Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(6): 1082-1086
Received: 11-09-2019
Accepted: 15-10-2019

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

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Abstract
Among the fifteen plants DUS characters recorded *ie* twenty six F_2, thirty four BC_1F_1 and eleven BC_1F_2 plants one of the promising F_2 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 days), and NRC 102 days to flowering (32), days to maturity (92). BC_1F_2 *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 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) [3]. 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 1: Salient features and pedigree of parental material used for the present investigation

Genotype	Phule Agrani (KDS 344)	Phule Sangam (KDS 726)	Phule Kimya (KDS 753)	NRC-101	NRC-102
Pedigree	JS-335 × EC-241780	JS-9305 × EC-241780	JS 9305 × 241780	Lsb-1 × PI542044	Lsb-1 × PI542044
Developed by	ARS Kasbe Digraj M.P.K.V., Rahuri	ARS Kasbe Digraj, M.P.K.V., Rahuri	ARS Kasbe Digraj M.P.K.V., Rahuri	Indian Institute of Soybean Research, Indore	Indian Institute of Soybean Research, Indore
Release year	2015	2016	2017	2014	2014

Table 1: Contd…

Genotype	Phule Agrani (KDS 344)	Phule Sangam (KDS 726)	Phule Kimya (KDS 753)	NRC-101	NRC-102
Stem termination	Semi Determinate	Semi Determinate	Semi Determinate	Determinate	Determinate
Pod pubescence	Present	Present	Present	Present	Absent
Pubescence colour	Gray	Gray	Twany	Gray	Gray
Flower Colour	Purple	Purple	Purple	Purple	Purple
Days to flowering	54	60	55	30	32
Days to maturity	102	113	109	90	92
Seed size	Small	Bold	Bold	Bold	Bold
Germination	Good	Poor	Good	Good	Good
TiTi or (*titi*)	SKTI present	SKTI present	SKTI present	Null allele	Null allele

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 F_1 Seeds. In early *Kharif* 2017, F_1 were sown and F_2 seeds were obtained. F_2 seeds were sown in summer 2018. Backcrosses *i.e.* BC_1F_1 were made in *Kharif* 2017 and selfed in summer 2018 were obtained BC_1F_1 selfed seeds were sown in *Kharif* 2018 to get BC_1F_2 seeds within stipulated period. Individual plants were studied for different yield associated as well as DUS parameters for soybean.

Table 2: Details of generations raised in different seasons

Year	Place	Season	Cross/self	Material obtained
2017	PGI, Botany, Research Farm, Rahuri.	Summer 2017	$P_1 \times P_2$	$6F_1$ Obtained
2017	PGI, Botany, Research Farm, Rahuri.	*Kharif* 2017	$F_1 \times P_1$ and $P_1 \times P_2$	6 BC_1F_1crossed seed + $6F_1$ cross seed
2018	PGI, Botany, Research Farm, Rahuri.	Summer 2018	F_2 selfed seed + BC_1F_1 Selfed + BC_1F_1 x P_1	6 F_2 + BC_1F_1 selfed seed BC_2F_1 crossed seed
2018	PGI, Botany, Research Farm, Rahuri.	*Kharif* 2018	BC_1F_2 Selfed BC_2F_1 selfed	,BC_1F_2 and BC_2F_1 all selfed seed (not useful du to recessive gene)

Result and Discussion

Among the fifteen plants DUS characters recorded *ie* twenty six F_2, thirty four BC_1F_1 and eleven BC_1F_2 plants one of the promising plants from crosss 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. BC_1F_1 cross Phule Agrani × NRC 101 (#2,#21,#11) observed determinate growth habit flower colour white as like to NRC 101 pod colour yellow days to maturity 97 days days to flowering 39 to 45 similarly (#5,) plants. BC_1F_2 *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 simirly observed above mentioned characters 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 (17.5) 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 F_2 and BC_1F_1 generation. Similar observations were also recorded for null homozygous recessive *titi* plants of BC_1F_2 populations.

