947| 1,097 | 1,338**  | 0.000 |
| Genotype (G)        | 9   | 110,776| 12,308| 15,016** | 0.000 |
| **Interaction**     |     |       |       |          |       |
| SxG                 | 9   | 42,494| 4,722 | 5,760**  | 0.000 |
| ExG                 | 36  | 83,246| 2,315 | 2,824**  | 0.006 |
| SxExG               | 36  | 53,525| 1,479 | 1,804    | 0.000 |
| Error               | 180 | 147,540| 0,820 |          |       |
| **Total**           | 299 | 739,028|      |          |       |

**: highly significant under level of 99%

CV = 14,46%
Sy= 0,074 (n=150)Sy= 0,116 (n=60)
Sy= 0,165 (n=30)Sy= 0,286 (n=10)Sy= 0,165 (n=30)Sy= 0,233 (n=15)
Sy= 0,369 (n= 6) Sy= 0,523 (n= 3)
In Table 8 founded that variable of yield (grain, wc: 15%) shown that genotypes of opv purple corn rejected of H1: β≠1, as long as could be selected for new candidate of new varieties opv (t-calc was significant), the slope of genotype G9.PLU.C0 was same with one. Two candidates (PMU9(S1). Syint.F.C1); PUM(S1)Sint.D.C1 and six non candidate indicates that genotypes have been stable in five environment under rainy and dry season, and could be reccommed that yield be increase if environment more suitable for all genotypes (Table 8). This two candidates have coefficient correlation r: 0.820 to 0.960. [6] that genotype would be recommend as new varieties if founded grain yield is more than check and coefficient of β1 = 1. [7], [8] shown genotype could be as variety which has β = 1 was significant different and grain yield is ore than total average, and β1< 1 was genotypes good adapted in marginal environment. In Table 7 and Table 8 shown that total means in rainy season: 6.04 tha and dry: 5.76 t/ha. The first candidate G1.PMU(S1).Synth.F.C1 on rainy grain yield 6.31 t/ha and dry 7. 39 t/ha, the second candidate G2.PMU(S1).Synth.D.C1 were 6.81 t/ha and 6. 78 t/ha. Check genotypes was not stable has β = 0 and yieldon rainy 6.04 t/ha and dry 5.76 t/ha.

### Table 8. Parameter of yield stability on opv purple corn under two season (rainy and dry), 2015/2016

| Genotypes      | r   | R²  | α   | β   | Se  | t_{calc} | Mse  |
|----------------|-----|-----|-----|-----|-----|----------|------|
| **Rainy season** |     |     |     |     |     |          |      |
| G1. PMU(S1).Synth.F.C1 | 0.960 | 0.937 | -0.804 | 1.177 | 0.177 | 1.003 | 0.234 |
| G2. PMU(S1).Synth.D.C1 | 0.887 | 0.789 | -3.430 | 1.695 | 0.511 | 1.360 | 1.961 |
| G3. PPU.FS.C2 | 0.900 | 0.810 | 0.648 | 0.929 | 0.260 | 0.273 | 0.508 |
| G4. PPU(S1).F.C1 | 0.928 | 0.860 | -0.480 | 1.138 | 0.265 | 0.521 | 0.527 |
| G5. PPH.FS.C1 | 0.920 | 0.846 | -0.242 | 1.050 | 0.261 | 0.224 | 0.511 |
| G6. PTU(S1).F.C1 | 0.905 | 0.819 | -0.691 | 1.054 | 0.286 | 0.188 | 0.614 |
| G7. PTH(S1).F.C0 | 0.894 | 0.800 | 1.226 | 0.755 | 0.218 | 1.122 | 0.358 |
| G8. PVU(S1).F.C0 | 0.890 | 0.792 | -0.384 | 1.035 | 0.306 | 0.115 | 0.706 |
| G9. PLU.C0 (check 1) | 0.820 | 0.673 | 4.190 | 0.265 | 0.107 | 6.873** | 0.086 |
| G10. Pulut URI 1 (check 2) | 0.929 | 0.978 | -0.025 | 0.893 | 0.078 | 1.366 | 0.048 |
| **Dry season** |     |     |     |     |     |          |      |
| G1. PMU(S1).Synth.F.C1 | 0.968 | 0.936 | -0.780 | 1.173 | 0.178 | 0.982 | 0.235 |
| G2. PMU(S1).Synth.D.C1 | 0.887 | 0.787 | -3.402 | 1.691 | 0.508 | 1.358 | 1.954 |
| G3. PPU.FS.C2 | 0.907 | 0.822 | 0.462 | 0.954 | 0.526 | 0.181 | 0.496 |
| G4. PPU(S1).F.C1 | 0.927 | 0.860 | -0.463 | 1.134 | 0.264 | 0.507 | 0.529 |
| G5. PPH.FS.C1 | 0.920 | 0.847 | -0.224 | 1.056 | 0.259 | 0.215 | 0.509 |
| G6. PTU(S1).F.C1 | 0.905 | 0.019 | -0.671 | 1.051 | 0.285 | 0.177 | 0.614 |
| G7. PTH(S1).F.C0 | 0.894 | 0.799 | 1.243 | 0.753 | 0.218 | 1.135 | 0.359 |
| G8. PVU(S1).F.C0 | 0.890 | 0.791 | -0.362 | 1.032 | 0.306 | 0.104 | 0.700 |
| G9. PLU.C0 (check 1) | 0.821 | 0.673 | 4.194 | 0.265 | 0.106 | 6.906** | 0.086 |
| G10. Pulut URI 1 (check 2) | 0.989 | 0.978 | -0.018 | 0.893 | 0.078 | 1.375 | 0.048 |

