Morphological observations for various DUS characters in crosses between trypsin inhibitor free and expressing soybean [Glycine max (L.) merrill.] genotypes

ST Pawale, VP Chimote and MP Deshmukh

Abstract

Among the fifteen plants DUS characters recorded ie twenty six F2, thirty four BC1:F1 and eleven BC2:F2 plants one of the promising F2 plants from Cross Phule Agrani × NRC 102 increase in 100 seed weight 14.14g over the parents 10.59g. In addition to reduced duration of flowering (42) days and maturity day (92) days (over parent Phule Agrani (54 days), (102), and NRC 102 days to flowering (32), days to maturity (92). BC1:F2 tili null allele expressing plants #5#31#38#48#29 from Phule Agrani × NRC 101 reduced flowering time (39) days to (45) days and maturity (99) days to (100) days and NRC 101 (30), (90) days. Cross Phule Agrani × NRC 102 reduced flowering time (42 to 45) days and days to maturity (98 to 99) days (#34#33#27). Cross Phule Kimya × NRC 101 (#37#58#59) reduced days to flowering (48 to 51) days and days to maturity (102 to 104) over the parents (55), (109) days and NRC (30) and (90) days with 100 seed weight (17.5g, 17g, 18g) and seed yield (19.2g, 19g, 20 g) seed yield per plant.

Keywords: Soybean, Kunitz trypsin inhibitor, null allele, DUS characters

Introduction

Soybean [Glycine max (L.) Merrill] is considered as “golden bean” due to its dual qualities viz; high protein (40%) and oil (18 to 20%) content. Its cultivation is rapidly expanding being an important source of edible oil with industrial applications; and partly due to its high nutritional values as food for both humans and livestock. The protein and oil account for 60% of the seed with about 30% carbohydrates. In addition, 100 g soybean contains 240 mg calcium, 690 mg phosphorus, 11.5 mg iron, 432 calories, 10.5g fats and 426 mg of vitamins (A, B and D) [Nagraj, 1995] [5]. The cultivated soybean [Glycine max (L.) Merrill] is a member of the family Fabaceae and sub family Papilionaceae. The Genus Glycine consists of two subgenera, Glycine and Soja (Moench) F.J. Herm. The subgenus Soja comprises the cultivated soybean [G. max (L.) Merrill] and its annual wild progenitor, G. soja Sieb and Zucc (also known G. ussuriensis).

The estimates of world soybean area, production and productivity for 2017-18 are 126.64 million ha, 346.31 million tons and 2.74 t/ha, against the 2016-17 figures of 121.10 million ha, 348.85 million tons and 2.88 t/ha (Anonymous, 2017b) [1]. Total soybean production in the world is 324.2 million tons, with the world largest soybean producers being USA (31.9%), Brazil (31.8%), Argentina (17.6%) China (3.8%) and India (3.6%) (Anonymous, 2017a) [1]. In 1960’s, 90% of global soybean export was destined from USA, which has gradually gone done to around 37% in recent years; with largest importers being China (44%) and European Union (22%). One of the major subjects of trade war between USA and China is the heavy duty on import of US soybean.

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Phule Agrani (KDS 344)</th>
<th>Phule Sangam (KDS 726)</th>
<th>Phule Kimya (KDS 753)</th>
<th>NRC-101</th>
<th>NRC-102</th>
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<tbody>
<tr>
<td>Pedigree</td>
<td>J5-335 × EC 241780</td>
<td>J5-9305 × EC 241780</td>
<td>J5 9305 × 241780</td>
<td>Ls-1 ×</td>
<td>Ls-1 ×</td>
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</tbody>
</table>