Morphological observations of F_2, BC_1F_1 and BC_1F_2

Morphological observations for 15 characters were recorded for twenty six F_2, thirty four BC_1F_1 and promising homozygous recessive null KTI free 11 BC_1F_2 plants and are presented in Table 1 to Table 5.

Among the twenty six F_2 plants studied sixteen exhibited early flowering and maturity (all from Cross I, II, V and VI); however F_2 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 F_2 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 F_2 plants exhibited yellow seed hilum colour like the donor NRC parents, while rest 14 (including all 5 from Cross VI) exhibited brown colour like recurrent parent. Sixteen F_2 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 the 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 BC_1F_1 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 BC_1F_1 plants had erect plant habit with rest of them being semi-erect. Eight plants exhibited determinate growth habit. Five BC_1F_1 plants had white coloured flowers.

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 pubencensce was absent.

Among the of eleven KTI free null allele possessing BC_1F_2 plants studied, all of them exihibited early flowering, with 8 plants had early maturity. All of them were determinate growth type and were semisecret; while nine of them exihibited 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 BC_1F_1 plants compared with parents as per DUS characters.

Sr. no	Cross Name	Fl. Colour	Seed Colour	Pod pubsecnce	Pod pub. Colour	GT	Pod colour	D M	D F	100 SW	Seed Shape	Leaf Colour	Plant Ht.	Seed Hilum Colour	Seed Lust	Gr. Hab	Pod Shatter	Leaf Shape
P1	P. Agrani	Pu	Y	P (less)	Gy	ID	Y	102	54	10.6	Eliptical	G	77.6	Brown	Dull	se	Non Sh	Ro
P2	P. Sangam	Pu	Y	P (less)	Gy	ID	Br	113	58	17.6	Eliptical	G	80.7	Brown	Dull	se	Non Sh	L
P3	P. Kimya	Pu	Y	P (less)	Gy	ID	Br/Bl	109	55	16.5	Eliptical	Dg	92	Brown	Dull	Se	Non Sh	Ro
P4	NRC-101	W/LP	Y	A	--	D	Br	90	30	14.6	Spherical	Dg	41	Yellow	Shiny	Er	Non Sh	Ro
P5	NRC-102	Pu	Y	A	--	D	Y	91	32	17.47	Spherical	Dg	38	Yellow	Shiny	Er	Non Sh	Po
1	Cross-I	Pu	Y	P (less)	Gy	ID	Y	103	53	11.4	Spherical	G	60	Yellow	Shiny	Se	Non Sh	Ro
2	Cross-I	Pu	Y	A	--	D	Y	97	45	16	Spherical	Dg	26	Brown	Shiny	Er	Non Sh	Po
3	Cross-I	Pu	Y	P (Less)	Gy	ID	Y	103	53	19.4	Spherical	G	62	Yellow	Shiny	Se	Non Sh	Ro
4	Cross-I	Pu	Y	P (less)	Gy	ID	Y	103	53	--	Eliptical	G	50	Yellow	Shiny	Se	Non Sh	Ro
5	Cross-II	Pu	Y	A	--	D	Y	92	42	14	Spherical	Dg	19	Brown	Shiny	Er	Non Sh	Po
6	Cross-II	Pu	Y	A	--	ID	Y	98	53	14	Spherical	Dg	47	Brown	Dull	Er	Non Sh	Po
9	Cross-III	Pu	Y	P (Less)	Gy	ID	Y & Br Spot	116	59	14	Eliptical	G	60	Yellow	Shiny	Se	Non Sh	L
10	Cross-III	Pu	Y	P (Less)	Gy	ID	Y & Br Spot	116	61	--	Eliptical	G	50	Brown	Shiny	Se	Non Sh	L
11	Cross-I	W	Y	A	--	D	Y	97	39	10	Spherical	Dg	42	Brown	Shiny	Er	Non Sh	Po
21	Cross-I	W	Y	A	--	D	Y	100	43	12.6	Sherical	Dg	32	Yellow	Shiny	Er	Non Sh	Po
23	Cross-II	Pu	Y	A	--	ID	Y	101	53	10.3	Eliptical	G	60	Brown	Dull	Se	Non Sh	Ro
24	Cross-II	Pu	Y	A	--	D	Y	94	44	12	Spherical	Dg	36	Brown	Shiny	Er	Non Sh	Po
25	Cross-II	Pu	Y	P	Gy	ID	Y	100	48	12	Spherical	G	90	Gray/ yellow	Shiny	Se	Non Sh	L
36	Cross-VI	Pu	Y	P (Less	Gy	ID	Y	113	60	12	Eliptical	G	40	Yellow	Dull	Se	Non Sh	L
38	Cross-VI	Pu	Y	P (Less)	Gy	ID	Y	113	60	11.4	Eliptical	G	74	Yellow	Shiny	Se	Non Sh	L
39	Cross-VI	Pu	Y	P	Gy	ID	Y	113	60	11	Eliptical	G	70	Yellow	Shiny	Se	Non Sh	L
40	Cross-VI	Pu	Y	P (Less)	Gy	ID	Br spot	113	62	14	Eliptical	G	97	Yellow	Dull	Se	Non Sh	L
41	Cross-VI	Pu	Y	P (Less)	Gy	ID	Y &Br Spot	112	60	15	Eliptical	G	76	Brown	Dull	Se	Non Sh	L