#### 3.2. Plant height and ear height

Means data under two seasons shown in Table 9, the two candidates G1. PMU(S1).Synth.F.C1 and G2. PMU(S1).Synth.F.C1 were highly significant to check G9. PLU.C0 saat MH and on dry season was not significant (Table 9). The average of ear height of two candidates were 94 dan 97 cm and not significant with check. The ideal of selection for ear height is middle thin plant height [9].
Table 9. Plant and ear height of opv genotypes, evt 2015-2016

| Genotype | Plant height, cm | Ear height, cm |
|----------|------------------|---------------|
|          | rainy | dry | means | rainy | dry | means |
| G1       | 191.6 a | 194.3 | 192.9 | 98.0 ab | 96.4 | 97.2 |
| G2       | 192.9 | 195.3 | 194.1 | 96.0 | 92.3 | 94.1 |
| G3       | 195.5 ab | 201.3 a | 198.4 | 87.8 | 94.5 | 91.2 |
| G4       | 198.4 ab | 198.5 | 198.5 | 90.4 | 94.7 | 92.6 |
| G5       | 194.9 ab | 189.9 | 192.4 | 96.0 b | 89.9 | 92.9 |
| G6       | 190.3 | 200.4 a | 195.4 | 94.0 b | 95.3 | 94.7 |
| G7       | 194.3 ab | 195.3 | 194.8 | 89.6 | 91.8 | 90.7 |
| G8       | 197.1 ab | 192.0 | 194.5 | 194.4 b | 94.2 | 94.3 |
| Check    |        |      |      |        |      |      |
| G9       | 181.9 | 190.5 | 186.2 | 89.0 | 95.0 | 92.0 |
| G10      | 181.1 | 199.1 | 190.1 | 83.0 | 98.6 | 90.8 |

Means
CV(%) 2.78 2.77 2.57 5.24 6.12 4.70
LSD 5% 9.16 9.31 8.56 8.25 ns 7.51
LSD 1% 12.54 12.75 11.73 11.30 ns 10.28

a : significant different in LSD under 95% to check 1
b : significant different in LSD under 95% to check 2
ns : not significant

The number of plant and ear harvested shown in Table 10. Analysis shown that there are significant plant and ear harvested in rainy season included means of data, in dry season two variable which observed not significant. The number of plant harvested 43 – 49 per se and ear harvested 53 under two candidates.