Table 1: Salient features and pedigree of parental material used for the present investigation
Soybean is predominantly self-pollinated crop in which pollination takes place before opening of flower. The healthy buds which are likely to open on next day morning were emasculation between 16.00 to 18.00 hrs and pollinated on next day morning (Carlson and Lersten, 1987) [4]. Staggered sowing at regular interval (3-6 days) was performed to insure matching of flowering time of parents used. Six crosses viz. Phule Agrani × NRC 101 (Cross I), Phule Agrani × NRC 102 (Cross II), Phule Sangam × NRC 101(Cross III), Phule Sangam × NRC 102 (Cross IV), Phule Kimya × NRC 101(Cross V) and Phule Kimya × NRC 102 (Cross VI) were effected in Summer 2017 and Kharif 2017 to produce the F1 Seeds. In early Kharif 2017, F1 were sown and F2 seeds were obtained. F2 seeds were sown in summer 2018. Backcrosses i.e. BC1F1 were made in Kharif 2017 and selfed in summer 2018 were obtained BC1F1 selfed seeds were sown in Kharif 2018 to get BC2F2 seeds within stipulated period. Individual plants were studied for different yield associated as well as DUS parameters for soybean.

Table 1: Details of generations raised in different seasons

<table>
<thead>
<tr>
<th>Year</th>
<th>Place</th>
<th>Season</th>
<th>Cross/self</th>
<th>Material obtained</th>
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<tr>
<td>2017</td>
<td>PGI, Botany, Research Farm, Rahuri.</td>
<td>Summer 2017</td>
<td>F1 × P1 and F1 × P2</td>
<td>6 F1: Obtained</td>
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<tr>
<td>2017</td>
<td>PGI, Botany, Research Farm, Rahuri.</td>
<td>Kharif 2017</td>
<td>F1: selfed seed + BC1F1 Selfed + BC1F1 × P1</td>
<td>6 F2 + BC1F1 selfed seed BC2F1 crossed seed</td>
</tr>
<tr>
<td>2018</td>
<td>PGI, Botany, Research Farm, Rahuri.</td>
<td>Summer 2018</td>
<td>BC1F1: Selfed BC1F1 selfed</td>
<td>BC1F2: and BC1F2 all selfed seed (not useful due to recessive gene )</td>
</tr>
<tr>
<td>2018</td>
<td>PGI, Botany, Research Farm, Rahuri.</td>
<td>Kharif 2018</td>
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</table>

Result and Discussion

Among the fifteen plants DUS characters recorded ie twenty six F2, thirty four BC1F1 and eleven BC1F2 plants one of the promising plants from cross Phule Agrani × NRC 102 increase in 100 seed weight (14.14) g over the parents (10.59) g. In addition to reduced duration of flowering (42) and maturity day (92) days (over parent Phule Agrani (54 days) (102 days), and NRC 101 (30), (90) and NRC 102 (32), (92). With main Kunitz trypsin inhibitor free plants validated by molecular marker. BC1F1 cross Phule Agrani × NRC 101 (#2,#21,#11) observed determinate growth habit flower colour white as like to NRC101 pod colour yellow days to maturity 97 days to flowering 39 to 45 similarly (#5,) plants. BC1F2 titi null allele exhibiting plants #5#31#38#48#29 from Phule Agrani × NRC 101 reduced flowering time 39 days to 45 days and maturity 99 days to 100 days similarly observed above mentioned characters cross Phule Agrani × NRC 102 reduced flowering time 42 days to 45 days and days to maturity (82 to 92) days (#34#39#827). Cross Phule Kimya × NRC 101 (#75#58#59) reduced days to flowering 48 to 51 days and days to maturity (102 to 104) over the parents (55, 109) days and NRC (30 and 90) days with 100 seed weight (17.5) g,(17) g, (18) g and seed yield (19.2) g (19) g (20) g seed yield per plant.

morphological observations where also recorded for various DUS characters total 15 as given in table (1 to 5) as specified by Ramteke et al. (2010) [6] in F2 and BC1F1 generation. Similar observations were also recorded for null homozygous recessive titi plants of BC1F2 populations.