Table 3: Contd……

Sr. no	Cross Name	Fl. Colour	Seed Colour	Pod pubsecnce	Pod pub. Colour	GT	Pod colour	D M	D F	100 SW	Seed Shape	Leaf Colour	Plant Ht.	Seed Hilum Colour	Seed Lust	Gr. Hab	Pod Shatter	Leaf Shape
42	Cross-VI	Pu	Y	P (less)	Gy	ID	Y	113	61	14	Eliptical	G	60	Brown	Shiny	Se	Non Sh	L
43	Cross-VI	Pu	Y	P (Less)	Gy	ID	Y	113	62	10.3	Eliptical	G	90	Brown	Dull	Se	Non Sh	L
46	Cross-VI	Pu		P (Less)	Gy	ID	Y & Br spot	113	62	14.5	Eliptical	G	90	yellow	Dull	Se	Non Sh	L
48	Cross-V	W	Y	A	--	D	Br & Bl spot	96	44	9	Eliptical	Dg	21	yellow	Dull	Er	Non Sh	Po
49	Cross-V	W	Y	A	--	D	Br & Bl spot	92	39	20	Spherical	Dg	23	Brown	Shinny	Er	Non Sh	Po
50	Cross-V	W	Y	A	--	D	Br & Bl spot	100	48	13	Eliptical	Dg	30	Yellow	Shiny	Er	Non Sh	Po
51	Cross-V	Pu	Y	P (Less)	Gy	ID	Br	109	54	16	Sphrical	G	60	Yellow	Shiny	Se	Non Sh	Ro
52	Cross-V	Pu	Y	P (Less)	Gy	ID	Br	109	56	14.8	Spherical	G	60	yellow	Shiny	Se	Non Sh	Ro
53	Cross-V	Pu	Y	P Less)	Gy	ID	Br	109	59	14.2	Eliptical	G	48	Brown	Dull	Se	Non Sh	Ro
54	Cross-VI	Pu	Y	P (Less)	Gy	ID	Br	104	54	16.3	Eliptical	G	42	Brown	Shiny	Se	Non Sh	Ro
55	Cross-VI	Pu	Y	P (Less)	Gy	ID	Br	104	54	13	Eliptical	Dg	30	Brown	Dull	Se	Non Sh	Ro
56	Cross-VI	Pu	Y	P (Less)	Gy	ID	Br	104	54	16	Eliptical	G	60	Brown	Shiny	Se	Non Sh	Ro
57	Cross-VI	Pu	Y	P (Less)	Gy	ID	Br	109	59	16.9	Eliptical	G	30	Brown	Dull	Se	Non Sh	Ro
58	Cross-VI	Pu	Y	P (Less)	Gy	ID	Br	109	53	19	Eliptical	G	42	Brown	Dull	se	Non Sh	Ro
59	Cross-VI	Pu	Y	P (less)	Gy	ID	Br	109	58	15.6	Spherical	G	60	Brown	Shiny	Se	Non Sh	Ro
60	Cross-VI	Pu	Y	P (less)	Gy	ID	Br	109	53	13.9	Eliptical	G	68	Yellow	Shiny	se	Non Sh	Ro