Table 10. Plant and ear harvested of opv genotypes, evt 2015-2016

| Genotype | Plant harvested | Ear harvested |
|----------|-----------------|---------------|
|          | rainy | dry | means | rainy | dry | means |
| G1       | 48.7 a | 44.9 | 46.8 | 51.9 | 59.5 | 50.7 |
| G2       | 48.3 | 43.7 | 46.0 | 53.5 a | 46.8 | 50.2 |
| G3       | 48.4 | 43.0 | 45.7 | 52.8 | 49.0 | 59.0 |
| G4       | 48.9 a | 44.9 | 46.9 | 52.6 | 48.9 | 50.8 |
| G5       | 49.2 a | 43.6 | 46.4 | 54.9 | 47.6 | 51.2 |
| G6       | 48.0 | 45.2 | 46.6 | 50.6 | 48.8 | 49.7 |
| G7       | 48.1 | 44.2 | 46.2 | 47.6 | 50.7 | 49.1 |
| G8       | 48.6 | 43.1 | 45.9 | 49.9 | 47.9 | 48.9 |
| Check    |        |      |      |        |      |      |
| G9       | 47.3 | 44.5 | 45.9 | 45.1 | 50.6 | 47.9 |
| G10      | 47.9 | 42.5 | 45.2 | 50.5 | 45.4 | 48.0 |

Means
CV(%) 2.76 1.44 1.62 5.26 4.15 5.72
LSD 5% 9.16 ns ns 8.25 ns ns
LSD 1% 12.54 ns ns 11.30 ns ns

a : significant different in LSD under 95% to check 1
b : significant different in LSD under 95% to check 2
ns : not significant

The weight cob to harvested and water content of seeds shown in Table 11. There are significant different of opv genotype in rainy and dry season included of means data. Two candidate were
superior compare to check and statistic test by LSD 95% was highly significant in rainy and dry season. Variable of water content shown was not significant between genotypes

Table 11. Weight of ear and water content of seeds harvested, evt2015-2016.

| Genotype | Weight of cob, kg | Water content, % |
|----------|------------------|------------------|
|          | rainy      | dry        | means | rainy      | dry        | means |
| G1       | 8.66 ab    | 7.25 b     | 7.96 ab | 30.4 | 28.4 | 29.4 |
| G2       | 7.93 ab    | 7.72 a     | 7.83 ab | 31.5 | 28.4 | 29.9 |
| G3       | 8.09 ab    | 7.26 b     | 7.68 ab | 31.9 | 27.9 | 29.9 |
| G4       | 8.10 ab    | 7.28 b     | 7.69 ab | 33.2 | 28.5 | 30.8 |
| G5       | 8.39 ab    | 6.91       | 7.65 ab | 32.7 | 27.9 | 30.2 |
| G6       | 8.25 ab    | 6.64       | 7.45 ab | 31.7 | 29.1 | 30.4 |
| G7       | 7.77 ab    | 6.68       | 7.23 ab | 31.8 | 27.8 | 29.8 |
| G8       | 6.81 a     | 6.75       | 6.78   | 31.9 | 28.2 | 30.0 |
| Check    |             |            |        |       |       |       |
| G9       | 5.99       | 6.50       | 6.04   | 31.7 | 28.4 | 30.0 |
| G10      | 6.09       | 6.12       | 6.10   | 32.2 | 28.0 | 30.1 |

CV(%) | 7.57 | 7.85 | 7.89 | 4.26 | 3.53 | 2.14 |
LSD 5% | 0.98 | 0.93 | 0.98 | tn   | tn   | tn   |
LSD 1% | 1.35 | 1.28 | 1.94 | tn   | tn   | tn   |

a : significant different in LSD under 95% to check 1
b : significant different in LSD under 95% to check 2
ns : not significant

3.3. Length and diameter of cobs
The first candidate G1 PMU(S1). Synt.D1.C1 more superior than two check but second candidate was not significant. The two candidate has length of cob 13-16 cm, and check 12-13 cm (Table 12).