Morphological observations of F2, BC1F1 and BC1F2

Morphological observations for 15 characters were recorded for twenty six F2, thirty four BC1F1 and promising homozygous recessive null KTI free 11 BC1F2 plants and are presented in Table 1 to Table 5. Among the twenty six F2 plants studied sixteen exhibited early flowering and maturity (all from Cross I, II, V and VI); however F2 from Phule Sangam (Cross III and IV) were late to flower and mature. Twenty Two (except 4 plants) from all crosses were determinate in growth habit. All F2 plants from all crosses had reduced plant height, however in plants from Cross I, II, V and VI height reduction was more severe (average of 22 cm) even as compared to dwarfed parents NRC101 (41 cm) and NRC102 (38 cm). Twelve F2 plants exhibited yellow seed hilum colour like the donor NRC parents, while rest 14 (including all from Cross VI) exhibited brown colour like recurrent parent. Sixteen F2 plants exhibited shiny seed lusture like donor NRC parents (including all from Cross-I and Cross-VI). Fourteen plants exhibited erect plant type (including all from Cross-I and V) like donor NRC parents (including all from Cross-I and Cross-VI). Fourteen plants exhibited erect plant type (including all from Cross-I and V) like donor NRC parents. Pods shattering was observed in 7 plants; while white coloured flowers were observed in four plants. Pod pubescence trait was absent in 15 plants. In BC1F1 generation, thirty four plants were studied, of which nine plants were early and 3 plants were medium in flowering. Ten plants exhibited early maturity; while 3 plants exhibited medium maturity. 16 plants exhibited maximum 100-seed weight, with all P. Agrani derived plants showing seed weight improvement. Thirteen plants were spherical in seed shape; while twenty two plants were having shiny seed lusture. Nine BC1F2 plants had erect plant habit with rest of them being semi-erect. Eight plants exhibited determinate growth habit. Five BC1F1 plants had white coloured flowers.

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Twenty one plants had yellow pod (with 5 having brown spots); 34 plants had brown pods (with 3 of them having black spots). 8 plants observed reduced plant height. In ten plants pod pubescence was absent. Among the eleven KTI free null allele possessing BC1F2 plants studied, all of them exhibited early flowering, with 8 plants had early maturity. All of them were determinate growth type and were semisecret; while nine of them exhibited reduced plant height. All of them had spherical seed shape with shiny seed lusture and with yellow seed hilum colour. Phule Agrani derived plants showed improvement of seed weight. All of them had non shattering pod. Eight plants had pointed leaf while three plants observed the round ovate; with lanceolate habit from NRC102.

### Table 3: Morphological details of BC1F2 plants compared with parents as per DUS characters.

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Cross Name</th>
<th>FL. Colour</th>
<th>Seed Colour</th>
<th>Pod pubescence</th>
<th>GT</th>
<th>Pod colour</th>
<th>D M</th>
<th>D F</th>
<th>100 SW</th>
<th>Seed Shape</th>
<th>Leaf Colour</th>
<th>Plant Ht.</th>
<th>Seed Hilum Colour</th>
<th>Seed Lust</th>
<th>Gr. Hab</th>
<th>Pod Shatter</th>
<th>Leaf Shape</th>
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<td>G</td>
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<td>Br/Bl</td>
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### Table 3: Contd……

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<th>Seed Colour</th>
<th>Pod pubescence</th>
<th>GT</th>
<th>Pod colour</th>
<th>D M</th>
<th>D F</th>
<th>100 SW</th>
<th>Seed Shape</th>
<th>Leaf Colour</th>
<th>Plant Ht.</th>
<th>Seed Hilum Colour</th>
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### Table 4: Morphological details of BC1F2 titti free plants compared with parents as DUS characters.

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<th>Plant No</th>
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<th>D to M</th>
<th>P H</th>
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<th>SYP</th>
<th>GT</th>
<th>SL</th>
<th>SS</th>
<th>SHL</th>
<th>Leaf Shape</th>
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<td>102</td>
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<td>Seed Colour</td>
<td>Pod pubescence</td>
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<td>Days Fl.</td>
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<td>Gy</td>
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<td>Gy</td>
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<td>P (Less)</td>
<td>Gy</td>
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**Phule Agrani x NRC 101**
- **Cross- 1 1** | Pu Yellow | P | Gy | D | Y | 92 | 42 | 11.8 | 28 | yellow | Shiny | Er | Non Sh | Ro |
- **Cross- 1 2** | Pu Yellow | P | Gy | D | Y | 97 | 44 | 11.8 | 22 | yellow | Shiny | Er | Non Sh | Ro |
- **Cross- 1 3** | Pu Yellow | P | Gy | ID | Y | 98 | 48 | 12 | 17 | Brown | Shiny | Er | Non Sh | Ro |
- **Cross- 1 21** | Pu Yellow | P | Gy | D | Y | 97 | 45 | 11.4 | 28 | Brown | Shiny | Er | Non Sh | Ro |
- **Cross- 1 27** | Pu Yellow | P | Gy | D | Y | 91 | 42 | 11.4 | 19 | yellow | Shiny | Er | Shattering | Ro |