Table 4: Morphological details of BC_1F_2 *titi* free plants compared with parents as DUS characters.

Plant No	D to F	D to M	P H	100 sed wt	SYP	GT	SL	SS	SHL	Leaf Shape	Gr. Hab	Pod Shatter
P. Agrani	54	102	74	10.59	15.59	ID	Dull	Eliptical	Brown	Ro	Se	Non Sh
P. Sangam	60	113	74	17.57	18	ID	Dull	Eliptical	Brown	Po	Se	Non Sh
P. Kimya	55	109	72	16.47	17.34	ID	Dull	Eliptical	Brown	Ro	Se	Non Sh
NRC 101	30	90	41	18.2	16	D	Shiny	Spherical	Yellow	Po	Er	Sh
NRC 102	32	92	38	17.27	18	D	Shiny	Spherical	Yellow	Po	Er	Sh
F_2 #21	48	97	28	11.38	13	D	Shiny	Spherical	Yllow	Po	Er	Non Sh

F_2 #31	42	92	11	14.14	15	D	Shiny	Spherical	Yellow	Po	Semi Er	Non Sh
F_3#1	32	98	43	18	65	D	Shiny	Spherical	yellow	Po	Semi Er	Non Sh
F_4 #4	38	99	40	19.57	43.3	D	Dull	Sperical	yellow	Po	Semi Er	Non Sh
BC_1F_2 #5	45	101	55	12.7	15.6	D	Shiny	Spherical	Yellow	Po	Semi Er	Non Sh
BC_1F_2#29	40	99	50	11.9	15	D	Shiny	Sperical	Yellow	Po	Semi Er	Non Sh
BC_1F_2#31	45	100	45	12	16	D	Shiny	Spherical	Yellow	Po	Semi Er	Non Sh
BC_1F_2#38	40	99	40	12.5	14	D	Shiny	Spherical	Yellow	Po	Semi Er	Non Sh
BC_1F_2#48	39	100	45	12.7	15	D	Shiny	Spherical	Yellow	Po	Semi Er	Non Sh
BC_1F_2#27	42	99	50	11.5	16	D	Shiny	Spherical	Yellow	Po	Semi Er	Non Sh
BC_1F_2#33	42	98	45	12	15	D	Shiny	Spherical	yellow	Po	Semi Er	Non Sh
BC_1F_2#34	45	99	50	11.9	14	D	Shiny	Sphrical	yellow	Po	Semi Er	Non Sh
BC_1F_2#37	50	103	70	17.5	19.2	D	Shiny	Spherical	yellow	Ro	Semi Er	Non Sh
BC_1F_2#58	51	104	68	17	19	D	Shiny	Sphericcal	yellow	Ro	Semi Er	Non Sh
BC_1F_2#59	48	102	70	18	20	D	Shiny	Spherical	yellow	Ro	Semi Er	Non Sh

Table 5: Morphological Details of F_2 Plants Compared with Parents As Per Dus Characters.