Table 12. Length and diameter of cob, evt2015-2016

| Genotype | Length of cobs, cm | Diameter of cobs, cm |
|----------|--------------------|----------------------|
|          | rainy      | dry        | means | rainy      | dry        | means |
| G1       | 13.5       | 16.0       | 14.7   | 4.0 ab    | 4.3        | 4.1    |
| G2       | 13.8 a     | 15.7       | 14.8   | 4.1 ab    | 4.3        | 4.2    |
| G3       | 13.8 a     | 15.7       | 14.8   | 4.1 ab    | 4.3        | 4.2    |
| G4       | 13.7 a     | 15.5       | 14.6   | 3.9 ab    | 4.3        | 4.1    |
| G5       | 13.3       | 15.5       | 14.4   | 3.9 ab    | 4.3        | 4.1    |
| G6       | 14.8 ab    | 22.2 a     | 18.5 ab | 3.8 ab    | 4.3        | 4.1    |
| G7       | 13.2       | 16.0       | 14.6   | 3.9 ab    | 4.3        | 4.1    |
| G8       | 14.2 ab    | 15.4       | 14.8   | 3.8 ab    | 4.3        | 4.1    |
| Check    |             |            |        |           |            |        |
| G9       | 12.3       | 15.2       | 13.7   | 3.7       | 4.3        | 4.0    |
| G10      | 12.8       | 16.2       | 14.5   | 3.7       | 4.4        | 4.0    |

CV(%) | 5.47 | 14.15 | 8.15 | 4.15 | 2.72 | 2.69 |
LSD 5% | 1.27 | 6.77  | 2.09 | 0.28 | tn   | tn   |
LSD 1% | 1.74 | 9.27  | 2.86 | 0.38 | tn   | tn   |

a : significant different in LSD under 95% to check 1
b : significant different in LSD under 95% to check 2
ns : not significant
3.4. Sheeling percentage and weight of 1000 seeds.
Data and result of analysis could shown in Table 13. The candidate to observed were 77-79% and not significant with check. The weight 1000 seeds was significant in rainy season and not significant in dry season.

Table 13. Shelling percentage and weight of 1000 seeds, evt.2015-2016.

| Genotype | Shelling, % | Weight of 1000 seeds, g |
|----------|-------------|-------------------------|
|          | rainy       | dry         | means     | rainy       | dry         | means     |
| G1       | 79,3        | 77,5        | 78,4      | 307,7 ab    | 314,5      | 311,1     |
| G2       | 78,0        | 77,9        | 78,0      | 322,3 ab    | 305,1      | 313,7     |
| G3       | 76,4        | 76,3        | 76,3      | 292,0 ab    | 316,6      | 304,3     |
| G4       | 78,5        | 78,1        | 78,3      | 308,7 ab    | 322,7      | 315,7     |
| G5       | 77,4        | 78,3        | 77,9      | 292,0 ab    | 309,3      | 300,6     |
| G6       | 78,4        | 76,5        | 77,4      | 310,0 a     | 308,4      | 309,2     |
| G7       | 77,0        | 77,0        | 77,0      | 295,3 ab    | 318,8      | 307,0     |
| G8       | 78,9        | 77,3        | 78,1      | 312,8 ab    | 325,1      | 319,0     |
| Check    |             |             |           |            |            |           |
| G9       | 78,7        | 77,7        | 78,2      | 266,9       | 326,4      | 296,6     |
| G10      | 77,5        | 77,6        | 77,6      | 269,3       | 330,9      | 300,1     |
| CV(%)    | 1,3         | 1,51        | 1,00      | 4,22        | 4,57       | 5,65      |
| LSD 5%   | ns          | ns          | ns        | 21,56       | ns         | ns        |
| LSD 1%   | ns          | ns          | nn        | 29,53       | ns         | ns        |

a : significant different in LSD under 95% to check 1  
b : significant different in LSD under 95% to check 2  
ns : not significant

3.5. Evaluation of downy mildew
The result of screening could concluded that first candidate G1.PMU(S1).C1.Synth.F was middle to moderate under 29,8% on 30 days after planting and 30,5% on 40 days after planting. The second candidate was very susceptible >60,0%.

4. Conclusion
1. Population of opv purple corn PMU(S1).Synth.F.C1 and PMU(S1).Synth.D.C1 poduced higher yield (ranking 1 and 2), seed texture flint and average yield under rainy and dry season 6,80-6,85 t/ha, higher 50% than the best of check PLU.C0.
2. Yield stability shown coefficient of slope (β) =1 was significant and could be recommended that the two candidate would be increase if environment more suitable like land preparation, fertilrzer and full sun shine.
3. The screening of downy meldows of candidate G1.PMU(S1).C1.Synth.F was middle to moderate 29,8% on 30 days after planting and 30,5% on 40 days after planting.

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