**Phule Agrani x NRC 102**
- **Cross- 1 31** | Pu Yellow | A | Gy | D | Dy | 92 | 42 | 10.2 | 19 | yellow | Shiny | Er | Sh | Ro |
- **Cross- 1 32** | Pu Yellow | A | Gy | ID | Dy | 98 | 48 | 10 | 38 | Brown | Dull | Se | Non Sh | Po |
- **Cross- 1 5** | Pu Yellow | A | Gy | D | Dy | 92 | 42 | 15 | 18 | yellow | Shiny | Er | Sh | Ro |

**Phule Kimya x NRC 101**
- **Cross- V 111** | W Yellow | P | Gy | D | Br | 97 | 45 | 12.1 | 29 | yellow | Shiny | Er | Sh | Ro |
- **Cross- V 115** | Pu Yellow | P | Gy | D | Br | 96 | 48 | 10 | 13 | Brown | Dull | Er | Non Sh | Ro |
- **Cross- V 3** | Pu Yellow | P | Gy | D | Br | 94 | 47 | 16 | 17 | Brown | Dull | Er | Sh | Ro |

**C-V**

**C-VI**
- **Cross- VI 119** | W Yellow | A | -- | ID | Br Spot | 98 | 44 | 11.3 | 42 | Brown | Shiny | Se | Sh | Po |
- **Cross- VI 121** | W Yellow | A | -- | D | Br | 92 | 43 | 13 | 19 | Brown | Shiny | Er | Non Sh | Po |
- **Cross- V I 6** | Pu Yellow | P | Gy | D | Y | 94 | 44 | 16 | 21 | Brown | Shiny | Er | Non Sh | Ro |
- **Cross- VI 7** | W Yellow | A | -- | D | Y | 94 | 44 | 13 | 19 | Brown | Shiny | Se | Non Sh | Po |
- **Cross- VI 9** | Pu Yellow | A | -- | D | Y | 92 | 42 | 16 | 21 | Brown | Shiny | Er | Sh | Po |

**Phule Kimya x NRC 102**
- **Cross- III** | Pu yellow | A | -- | NA | 113 | 64 | 12.2 | 42 | Brown | Dull | se | Non Sh | Po |
- **Cross- III** | Pu yellow | A | -- | D | NA | 113 | 64 | 10 | 41 | yellow | Dull | se | Non Sh | Po |
- **Cross- III** | Pu yellow | A | -- | D | NA | 119 | 64 | 11 | 45 | Yellow | Dull | se | Non Sh | Po |
- **Cross- III** | Pu yellow | p | Gy | D | NA | 108 | 65 | 10 | 41 | yellow | Dull | Se | Non Sh | Ro |
- **Cross- III** | Pu yellow | p | Gy | ID | Yellow | 108 | 60 | 10.5 | 38 | yellow | Shiny | Se | Non Sh | Ro |

**Phule Sangam x NRC 101**
- **Cross- IV** | Pu yellow | p | Gy | D | NA | 108 | 63 | 13 | 50 | yellow | Shiny | Se | Non Sh | Po |
- **Cross- IV** | Pu yellow | A | Gy | D | NA | 113 | 63 | 11 | 40 | Yellow | Shiny | Se | Non Sh | Po |
- **Cross- IV** | Pu yellow | A | Gy | D | Na | 113 | 63 | 10.7 | 40 | Brown | Dull | Se | Non Sh | La |
- **Cross- IV** | Pu yellow | A | Gy | Not Available | NA | 113 | 63 | 12.2 | 35 | Brown | Dull | Er | Non Sh | Po |
- **Cross- IV** | Pu Yellow | A | Gy | NA | NA | 64 | 12 | 45 | Brown | Dull | Se | Non Sh | Po |

**Phule Sangam x NRC 102**

**Table 5: Contd…..**

**Reference**