Cross Name	Flr Colour	Seed Colour	Pod pubsecnce	Pod pub. Colour	GT	Pod colour	Days Mat.	Days Fl.	100 Seed Wt	Plant Ht.	Seed Hilum Colour	Seed Lust	Gr. Hab	Pod Shatter	Leaf Shape
P1 P.Agrani	Pu	Yellow	P (less)	Gy	ID	Y	102	54	10.6	74	Brown	Dull	Se	Non Sh	Ro
P2 P.Sangam	Pu	Yellow	P (less)	Gy	ID	Br	113	60	17.6	74	Brown	Dull	Se	Non Sh	Po
P3 P.Kimya	Pu	Yellow	P (Less)	Gy	ID	Br/Blakish	109	55	16.5	72	Brown	Dull	Se	Non Sh	Ro
P4 NRC-101	W/Pu	Yellow	P (less)	Gy	D	Y/Br	90	30	14.6	41	Yellow	Shiny	Er	Sh	Po
P5 NRC-102	Pu	Yellow	Less	Gy	D	Y	90	32	17.3	38	Yellow	Shiny	Er	Sh	Lan
C-I	**Phule Agrani x NRC 101**														
Cross- I 1	Pu	Yellow	P	Gy	D	Y	92	42	11.8	28	yellow	Shiny	Er	Non Sh	Ro
Cross- I 2	Pu	Yellow	P	Gy	D	Y	97	44	11.8	22	yellow	Shiny	Er	Non Sh	Ro
Cross- I 3	Pu	Yellow	P	Gy	ID	Y	98	48	12	17	Brown	Shiny	Er	Non Sh	Ro
Cross-I 21	Pu	Yellow	P	Gy	D	Y	97	45	11.4	28	Brown	Shiny	Er	Non Sh	Ro
Cross- I 27	Pu	Yellow	P	Gy	D	Y	91	42	11.4	19	yellow	Shiny	Er	Shatering	Ro
C-II	**Phule Agrani x NRC 102**														
Cross- II 31	Pu	Yellow	A	Gy	D	DY	92	42	10.2	19	yellow	Shiny	Er	Sh	Ro
Cross- II 32	Pu	Yellow	A	Gy	ID	DY	98	48	10	38	Brown	Dull	Se	Non Sh	Po
Cross- II 5	Pu	Yellow	A	Gy	D	DY	92	42	15	18	yellow	Shiny	Er	Sh	Lan
C-V	**Phule Kimya x NRC 101**														
Cross V 111	W	Yellow	P	Gy	D	Br	97	43	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

Table 5: Contd…..

Cross Name	Flr Colour	Seed Colour	Pod pubsecnce	Pod pub. Colour	GT	Pod colour	Days Mat.	Days Fl.	100 Seed Wt	Plant Ht.	Seed Hilum Colour	Seed Lust	Gr. Hab	Pod Shatter	Leaf Shape
C-VI	**Phule Kimya x NRC 102**														
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-VI 6	Pu	Yellow	P	Gy	D	Y	95	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
Cross-III	**Phule Sangam x NRC 101**														
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 Br Spot	108	60	10.5	38	yellow	Shiny	Se	Non Sh	Ro
Cross-III	**Phule Sangam x NRC 102**														
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	N A	NA	NA	64	12	45	Brown	Dull	Se	Non Sh	Po

Reference

1. Anonymous, World Soybean Production by the Soybean Processors Association of India, 2017a.
2. Anonymous, Survey of Soybean Crop - Kharif 2017 by the Soybean Processors Association of India. http://www.sopa.org/news/survey-of-soybean-crop-

Kharif-Anonymous, www.ncbi.n/nih.gov/Taxonomy/Browsers, 2017c.
3. Anoymous. Annual Report 2017-18 by Indian Council of Agriculture Research and National Research Centre on Soybean, Indore, 2017b.
4. Carlson JB, Lersten NR. Reproductive morphology in Soybeans: Improvement production and uses. Wilcox JR. ed. American Society of Agronomy Monograph series no 1b, Madison, Wisconsin, USA, 1987, 95-134.
5. Nagraj G. Quality and utility of oilseeds. Directorate of Oilseeds Research Publication (ICAR) Rajendranagar, Hyderabad. 1995, 36-40.
6. Ramteke R, Kumar V, Murlidharan P, Agarwal AK. Study on genetic variability and traits interrelationship among released soybean varieties of India [*Glycine max* (L.) Merrill] Electronic Journal of Plant Breeding. 2010; 1(6):1483-1487.